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Abstract

The study used the CVC 3-Letter Words and Phonics application to enhance reading skills among kindergarten learners. Using a pretest-posttest quasi-experimental design, the study was conducted at Nalsian Elementary School in Bayambang, Pangasinan, Philippines. Specifically, it involved 21 kindergarten learners enrolled at this school during the 2023-2024 school year. The research examined 21 kindergarten students in the Philippines. A questionnaire was used to gather data on learners' profiles, while a researcher-made reading test assessed reading levels before and after exposure to interactive applications. The study revealed that interactive applications had a statistically significant positive impact on learners' reading skills, as evidenced by a Wilcoxon signed-rank test ($Z = -4.019$, $p < 0.001$). Before the intervention, 81% of learners were assessed as "full refresher," while after, 81% were "grade ready." The gain in reading levels was not significantly associated with learners' demographic and home environment variables, suggesting that interactive applications can benefit all learners regardless of factors such as gender, availability of reading materials at home, parents' educational attainment, internet connection status, and electronic gadgets used in the household. The gain in reading levels was not significantly associated with learners' profile variables, suggesting that interactive applications can benefit all learners regardless of background. Mean scores increased from 8.81 (SD=4.96) before intervention to 18.57 (SD=2.68) after intervention. Interactive applications offer engaging, multimodal experiences. The study's limitations include a small sample size and the use of an intact class from a single school. Future research should explicitly state in the abstract the inclusion of control groups and larger sample sizes to validate the effectiveness of interactive applications in developing reading skills among young learners. The results can inform the design and implementation of reading interventions that leverage these applications to support kindergarteners' success.

Keywords: *digital interactive literacy, digital learning, early childhood education, early literacy, educational technology, kindergarten learners, phonics, sight words*

Introduction

Reading proficiency, which encompasses various components including phonics and letter recognition, is fundamental for academic success and lifelong learning (Solari, 2014; Schmitt et al., 2015). Phonics, the understanding of letter-sound relationships, and letter recognition, the ability to identify and name letters, are crucial early literacy skills that form the foundation for more advanced reading abilities.

Early childhood is critical for developing reading skills as children grasp phonics, letter recognition, and word formation (Dickinson & Porche, 2011). However, many children enter kindergarten with gaps in reading readiness (Wood, 2019), which can lead to long-term academic challenges if not addressed promptly.

Recent years have seen growing interest in using interactive applications to enhance early literacy instruction. These digital tools offer engaging, multimodal learning experiences tailored to individual needs and learning styles (Outhwaite et al., 2019). Studies have shown promising results for using such applications to improve young children's letter knowledge, phonological awareness, and word recognition skills (Neumann, 2018; Fokides & Zachristou, 2019).

However, research focusing on the effectiveness of interactive applications for developing reading skills among kindergarten learners remains limited. These tools, particularly in resource-constrained environments, can bridge learning gaps. Most existing studies have examined older children or broader age ranges, leaving a gap in our understanding of how these tools impact the earliest stages of formal reading instruction. Additionally, few studies have explored how learners' characteristics may influence the impact of interactive applications on reading outcomes, particularly in diverse educational contexts like the Philippines.

This study aims to address these gaps by investigating the effectiveness of interactive applications in developing reading skills among kindergarten learners in the Philippines. By focusing on this specific age group and context, the research will contribute valuable insights into the potential of interactive applications to enhance early reading instruction in settings with limited resources or diverse learner populations. The findings may have broader implications for early literacy instruction in various cultural and socioeconomic contexts and could inform evidence-based practices for integrating technology into early childhood education (Hirvonen et al., 2015; Tupas, 2015).

To achieve these aims and address the research questions, a carefully designed methodology was implemented, taking into account the unique linguistic and educational landscape of the Philippines (Bautista & Gonzalez, 2006; Bernardo, 2004). The following section details the research design, participant selection, data collection instruments, and procedures used to investigate the impact of interactive applications on kindergarten learners' reading skills, considering the multilingual context of Philippine education (Dekker & Young, 2005; Padilla, 2018).

