

Mobile Application for Mastery of Science Process Skills in Year 6 KSSR Science

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ABSTRACT: This project presents the development of Curio Sains, a mobile learning application designed to enhance Year 6 students' mastery of Science Process Skills (SPS) in full alignment with the Kurikulum Standard Sekolah Rendah and the Dokumen Standard Kurikulum dan Pentaksiran (DSKP) requirements. The study addresses a common challenge in primary science education, namely students' difficulties in identifying manipulated, responding, and constant variables, as well as constructing systematic and scientifically accurate conclusions. The application was developed using the Evolutionary Prototyping methodology, which involved iterative cycles of design, testing, and refinement based on feedback from relevant stakeholders. This approach ensured that the application's three-tier pedagogical scaffolding remained both technically robust and educationally effective, enabling learners to progress from guided keyword recognition to independent answer construction. The development results indicate that Curio Sains functions as a high-fidelity digital learning assistant that supports both self-paced student learning and teacher-led classroom instruction. By integrating complex scientific heuristics into a gamified mobile environment, the project offers a practical framework for the digital transformation of science education and contributes an innovative approach to improving SPS mastery among primary school students.

KEYWORDS: Mobile Application, Curio Sains, science process skills

INTRODUCTION

Science is a fundamental subject in Malaysia's primary school curriculum, essential for fostering curiosity, critical thinking, and problem-solving abilities from a young age. By means of science, learners start to grasp the natural environment, examine cause and effect connections, and cultivate the skills to inquire, test, and think critically. These skills are crucial not only for educational achievement but also for equipping students to excel in a swiftly evolving, technology-oriented world. To achieve this, the curriculum emphasizes the mastery of Science Process Skills (SPS), which provides the framework for scientific inquiry and analytical thought. The mastery of Science Process Skills is vital because it requires students to move beyond the simple memorization of facts toward active scientific reasoning. Students must demonstrate proficiency in identifying variables, specifically manipulated, responding, and constant variables, while also constructing logical observations and conclusions based on experimental data. Scientific reasoning serves as the cognitive bridge that allows students to interpret evidence and explain natural phenomena. However, many students struggle with the technical requirements of answering subjective questions in the KSSR Science assessment, often finding it difficult to structure their thoughts into coherent scientific statements. To address these challenges, this project involves the development of Curio Sains, an interactive, question-based mobile application designed for Year 6 students (Mushani, 2021; Elliyani et al., 2024). The system is modeled after successful language-learning platforms like Duolingo, prioritizing iterative, bite-sized learning to ensure long-term retention. Curio Sains functions as a digital coach that breaks down complex scientific heuristics into manageable interactive tasks. The core of the application is a three-tier pedagogical scaffolding system designed to transition students from basic recognition to independent mastery. In the first level, students are introduced to station-specific keywords through binary-choice tasks that build foundational confidence. The second level utilizes multiple-choice questions to test their ability to apply these keywords in different contexts. Finally, the third level requires students to fill in the blanks to construct complete scientific answers for variables and conclusions. This structured approach, combined with a dual-user interface for students and teachers, ensures that the learning experience remains aligned with the KSSR DSKP requirements while fostering the critical thinking skills necessary for academic success (Yusoff & Tan, 2020; Dong et al., 2023).

Science education in Malaysia is designed to produce a scientifically literate society capable of competing in a global, technology-driven economy. Under the Primary School Standard Curriculum (KSSR), the Ministry of Education emphasizes the development of curiosity, critical thinking, and problem-solving skills through a structured inquiry-based approach. The core of this curriculum is the

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mastery of Science Process Skills (SPS), which provides students with the necessary tools to investigate natural phenomena systematically. These skills are essential not only for academic success in primary school but also as a foundation for advanced scientific study in secondary and tertiary education (Karpudewan et al., 2022; Semercioğlu, 2025).

