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The effectiveness of app-based dialogic reading on children's speech delay

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ABSTRACT

The prevalence of speech delay in early childhood continues to increase which correlates with high passive screen time and lack of parent-child responsive verbal interaction. This study aims to test the effectiveness of application-based 'dialogic reading' interventions on improving children's expressive language skills with speech delay indications. The research method uses a quantitative approach with a quasi-experimental pretest-posttest control group design. The sample consisted of 34 children aged 3-5 years with speech delay divided into experimental groups and control groups. The experimental group received an intervention of dialogic reading application for 15 minutes per day for 8 weeks. The measurement instrument used the Early Language Milestone Scale-2 (ELMS-2) and an interaction observation sheet. Data analysis was conducted using Independent Sample T-Test and N-Gain Score. The results showed a significant difference ($p < 0.001$) with the experimental group's N-Gain of 0.71 (high category) higher than that of the control group of 0.32 (medium category). The conclusions showed that application-based dialogic reading was effective in improving vocabulary, Mean Length of Utterance (MLU), and verbal responsiveness as a parent-mediated intervention model.



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Introduction

Expressive language development at the age of 3-5 years is the main predictor of children's cognitive and academic success. In this phase, children should ideally have mastered 900-1500 vocabulary and are able to string sentences with a Mean Length of Utterance (MLU) of 3-4 words (Salsabilla et al., 2023); (Capone Singleton, 2024). However, global data shows that the prevalence of speech delay is still high. Al-Qahtani et al. reported that 5-10% of preschool children experience speech delays (Al-Qahtani, 2025), while in Indonesia there is a 30% increase after the pandemic (Oktariani, 2022). This condition is in line with the findings of Nurkhamidah and also Siti Aminah & Ratnawati that speech delay is a disorder that inhibits children's ability to express ideas verbally (Nurkhamidah et al., 2024); (Aminah & Ratnawati, 2022).

The causative factors of speech delay are multifactorial. Madigan and McArthur's meta-analysis study proved that every additional 30 minutes of passive screen time increases the risk of language delay by up to 49% (Madigan, 2022); (McArthur, 2023). This is reinforced by Brushe and Massaroni who found that passive screen time replaces essential parent-child reciprocity interactions (Brushe, 2024); (Massaroni, 2023). Meanwhile, Ghaisani and Angraeni in the Indonesian context emphasized that less responsive parenting and uncontrolled

exposure to gadgets are the main determinants (Ghaisani et al., 2022); (Angraeni, 2024). In addition, factors such as home environment (Law, 2022), parenting stress (Lei et al., 2026), quality of language input (Cartmill, 2022) and nutritional factors such as iron and vitamin D deficiencies (Mondal, 2024) also contribute to speech delays.

The impact of unintervened speech delay is long-term. Walquist-Sørli in a systematic review proved that children with speech delay are 3.5 times more likely to have reading difficulties (Walquist-Sørli, 2025). Sansavini and Whitehouse et al. (2024) in a 20-year longitudinal study showed that early language delay correlates with low literacy and social competence in adolescents (Sansavini, 2022). Suttora's findings also emphasize the importance of joint attention and expressive language predictors as foundations of development (Suttora, 2022). Therefore, early detection is crucial (Singleton & Saks, 2023).

Existing interventions still have limitations. Conventional speech therapy in clinics requires high costs and limited experts (Perdina & Prisuna, 2024). Teachers' strategies in inclusive schools are still conventional (Pujianti et al., 2023), while media such as audio flashcards (Febrianti et al., 2024) and ABA therapy (Noorhayana, 2025) have not been integrated with the role of parents. On the other hand, parent-implemented interventions have proven to be the most effective. Roberts & Kaiser's meta-analysis showed that parent-mediated interventions had a higher effect size than therapists (Roberts & Kaiser, 2023). Romeo even proved neurologically that parent-child conversations increase language brain activation (Romeo, 2023);

One of the most evidence-based parent-mediated methods is dialogic reading. Heidlage in a meta-analysis in *Early Childhood Research Quarterly* reported that dialogic reading increased expressive vocabulary with an effect size of 0.72 through PEER (Prompt, Evaluate, Expand, Repeat) and CROWD (Heidlage, 2024) techniques. However, conventional implementations are often inconsistent because parents have difficulty applying these techniques. In the digital era, the transformation of dialogic reading into interactive applications is a solution. Dykstra and DeVeney proved that technology-assisted intervention and telepractice increased engagement by 65% and were effective as therapeutic accompaniments (Dykstra, 2023); (DeVeney, 2022). Handhika in a scoping review in Indonesia emphasized the potential of AI for speech delay intervention, but its implementation is still limited (Handhika, 2025).

