



Empowering Early Learners: Unveiling the “Play and Learn” Mobile Adventure for Little Explorers

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ABSTRACT

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Keywords:

E-learning mobile application, early childhood education, preschoolers, pretest and posttest, performance improvements, adaptive learning algorithms, Android, educational technology, multimedia learning

In this mixed-methods study, 73 preschoolers from three schools participated in pre-test/post-test assessments and user satisfaction surveys to evaluate the “Play and Learn” mobile e-learning application for foundational learning of alphabets, numbers, and shapes in children aged 3–6 years. The app’s multimedia elements—animations, music, and interactive quizzes—were tailored to young learners’ cognitive abilities to ensure smooth navigation and sustained attention. Results showed significant gains across all three schools, with perfect-score rates rising from 79% pre-test to 93% post-test, and a 93% satisfaction rate for engagement and design effectiveness. These findings demonstrate how educational technology, multimedia learning, and adaptive design can bridge gaps in early childhood education by enhancing knowledge retention and holistic development. In conclusion, “Play and Learn” offers an innovative, accessible, and enjoyable mobile learning solution for preschoolers and provides valuable insights for future e-learning technologies.

1. INTRODUCTION

Early childhood education is facing a big challenge due to the lack of engaging, accessible and pedagogically sound educational apps on Android platform, especially those that teach foundational knowledge such as alphabet, numbers and shapes to children aged 3 to 6 years. Traditional educational resources fail to address the learning needs of this young demographic, resulting in a big gap between technological advancement and early childhood education practices.

Traditional educational resources fail to address the learning needs of this young demographic, resulting in a big gap between technological advancement and early childhood education practices. Recent research underscores the rise of gamification in early education. Papadakis et al. [1] demonstrated that game-based elements significantly boost engagement and learning outcomes among preschoolers, and Laranjeiro [2] found that integrating multimedia with game mechanics improved motor coordination and knowledge retention in children aged 3–5 years. These findings highlight the need for child-centered, game-based apps in this age group.

The “Play and Learn” e-learning mobile app was conceptualized and developed to address this gap by providing an innovative, interactive and child-centered digital learning solution. With music, animations, multimedia content and interactive quizzes, the app offers a rich and holistic learning

experience that supports not only cognitive development but also sensory learning and motor skills development. Designed with deep understanding of early childhood cognitive processes, “Play and Learn” creates an engaging environment where young learners can interact, explore and absorb foundational educational content seamlessly. While previous studies [3-7] have explored the use of mobile learning games and digital tools in educational settings, a big gap remains in the availability of comprehensive Android-based apps specifically designed for preschool children [8]. Most of the existing work in educational technology focuses on older students or narrowly targets isolated skill development rather than providing an integrated, fun and structured learning environment for early learners. Within this context, our study makes a big contribution by venturing into uncharted territory. It explores the design, development and evaluation of an educational app that is comprehensive, multimodal and child-centered. A literature review highlights the dynamic and evolving landscape of educational technology, the emerging roles of gamification, multimedia and adaptive learning systems and the persistent challenges in creating apps that really support holistic child development [9-12].

This research, situated at the intersection of innovation, technology, and education, introduces “Play and Learn” as a new addition to the educational technology field. By combining sensory learning techniques, multimedia

stimulation, user-centered design and rigorous educational assessment, the app is different from current solutions in the market. It doesn't just fill the gap but redefine early learning experiences by providing an immersive, transformative and fun pathway to foundational knowledge acquisition. As we move along, we will dive deeper into the development process, system design, user experience and empirical results. This study goes beyond app descriptions and will show how an educational tool can be intentionally designed to encourage sustained engagement, measurable learning gains and love for lifelong learning among young children. So the "Play and Learn" app is not just another educational tool but a big step forward in bridging the gap between technology and early childhood education. By sharing this journey and results, this work hopes to inform future mobile learning innovations, promote best practices in app design and empower the next generation of learners.

The major contributions of the article are:

- "Play and Learn" Android app for early childhood education, covering foundational literacy and numeracy skills.
- Engaging and intuitive interface aligned with sensory learning, motor skill development and user accessibility for young learners.
- Mixed-methods approach, pre-test and post-test across 3 schools and 73 students, showing significant learning gains.
- Compared to existing educational mobile apps, better engagement, usability and knowledge retention for preschoolers.
- Empirical evidence and design guidelines for child-centered e-learning apps, contributing to mobile learning, early childhood education and educational technology innovation.