Despite its importance, mastering Science Process Skills remains a significant challenge for many Year 6 students. While students may be able to memorize scientific facts, they often struggle with the higher-order thinking required for subjective assessments. Specifically, students find it difficult to identify manipulated, responding, and constant variables and to construct logical conclusions based on experimental data. This difficulty stems from a gap in scientific reasoning, where learners are unable to connect observed evidence with formal scientific statements. Consequently, traditional teaching methods often fail to provide the repetitive, personalized coaching needed for students to master these complex heuristics. The integration of mobile learning and gamification has emerged as a promising solution to bridge this pedagogical gap. Digital platforms offer a more dynamic environment than conventional textbooks, allowing for immediate feedback and interactive engagement. According to Mahamad et al. (2020), mobile learning for Science Process Skills can significantly enhance student participation by providing accessible and flexible learning opportunities. Furthermore, gamified elements such as tiered challenges and reward systems have been shown to increase student motivation and improve conceptual understanding (Zainuddin et al., 2020). These technologies allow for a "scaffolded" learning experience, where complex tasks are broken down into manageable steps that align with the cognitive development of the learner. In light of these developments, there is a clear need for a specialized digital tool that focuses on the technical mastery of SPS for Year 6 students. Curio Sains is developed to address this need by providing an interactive, question-based learning environment. By focusing on challenging topics such as Humans, Speed, Animals, and Forces, the application employs a three-tier scaffolding system to guide students from keyword recognition to independent answer construction. This approach ensures that students do not just memorize answers but instead develop the underlying logical reasoning required by the KSSR DSKP. Through this iterative learning model, Curio Sains serves as a digital assistant that supports both self-paced student mastery and teacher-led classroom management.

LITERATURE REVIEW

Mobile Learning and Question-Based Mechanics

Mobile learning has emerged as a powerful vehicle for delivering science content, particularly when paired with inquiry or question-based mechanics. Research indicates that engaging in mobile scientific inquiry affects the development of science process skills (SPS) significantly and positively (Ekici et al., 2020). Meta-analyses on the subject show that mobile learning increases science achievement with a notable effect size ($g = .857$), and these effects are even larger for inquiry or game-based learning compared to other activities (Dong et al., 2023). Successful examples include the Okiwibook scientific app, which utilized interactive quizzes and energy-related activities to simplify complex topics (Kamarudin et al., 2024). Such platforms often utilize a tiered structure where each level provides correlated resources, including animations, simulations, and quizzes, to reinforce learning outcomes (Tavares et al., 2021).

Research Gaps and the Need for Structured Tools

Despite the benefits of digital tools, there is a clear necessity for systematic guidance in implementing digital inquiry-based science teaching. Many primary science teachers require better support to align their lessons with digital content and utilize technology effectively (Kamarudin et al., 2024). Recent updates to science curricula worldwide highlight a shift away from purely theoretical knowledge toward practical, skill-oriented learning (Semercioğlu, 2025). Many teachers still struggle to implement inquiry-based teaching without the right tools, underscoring the gap that applications like Curio Sains aim to fill (Yáñez-Pérez et al., 2024).

Analysis of existing Applications

A Mobile App for Inquiry-Based Science Teaching IndagApp is a free mobile and PC application designed to support inquiry-based science teaching for students aged 10–14. It guides users through all five phases of the scientific inquiry cycle, including formulating research questions, developing hypotheses, designing experiments, interpreting data, and drawing conclusions. Developed using a user-centered approach, the app includes ten interactive science units aligned with the Spanish curriculum. It features 3D simulations, realistic scenarios, data collection tools, and built-in scaffolding such as videos and text explanations to support student learning. The app was tested with 90 pre-service teachers using a mixed-methods approach to evaluate its usability and effectiveness in the classroom. The main advantage of IndagApp is its comprehensive approach to inquiry learning, addressing gaps found in other virtual science tools that often skip key steps of the inquiry process. It is designed to reduce cognitive overload while keeping students engaged through age-appropriate visuals and structured learning. However, the app is currently only available in Spanish and requires teacher guidance, making it less suitable for independent learning. Additionally, the app focuses on topics that can be taught through experimentation, which may not cover all areas of the science curriculum. Overall, IndagApp is a valuable and innovative tool that promotes reform-oriented science teaching through meaningful, technology-enhanced inquiry experiences. Comparative Table based on Existing Applications. The analysis of existing applications is conducted to identify their strengths and weaknesses, which can serve as a basis for improving the application to be developed.

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Comparative Analysis of Existing Science Learning Applications

Several mobile learning applications have been developed, as presented in Table 1, to support science education through interactive and technology-enhanced learning experiences. Each application offers distinct features and instructional approaches that contribute to student engagement and learning effectiveness.

IndagApp is an inquiry-based science learning application designed for students aged 10–14 years. The application guides learners through the complete scientific inquiry process, including formulating research questions, developing hypotheses, conducting experiments, analysing data, and drawing evidence-based conclusions.

