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MASAKIMIA: A MOBILE APPLICATION LEARNING CHEMICAL SUBSTANCE FOR CHEMISTRY STUDENTS

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Abstract—**This research paper addresses the necessity for a mobile learning application tailored to Malaysian chemistry students through the "MasaKimia" (MK) project. The project aims to revolutionize chemistry education via an interactive mobile application. MK is designed to provide an engaging and effective learning experience by featuring an interactive periodic table, quiz games, and digital flashcards. Aligned with the latest Malaysian chemistry curriculum, this project seeks to bridge the gap in accessible, high-quality mobile learning resources for students. The anticipated outcome, the MK mobile learning application, promises to be a comprehensive and engaging educational tool, poised to significantly enhance chemistry education in Malaysia. This paper envisions a future where technology and education converge, delivering a transformative learning experience and ensuring no student is left behind in their pursuit of knowledge.**

I. INTRODUCTION

Chemistry is a fundamental science that is essential for understanding the world around us. It has a wide range of applications in academia and industry, including medicine, materials science, and energy production. However, chemistry can be a challenging subject to learn, especially when it comes to understanding the properties and interactions of chemical substances. This is where mobile learning applications can play a valuable role. Mobile learning applications can provide students with a convenient and engaging way to learn about chemical substances. They can also offer a variety of features that can help students to better understand and retain information, such as interactive exercises, simulations, and games. This project aims to develop a mobile learning application for chemistry students that will help them to learn about chemical substances in a comprehensive and interactive way. The application will cover a wide range of topics, including the periodic table, chemical substances, and chemical formulas. The application will be developed using a user-centered design approach, ensuring that it meets the needs of chemistry students. It will also be aligned with the latest chemistry curriculum. This project is expected to contribute to the advancement of knowledge and understanding in the field of chemistry education. It is also expected to benefit chemistry students by providing them with a more effective and engaging way to learn about chemical substances.

II. PROBLEM STATEMENT

Traditional educational methods in chemistry often fail to engage students effectively, resulting in disengagement and poor academic performance.

- **Lack of Engaging Learning Resources**: Traditional methods often fall short in capturing students' attention and fostering a genuine interest in the subject. This gap hinders the effectiveness of chemistry education and may contribute to reduced academic performance.
- **Overwhelming Memorization**: Students in chemistry education face the daunting task of memorizing a vast array of chemical elements, substances, compounds, and formulas.
- **Limited Access in Remote Learning**: Students in remote and underserved areas face challenges in accessing quality educational tools. The absence of tailored tools for chemistry education further widens the gap between students in urban and remote areas.

III. OBJECTIVES

Designing an interactive periodic table is a primary objective of this project. The goal is to create a dynamic tool that allows users to explore elements comprehensively. Users should be able to access detailed information about the atomic structures of elements, facilitating deeper understanding and engagement with the subject matter.

Another key objective is the development of engaging quiz games. These quizzes will cover various chemistry topics and incorporate features such as rewards, hints, and progress tracking. By making the learning experience interactive and

gamified, this objective aims to enhance user engagement and retention of knowledge.

Creating digital flashcards is also a crucial objective of this project. These flashcards will serve as a tool for quick memorization of chemical formulas, elements, and key concepts. By providing a convenient and accessible way to review essential information, this objective aims to support effective learning and recall.

Lastly, ensuring offline accessibility of the application's features is an essential objective. By allowing users to access the app without an internet connection, it becomes usable anywhere, regardless of internet availability. This objective aims to maximize the accessibility and usability of the application, catering to users in various environments and situations.

IV. LITERATURE REVIEW

The literature surrounding mobile learning in chemistry education provides valuable insights into the usage patterns, effectiveness, and challenges associated with integrating mobile technology into teaching and learning processes.

Matriculation students' usages and its driving factors in mobile learning for Chemistry Lok and Hamzah (2022) investigated the utilization of mobile devices among Malaysian matriculation students for learning Chemistry. Their qualitative case study, published in the International Journal of Evaluation and Research in Education (IJERE), revealed that students predominantly engaged in referential and collaborative learning activities using mobile devices. Factors driving this usage included the ability of mobile learning to overcome learning difficulties, convenience, and enhanced user experience in the digital age. The study underscores the importance of understanding context-specific mobile learning practices among students to inform effective instructional strategies [1].