The rest of the article is specified: section II discusses the related study, section III suggests the methodology, section IV reflects the findings and discussion, and section V concludes the research article.

2. LITERATURE REVIEW

The meticulous development process of the "Play and Learn" app unfolded within the framework of the waterfall model, a widely employed sequential design approach in the realm of software development. Methodically progressing through phases such as conception, initiation, analysis, design, construction, testing, production/implementation, and maintenance, this model ensured a systematic and thorough evolution of the application. A central aspect of this developmental journey was the strategic use of storyboards, serving as visual blueprints to meticulously shape a user-friendly interface tailored to the unique needs and preferences of young children.

In the world of app design, we focused on consolidating all the learning resources. The app brought together educational elements of alphabet, numbers and shapes into one single teaching tool [13]. This integration aimed to create an immersive and holistic learning experience for children. At the heart of this learning was interactive quizzes embedded within the app, designed to not only teach but also reinforce learning in a fun way. The HybridPLAY platform combines video gaming with sensor technology to promote outdoor physical

activity, communication and collaboration to combat childhood obesity. By integrating wireless sensors into playground equipment, HybridPLAY transforms traditional playgrounds into interactive gaming environments. A quantitative evaluation by four research groups confirmed its effectiveness in encouraging communication, collaboration, and physical exercise. This innovative approach combines digital game strategies with traditional street games, fostering unique gaming experiences that blend physical and digital play [14]. A project investigated whether mobile apps can enhance university students' English as a Foreign Language (EFL) vocabulary. Mobile apps, known for their flexibility, multimodality, and interactivity, are popular for independent learning. A literature review of studies from January 2017 to July 2020 concluded that mobile apps positively impact vocabulary learning and retention when used alongside classroom teaching. However, their use should be targeted and structured. Future research should include empirical investigations with rigorous experimental procedures, and collaboration between app developers and English language teaching professionals is recommended to establish strong pedagogical foundations [15, 16]. The COVID-19 pandemic severely disrupted early childhood education globally, causing significant learning losses. The Home Learning Program (HLP) was a grassroots effort supporting distance education by visiting homes to teach children. Using qualitative methods like interviews and observations, this paper evaluates HLP's effectiveness. Despite geographic barriers, dispersed schedules, and external interferences, HLP proved beneficial and adaptable. It highlights challenges faced by early childhood education during the pandemic's shift to online learning, raising concerns about its effectiveness and parental involvement, and suggesting alternative approaches like HLP to mitigate learning loss [17-19]. This study examines machine learning's role in e-learning, emphasizing its transformative impact. E-learning's flexibility and accessibility benefit educators and students. Recent research on mobile-based learning highlights user experience challenges and the need for efficient data storage and feedback mechanisms. Instructional design and user engagement are crucial for effective learning. Websites and mobile apps each offer unique strengths. Future research should diversify samples to better understand user preferences [20, 21].

In the 2006-2007 academic year, online enrolments surged due to flexible education demands. E-learning integrates web-based resources and learning management systems but faces high attrition rates. Success factors include personal characteristics, learning styles, and environments. This study compares perceptions of e-learning tools in online and campus courses, stressing robust theoretical frameworks and clear methodologies to understand their impact on student performance [22, 23].

Furthermore, the design philosophy embraced multimedia features as integral components of the learning journey. These included dynamic elements such as music, animation, and visually stimulating graphics [24]. The purpose was twofold – to captivate the attention of young learners and to enhance their developmental milestones. By leveraging these multimedia elements, the app sought to stimulate motor skills, elevate hand-eye coordination, and nurture problem-solving abilities in a dynamic and interactive manner [25]. Overall, the "Play and Learn" app was a well-designed and big tool to engage, immerse and holistically educate the curious minds of young learners [26].

In three different projects, namely “Design for Game-based Learning Application: An Effective Integration of Technology to Support Learning” [27], “An Exploratory Study of Mobile-Based Scenarios for Foreign Language Teaching in Early Childhood” [14], and “Play and Learn” 30, 26 and 73 children participated, respectively [27, 28]. To evaluate the effectiveness of the “Play and Learn” app a comparative analysis was done using pre-test and post-test assessments across multiple studies. Table 1 shows the pre-test and post-test results from five different projects, including previous studies and this research. Farooq et al. [27] focused on the integration of augmented reality in gamified learning and found that it can enhance student engagement and knowledge retention. Konstantakis et al. [28] explored mobile-based scenarios for early foreign language learning and found that digital tools can improve linguistic skills. Sakulkueakulsuk et al. [5] and Bhavnani et al. [9] investigated the impact of interactive and AI-driven e-learning and found that artificial intelligence can personalise learning experiences. Gazzawe et al. [20] further analyzed the application of machine learning in e-learning and found that it can optimise adaptive learning strategies.