Saintifik is a game-based mobile learning application specifically developed for Indigenous students in Malaysia. The application integrates science content with gamification elements such as points, timers, rewards, and health bars to enhance learner motivation, participation, and engagement throughout the learning process.

Animals is an interactive mobile application that focuses on animal science education. It incorporates visual learning materials, animations, and educational mini-games to facilitate students' understanding of animal anatomy, reproduction, and feeding habits in an engaging and accessible manner.

In comparison, **Curio Sains** integrates multiple pedagogical and technological elements within a single platform, including game-based learning, curriculum alignment with the KSSR Science syllabus, science process skills development, and teacher monitoring features. This comprehensive approach enables students to engage in meaningful science learning experiences while allowing teachers to monitor and support learners' progress effectively (Mahamad et al., 2020; Zainuddin et al., 2020; Dong et al., 2023).

Table 1: Comparative Analysis of Existing Science Learning Applications

Feature	IndagApp	Saintifik	Animals	Curio Sains
Learning Approach	Inquiry-Based Learning	Game-Based Learning	Interactive Visual Learning	Quest-Based RPG Learning
Target Users	Students aged 10–14	Indigenous Primary Students	General School Students	Year 6 Primary Students
Curriculum Alignment	Spanish Science Curriculum	Malaysian Standard 1 Science Curriculum	Animal Science Topics	Year 6 KSSR Science Curriculum
SPS Support	High	Moderate	Low	High
Gamification	Limited	High	Moderate	High
Interactive Activities	3D Simulations	Science Games	Mini-Games	Missions and Quests
Teacher Monitoring	Required	Limited	Limited	Real-Time Tracking
Multimedia Features	Videos and 3D Models	Graphics and Rewards	Animations	Animations and Audio
Learning Scope	Inquiry Topics	Basic Science Topics	Animal Science Only	Comprehensive Year 6 Science
Main Limitation	Teacher Dependence	Limited Coverage	Limited Topic Scope	Not Identified
Overall Strength	Complete Inquiry Support	Strong Motivation	Visual Learning	Comprehensive Integration

METHODOLOGY

In this project, the Evolutionary Prototyping Model was selected as the primary development methodology, as illustrated in Figure 1. This model is highly suitable for the interactive and feedback-driven nature of the Curio Sains mobile application because it supports continuous system improvement through iterative development and refinement. Unlike traditional linear models, the Evolutionary Prototyping approach begins with the development of a core prototype, which is progressively enhanced based on stakeholder feedback until the final system is achieved. Since Curio Sains is designed for Year 6 students following the KSSR Science syllabus, this methodology ensures that the application remains technically reliable, user-friendly, and educationally effective throughout the development lifecycle. The development process started with **Phase 1: Requirement Analysis and Planning**, where user needs, learning objectives, and KSSR DSKP requirements were identified and analyzed. This was followed by **Phase 2: Architectural Design and Wireframing**, which focused on designing the system structure, interface layout, and interaction flow for both students and teachers. In **Phase 3: Development of the Core Prototype**, a functional prototype containing the main learning modules and Science Process Skills (SPS) features was developed. Next, **Phase 4: Prototype Evaluation and Feedback** involved collecting feedback from users and stakeholders to identify weaknesses, usability issues, and areas for improvement. The iterative nature of the model allowed the prototype to be refined repeatedly based on this feedback. Subsequently, **Phase 5: System Evolution and Full Implementation** expanded the prototype into a complete system by integrating advanced features such as the three-tier pedagogical scaffolding and the dual-user interface for teachers and students. Finally, **Phase 6: Final**

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Validation and Deployment ensured that the completed application met functional, educational, and usability requirements before deployment. Overall, the Evolutionary Prototyping Model enabled continuous testing, validation, and enhancement throughout the project. This iterative process ensured that Curio Sains was fully aligned with the KSSR DSKP standards while effectively supporting the learning needs and engagement of primary school students (Pressman & Maxim, 2020).

