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Impact of Reading Eggs on Reading Skills: A TaRL-Based Study of Age and Gender Dynamics

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ABSTRACT This study examines the impact of the Reading Eggs application on developing reading skills among young ESL (English as a Second Language) learners, focusing on age and gender differences within the Teaching at the Right Level (TaRL) framework. A quantitative pre-test/post-test design was employed to assess changes in reading skills following a two-week intervention using Reading Eggs. The participants included 28 primary school students grouped by age and gender to explore demographic effects. A two-way ANOVA was conducted to evaluate the influence of age, gender, and their interaction on reading skills. While the results showed no statistically significant effects, a large effect size for age suggests a potential influence constrained by the limited sample size. Gender and the interaction of age and gender demonstrated negligible effects. Data analysis included two-way ANOVA, hierarchical regression, and Structural Equation Modeling to uncover nuanced relationships between age, gender, and program effectiveness. The findings revealed no statistically significant effects, although a large effect size for age suggests a potential impact limited by the small sample size. Gender and the interaction of age and gender demonstrated negligible effects. These results underscore the need for further research with larger, more diverse samples to explore the potential benefits of digital tools like Reading Eggs. The study highlights the practical value of integrating technology with adaptive frameworks such as TaRL, providing insights for educators to enhance literacy instruction in ESL contexts.

Keywords: Reading Eggs, reading skills, ESL learners, TaRL approach, age differences, gender differences, digital literacy tools.

ABSTRAK: *Studi ini meneliti dampak aplikasi Reading Eggs terhadap pengembangan keterampilan membaca pada pelajar muda ESL (English as a Second Language), dengan fokus pada perbedaan usia dan jenis kelamin dalam kerangka Teaching at the Right Level (TaRL). Desain penelitian kuantitatif pre-test/post-test digunakan untuk menilai perubahan keterampilan membaca setelah intervensi selama dua minggu menggunakan Reading Eggs. Partisipan terdiri dari 28 siswa sekolah dasar yang dikelompokkan berdasarkan usia dan jenis kelamin untuk mengeksplorasi efek demografis. Analisis ANOVA dua arah dilakukan untuk mengevaluasi pengaruh usia, jenis kelamin, dan interaksi keduanya terhadap keterampilan membaca. Meskipun hasil menunjukkan tidak ada efek yang signifikan secara statistik, ukuran efek yang besar untuk faktor usia mengindikasikan potensi pengaruh yang terbatas oleh ukuran sampel yang kecil. Jenis kelamin dan interaksi antara usia dan jenis kelamin menunjukkan efek yang dapat diabaikan. Temuan ini menyoroti pentingnya penelitian lebih lanjut dengan sampel yang lebih besar dan representatif untuk memvalidasi manfaat potensial alat digital seperti Reading Eggs dalam meningkatkan keterampilan membaca. Studi ini menegaskan nilai praktis integrasi teknologi dengan kerangka adaptif seperti TaRL untuk memenuhi kebutuhan pembelajar yang beragam, memberikan wawasan bagi pendidik yang ingin meningkatkan pengajaran literasi dalam konteks ESL.*

Kata kunci: *alat literasi digital, keterampilan membaca, pembelajar ESL, pendekatan TARL, perbedaan gender, perbedaan usia, reading eggs.*

INTRODUCTION

Reading skills are essential both academically and in developing an individual's language skills. Reading is the ability to comprehend speech in its written form (Seventilofa, 2022). For ESL learners, good reading skills are essential in vocabulary acquisition, comprehension, grammar awareness, and communication, which help them succeed in other subjects. It even fosters cognitive development, critical thinking, and independent learning. According to Moats 2009, learning to read is among the most critical goals of early schooling; early literacy skills, such as letter recognition, phonics, and vocabulary, form the foundation for new learning in other subjects. It also enhances cognitive capabilities, including memory, concentration, and problem-solving, essential in academic pursuits. It supports social development, enabling children to express themselves clearly and understand others while boosting self-confidence to tackle more complex tasks as they advance in education. Research shows that a strong reading foundation in preschool predicts future reading performance and equips children for continued success in primary school (Sucena et al., 2023). Early reading habits are crucial for overall cognitive, social, emotional, and academic growth. They enhance language abilities, nurture creativity and empathy, and fortify parent-child attachment supporting lifelong learning.