Smartphones Visualization of Learning and Memorizing Processes Using Mobile Devices Research conducted at St. Petersburg State University of Architecture and Civil Engineering highlighted the effectiveness of visualization tools in educational settings (Year not provided). By actively introducing visualization of learning and memorizing processes through mobile platforms, researchers demonstrated positive impacts on students' cognitive activities, motivation, and academic performance. This underscores the potential of mobile technology to enhance learning experiences and facilitate knowledge retention through visual aids [2].

Teaching and Learning Chemistry Using Smartphones Zurita and Nussbaum (2014) identified several advantages of using smartphones in teaching and learning chemistry. Their study revealed that smartphones can improve students' understanding of chemistry concepts while facilitating social relationships and critical thinking skills. Furthermore,

smartphones serve as versatile tools for sharing lesson notes, collecting data, and accessing chemistry-related apps, offering additional avenues for learning beyond traditional classroom settings (Pachler et al., 2011) [3].

Chemistry on the Go: Review of Chemistry Apps on Smartphones Libman and Huang's (2013) comprehensive review of chemistry apps for smartphones provides insights into the educational and professional uses of mobile applications in chemistry. The review categorized apps by disciplines and target user groups, highlighting their potential contributions to learning and research. With a focus on enhancing accessibility to chemistry-related information and facilitating interactive learning experiences, these apps offer valuable resources for students, educators, and professionals alike [4].

Chemistry Mobile Learning Dalam Peningkatan Kemampuan Berpikir Kritis Peserta Didik Afrina's study on the development of an Android-based learning media for enhancing students' critical thinking skills in chemistry demonstrated significant improvements in students' abilities (Year not provided). Utilizing the ADDIE model for research and development, the study underscored the effectiveness of interactive learning technologies in promoting critical thinking, engagement, and communication skills among students. The findings highlight the potential of mobile learning applications to foster meaningful and student-centered learning experiences in chemistry education [5].

Overall, the literature reviewed underscores the potential of mobile learning to enrich chemistry education by providing convenient access to resources, fostering engagement, and enhancing learning outcomes. However, challenges such as ensuring equitable access and addressing pedagogical concerns warrant further exploration to maximize the benefits of mobile technology in chemistry education. [6]

Study on the Existing Application The proliferation of chemistry-focused mobile applications offers diverse opportunities for enhancing chemistry education. Applications such as "Pocket Chemist," "Chemistry Lab: Compounds Game," "ChemQuiz-GSCE Chemistry," "Organic Chemistry Flashcards," and "Periodic Table 2024: Chemistry" provide interactive tools for learning, reinforcement, and assessment. These applications cater to various learning preferences and offer accessible resources for students and educators seeking to augment traditional learning methods with mobile technology [7]–[11].

Pocket Chemist [7]

The integration of mobile applications in educational contexts has gained significant attention, with chemistry-focused apps like "Pocket Chemist" exemplifying the trend of leveraging technology for enhanced learning. These apps provide convenient access to crucial information, aiding in the understanding of the Periodic Table and essential chemical properties. Mobile apps are recognized as valuable tools for engagement and learning, supporting tasks such as naming compounds, calculating molar mass, determining bonding types, and understanding oxidation states. The user-friendly interface of "Pocket Chemist" facilitates easy access to chemical formulas and calculations, including empirical and molecular formulas, balancing chemical equations, and determining reaction types and limiting reagents. A thorough literature review would explore the effectiveness and pedagogical implications of such educational mobile applications.

Chemistry Lab: Compounds Game [8]

The educational game "Chemistry Lab," developed by Monster Brain and released on November 16, 2018, offers a fun and engaging approach to learning chemistry on the Android platform. Users can explore chemical compounds of everyday substances through four distinct modes: Catch Molecules, Molecule Maker, Balancing Equations, and Reference Compounds Information. The game is user-friendly and available for free on Google PlayStore, supporting multiple languages to enhance accessibility. By providing an interactive and multilingual experience, "Chemistry Lab" encourages users to learn chemistry in an enjoyable way, making it a valuable educational tool for a global audience.