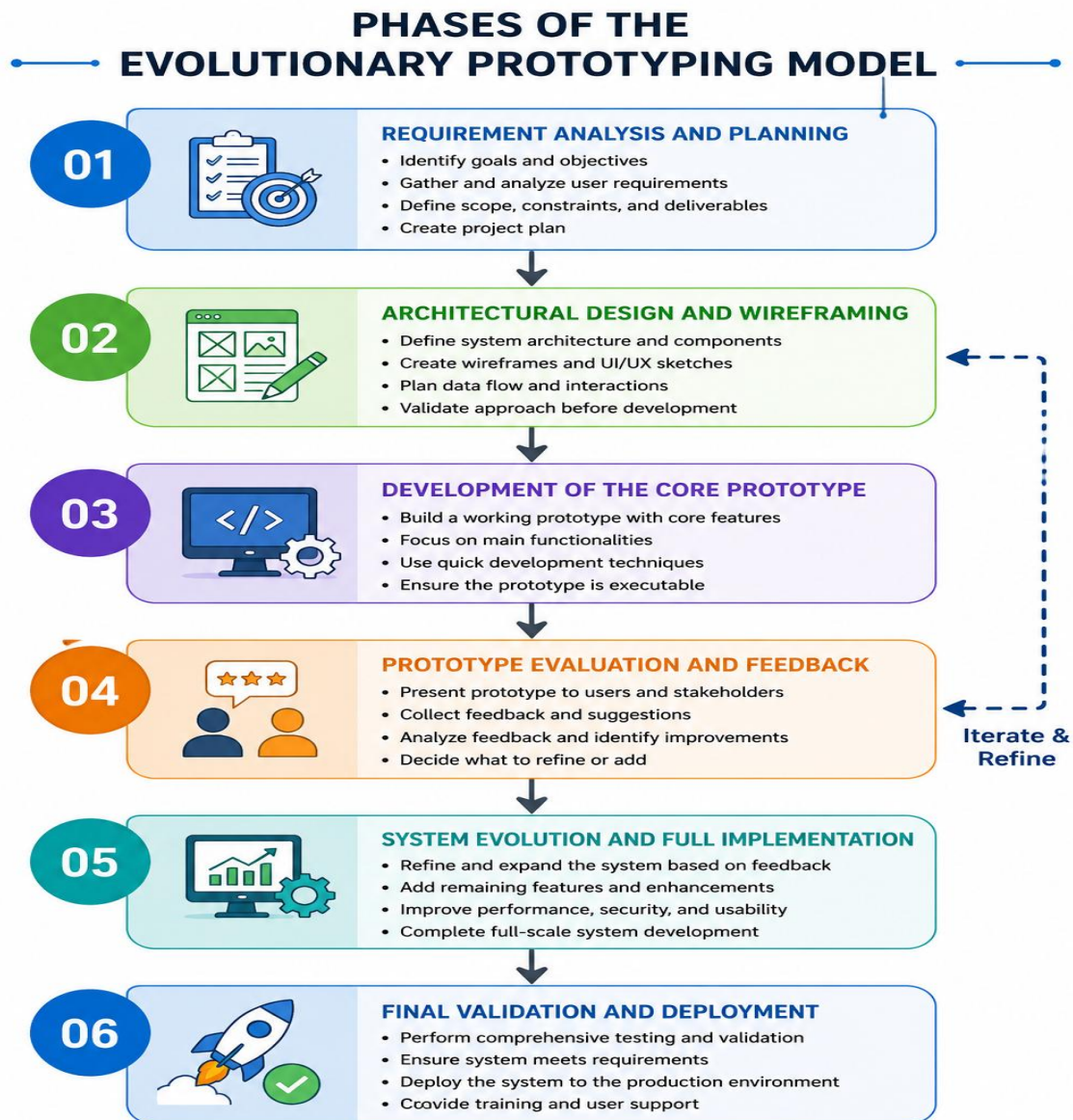


Figure 1: Process Flow of the Evolutionary Prototyping Model

Phase 1: Requirement Analysis and Planning

The development process began with a comprehensive analysis of the KSSR DSKP for Year 6 Science. The primary goal was to translate complex Science Process Skills (SPS) into interactive, question-based mechanics. This phase involved identifying the core learning objectives for the selected topics: Humans, Animals, Force, and Speed. Technical requirements were defined for the student and teacher modules, including the logic for the three-tier scaffolding and the integration of Supabase for real-time progress tracking. Input was collected from science teachers to ensure that the "Smart Notes" (Nota Pintar) and quiz components accurately reflected school-taught strategies for identifying variables and making conclusions.