At the same time, teaching reading to primary students involves many challenges that must be dealt with for effective literacy development. These include a general problem of insufficient teacher preparation to effectively handle such training in phonological awareness and ineffective pedagogical strategies(Haile & Mendisu, 2023). This mostly results from poor training by teacher-training programs concerning what to expect among diverse learners who come to their classes, even those with difficulties such as dyslexia(Lu, 2022). This problem is further compounded by limited access to quality teaching materials, which restricts the variety of texts available to engage students and match their reading levels. Moreover, instructional time for reading and practice is usually insufficient. Other challenges are student-related, such as motivation and engagement. Too many students enter primary school with minimal basic sight vocabulary, which reduces their reading abilities and frustrates them. The lack of background knowledge in different domains makes it even more difficult for them to integrate new information into previous learning. These difficulties are compounded by environmental factors like the absence of print-rich environments at home and in classrooms, which hinder reading development (Nkengbeza et al., 2022).

A love for reading can only be developed in a supportive environment. ESL learners may have interference from their mother tongue, which complicates the comprehension of English texts, especially in vocabulary and syntax (Meng, 2021). Teachers also face challenges in assessing reading skills due to varying skill levels and learning styles, which can lead to the misidentification of students needing support. These challenges can be overcome through better teacher training,

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adequate resources, student involvement, and a conducive learning environment. Technology also plays an important role in making learning interactive and accessible. It allows for personalized learning in which students learn at their own pace, with content tailored to their needs (Rahmawati & Nurachadija, 2023). Differentiated instruction through various digital tools, such as educational apps and games, helps to enhance creativity, collaboration, and critical thinking. They also prepare students for a digital future and pave the way to inclusivity in education, which aligns with UNESCO's SDG 4 on quality education (UNESCO, 2024). The Reading Eggs application is a digital literacy platform for children aged 2 to 13. It integrates gamified learning activities with interactive exercises to develop key literacy skills such as phonics, vocabulary, fluency, and comprehension. Developed by 3P Learning, the program provides customized learning pathways through diagnostic assessments, ensuring that every student works appropriately for steady progress. It then gives them real-time feedback that builds confidence and fosters continuous improvement. In addition, Reading Eggs provides the teacher with progress-monitoring tools to identify at-risk students and support them with targeted interventions(*Reading Eggs*, 2022). The program aligns well with Pratham's Teaching at the Right Level (TaRL) framework. By combining adaptive learning with scaffolded lessons, Reading Eggs addresses learning gaps effectively while accommodating diverse age and gender needs (Muammar et al., 2023). Its engaging features—such as interactive games, animations, and a vast library of e-books—enhance student motivation and reduce disparities in literacy performance. Research supports the effectiveness of Reading Eggs for improving literacy outcomes. For example, Lowery (2022) showed how it was able to bring about an improvement in the reading ability of elementary students over a 12-week structured intervention. With Reading Eggs, teachers can help facilitate collective and efficient literacy learning that inspires lifelong enthusiasm and love for reading. It investigates the effectiveness of the Reading Eggs application in enhancing phonics, vocabulary, fluency, and reading comprehension among upper primary school students (Latisha D. Lowery, 2022). This application is expected to yield useful research findings that address relevant and practical improvements in critical aspects of literacy education. Specifically, the study investigates how Reading Eggs enhances reading skills through targeted instruction in phonics, vocabulary, fluency, and comprehension, thus building students' foundations for literacy. Additionally, by aligning with the Teaching at the Right Level (TaRL) approach, the application emphasizes personalized learning pathways that cater to students' abilities, allowing for steady progress and reducing disparities in achievement (Lomak Norita Simanjuntak et al., 2024).

This study investigates the impact of the Reading Eggs application on elementary school students' reading skills, particularly in phonics, vocabulary, fluency, and comprehension. It also explores age and gender dynamics to determine how the program addresses diverse learning needs. By aligning with the TaRL framework, the study aims to provide insights to enhance literacy instruction and promote equitable learning opportunities for all students.