Materials and Methods

Research Design

This study employed a one-group pretest-posttest quasi-experimental design to determine the effectiveness of interactive applications in developing reading skills among kindergarten learners. This design was chosen for its ability to capture changes in reading performance over time within a single group of participants, an approach that aligns with recent educational research trends in the Philippines (Cruz, 2010; Vizconde, 2006). By comparing learners' reading levels before and after exposure to the intervention, researchers could assess the impact of interactive applications on early literacy skills, while considering the unique challenges of English language instruction in the Philippine context (Ocampo, 2002).

The one-group pretest-posttest design offers several advantages in this context. It allows for a focused examination of the intervention's effects within a naturalistic classroom setting, maintaining the ecological validity of the study. This approach is particularly suitable for exploratory research in educational technology, where the primary aim is to establish the potential efficacy of a novel intervention (Shadish et al., 2002). However, it is essential to note the limitations of this design, including the lack of

a control group and potential threats to internal validity, such as maturation effects or history effects. While effective for assessing within-group changes, the lack of a control group limits the ability to establish causality. Despite these limitations, the design provides valuable preliminary evidence of the effectiveness of interactive applications in developing reading skills among kindergarten learners, laying the groundwork for more rigorous experimental studies in the future.

Subjects and Sampling

The study subjects consisted of 21 kindergarten learners enrolled at Nalsian Elementary School in Bayambang, Pangasinan, Philippines, during the school year 2023-2024. This sample comprised nine male and 12 female students, reflecting a relatively balanced gender distribution. Selecting participants from a single school in a specific geographic location provides a focused snapshot of early literacy development within this educational context. Nalsian Elementary School, as a public institution in the Philippines, represents a typical learning environment for many young Filipino students, potentially enhancing the generalizability of the study's findings to similar settings within the country.

An intact class was utilized for this research, employing a convenience sampling approach. This methodological decision was made to maintain the natural classroom dynamics and avoid disrupting established educational routines. While convenience sampling has limitations in terms of representativeness and potential bias, it offers practical advantages in educational research, particularly when working with young children. By preserving the existing class structure, the study aimed to capture the effects of the intervention within a realistic classroom environment, thus enhancing its ecological validity. However, it is important to acknowledge that using an intact class and the relatively small sample size (n=21) may limit the generalizability of the findings to broader populations, necessitating cautious interpretation and further research with larger, more diverse samples.

Setting

The study was conducted at Nalsian Elementary School, a public educational institution in Bayambang, Pangasinan, Philippines. The study was conducted at Nalsian Elementary School, a public educational institution in Bayambang, Pangasinan, Philippines. This setting is significant as it represents a typical learning environment for many Filipino children, particularly those in rural or semi-urban areas. Public schools in the Philippines often face challenges such as limited resources and large class sizes, making them an essential context for researching innovative educational interventions. Nalsian Elementary School, like many of its counterparts, serves a diverse student population from various socioeconomic backgrounds, providing a rich environment for examining the effectiveness of interactive applications across different learner profiles.

The intervention occurred in a kindergarten classroom that was specially equipped with tablets for student use. This setup represented a notable investment in technology integration at the early childhood education level, which was not yet commonplace in many Philippine public schools. The provision of tablets for each student in the classroom created a unique learning environment, allowing individualized, hands-on interaction with the interactive applications. This technological enhancement of the traditional kindergarten classroom setting allowed us to explore how digital tools could be effectively incorporated into early literacy instruction in a resource-constrained public school context. The contrast between the traditional classroom setting and the introduction of tablets for learning offered valuable insights into the feasibility and impact of technology-enhanced instruction in similar educational contexts.

Data Gathering Instruments

Two researcher-made instruments were developed and utilized in this study to collect comprehensive data on the kindergarten learners' backgrounds and reading skills. The first instrument

was a questionnaire checklist to establish the learners' profiles. This questionnaire gathered crucial demographic and contextual information, including the learners' sex, availability of reading materials at home, parents' educational attainment, internet connection status, and electronic gadgets used in the household. These variables were selected based on their potential influence on early literacy development, as identified in previous research (e.g., Neuman & Celano, 2001; Bradley & Corwyn, 2002). By collecting this information, the researchers aimed to explore potential relationships between these background factors and the effectiveness of the interactive applications in developing reading skills.