Phase 2: Architectural Design and Wireframing

In this phase, the system's architecture was designed to support a dual-user environment. Using tools such as Figma, wireframes and low-fidelity prototypes were created to map out the navigation flow of the Belajar Bersama Curio stations and the classroom management interface. The design prioritized an intuitive user experience (UX) for young learners, focusing on clear visual cues for the three levels of difficulty. Storyboards were drafted to illustrate the transition from Level 1 (binary choice) to Level 3 (fill-in-the-blank), ensuring a logical pedagogical flow throughout the application.

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Phase 3: Development of the Core Prototype

The initial prototype was developed using the Flutter framework and Dart programming language. This version featured the core logic of the application, focusing on the first two topics: Humans and Speed. This "evolutionary core" included the functional three-tier scaffolding system, allowing users to earn scores through station-based challenges. Backend integration with Supabase was established to manage user authentication and store ranking data. At this stage, the prototype was a working version of the final app, providing a solid foundation for further expansion and refinement.

Phase 4: Prototype Evaluation and Feedback

The core prototype underwent usability testing with a target group of Year 6 students and a science teacher. The evaluation focused on the clarity of the SPS keywords and the effectiveness of the interactive levels. Feedback indicated high levels of engagement, but identified a need for more descriptive visual feedback when students provided incorrect answers in the fill-in-the-blank sections. Suggestions were also made to enhance the "Ranking" interface to increase student motivation. This feedback was systematically documented to guide the next stage of the application's evolution.

Phase 5: System Evolution and Full Implementation

Based on the evaluation findings, the prototype was expanded and refined. This phase involved completing the remaining topics, Force and Animals, and integrating the full Teacher Module. The teacher interface was evolved to include class creation via unique join codes and student list monitoring. The "Ranking" and "Star" systems were optimized for all modules, and adaptive quiz logic was introduced to improve replayability. The final refinements included the addition of high-quality animations and sound effects, transforming the initial prototype into the complete Curio Sains ecosystem.

Phase 6: Final Validation and Deployment

The final phase focused on validating the fully evolved system in a classroom environment. The application was assessed for its technical stability and pedagogical effectiveness in teaching Science Process Skills. Teachers evaluated the classroom management tools, while students interacted with the complete range of stations and quizzes. The results confirmed that the evolutionary approach resulted in a robust digital learning assistant that strictly adheres to KSSR standards. The project concluded with the documentation of the system's performance and recommendations for future iterations, such as adding progress analytics for parents.

RESEARCH FINDING

Functional Testing

Functional testing was conducted to ensure that each core module in Curio Sains operated in accordance with the KSSR Science DSKP requirements and the application's intended instructional logic, as illustrated in **Figure 2: Four Type of Testing Flow**. This process involved systematically evaluating the three main modules—Nota Pintar, Kelas Saya, and Belajar Bersama Curio to verify that all features functioned accurately and responded appropriately to user interactions. The Nota Pintar module was tested to confirm that high-impact keywords were successfully retrieved from the Supabase database and displayed in a concise, well-structured format that enhanced readability while minimizing cognitive overload. For the Kelas Saya module, testing focused on the reliability and security of the 6-digit Join Code mechanism to ensure that students were correctly enrolled into their respective classes and that their learning progress was accurately synchronised with the teacher dashboard. Meanwhile, the Belajar Bersama Curio module, which integrates the Three-Tier Scaffolding framework, was evaluated through multiple simulated learning scenarios to validate the sequential lock mechanism. This mechanism ensured that students could only access higher learning levels after successfully completing the previous stages. Particular attention was given to Level 3 (Statement Construction), where various scientific statements were submitted to assess the accuracy of the keyword-matching algorithm in evaluating student responses based on predefined variables stored in the database. In addition, the real-time leaderboard functionality was tested to verify that points and star rewards were updated instantly through Supabase Realtime whenever students completed a learning activity or module. Any issues identified during the functional testing process were carefully documented, analysed, and resolved to ensure that the final version of Curio Sains operated reliably, efficiently, and in full compliance with all specified functional requirement. (Pressman & Maxim, 2020; ISO/IEC 25010, 2011).