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RESEARCH METHOD

The researcher conducted quantitative research because it focused on systematically collecting and analyzing numerical data to test hypotheses, identify patterns, and measure relationships or effects. The main focus of this research was to evaluate the impact of Reading Eggs. A pre-test and post-test were used to measure changes in reading skills before and after the implementation of Reading Eggs. This method provided the tools needed to systematically evaluate the impact of Reading Eggs on reading skills while exploring the influence of age and gender. Its ability to produce objective, generalizable, statistically valid findings made it the most suitable method. The target population was Primary 3 and 4 students, with 27 students. The research sample consisted of only 27 students due to several factors. First, as the students were under 17 years old, the researcher was required to obtain consent from their guardians, which limited the number of participants. Out of 60 consent forms distributed, only 27 were returned, reducing the sample size. Additionally, the school was an international institution with strict regulations regarding publishing students' personal information, which required careful consideration of privacy policies. The size of each class also contributed to the limited sample, as each class contained fewer than 20 students from each parallel class. Lastly, some guardians or parents were unable to meet the submission deadline due to their busy schedules, contributing to the reduced number of participants in the study.

This study was divided into three groups: Group 1, with an age range of seven to eight years; Group 2, with ages eight to nine years; and the third group, consisting of boys and girls in each age group. Dividing the sample into three groups based on age and gender dynamics allowed for a well-rounded analysis of the implications of the Reading Eggs program. Grouping by age considered differences in cognitive and literacy development, as well as the relevance of the curriculum, fitting with the developmental needs of 7–8 and 8–9-year-olds. The groupings by gender highlighted potential differences in learning styles and equity considerations that might enable interventions tailored for boys and girls. The analysis of the interaction between age and gender went a little deeper to describe how age and gender impacted literacy outcomes. It ensured a proper and effective review of the program’s effectiveness.

Several tools were used for assessment; the first was Reading A to Z, which contained assessments of phonics, vocabulary, and reading comprehension. In his research, Cheng (2022) emphasized the effectiveness of tools like Reading A to Z in formative assessments within ESL settings, noting their ability to provide accurate and real-time data on learner progression. This capability allows educators to monitor students' development closely and make informed instructional decisions. Building on this, Guo et al. (2021) found that teacher engagement with Reading A to Z significantly enhanced reading comprehension. Their study demonstrated that the platform's structured design supported personalized instruction, enabling teachers to tailor lessons to students' individual needs, thereby improving overall learning (Guo et al., 2021).

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The next step was an interview. The questions related to the student's background included age, gender, and several questions about interest in reading. The researcher asked additional questions to gather more information about the students' reading background. For example, questions about reading habits, such as how often they read, what they enjoy reading, and whether they preferred books, comics, or online articles, provided valuable insights. Asking about parental involvement at home, school support explored whether students enjoyed reading activities or found specific programs helpful. It also explored motivation, which uncovered why students thought reading was important and what motivated them to read more, such as rewards, curiosity, or fun. It was also important to identify challenges in reading by asking if students faced difficulties like understanding words or staying focused or if certain texts were more challenging for them. These questions benefited the research in many ways.

The participants underwent two cycles of assessments. The first was a pre-test. This test established the beginning of each student in terms of reading ability. After the students did the pre-test, the researcher conducted an intervention using the Reading Eggs application. Participants underwent one reading cycle using Reading Eggs for two weeks with a time of 30 minutes each day. This activity was carried out in the classroom using iPads provided by the school, starting at the same level for each student. Participants underwent one reading cycle using the Reading Eggs application for two weeks, with a duration of 30 minutes each day. The reason for limiting the Reading Eggs sessions to 30 minutes per day was that the students already used the program during their regular English lessons. This additional time allowed them to engage with the platform without overwhelming their daily schedule. By integrating the Reading Eggs sessions into their existing English lessons, the researcher ensured that students could reinforce their reading skills within the structured framework of their regular classroom activities, providing a balanced approach to learning without overloading them with too much screen time. After conducting the intervention, students were given a post-test. The data analysis was conducted using SPSS. Paired-sample t-tests were conducted to examine the pre-test and post-test scores within each group to analyze the data. An ANOVA was used to examine differences in reading improvement across age groups and genders, identifying if any demographics benefited more from the Reading Eggs program. Additionally, effect sizes were calculated to determine if the intervention was practically significant, supplementing the statistical results. Pre-test and post-test scores were compared to determine the consistency of testing conditions and ensure the reading assessment aligned with Reading Eggs.