The second instrument was a 20-item reading test, carefully structured to assess critical components of early literacy. This test was divided into two tasks: Task 1 focused on letter recognition and comprised ten items. In contrast, Task 2 assessed the learners' ability to read CVC (Consonant-Vowel-Consonant) patterns and basic sight words, consisting of 10 items. These specific tasks align with established frameworks of early reading development, which emphasize the importance of letter knowledge, phonological awareness, and sight word recognition as foundational skills for reading proficiency (Ehri, 2005; National et al., 2008). Using the same test as both a pretest and posttest, the researchers ensured a consistent measure of reading skills before and after the intervention, allowing for a direct comparison of learner progress.

To ensure the reliability and validity of these instruments, rigorous validation procedures were employed. The content validity of the questionnaire checklist and the reading test was established through expert review. Five experts in early childhood education, literacy instruction, and educational assessment evaluated the instruments. These experts evaluated the relevance, clarity, and comprehensiveness of the items in relation to the study's objectives and the target age group.

The experts provided detailed feedback on each item, suggesting modifications to improve clarity and age-appropriateness. For instance, in the reading test, one expert recommended simplifying the instructions for Task 1 to ensure better comprehension by kindergarten learners. Another expert suggested including more commonly encountered sight words in Task 2 to better reflect the typical vocabulary of Filipino kindergarteners.

The researchers carefully reviewed all expert feedback and made necessary revisions to the instruments. This iterative process involved multiple rounds of refinement until a consensus was reached among the experts. The final versions of the instruments incorporated all key recommendations from the expert panel.

The validation process yielded an average rating of 5.00 on a 5-point scale, indicating high content validity. This high rating suggests that the instruments were deemed appropriate and effective for measuring the intended constructs in the context of kindergarten learners in the Philippines. The involvement of multiple experts and the high validity rating strengthen the credibility of the data gathered using these instruments, providing a solid foundation for the study's findings and conclusions.

Data Gathering Procedure

The data-gathering procedure for this study was carefully designed and executed to ensure ethical compliance, participant engagement, and accurate assessment of reading skills. The process began with securing the necessary permissions from key educational authorities. The researchers first obtained approval from the school division Superintendent, recognizing the importance of aligning the study with broader educational policies and objectives. Subsequently, permission was sought from the Public Schools District Supervisor, ensuring that the study adhered to district-level guidelines and priorities. Finally, the School Principal's approval was secured, acknowledging the school's autonomy and the importance of their support in facilitating the research within the school environment. This

hierarchical approach to obtaining permissions ensured compliance with administrative protocols and helped build a supportive network for the study's implementation.

Following the acquisition of official permissions, the researchers engaged with the parents of the kindergarten learners. A comprehensive briefing session was conducted to explain the study's purpose, potential benefits, and implications for their children's education. This step was crucial in ensuring transparency and building trust with the families involved. The researchers provided detailed information about the nature of the interactive applications, the duration of the intervention, and the types of assessments that would be conducted. Parents were encouraged to ask questions and voice any concerns they might have. After this thorough explanation, informed consent was obtained from each parent, ensuring their children's participation in the study was voluntary and based on a clear understanding of the research process.

The next phase involved the administration of the pretest to the learners. This initial assessment was crucial in establishing a baseline measure of the children's reading skills before the intervention. The 20-item reading test, covering letter recognition, CVC patterns, and basic sight words, was administered individually to each learner to ensure accurate assessment. The scores from this pretest were meticulously recorded and then interpreted using the Comprehensive Rapid Literacy Assessment (CRLA) grading scale and descriptors. The CRLA is a standardized tool designed to provide a nuanced understanding of early literacy skills, allowing for detailed categorization of learners' reading abilities. This interpretation provided a clear picture of each child's initial reading level as a crucial reference point for measuring post-intervention progress.

The intervention phase of the study was implemented over four weeks and strategically divided to focus on different aspects of early reading skills. The interactive applications concentrated on letter recognition activities during the first two weeks. This initial focus aligns with research indicating the fundamental importance of letter knowledge in early reading development (Piasta & Wagner, 2010). The applications likely included games and exercises designed to help children identify and differentiate between various alphabet letters in isolation and simple words, and the latter two weeks shifted focus to reading CVC patterns and basic sight words. This progression follows a logical sequence in early reading instruction, building upon the letter recognition skills to form simple words and recognize common sight words. Throughout these four weeks, learners engaged with the interactive applications under the supervision of their teachers, ensuring consistent and appropriate use of the technology.