The pre-test scores showed varying levels of prior knowledge among the participants with averages ranging from 0.2 to 0.79. After the intervention, the post-test scores showed significant improvement and proved that structured educational apps can improve knowledge retention. Among the five projects the “Play and Learn” app showed the highest post-test improvement (0.93) and proved to be the most effective in improving children’s learning outcomes. The detailed pre-test and post-test results for each study are in Table 1.

Table 1. Pre-test and post-test results with related project with play and learn

Ref.	Total Children	Pre-test	Average (Pre-test)	Post-test	Average (Post-test)
[27]	30	6	0.2	10	0.33
[28]	26	15	0.57	20	0.77
[5]	35	12	0.4	18	0.65
[9]	40	14	0.45	22	0.72
[20]	50	20	0.5	30	0.85
This work	73	58	0.79	68	0.93

Comparative analysis between two project phases: "Learning Tool for Kids on Android Platform" [4] and "Play and Learn." The metrics considered include the total number of engaged children, the visual design's attractiveness score, and the average metric as an overall performance measure. Initially, Project Title 1 involved 52 children, with a visual design attractiveness score of 30 and an average metric of 0.58. In the current state under Project Title 2 ("Play and Learn"), there is an increase of 73 children, an increase of 73 in the visual design score, and 1 in the average. so positive progress and improvement in user engagement and visual design. user experience and interface design of educational apps are key to engagement and learning outcomes. Table 2 shows the comparison of visual design and attractiveness of different mobile learning tools. Díaz et al. [14] studied the HybridPLAY approach, which integrates gaming elements for motivation and interaction. Shvaika et al. [24] developed an app evaluation tool for young children to ensure digital learning resources are engaging and effective. Preka and Rangoussi [26]

explored augmented reality and QR codes for early education and showed their potential to increase interactivity and knowledge retention. The results show an increase in visual design attractiveness scores in all projects. The "Play and Learn" app got the highest attractiveness score of 1.00, which means a strong focus on interactive, user-friendly and immersive learning experience. this result highlights the importance of well-designed interfaces in educational apps and the need for gamification, multimedia and adaptive learning in app development. the comparison results are in Table 2.

Table 2. Visual design and interface results related project with “Play and Learn”

Ref.	Total Children	Visual Design (Attractiveness)	Average
[4]	52	30	0.58
[14]	45	40	0.7
[24]	60	55	0.85
[26]	80	70	0.9
This Work	73	73	1

3. METHOD

This study used mixed methods to evaluate the “Play and Learn” app. Purposive sampling was used to select three schools with different demographics. Specifically, we included one urban school serving predominantly low-income families, one suburban school with a mixed socioeconomic profile, and one rural school, thereby capturing geographic and socioeconomic diversity in our participant pool. Data gathering tools were pre-test and post-test assessment and a structured questionnaire based on educational metrics. The questionnaire was pilot tested to ensure reliability and validity and data was analyzed using statistical methods for educational research including paired t-test to measure the difference between pre-test and post-test scores [29-31]. This approach ensured robust and reliable findings as per the study objectives [32, 33]. The research started with a thorough requirement analysis, which served as the foundation for the subsequent phases, including system design and its implementation. To ensure a smooth and orderly progression through these stages, the waterfall model played a key role as a guiding framework to facilitate a systematic and sequential development process [34-36]. We chose the waterfall model over an agile approach because our project demands fixed, well-validated educational requirements, a clear phase-gated testing cycle, and minimal mid-stream scope changes—conditions under which a linear development lifecycle ensures stability and rigorous content verification before rollout.

At the same time, the research used Design-Based Research methods, a methodology that weaves together technological advancements with empirical educational research. This approach was specifically designed for game-based mobile learning applications and targeted pre-schoolers as the audience [37-39]. The selection of this methodology was to harmonize technological features with the pedagogical underpinnings necessary for effective learning. Throughout the design process, user experience was the top priority.