RESULTS AND DISCUSSION

Results

This study aimed to evaluate the impact of the Reading Eggs application on reading skills across different age groups and genders. In this study, 15 girls and 12 boys joined the test. After some interviews, 37% of the participants had reading eggs and had tried them before, yet 63% of participants did not use reading eggs

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even though they had the account. To enhance the effectiveness of reading comprehension strategies, the mean and standard deviation of the pre-test and post-test scores of two separate groups were estimated.

Table 1. Comparison of Pre-Test and Post-Test scores

Group	Pre-Test mean	Pre-Test SD	Post Test Mean	Post Test SD	Mean Diff
Younger M	42,2	18,8	77,4	13,1	35,2
Younger F	41,7	22,2	80,7	11,8	39,0
Older M	35,7	19,1	68,8	15,3	33,1
Older F	36,5	16,3	75,5	17,0	39,0

Table 1: Pre-test vs. Post-test Scores among Four Groups by Age and Gender (Younger M = Younger Male, Younger F = Younger Female, Older M = Older Male, and Older F = Older Female) In the pre-test condition, Younger M and Younger F had a mean score of 42.2 and 41.7, respectively. In contrast, the mean for Older M and Older F was a little lower, 35.7 and 36.5, respectively. The SD at pre-test marks the variability in the scores; therefore, the highest variability is for Younger F with an SD of 22.2, while the minimum variability is for Older F, which is 16.3.

The test performances of all groups thus considerably improved from the pre-test. Younger F recorded the highest post-test mean score of 80.7, while Younger M was at 77.4. Results for Older F had an average of 75.5; for Older M, it was 68.8. Standard deviations from the post-test were from a low of 11.8 for Younger F to a high of 17.0 for Older F.

The mean difference between the pre-and post-test scores signals the increase in their improvement across the groups. Older F had the highest with a mean difference of 39.0, closely followed by Younger F at the same value of 39.0. In this regard, Younger M and Older M have lower mean differences at 35.2 and 33.1, respectively. Such results would signify that the intervention benefited the groups, albeit there were remarkable improvements in females.

The results also show that gains in absolute scores for the youngest age group, especially females, were upward even though all groups benefited, and these gains have been included in their post-tests. Such a finding might hint at age and gender affecting the efficiency of this intervention; it is possible that younger participants female ones-adjusted better either to the teaching methodology or to the materials used.

Table 2. Statistic of Reading Skills Score by Age and Gender

Group	N	Mean	Score SD	Minimum	Maximum
Younger M	5	59,5	13,1	66	94
Younger F	4	61	22,2	64	91
Older M	8	52	15,3	56	100
Older F	11	56	17,01	51	98

Table 2 presents the descriptive statistics of reading skills by age and gender. The sample sizes N were smaller: Younger M = 5; Younger F = 4, Older M =

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8, and Older F = 11 was the biggest. On the comparison of average scores, Younger F got the highest mean score of 61, tagged closely by Younger M with a score of 59.5. Older Males scored the lowest mean, with 52, while Older Females scored slightly higher at 56.

Standard deviations denote the amount of variation in each group. Younger F, with SD = 22.2, had the highest variability, while Younger M gave the minimum with an SD of 13.1. Minimum and maximum scores help to bring into perspective how wide the range in performance was within each group. Younger Males had scores between 66 and 94, and Younger Females scored between 64 and 91. Scores between 56 and 100 were for Older Males, while the Older Females had scores between 51 and 98.

Data here indicate that, overall, younger participants performed better than older participants, as evidenced by higher mean scores for both male and female groups. However, the broader range of scores and higher variability within the Younger F and Older F groups indicate a greater disparity in reading skill levels among female participants than among males. This would suggest possible factors of individual learning differences or responsiveness to the intervention used in this study.