Following the four-week intervention, the posttest was administered to the learners. This posttest was identical to the pretest, directly comparing reading skills before and after exposure to the interactive applications. As with the pretest, scores were carefully recorded for each learner. The interpretation of these scores again utilized the CRLA grading scale and descriptors, maintaining consistency in the assessment approach. This final step in the data-gathering procedure provided the crucial data needed to evaluate the effectiveness of the interactive applications in developing reading skills. By comparing the pretest and posttest scores and interpretations, the researchers were able to quantify the progress made by each learner and assess the overall impact of the intervention on the class.

To ensure the ethical conduct of this research, several protocols were implemented. Institutional Review Board (IRB) approval was obtained before commencing the study. Detailed information about the study's purpose, procedures, potential risks, and benefits was provided to parents/guardians of all participating children, and written informed consent was obtained. Importantly, an age-appropriate assent process was conducted with the kindergarten learners. The researchers used simple language and visual aids to explain the study activities, emphasizing that participation was voluntary. Children were asked to verbally agree before participating. This process was conducted in the presence of their teachers to

ensure comfort and understanding. If a child showed any signs of reluctance or discomfort, they were not included in the study, even if parental consent had been obtained. All personal information and research data were kept confidential and stored securely, with only anonymized data used in analysis and reporting. It was made clear to both parents and children that participation was entirely voluntary and that they could withdraw from the study at any time without any negative consequences. These ethical protocols were rigorously followed throughout the research process to protect the rights and well-being of the young participants and to maintain the integrity of the study.

Intervention

The intervention utilized ABC Mouse® (Age of Learning, Inc., Glendale, CA, USA), an interactive learning application installed on tablets. For four weeks, learners engaged with the application for 30 minutes daily, five days a week.

Statistical Treatment

Data analysis was performed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). The following statistical tests were employed:

1. Descriptive statistics (frequency, percentage, mean, standard deviation) to describe learners' profiles and reading levels.
2. Wilcoxon Matched-Pair Signed Rank Test to determine the significance of the difference in reading levels before and after the intervention.
3. Kendall's Tau-b and Point-Biserial Correlation Coefficients determine the relationship between reading level gains and learners' profile variables.

The significance level was set at $\alpha = 0.05$ for all statistical tests.

This methodology allowed for a comprehensive investigation of the effectiveness of interactive applications in developing reading skills among kindergarten learners while considering the influence of learners' background characteristics.

Ethical Considerations

To ensure the ethical conduct of this research, several protocols were implemented:

1. Institutional Review Board (IRB) Approval: Before commencing the study, approval was obtained from the relevant institutional review board or ethics committee.
2. Informed Consent: Detailed information about the study's purpose, procedures, potential risks, and benefits was provided to parents/guardians of all participating children. Written informed consent was obtained from parents/guardians before any data collection or intervention activities began.
3. Child Assent: Age-appropriate, simple explanations of the study activities were provided to the kindergarten learners. The children were then asked if they would like to participate, and their verbal assent was obtained before proceeding with any research activities.
4. Data Protection: All personal information and research data were kept confidential and stored securely. Only anonymized data was used in the analysis and reporting of results.
5. Voluntary Participation: Parents and children were clearly informed that participation was entirely voluntary and that they could withdraw from the study at any time without any negative consequences.

6. Minimizing Disruption: The research activities were designed to minimize disruption to the children's regular educational activities.
7. Equitable Access: After the study, the interactive application was made available to all children in the class, including those who may not have participated in the study, to ensure equitable access to educational resources.
8. Reporting of Results: Commitments were made to share the study's findings with the school and parents in an accessible format.

These ethical protocols were rigorously followed throughout the research process to protect the rights and well-being of the young participants and to maintain the integrity of the study.

Results and Discussion

This section presents and interprets the study's findings about the research questions and existing literature.

3.1 Profile of Kindergarten Learners

Table 1.