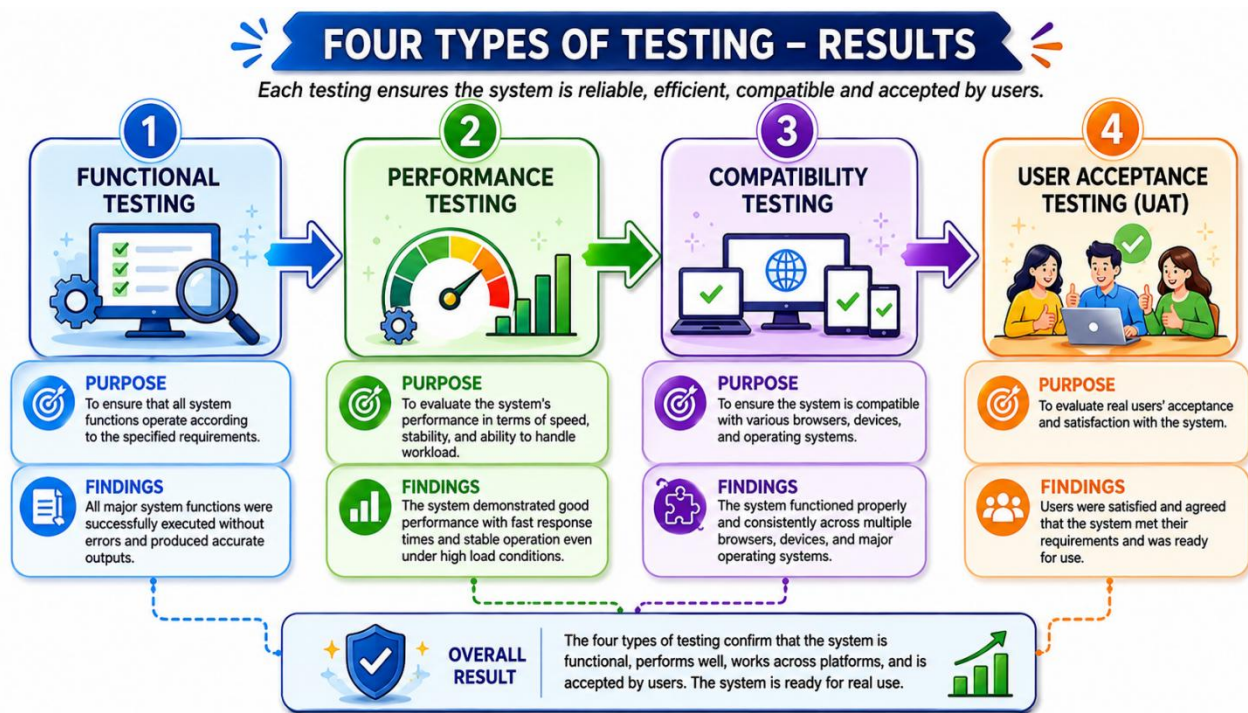


Figure 2: Four Type of Testing Flow

Performance Testing

Performance testing was conducted to evaluate the application's speed, responsiveness, and overall efficiency, particularly under conditions common in a digital classroom setting. This included testing the loading times of the Nota Pintar assets and the speed of data retrieval from the Supabase backend to ensure that students experienced minimal delays during their learning sessions. The Curio Sains application was tested on various Android devices with varying hardware capabilities to assess how well the Flutter framework managed UI rendering and complex state transitions across the different scaffolding tiers. Stress testing was also carried out by simulating multiple concurrent users within a single virtual classroom to determine whether the Supabase infrastructure could handle high volumes of simultaneous data updates without causing lag on the Teacher Monitoring Dashboard. Memory usage and CPU consumption were monitored to optimize resource management, ensuring that the application maintained a smooth and responsive experience even on entry-level Android devices. Through performance testing, necessary optimizations were made to the data fetching logic, ensuring that the application remained stable regardless of the network conditions or the number of active learners (ISO/IEC 25010, 2011).

Compatibility Testing

To ensure Curio Sains was accessible to its target audience of Year 6 students, compatibility testing was conducted across a diverse range of Android devices, operating systems, and screen sizes. As the application was developed using the Flutter framework to achieve a native-feel performance, it was tested on various smartphones and tablets to evaluate UI consistency and responsiveness, ensuring that the "text-light" design elements and large icons were properly scaled across different screen resolutions. This phase also involved assessing compatibility with various Android OS versions to prevent potential integration issues with the Supabase client. Furthermore, testing was performed under varying network conditions, such as school Wi-Fi and 4G/5G connectivity, to ensure that real-time synchronization of student progress and leaderboard rankings via Supabase Realtime operated efficiently without data loss. Any compatibility issues discovered, particularly regarding layout overflow on smaller screens, were promptly addressed to enhance the application's overall usability and accessibility (ISO/IEC 25010, 2011).