ChemQuiz-GSCE Chemistry [9]

The AQA GCSE Chemistry revision app, developed by a PhD physicist and teacher, is a comprehensive tool for students preparing for AQA GCSE Chemistry courses. With over 700 multiple-choice questions, the app covers all syllabus aspects, offering a dynamic platform for knowledge reinforcement. Features like progress meters and self-assessment emphasize the value of testing oneself as a learning method. The app includes past papers for authentic exam practice and gamifies learning with famous chemist collector's cards, providing incentives for deeper engagement. This approach helps students consolidate knowledge and improve exam readiness.

Organic Chemistry Flashcards [10]

The Organic Chemistry Flashcards Quiz Study Aid app presents a valuable tool for students and enthusiasts seeking to reinforce their knowledge of organic chemistry concepts in an interactive and engaging manner. The app's design focuses on facilitating effective learning through a quiz format, encouraging users to test their understanding of fundamental concepts, nomenclature, functional groups, and various reac-

tion types, including alkene, alcohol, hydrogenation, addition, substitution, and elimination reactions. The app's randomization of question order and answer positions contributes to a dynamic learning environment, preventing users from memorizing answers based on specific patterns. This design choice aims to encourage active recall and comprehensive understanding of organic chemistry concepts.

Periodic Table 2024: Chemistry [11]

The "Periodic Table" app, available on both Google Play and the App Store, serves as a comprehensive and user-friendly tool for individuals interested in delving into the world of chemistry. This app capitalizes on the enduring relevance of the Mendeleev Table, a stalwart aid in the study of chemistry for over 150 years. By seamlessly integrating a vast array of functions and information about chemical elements, the "Periodic Table" app positions itself as a valuable resource for both students and enthusiasts. The app's longevity is attributed to its role as an indispensable companion in the exploration of chemical elements and their compounds. Its user interface is designed for convenience, providing users with a rich repository of information at their fingertips. By downloading the app, users can access a plethora of details about chemical elements, enabling a deeper understanding of their properties, behaviors, and significance in various contexts.

TABLE I
COMPARISON OF CHEMISTRY LEARNING APPS

Features	Pocket Chemist	Chemistry Lab: Compounds Game	GCSE Chemistry Quizzes	Organic Chemistry Flashcards	Periodic Table 2024: Chemistry	MK
Interactive Gameplay	No	Yes	Yes	No	Yes	Yes
Flashcards for Learning	No	No	No	Yes	No	Yes
Smart Questions Feature	No	No	No	Yes	No	Yes
Comprehensive Information	sive No	No	No	No	Yes	Yes
Multiple Game Modes	No	Yes	No	No	No	Yes

In conclusion, a comprehensive literature review focusing on the utilization of mobile devices and applications in the realm of MasaKimia, with a specific emphasis on Chemistry education. The reviewed studies delve into various aspects, including the mobile learning patterns among matriculation students in Malaysia, the effectiveness of visualization tools in higher education, the advantages of integrating smartphones into Chemistry teaching and learning, and the potential of Chemistry apps. These studies collectively emphasize the con-

Fig. 2. System Architecture

venience, accessibility, and efficacy of mobile learning tools in enhancing students' understanding and performance in Chemistry. Furthermore, the chapter explores specific Chemistry-related apps, recognizing their roles in facilitating interactive learning experiences and providing valuable resources for both students and enthusiasts. Overall, the literature underscores the growing significance of mobile learning in Chemistry education and highlights the potential transformative impact of technology on traditional teaching methods. These insights serve as a foundation for subsequent chapters, guiding the development and implementation of MasaKimia as a dynamic and engaging platform for Chemistry education.