It was found from a review of the various literature. First, the population gap: research in Indonesia is still in the form of case studies (Nurkhamidah et al., 2024) or descriptive (Salsabilla et al., 2023), there have been no experiments on children with diagnosed speech delay. Second, the intervention gap: previous studies using print media or audio flashcards (Febrianti et al., 2024), have not integrated dialogic reading with applications that automatically guide parents. Third, the methodology gap: there have been no studies that have tested effectiveness with the ELMS-2 standard instrument and measured MLU and responsiveness simultaneously in the control design. Ayuso recommends a structured intervention model post-COVID-19 (Ayuso-Lanchares, 2024).

Based on this gap, the novelty of this research lies in the development of an application-based dialogic reading model that automates PEER/CROWD prompts and integrates parent-mediated therapy principles. This study aims to test the effectiveness of the intervention on the improvement of expressive language of children with speech delays. The results are expected to be an affordable, fun, and sustainable intervention model.

Method

Research Design

This study uses a quantitative approach with a quasi-experimental pretest-posttest control group design (Ghaisani et al., 2022). This design was chosen because it allows testing the effectiveness of the intervention without conducting full randomization, which is ethical for the child population with speech delay indications (Salsabilla et al., 2023). The study was conducted over 8 weeks of intensive intervention to comprehensively look at expressive language changes.

Population and Sample

The population in this study was children aged 3-5 years with indications of speech delay. The operational definition of speech delay refers to Siti Aminah & Ratnawati, namely the delay in expressive language skills under the chronological age (Aminah & Ratnawati, 2022). The sample of 34 children was divided into 17 children in the experimental group and 17 children in the control group, according to the inclusion criteria in the Febrianti study. (Febrianti et al., 2024).

The sampling technique used purposive sampling with inclusion criteria: (a) age 36-60 months, (b) ELMS-2 score below the late cut-off, (c) no hearing loss and autism, (d) parents have a smartphone and are willing to participate in the program. The exclusion criteria are children who are undergoing other intensive speech therapy

(Perdina & Prisuna, 2024). The total sample of 34 is considered adequate for an experimental test of early childhood education (Pujiati et al., 2023).

Research Variables

The independent variable is an application-based dialogic reading intervention. The dependent variable is an expressive language ability that includes three indicators: (1) vocabulary mastery, (2) Mean Length of Utterance (MLU), and (3) verbal responsiveness (Angraeni, 2024). The control variables are passive screen time and parenting, which are measured as covariates according to the findings of Ghaisani and Oktariani (Ghaisani et al., 2022); (Oktariani, 2022).

Research Instruments

The main instrument uses the Early Language Milestone Scale-2 (ELMS-2) which has been adapted for the Indonesian context with a Cronbach Alpha reliability of 0.87 (Nurkhamidah et al., 2024). ELMS-2 measures both receptive and expressive aspects of language. The second instrument is an observation sheet of parent-child interaction adopted from the Whitehurst dialogic reading model with a modification of the PEER (Prompt, Evaluate, Expand, Repeat) indicator (Febrianti et al., 2024). Observations were made by two independent observers with an inter-rater reliability of Kappa of 0.82.

The dialogic reading application was developed with the following features: (a) interactive picture stories, (b) CROWD (Completion, Recall, Open-ended, Wh-questions, Distancing) automatic prompts, (c) children's voice recorders to measure MLU, and (d) vocabulary development dashboard (Noorhayana, 2025). Application validation was carried out by PAUD material experts and educational technologists with an Aiken V score of 0.89 in the high valid category.

Research Procedure

The research procedure consists of three stages. The preparation stage includes initial screening using ELMS-2 and screen time interviews with parents (Oktariani, 2022). Implementation stage: the experimental group was given parent-mediated therapy training for 2 sessions on dialogic reading techniques (Perdina & Prisuna, 2024). The intervention was carried out 15 minutes per day for 8 weeks at home with parental assistance. Each session, the application will provide 5-7 dialogical prompts and parents are asked to expand and repeat. The control group received conventional reading activities without dialogical prompts as is common practice in early childhood education (Pujiati et al., 2023).

To maintain fidelity, the researcher conducted weekly monitoring through application data logs and short videos of interactions uploaded by parents. This is in line with the principle of parent-implemented intervention that emphasizes consistency (Angraeni, 2024).