Table 3. Results for the Effect of Age and Gender Using Reading Eggs

Factor	F-Value	P-Value	Effect Size
Age	2,22	.149	.85
Gender	.016	.901	.001
Age X Gender	.016	.901	.001

Results from ANOVA showed that none of the factors, which included age, gender, and the interaction of gender, significantly influenced reading skills since their p-values were greater than 0.05. More precisely, the main effect of Age showed an F-value of 2.22 and a p-value of 0.149. Hence, the differences in reading skills between age groups were not significant. However, its effect size for Age, $\eta^2 = 0.85$, indicates a very large practical effect, highly unusual and perhaps worthy of further investigation in the data or methodology.

The overall effect of Gender had a corresponding F-value of 0.016 and p-value of 0.901; thus, no significant difference in reading skills was noted between males and females. The effect size for Gender was $\eta^2 = 0.001$, indicating that gender is a negligible predictor of reading skills. Additionally, no significant interaction effect of Age and Gender was found because F = 0.016 with a p-value of 0.901. For the interaction, $\eta^2 = 0.001$, standing for a minimal effect and hence indicates no combined meaningful influence of age and gender upon reading skills. In other words, although Age was associated with a very large effect size, the lack of statistical significance necessitates further consideration of the data, such as checking for outliers or verifying that assumptions for ANOVA were met. The small effects of Gender and the interaction of Age and Gender are negligible in affecting reading skills.

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Discussion

Reading is a fundamental skill in learning, serving as the cornerstone for academic success across all subjects. It enhances cognitive abilities, including comprehension, critical thinking, and the capacity to analyze and synthesize information. Reading fosters vocabulary growth, memory development, and sustained focus while promoting empathy and cultural awareness by exposing learners to diverse experiences and perspectives. Despite its importance, many students face challenges in developing reading proficiency. In this study, researchers conducted a study to examine the effects obtained by the Reading Eggs application on solving problems in reading proficiency. Zucker, Moody, and McKenna demonstrated that integrating technology into reading instruction, such as through applications like Reading Eggs, significantly enhances student engagement and boosts reading proficiency(Nurmala et al., 2023). Reading Eggs are used to optimize students' reading skills because they relate to behaviorism and constructivism theories. The pre-test and post-test result significantly improve students' reading skills after using the Reading Eggs application. This improvement aligns with the principles of Constructivist Theory, which emphasizes active learning and knowledge construction. Reading Eggs engages students through interactive activities, such as phonics games, letter-sound matching exercises, and reading comprehension tasks. These activities require learners to actively process and apply new information, constructing their understanding of language and literacy in a meaningful context(L. S. Vygotsky, 2020). From a Behaviorist perspective, the application leverages positive reinforcement to motivate students and encourage consistent engagement. For example, features like badges, rewards, and congratulatory messages serve as reinforcers that shape behavior and sustain effort. Many students expressed enthusiasm about earning rewards after completing tasks, suggesting that these reinforcements played a role in their improved performance. This improvement can be attributed to the immediate feedback provided by Reading Eggs, which reinforces correct responses and encourages repetition of tasks, a hallmark of Behaviorist strategies.

During the interview, most students expressed happiness and excitement about using the Reading Eggs application. Observations revealed that the application significantly motivated them to learn. This enthusiasm was evident in their engagement and enjoyment of the freedom to explore various activities. Students reported feeling empowered by their ability to choose tasks and control their learning journey. Reading Eggs allows them to select activities, progress at their own pace, and set personal goals. The application also offers scaffolded activities tailored to their skill levels, providing immediate feedback, rewards, and badges upon completing tasks. Notably, 13 students shared their goal of collecting ten thousand eggs to redeem as rewards for their parents, demonstrating their motivation and engagement. Researchers observed a noticeable difference between learning through traditional methods and using the Reading Eggs application. Students consistently demonstrated greater optimism and eagerness when engaging with Reading Eggs, highlighting the positive impact of its interactive and student-centered approach. The findings align with the Self-