Profile of Kindergarten Learners

Characteristics	Percentage (%)
Gender	
Female	57.1
Male	42.9
Activity Books at home	81.00
Smart cellphone usage	100.0
Parents' Education (High School Graduates)	
Fathers	42.9
Mothers	38.1
Internet connection (Mobile data)	45.0

Source: Processed by researchers (2024)

These findings provide context for understanding the learners' backgrounds and access to resources that may support reading development.

3.2 Reading Levels Before and After Exposure to Interactive Applications

Table 2.

Descriptive Statistics and Assessment Levels of Kindergarten Learners' Reading Performance

Component	Before Intervention	After Intervention
Mean ± SD	Mean ± SD	
Letter Recognition	6.00 ± 3.39	9.62 ± 0.80
CVC Pattern	0.22 ± 1.09	3.76 ± 1.09
Basic Sight Words	1.40 ± 0.65	4.24 ± 1.00
Overall Score	8.81 ± 4.96	18.57 ± 2.68
Assessment Level	**Before (%)**	**After (%)**
Full Refresher	81	-
Grade Ready	-	81

Source: Processed by researchers (2024)

The results show a substantial improvement in all aspects of reading performance after the intervention. The shift from 81% of learners assessed as "full refresher" before the intervention to 81% assessed as "grade ready" after the intervention indicates the effectiveness of the interactive applications in developing reading skills. These findings align with previous research, such as that of Neumann (2018), who also noted significant improvements in early literacy skills using interactive applications. Similarly, Fokides and Zachristou (2019) observed the positive effects of tablet use on kindergarteners' letter knowledge and phonological awareness. The consistency between our results and these prior studies strengthens the evidence for the potential of interactive applications in enhancing early reading skills.

3.3 Difference in Reading Levels Before and After Exposure to Interactive Applications

Table 3.

Difference in Reading Levels Before and After Exposure to Interactive Applications

Performance	MS	SD	MD (Pre-Post)	Wilcoxon Matched-Pair Signed Ranmk Test	
				z	p-value
Pretest	8.81	4.96	-9.76	-4.019	<.001
Posttest	18.57	2.68			

Source: Processed by researchers (2024)

The significant difference ($Z=-4.019$, $p<.001$) in reading levels before and after the intervention provides strong evidence of interactive applications' effectiveness in developing reading skills among kindergarten learners. This aligns with previous studies demonstrating the positive impact of technology-enhanced instruction on early literacy skills (Neumann, 2018; Fokides & Zachristou, 2019).

3.4 Relationship Between Gain in Reading Levels and Learners' Profile Variables

Kendall's Tau-b and Point-Biserial Correlation Coefficients showed no significant relationship between the gain in reading levels and learners' profile variables ($p>.05$). This suggests that the interactive applications were practical across diverse learner backgrounds, potentially serving as an equalizing tool in early literacy instruction.

Discussion

This study's significant improvement in reading levels across all components (letter recognition, CVC patterns, and essential sight words) highlights the potential of interactive applications to provide engaging, multimodal learning experiences that support early literacy development (Outhwaite et al., 2019). This comprehensive enhancement of reading skills suggests that well-designed interactive applications can effectively target multiple aspects of early literacy. The multimodal nature of these applications, which often combine visual, auditory, and kinesthetic elements, may be particularly beneficial for young learners still developing their cognitive and sensory processing abilities. This aligns with theories of multiple intelligences and diverse learning styles, suggesting that interactive applications can cater to a wide range of learner needs and preferences.

A particularly noteworthy finding is the lack of a significant relationship between the gain in reading levels and learners' profile variables. This result indicates that interactive applications may help bridge the gap in reading readiness among children from diverse backgrounds (Wood, 2019). In the context of the Philippines, where socioeconomic disparities can significantly impact educational outcomes, this finding is especially promising. Interactive applications could serve as an equalizing force in early literacy education, providing high-quality learning experiences to children regardless of their home environment, parental education level, or access to traditional reading materials. This potential for reducing educational

inequalities aligns with global efforts to promote inclusive and equitable quality education, as outlined in the United Nations Sustainable Development Goals.