User Acceptance Testing (UAT)

User Acceptance Testing (UAT) was an essential phase in validating the engagement, pedagogical effectiveness, and real-world applicability of Curio Sains. This stage involved actual Year 6 students and Science teachers, who tested the application under realistic usage conditions within a primary school environment. Participants were asked to navigate through the Nota Pintar to review keywords, enroll in a virtual classroom via the Kelas Saya module using a 6-digit Join Code, and complete the Belajar Bersama Curio scaffolding tiers. Feedback was collected through direct observations and surveys focusing on the ease of navigation, the clarity of the keyword-based instructions, and the overall satisfaction with the 3-tier learning flow. The insights gathered from UAT were invaluable for making final adjustments to the user interface and the difficulty curve of the Level 3 statement construction,

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ensuring the app met the expectations of both learners and educators while providing an effective tool for mastering Science P language skills (Ateş & Köroğlu, 2024).

The comprehensive testing process ensured that Curio Sains evolved into a fully functional, user-friendly, and high-performance application suitable for enhancing the mastery of Science Process Skills. "Functional testing confirmed that the 3-Tier Scaffolding and Kelas Saya modules worked correctly, while performance testing optimized the responsiveness of the Supabase backend. Compatibility testing ensured that the app remained accessible across various Android devices, and UAT validated the application's real-world effectiveness in a classroom setting. The iterative approach to testing allowed for continuous improvements, ensuring that Curio Sains achieved its objective of providing a structured, interactive, and immersive digital learning experience. Through this rigorous process, the application successfully reached a stable and well-optimized final version, ready to assist Year 6 students in their scientific journey.

DISCUSSION

The iterative Evolutionary Prototyping approach enabled continuous improvements to Curio Sains based on pedagogical requirements and iterative testing results. The integration of Flutter and Supabase facilitated the development of a high-performance application that handles real-time data synchronization between students and teachers efficiently. Various testing methods, including functional, performance, and user acceptance testing, validated the system's ability to guide students through complex scientific reasoning without the cognitive burden of dense textbook reading. One of the core features, Belajar Bersama Curio, successfully implemented the 3-tier scaffolding logic, transitioning students from simple recognition in Level 1 to independent construction in Level 3. However, developing the validation logic for Level 3 presented a technical challenge, particularly in ensuring that the keyword-matching algorithm accurately identified scientific variables within a student's typed sentence. While the current version effectively matches against pre-defined keyword sets in the database, future enhancements could involve Natural Language Processing (NLP) to provide more flexible and nuanced feedback on student-constructed hypotheses and conclusions.

CONCLUSION

This chapter discussed the findings, implications, and future trajectory of the Curio Sains project. The system successfully provided an interactive and educational experience, particularly through its unique scaffolding logic and keyword-focused modules, which encouraged students to master Science Process Skills with confidence. The study demonstrated the effectiveness of technology-driven engagement strategies in primary science education. While the project has been successful, integrating AI-based validation and AR enhancements could further elevate the system's pedagogical impact. Overall, this research lays a strong foundation for future innovations in KSSR digital learning, showcasing how interactive applications can modernize science education, improve student performance, and simplify complex scientific concepts for the digital generation.

ACKNOWLEDGEMENT

All praise and thanks are due to Allah S.W.T, the Almighty, for granting me the strength, perseverance, and knowledge to successfully complete this Final Year Project report. I would like to express my deepest gratitude to my esteemed supervisor, Professor Madya Dr. Abu Bakar Bin Ibrahim, for their unwavering support, invaluable guidance, and constructive criticism throughout the entire process of developing the Curio Sains mobile application and writing this thesis. Their dedication and expertise were instrumental in shaping the direction and quality of this research. My sincere appreciation goes to my beloved parents, Rozita Binti Abdul Karim and Roslan Bin Hassan, for their endless love, sacrifices, encouragement, and prayers. Their belief in me provided the foundation for my academic journey and the motivation to overcome every challenge. Finally, a heartfelt thank you to my friends, Nur Athira Wahida, Raja Nur Aliesa, and Maybelline, for their companionship, technical advice, and emotional support. Their assistance, especially during the demanding phases of development and testing, made the completion of this project significantly smoother. To all those who have supported me directly and indirectly, thank you.

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