V. METHODOLOGY

VI. SYSTEM ARCHITECTURE

The system architecture diagram illustrates the interaction between different modules and components within an educational application designed for chemistry learning. The user initiates the process by launching the application on a mobile device, which serves as the central hub for accessing various modules. The Element Module, Compound Module, Reaction Module provide foundational knowledge. The Periodic Table Module acts as a reference tool, enhancing the learning experience. Users can engage with the Quiz Module to test their understanding, with their scores and progress being stored and retrieved from an Online Database. This database is also accessible by an Admin, who can view, edit, and delete data to maintain the system's integrity. The Flashcard Module aids in memorization and retrieval practice, contributing to the user's learning process. Overall, this architecture ensures a seamless flow of information and interaction, promoting an integrated and comprehensive approach to chemistry education.
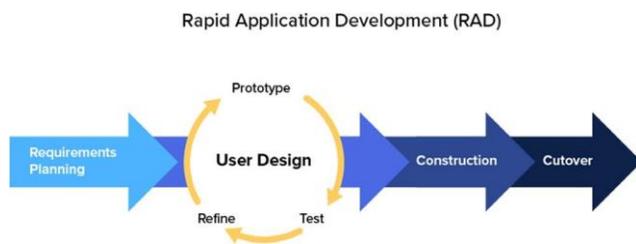

Fig. 1. RAD methodology

The Rapid Application Development (RAD) methodology was employed to structure the development of MasaKimia, organizing the process into distinct phases that align with the principles of RAD and emphasizing rapid prototyping and iterative feedback. The planning phase involved estab- lishing project objectives, scope, and requirements, including defining functionalities, identifying user needs, and setting milestones. The user design phase focused on user involvement through the creation of mock-ups, wireframes, or prototypes, allowing for continuous user feedback and collaboration to ensure the application meets user expectations. During the construction phase, developers built core features and made frequent iterations based on user feedback, enabling a flexible and adaptive development process. Testing was an ongoing process throughout the lifecycle, aimed at identifying and addressing bugs, glitches, or performance issues to ensure reliability, functionality, and user-friendliness. Upon successful testing, the deployment phase released MasaKimia to end- users, with continuous monitoring and support to address post- deployment issues. The use of RAD methodologies ensured a more responsive and user-centered development approach, ultimately leading to a more refined and effective application.

VII. PROTOTYPE

Fig. 3. Home page

Fig. 4. Quiz page

Fig. 5. Quiz level page

Fig. 6. Quiz game page

Fig. 7. Flashcard level page
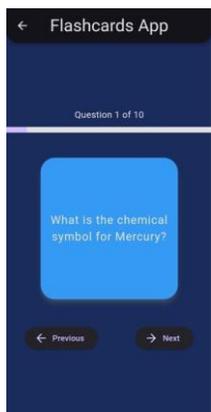
Fig. 8. Flashcard page
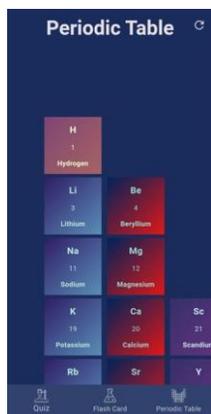
Fig. 9. Periodic page

Fig. 10. Periodic page

VIII. CONCLUSION

In conclusion, the MasaKimia mobile application marks a significant advancement in chemistry education for Malaysian students, addressing the challenges of traditional learning methods. By integrating interactive features such as a dynamic periodic table, quiz games, and digital flashcards, MasaKimia enhances student engagement and learning effectiveness. The project, guided by the Rapid Application Development (RAD) methodology, focused on user-centered design, ensuring continuous feedback and iterative improvements. The literature review highlights the effectiveness of mobile learning tools, and the application's robust system architecture supports a comprehensive learning experience. MasaKimia aligns with the latest Malaysian chemistry curriculum, promising to bridge the gap between technology and education, making chemistry more accessible and engaging for all students. Future efforts will aim to expand features, incorporate user feedback, and evaluate the application's impact to continually enhance its educational value.
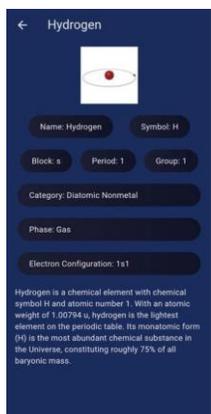
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