Data Analysis Techniques

Data analysis used two stages. First, the prerequisite test included the Shapiro-Wilk normality test and the Levene homogeneity test. Second, the hypothesis test used the Independent Sample T-Test to see the difference in gain scores between the experimental and control groups (Ghaisani et al., 2022). To see the level of effectiveness, the N-Gain Score was used with the formula $(\text{posttest-pretest})/(\text{ideal-pretest score})$ with the high category >0.7 , medium $0.3-0.7$, low <0.3 (Febrianti et al., 2024). The MLU analysis was carried out in a quantitative descriptive manner by calculating the average speech length from the application recording. All analyses were conducted with the help of SPSS 26 with a significance level of $p < 0.05$.

This research has fulfilled research ethics with informed parental consent and maintaining the confidentiality of children's data according to the principles of early childhood research (Salsabilla et al., 2023).

Results and Discussions

Description of Initial Data

The sample characteristics showed age and gender homogeneity. The average age of the experimental group was 49.2 months and the control was 48.7 months. The ELMS-2 pretest scores of the experimental group were 42.15 (SD=5.21) and the control 41.88 (SD=5.43), which indicated that both were in the category of mild-moderate speech delay (Salsabilla et al., 2023). The results of the Shapiro-Wilk normality test showed that the data were normally distributed ($p=0.342$ experiments; $p=0.287$ controls) and the Levene test were homogeneous ($p=0.412$), making it feasible to conduct a parametric test (Ghaisani et al., 2022).

Effectiveness on Expressive Language Skills

The results of the Independent Sample T-Test showed a significant difference in ELMS-2 gain score between the two groups ($t=7.842$, $p<0.001$). The average posttest of the experimental group increased to 78.41

(SD=6.12), while the control group was only 58.32 (SD=5.89). This finding is in line with Febrianti who reported that digital media significantly increased the vocabulary of speech delay children (Febrianti et al., 2024).

The N-Gain Score analysis strengthened these findings. The experimental group obtained an N-Gain of 0.71 in the high category, while the control group obtained a 0.32 moderate category. This value of 0.71 exceeded the high effectiveness threshold set in language intervention studies (Pujiati et al., 2023). This proves that the duration of 15 minutes/day for 8 weeks is effective, in contrast to conventional interventions that require a longer duration (Perdina & Prisuna, 2024).

Table 1. Comparison of N-Gain Expressive Language Ability

Groups	Pretest	Posttes	N-Gain	Category
Eksperimen	42,15	78,41	0,71	Tinggi
Control	41,88	58,32	0,32	Sedang

Improvement of Specific Indicators: Vocabulary, MLU, and Responsiveness

In detail, improvements occurred in three indicators. First, expressive vocabulary. The experimental group experienced an average addition of 112 new words, much higher than the 48-word control. Second, the Mean Length of Utterance (MLU). The experimental group's MLU increased from 1.8 to 3.4 words per utterance, while the control from 1.7 to 2.2. Third, verbal responsiveness measured through observation sheets increased from 2.1 to 4.3 responses per reading session in the experimental group. This confirms that dialogic reading transforms children from passive listeners to active storytellers (Angraeni, 2024).

Why App-Based Dialogic Reading is More Effective.

The high effectiveness of the experimental group can be explained through three mechanisms. First, the automated prompt mechanism. This application automates the PEER and CROWD techniques thereby minimizing parental inconsistency. Heidlage in a meta-analysis in *Early Childhood Research Quarterly* proved that parent-implemented dialogic reading had an effect size of 0.72 when parents got clear scaffolding (Heidlage, 2024). These findings are also in line with Roberts & Kaiser who assert that the success of parent-mediated interventions lies in the quality of the guidance, not just the quantity (Roberts & Kaiser, 2023).

Second, the mechanism of technological engagement. In contrast to static print books, applications with interactive audio-visual features increase joint attention. This is proven by Dykstra in the *Journal of Medical Internet Research* that technology-based interventions increase engagement by 65% (Dykstra, 2023). Massaroni et al. (2023) and Brushe et al. (2024) emphasize that active and interactive screen time actually has a positive impact, as opposed to passive screen time which is negatively correlated with language (Madigan, 2022). Thus, this study reconciles the screen time paradox: not eliminating technology, but turning it into active.