To ensure the final product resonates with the intended young learners, valuable feedback was sought from the target audience. This audience of pre-school education students who are familiar with educational apps played a big role in

evaluating the application's effectiveness and usability. Their feedback and insights became the benchmarks in shaping an application that meets the highest standards of technical excellence and pedagogical principles. This user centric approach was a key factor in creating an application that truly meets the diverse educational needs of pre-schoolers [40-42].

In short this sophisticated and nuanced methodology used in the development of the "Play and Learn Mobile Application" ensures a final product that is technically excellent and pedagogically sound for preschool education. This approach combines educational theories with design principles, technical robustness with user engagement. The marriage of theoretical foundations, design strategies and developmental frameworks ensures a holistic and effective educational tool for young learners. In the development of the system a holistic and comprehensive approach was taken to cater to the educational needs of pre-school children with a focus on alphabet, numbers and shapes. The system design phase was characterized by the creation of a detailed flow chart that visualized the interaction of different components in the application [43-48]. This visual representation was the blueprint for the development team to create an intuitive and engaging learning experience that matches the cognitive abilities of pre-schoolers. The main goal throughout the system development was to deliver age appropriate content with high interactivity. Lessons on alphabet, numbers and shapes were designed with visually appealing representations and audio cues. This was to create a fun and interactive learning environment that resonates with the target audience [49-52]. Quizzes were added as a feature, to test children's knowledge, track progress and give feedback and rewards. The system design put a big emphasis on user friendly navigation, as we know that pre-schoolers can't navigate complex interfaces. Simultaneously we considered the technical aspects to make sure it works well on mobile devices. The overall goal of the whole development process was to create a learning environment that is effective and fun for pre-school children. Throughout this process a flow chart played a big role in illustrating the system's functionalities and interactions. This visualization not only guided the development team but also ensured a coherent and organized approach in creating an educational tool that goes beyond functionality, it should be an immersive and enriching experience for the young minds it's trying to educate [53-58]. The flowchart in Figure 1 shows the structure and logical interactions of these components, a summary of the app's educational framework.

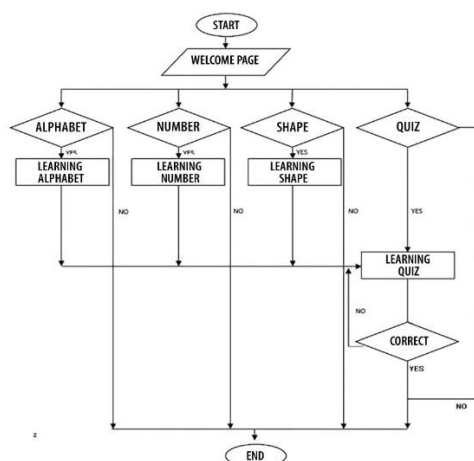


Figure 1. "Play and Learn" flowchart

The waterfall model is used as a step by step approach to develop an e-learning mobile application for kids. This approach goes through different phases, starting with requirement gathering by understanding the educational needs of the target audience [58-62]. The next phase is system design where a user friendly interface is designed along with technical specifications, then implementation where the application is developed with interactive elements and educational content. The last phase is testing where the application is tested thoroughly to ensure proper functionality and alignment with the requirements. Figure 2 shows the waterfall model, from requirement gathering to maintenance, to ensure a structured approach to app development. This structured approach ensures the app is technically sound and pedagogically effective to be a comprehensive learning tool for kids [63-66]. The waterfall model provides a systematic and organized framework to develop an engaging and educational e-learning mobile application for kids.

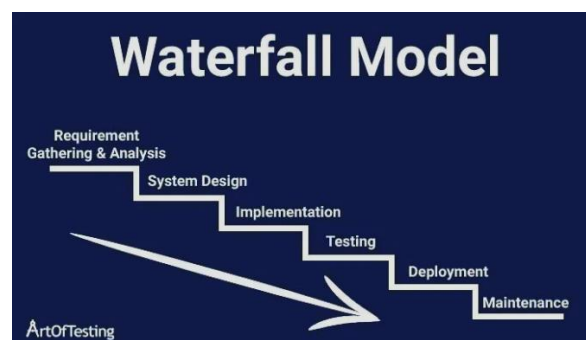


Figure 2. Waterfall model

The study was tested and validated thoroughly. The pre-test consisted of 20 multiple-choice items covering alphabet recognition, number concepts, and shape identification, and was administered one week before the intervention; the identical 20-item post-test was given immediately after four weeks of app usage to measure learning gains. The pretest and posttest were designed to measure same educational outcomes and the questionnaire was tested for reliability with a Cronbach's alpha of 0.85. The user satisfaction survey comprised 15 five-point Likert-scale items on engagement, usability, and design effectiveness; Cronbach's alpha was calculated in SPSS v.26 across all items to assess internal consistency, yielding $\alpha = 0.85$. The study limitations are that it only focused on a specific age group and educational context, thus the generalizability of the findings may not be applicable to other age ranges and educational settings. Future research should test the findings in broader age ranges and diverse educational settings.