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Determination Theory, as the autonomy provided by the Reading Eggs application fosters intrinsic motivation. With the Expectancy-Value Theory, students' desire to collect rewards and achieve personal goals reflects their positive expectations of success and the value they place on the activities(Yue & Lu, 2022). Reading Eggs is a comprehensive literacy application that offers a wide range of content, including phonics, reading comprehension, vocabulary development, and storybooks. It supports teachers in delivering targeted reading instruction tailored to various age groups and skill levels. The platform promotes active learning, self-paced exploration, and formative assessment practices. Through multimedia elements such as videos and interactive games in Reading Eggspress, the app enhances student engagement. While Reading Eggs serves as an effective alternative to traditional printed worksheets by incorporating digital activities, it is important to note that motor skills development still requires hands-on tasks, making the complete elimination of paper-based activities less advisable. This finding is aligned with the TPACK (Technological, Pedagogical, and Content Knowledge) and SAMR (Substitution, Augmentation, Modification, and Redefinition) frameworks. The function of technologies in TPACK is as learning tools to help teachers enhance teaching instructions (Parsons, 2020) and, at the same time, assist students to be more engaged and interactive in their learning experience (Sindi Alivi, 2019).

Although the effect size for age implies that age might exert a large practical effect on reading execution, the difference was not statistically significant. This change usually attributes itself to the small size of the actual sample or the variability of data. With this high value of effect, it could be said safely that age plays a role in the student growth of reading abilities; this would infer that younger students would benefit from technology differently than physiologically older students, further backing developmental theories that suggest that cognitive and literacy skills grow with age. This contradicts the findings of a study conducted by Vlachos, F., and Papadimitriou, A., which demonstrated a significant effect of age on reading performance. Their research showed that older children had better scores than younger children in reading fluency, reading comprehension, and overall reading performance (Manu et al., 2023). However, because no statistical differences were found, this observation cannot serve as a generalized statement supporting the conclusions because a more significant sample is needed for this inference.

Gender Difference shows no statistically significant difference in the effectiveness of Reading Eggs on the reading skills of male children and those of their female counterparts. This somewhat agrees with previous research, which suggests that gender is not a crucial factor in student engagement and successful outcomes through educational technologies. It can also mean that this application provides an equal learning opportunity to all. Gender was insignificant since we did not obtain statistically significant differences in reading performance between the two genders (Engel de Abreu et al., 2020). These results generally align with previous research, which found no female superiority in reading.

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The next findings indicate that the interaction between age and gender did not reveal any meaningful statistical effect. This means that the effect is not large enough to define meaningfully reading development as age differences that run parallel across genders are in operation, and Reading Eggs is independent of this interaction of demographic factors. This finding is important as it emphasizes the neutrality of the tool in catering to diverse learner profiles. Supporting this view, several studies have found that while age and gender can influence literacy development, the effectiveness of educational tools often transcends these demographic variables. For instance, studies have shown that digital literacy tools can be equally effective across various age groups and genders, especially when designed with inclusivity (van Steensen et al., 2019). These tools, like Reading Eggs, may provide a level of engagement and feedback that caters to a wide range of learners, regardless of gender or age. However, it is important to note that other studies have suggested that demographic factors can still play a role in learning outcomes, particularly in contexts where gender stereotypes or socio-cultural influences may affect engagement with technology-based learning tools. While the current study did not find such effects, it is worth considering that other contextual factors could influence how learners from different demographic backgrounds interact with the platform.

Reading Eggs has generally improved reading skills in all students, regardless of age or sex. Relevantly, younger students, especially females, should have benefitted the most from the app, given that they recorded the highest scores in the post-test and the largest mean difference. Although the results revealed no statistically significant effects of age and gender on reading skills, it is important to note that the effect size for age was large, suggesting that age could still play a role in reading proficiency. This discrepancy between statistical insignificance and large effect size warrants further investigation. The sample size in this study may have limited the ability to detect statistically significant differences. Future studies with a larger, more representative sample would help clarify the role that age and gender play in reading development.

CONCLUSION

The analysis found that age and gender did not affect reading skills statistically significantly, however, the large effect size for age suggests a potential practical influence on reading skills, despite the lack of statistical significance. This inconsistency highlights the need for further research with a larger sample to clarify whether age and gender have meaningful effects on reading proficiency. A key limitation of this study is the small sample size, which may have reduced the statistical strength of the analyses and limited the generalizability of the findings. The sample size was constrained due to a low response rate from parents who were asked to consent to their children's participation.

Future research should address this limitation by increasing the sample size. Strategies such as improved follow-up with parents, offering incentives for participation, or simplifying the consent process could enhance response rates. A

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larger sample would strengthen the robustness of analyses, improve statistical power, and yield more reliable and generalizable conclusions.

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