These findings address a critical gap in research on the effectiveness of interactive applications specifically for kindergarten learners. Much of the existing literature on educational technology focuses on older students or broader age ranges, leaving a need for more information on how these tools impact the earliest stages of formal education. This study contributes valuable insights into early literacy instruction by demonstrating the efficacy of interactive applications for kindergarten-aged children. It provides empirical support for integrating technology into early childhood education curricula, a topic that has been debated among educators and policymakers.

The results suggest that integrating such applications into kindergarten classrooms could be a promising strategy for enhancing reading skills development. This has important implications for educational practice and policy. For educators, it suggests the need for professional development in effectively using interactive applications as part of a comprehensive literacy instruction approach. For policymakers and school administrators, it highlights the potential value of investing in technology infrastructure and digital resources for early childhood education. However, it is crucial to note that interactive applications should be seen as a complement to, rather than a replacement for, traditional teaching methods and human interaction in the learning process.

However, the study's limitations must be carefully considered when interpreting these results. The small sample size (n=21) and the use of an intact class from a single school limit the generalizability of the findings to broader populations. This restricted sample may not fully represent the diversity of kindergarten learners across different socioeconomic backgrounds, cultural contexts, or educational settings.

The lack of a control group is another significant limitation. Without a comparison group that did not receive the intervention, it becomes difficult to attribute the observed improvements solely to the interactive applications. Other factors such as natural maturation, general classroom instruction, or even the novelty effect of using technology could have contributed to the gains in reading skills.

Additionally, the study's focus on short-term outcomes leaves questions about the long-term retention and transfer of the acquired reading skills. It remains unclear whether the improvements observed immediately after the intervention would be sustained over time or translate into better overall academic performance.

Future research should address these limitations by:

1. Exploring larger, more diverse samples that better represent the target population.
2. Incorporating control groups to isolate the effects of interactive applications from other potential influencing factors.
3. Conducting longitudinal studies to assess the sustained impact of interactive applications on reading development over extended periods.
4. Investigating potential moderating factors such as prior exposure to technology, learning styles, or specific learning difficulties.

Such expanded research efforts would further validate these findings and provide a more comprehensive understanding of the role of interactive applications in early literacy instruction across various educational contexts.

Conclusion

This study sought to investigate the effectiveness of interactive applications in developing reading skills among kindergarten learners and examine the relationship between reading improvement and learners' profile variables. Based on the findings, we can conclude:

1. Interactive applications efficiently develop developing reading skills among kindergarten learners. The significant improvement in reading levels across all components (letter recognition, CVC patterns, and basic sight words) demonstrates the potential of these tools to enhance early literacy instruction.
2. The intervention's impact was substantial, transforming most learners from "full refresher" to "grade ready" status. This suggests that interactive applications can rapidly accelerate reading skill development in a relatively short period.
3. The effectiveness of interactive applications is consistent across diverse learner backgrounds. The lack of significant relationships between reading gains and profile variables indicates that these tools may serve as equalizers in early literacy education, potentially helping to bridge achievement gaps.
4. The study reveals the potential of technology-enhanced instruction to create engaging, multimodal learning experiences that cater to the needs of young learners. This aligns with contemporary educational theories emphasizing the importance of interactive and personalized learning environments.

These conclusions have important implications for early childhood education:

- Educators and policymakers should consider integrating interactive applications into kindergarten reading curricula as complementary to traditional instruction.
- The design of early literacy interventions should leverage the engaging nature of interactive applications to maximize learner engagement and reading skill development outcomes.
- The potential of these applications to benefit learners regardless of background suggests they could be precious in diverse or resource-limited educational settings.

While these findings are promising, it is essential to note the study's limitations, including its small sample size and single-school setting. Future research should:

- Explore the long-term impacts of interactive application use on reading achievement.
- Investigate the specific features of these applications that contribute most to reading skill development.
- Examine how interactive applications can be most effectively integrated with traditional teaching methods.

In conclusion, this study provides strong evidence for the potential of interactive applications to enhance early reading instruction in kindergarten classrooms. By embracing these tools, educators can create more inclusive, engaging, and effective learning environments that foster a strong foundation in literacy for all learners.