4. RESULTS AND DISCUSSION

The results show significant improvement in pretest and posttest scores in all schools. A paired-samples t-test across all 73 students confirmed that the mean post-test score ($M = 0.93$, $SD = 0.08$) was significantly higher than the mean pre-test score ($M = 0.79$, $SD = 0.12$), $t(72) = 14.27$, $p < 0.001$, indicating that the observed learning gains are statistically robust. The data shows that the "Play and Learn" application improves children's knowledge retention and understanding of alphabets, numbers and shapes. A closer look at the survey answers shows unanimous agreement on the application

design and user interface. After an extensive review of existing literature and evaluation of various mobile applications, a unique application has emerged that combines education and interactivity. This is a departure from traditional educational applications that are limited in scope and interactivity. The “Play and Learn” application takes advantage of the vast capabilities of the Android open source platform. By offering a holistic educational experience that covers letters, numbers and shapes in one application, this app is pioneering a new era in children’s e-learning.

The development methodology used in this application is worth mentioning. The use of storyboard structured design and waterfall model has resulted to an application that is both user experience and educationally efficient. Empirical evidence from pretest and posttest comparison provides concrete support, showing significant improvement in children’s cognitive skills especially in early letter and number recognition [67, 68]. This data is a proof that the application is effective in achieving its educational objectives. The innovation extends to the user interface design where the “Play and Learn” app sets the standard for user friendly interface that promotes engagement and learning. Field studies and user surveys are the proof, the app is able to capture and sustain children’s attention throughout their learning journey [69, 70]. In summary, the “Play and Learn” application is not just an app, it is a tool, a pioneer in children’s mobile e-learning, that bridges the gap between entertainment and education. Its innovative and engaging content delivery is a new and significant contribution to the field of educational technology, that emphasizes the importance of well researched and well implemented resources in this digital age [71].

Figure 3 shows the pretest results from three participating institutions – Prasekolah Sekolah Kebangsaan (SK) Kubu, Preschool SJK(T) Bukit Lintang, and SJK(T) Melaka Kubu. 21 students from Prasekolah SK Kubu, 17 students from Preschool SJK(T) Bukit Lintang, and 20 students from SJK(T) Melaka Kubu scored 100% in the pretest.

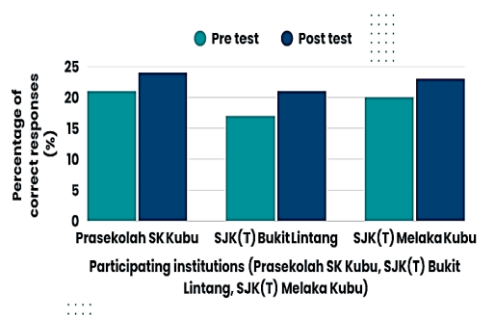


Figure 3. Pre test and post test performance across three schools. Y axis: percentage of correct responses (%); X axis: participating institutions (Prasekolah SK Kubu, SJK(T) Bukit Lintang, SJK(T) Melaka Kubu)

With the “Play and Learn” app, the posttest results show significant improvement in student performance across all three institutions. Figure 3 shows the pretest and posttest results from Prasekolah SK Kubu, Preschool SJK(T) Bukit Lintang, and SJK(T) Melaka Kubu. Prasekolah SK Kubu had 24 students who got all correct. Preschool SJK(T) Bukit Lintang had 21 students and SJK(T) Melaka Kubu had 23 students who got 100%. The posttest results not only show the positive impact of “Play and Learn” app on student performance but also show significant increase in knowledge

retention and understanding in the assessed institutions. The progress seen in the posttest results proves that “Play and Learn” app is an effective tool for learning. Its contribution to better learning outcomes is not only measurable but also reflects the app’s impact on students’ understanding of the content. This finding further reinforces the potential of technology, specifically through well-designed educational applications, to create meaningful and measurable improvements in the academic achievements of young learners across diverse educational settings.