Third, the neurobiological mechanisms of conversation. Romeo in the *Journal of Neuroscience* proves that reciprocal conversations increase the activation of Broca's area in children (Romeo, 2023). This application forces turn-taking conversations through open-ended questions and Wh-questions, which according to Levickis are predictors of the quality of language input (Levickis, 2023). Karrass & Braungart-Rieker in *Child Development* also found that parental responsiveness is a major mediator of children's language development speech delay (Karrass & Braungart-Rieker, 2024).

Contribution to Passive Screen Time Issues and Parenting Stress

These findings provide an answer to Ghaisani and Oktariani's concerns about the impact of gadgets post-pandemic (Ghaisani et al., 2022); (Oktariani, 2022). Application log data shows that the passive screen time of the experimental group decreased from 132 minutes to 71 minutes per day because it was replaced by educational active screen time. This is in line with Law's that an interaction-rich home environment is a protective factor (Law, 2022). In addition, from the parents' side, the parenting stress score measured briefly decreased because the app provided a clear structure, in contrast to Tseng's findings that parenting stress inhibits language stimulation (Tseng, 2023).

Implications for the Long-Term Impact of Speech Delay

An increase in MLU from 1.8 to 3.4 has preventive implications. Walquist-Sørli in a meta-analysis warned that untreated speech delay increases the risk of reading difficulties by 3.5 times (Walquist-Sørli, 2025). By improving MLU and vocabulary in the golden age, this intervention breaks the chain of risk, in line with the recommendations of Whitehouse et al. (2024) on the importance of early intervention before the age of 5. The N-Gain result of 0.71 was also higher than the flashcard audio intervention (Febrianti et al., 2024) with an N-Gain of 0.58 and ABA (Noorhayana, 2025) which focused more on compliance, rather than generative language.

Novelty and Limitations

The novelty of this research is the integration of three elements that were previously separate: dialogic reading, parent-mediated therapy, and application technology. Previous research such as Handhika is still in the form of a scoping review of the potential of AI, not yet in the form of an effectiveness test (Handhika, 2025). The Bao and Ayuso-Lanchares study document the impact of COVID-19 on language, but does not offer a structured digital solution model (Bao, 2024); (Ayuso-Lanchares, 2024).

A limitation of the study is the duration of follow-ups that have not measured long-term retention such as longitudinal studies (Sansavini, 2022). In addition, nutritional factors (Mondal, 2024) and bilingual exposure (Molina et al., 2024) have not been strictly controlled.

Conclusion of the Discussion

Overall, application-based dialogic reading has proven to be effective because it changes the paradigm from passive screen time to active co-viewing, from parents as readers to facilitators, and from children as listeners to storytellers. This model is relevant as an affordable and sustainable intervention in the Indonesian context according to the principles of early detection (Singleton & Saks, 2023).

Conclusions

This study aims to test the effectiveness of application-based 'dialogic reading' interventions on improving early childhood expressive language skills with speech delay indications. Based on the results of quasi-experimental pretest-posttest control group design tests on 34 children aged 3-5 years, it can be concluded that the intervention has proven to be significantly effective. The results of the analysis showed a significant difference in ELMS-2 gain score between the experimental and control groups ($p < 0.001$). The experimental group that received a 15-minute application intervention per day for 8 weeks obtained an N-Gain Score of 0.71 in the high category, much higher than the control group that only obtained 0.32 moderate categories with conventional reading activities. The improvement occurred comprehensively in three main indicators: (1) expressive vocabulary mastery increased by an average of 112 new words, (2) Mean Length of Utterance (MLU) increased from 1.8 to 3.4 words per speech, and (3) verbal responsiveness increased from 2.1 to 4.3 responses per session. This effectiveness is explained by three mechanisms. First, the application automates PEER and CROWD techniques to ensure consistency in the application of dialogic reading by parents as the main therapist in the parent-mediated therapy model. Second, the transformation of passive screen time into interactive active co-viewing has been proven to increase joint attention and turn-taking conversation, which neurologically increases the activation of language areas. Third, the automatic prompt feature and developmental dashboard are able to reduce parenting stress and replace passive screen time by up to 46%. Theoretically, this study enriches the treasure of children's language interventions by integrating educational technology into the parent-mediated model that has been conventional so far. In practical terms, this application offers an affordable, fun, and sustainable early intervention model that can be used by parents at home, early childhood education teachers, or as a speech therapy companion in the clinic. The limitations of the study lie in the absence of long-term follow-up to measure retention and generalization to early literacy ability, as well as the lack of control for nutritional factors and bilingual exposure. Recommendations for further research are to conduct a 6-12 months longitudinal study, expand the sample, and integrate Artificial Intelligence features for prompt personalization according to the child's language level.

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