Recommendations

Based on the findings and conclusions of this study, we offer the following recommendations for future research, educational practice, and policy:

For Researchers:

1. Conduct longitudinal studies to examine the long-term effects of interactive applications on reading achievement beyond kindergarten.
2. Investigate the optimal duration and frequency of interactive application use for maximum reading skill development.
3. Explore the effectiveness of interactive applications across different socioeconomic backgrounds and cultural contexts.
4. To further validate the effectiveness of interactive applications in developing reading skills, design studies with larger sample sizes and include control groups.
5. Examine the specific features of interactive applications (e.g., gamification elements, personalized learning paths) that contribute most significantly to reading skill development.

For Educators:

1. Integrate interactive applications into kindergarten reading curricula to complement traditional instruction methods. This integration should be thoughtful and purposeful, ensuring that technology enhances rather than replaces effective teaching practices.
2. Participate in comprehensive professional development opportunities focused on effectively implementing and leveraging interactive applications in classrooms. This training should cover:
    - Best practices for blending digital and traditional literacy instruction
    - Strategies for differentiating instruction using interactive applications
    - Techniques for facilitating student engagement with digital learning tools
    - Methods for troubleshooting common technical issues
3. Regularly monitor and assess students' progress using interactive applications to ensure they meet individual learning needs. Use the data generated by these applications to inform instructional decisions and provide targeted support.
4. Develop lesson plans incorporating interactive applications and hands-on activities to reinforce reading skills. For example, follow up a digital letter recognition game with a tactile alphabet activity.
5. Explore ways to involve parents in supporting their children's use of interactive applications at home, extending the learning beyond the classroom. This could include providing guidance on recommended applications, suggesting home literacy activities that complement digital learning, and sharing progress updates.
6. Create a classroom environment that supports seamless transitions between digital and traditional learning experiences. This might involve setting up dedicated tech stations alongside traditional reading corners.
7. Collaborate with colleagues to share best practices, troubleshoot challenges, and develop innovative approaches to integrating interactive applications in early literacy instruction.

For Policymakers and School Administrators:

1. Allocate dedicated funding for acquiring and implementing quality interactive applications in kindergarten classrooms. Prioritize this funding for rural and under-resourced areas to help bridge the digital divide in early childhood education.
2. Develop comprehensive guidelines for selecting and using interactive applications in early literacy instruction. These guidelines should:
    - Outline criteria for evaluating the educational value and age-appropriateness of applications
    - Provide benchmarks for time spent on digital learning activities
    - Offer strategies for integrating applications with existing curriculum standards
3. Create policies that support integrating technology-enhanced learning in early childhood education curricula. This could include:
    - Updating curriculum frameworks to incorporate digital literacy skills explicitly
    - Establishing standards for teacher proficiency in educational technology use
    - Implementing regular technology audits to ensure equitable access across schools
4. Initiate partnerships between educational institutions, technology companies, and research organizations to:
    - Develop locally relevant and culturally appropriate interactive applications
    - Conduct large-scale studies on the long-term impact of these applications
    - Create professional development programs for educators on effective tech integration
5. Establish a task force to monitor and evaluate the implementation of interactive applications in early childhood education. This group should regularly report on outcomes, challenges, and best practices.
6. Implement a grant program to support innovative projects that combine interactive applications with traditional teaching methods in early literacy instruction.
7. Develop a centralized resource hub for educators and administrators to access vetted interactive applications, implementation guides, and success stories from other schools.

For App Developers:

1. Collaborate with early childhood education experts to ensure that interactive applications align with current best practices in literacy instruction.
2. Develop features allowing easy progress monitoring and data collection to support ongoing research and assessment.
3. Create culturally responsive and adaptable applications to diverse learning contexts.

For Future Research Directions:

1. Investigate the combined effects of interactive applications and traditional teaching methods on reading skill development.

2. Explore the potential of interactive applications to support reading skill development for children with learning disabilities or those learning a second language.
3. Conduct comparative studies of different types of interactive applications to identify the most compelling features and approaches for kindergarten learners.
4. Examine the impact of interactive applications on other aspects of child development, such as digital literacy, fine motor skills, and social-emotional learning.

Addressing these recommendations, future research and educational practices can build upon this study's findings to further enhance early literacy instruction and support the reading development of young learners in an increasingly technology-rich educational environment.

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