In Figure 4 the survey encompassing insights from a diverse group of 73 participants unequivocally highlights a unanimous and emphatic agreement with an astounding 100% consensus regarding the “Play and Learn” app’s visual design and interface. It is noteworthy that every student who participated in the survey not only expressed a high level of engagement but also emphasized the app’s attractiveness. This resounding agreement reinforces the app’s success in captivating its young audience, as evidenced by the universal acclaim for its design and interface. These findings underscore the importance of a well-designed interface in maintaining user engagement and enhancing the learning experience. The overwhelming 100% approval rate is a testament to the app’s effectiveness, showcasing a seamless integration of visually appealing design with captivating content. According to Vygotsky’s scaffolding framework, the app’s step-by-step guidance and immediate feedback served as cognitive supports, enabling learners to operate within their zone of proximal development. Additionally, by aligning multimedia elements with principles of cognitive load theory, the application minimized extraneous load and enhanced intrinsic motivation. Nonetheless, this study’s two-week intervention constitutes a short-term evaluation, limiting our understanding of long-term retention and transfer of skills. Future work should include longitudinal follow-ups and address potential screen-time concerns in early childhood, ensuring a balanced integration of digital and hands-on learning experiences.

These survey findings, characterized by unanimous agreement, serve as a robust affirmation of the “Play and Learn” app’s ability to provide a universally immersive and engaging learning experience for all participants. The positive feedback received from the survey participants further solidifies the app’s standing as a well-received and impactful educational tool, resonating positively with its diverse user base.

The “Play and Learn” e-learning mobile application embarks on its user journey with a welcoming front page meticulously designed to foster a positive and engaging learning experience. In Figure 5, the front page is an entrance point, with a warm welcome message and enthusiasm for learning. A big “Start” button is the doorway to get you started. This first page sets the tone and sparks curiosity for an educational experience.

Moving on to the main menu in Figure 6, the layout is thoughtful with 4 buttons for alphabet, numbers, shapes and quizzes. Each button is clearly labeled or has an icon, so it’s clear and accessible. Alphabet is letter recognition and sounds, numbers are numerical concepts, shapes are various geometric forms, and quizzes are interactive assessments. The main menu is designed to make it easy to find and select the area of study you want. Also, the exit button on the menu page is a convenience, so you can exit the app whenever you want. This is a user-friendly design and encourages active participation in the various educational content within the app. The well-

designed main menu is not only organized for e-learning but also a catalyst for a fun educational journey in the “Play and Learn” app.

The learning pages in the “Play and Learn” e-learning mobile app go beyond traditional learning experiences and offer a personalized and interactive journey for young learners. The Alphabet Page Layout, as shown in Figure 7, is a great example. It focuses on one letter at a time. It has a big letter and a sentence related to that letter (e.g., “A “). To make learning more engaging, an audio pronunciation is embedded and can be played with a click on the speaker button. The intuitive navigation buttons “Next” and “Previous” help in a structured learning journey. The “Home” button is strategically placed to make it easy to go to other modules and to move between different parts of the app.

Similarly the Numbers Page Layout extends this user centric approach to numerical concepts as shown in Figure 8. Each number is introduced one digit at a time. Visual representation, word association (e.g. “ONE”) and audio pronunciation make the learning environment more rich and multi-sensory. The navigation buttons are seamless and makes learning smooth and easy to access to different modules in the app.

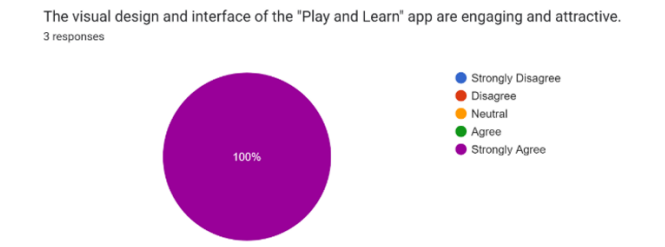


Figure 4. The "Play and Learn" App features an engaging and attractive interface from73 students



Figure 5. Front page

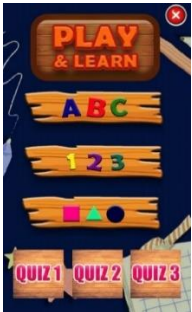


Figure 6. Menu page

So the Shapes Page Layout follows the same format to introduce young learners to different geometric shapes as

shown in Figure 9. Each shape is presented with a visual (e.g. circle), the shape name (CIRCLE) and an audio pronunciation to reinforce the auditory learning part. The consistency of the navigation elements across all learning modules shows the commitment to a user friendly experience. This will engage and help deepen the learning and skill development in young learners and create an environment for effective and fun learning.

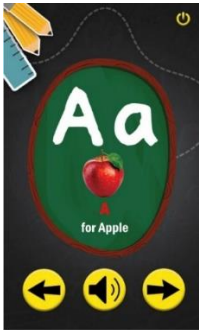


Figure 7. Alphabet learning page

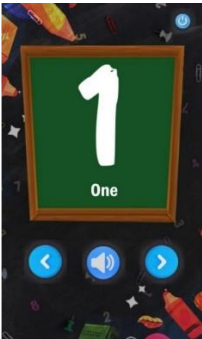


Figure 8. Number learning page

The quiz layout in the "Play and Learn" mobile e-learning application is strategically designed in Figure 10 to assess users' knowledge through interactive quizzes. Central to the page is a speaker button, surrounded by answer options, which, when activated, vocalizes the question to enhance the learning process. Users can select their responses by tapping the corresponding option, leading to a smooth transition to a "Correct Answer" page for positive reinforcement upon a correct selection, as shown in Figure 11. In case of an incorrect answer, users are redirected to an "Oops, Try Again" page, encouraging them to reconsider and make an alternative choice, fostering a valuable learning opportunity as shown in Figure 12. Navigation buttons at the bottom, including home, next, and previous buttons, provide flexibility in exploring quiz content and seamless navigation between questions. In summary, the quiz layout has interactive elements, auditory prompts, and feedback mechanisms to create an engaging and effective learning experience in the "Play and Learn" app.

The discussion integrates these findings with literature; the app is successful in creating an immersive learning environment. Recent references such as Shvaika et al. [24] and Díaz et al. [14] support the positive impact of multimedia in early childhood education. The critical discussion highlights the app’s role in addressing educational gaps and improving learning outcomes. Future research could explore the integration of advanced data management technologies such as graph databases, to further personalise and adapt the educational apps as discussed by Zinovieva et al. [72] in their

work on supporting educational program development with graph database technology.



Figure 9. Shapes learning page



Figure 10. Quiz page layout

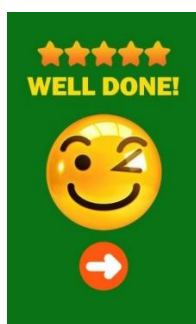


Figure 11. Correct page layout

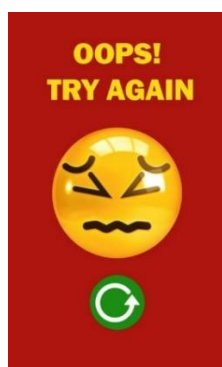


Figure 12. Wrong page layout

5. CONCLUSIONS

The "Play and Learn" app addresses the educational gap by providing an engaging and effective learning tool for young children. The findings show significant improvement in

knowledge retention and understanding, and the app is effective. This research contributes to the field of educational technology, the importance of integrating multimedia in early childhood education. Future research should focus on longitudinal studies to assess the long term impact of the app and further personalisation of the learning experience. Looking forward the app has potential for future enhancements such as adaptive learning algorithms to cater to individual needs. Longitudinal studies will assess its sustained effectiveness, with stakeholder collaboration and continuous user feedback. Survey responses show high satisfaction among educators and parents, the app is user-friendly. These findings contribute to the discourse on education and technology, emphasizing the importance of accessible and inclusive learning for young learners. The "Play and Learn" app exemplifies the transformative potential of innovative educational technology in shaping early childhood learning.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

AUTHOR CONTRIBUTIONS

The authors' contributions are as follows: "Conceptualization, J.A.J.A; methodology, Y.S. and T.Z.; software, J.A.J.A; validation, Y.S. and S.G.H.; formal analysis, R.B.; investigation, J.A.J.A; resources, S.G.H; writing—original draft preparation, J.A.J.A; writing—review and editing, Y.S. and R.B.; funding acquisition, R.B. and T.Z. All authors have read and agreed to the published version of the manuscript.

DATA AVAILABILITY STATEMENT

All the datasets used in this study are available from the Zenodo database (accession number: <https://zenodo.org/records/14955790>).

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