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EXPLORING STUDENT FEEDBACK ON A CUSTOM-BUILT MOBILE QUIZ APP FOR THE REPRODUCTIVE PHYSIOLOGY MODULE

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Abstract:

The use of mobile quiz application in the field of medical education is rising because it offers new approaches for increasing the level of learner's participation and performance. This study aims to explore student's feedback on the development and effectiveness of the Reproductive Physiology Quiz app, a custom-built mobile application for quizzes that enhances learning in the Reproductive Physiology module. The app is developed using Buildbox and contains features like the life system (nyawa), which is based on mastery learning and immediate feedback on incorrect answers. About ten Year 2 medical students had recently completed the Reproductive Physiology module involved in the pilot study of this custom-built mobile app. Their feedbacks were acquired through a questionnaire that contained both multiple-choice-close-ended and open-ended questions. The study revealed that 100% of the students reported that the app was appealing and enhanced their learning experience, while 90% stated that it was helpful in evaluating their knowledge. The qualitative data revealed some suggestions for improvement such as the need for different types of questions, random order of questions, and the need for more elaboration of the answers. The open-ended responses also pointed out the possible directions for improvement, such as the different types of questions, the different order of the questions, and the more detailed explanations of the answers. Furthermore, the learners also agreed that the app offers flexibility for self-assessment and recalls their knowledge on reproduction. These results indicate that mobile quiz applications such as Repro Quiz may increase student engagement, knowledge, and self-learning in medical education. Future studies should aim at extending the app to include other modules and incorporating the feedback of a larger cohort of students to enhance the features and usability of the app.

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Keywords:

Quizz App, Reproductive Physiology, Student Feedback, Buildbox

Introduction

Background of Study

Nowadays, in this advanced educational era and the integration of Educational Technology, mobile learning as an additional feature in teaching education is integral to the higher education system. Mobile learning devices enable learners to access course material at their own will and convenience and offer flexibility, where learning can take place virtually anywhere, not necessarily within the confines of a classroom. Mobile quiz applications are among the mobile learning technologies that have been employed in many fields as a tool (Chandran et al., 2022; Göksu & Atıcı, 2013; Lajane et al., 2023; Milton & Subramaniam, 2023; Weisberg et al., 2023), particularly in medical education. The use of mobile quiz apps in the medical field can help enrich the delivery of knowledge not only to the students but also to the practitioners (Chang & Hwang, 2018; McCarthy et al., 2022; Zolfaghari, Shirzadi, & Motamed, 2023). This paper has highlighted how mobile learning tools can be useful in improving the understanding of difficult concepts like physiology where the use of interactive and material that captures learners' attention may be an added advantage. The physiological concepts are challenging, especially the systems of the body including the reproductive system, in which learners need to have a good understanding of the function and interconnection of the involved systems to succeed in their studies (Flor et al., 2020).

Malaysia has also initiated various efforts to improve medical education and has incorporated many educational technologies with the use of mobile applications being on the rise (Attalla, Hanafy, Akter, & Ruhi, 2020; Jembai et al., 2022). Nevertheless, there is a limited research on the application of mobile learning tools in certain medical topics in the Malaysian public universities especially for physiology modules. There is no research that has been done to determine the perception of the medical students towards mobile quiz applications in the area of learning physiology in public universities in Malaysia. This is a research gap that shows how little is known about the impact of mobile application in the delivery of medical education in this locality.

Before a massive launch of a mobile quiz app in the digital playstore, it is important to conduct a pilot launch with a small number of participants as a way of testing the efficiency of the app. Technical and pedagogical challenges that can hinder the efficiency of the app can be observed in addition to the enhancement of the app's effect on student learning and engagement in the course. A pilot enables the developers and educators who are involved in creating the app to fine-tune it before it is out for use by other people. In the case of this mobile quiz app for the reproductive physiology module, the current study involves a pilot implementation at Universiti Teknologi MARA with a small set of medical students who were allowed to use the app and give insight into its features, usability, and effectiveness in enhancing the learning outcomes of the reproductive physiology module.

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The incorporation of mobile learning in medical education is in line with the objectives stipulated under the Malaysian Education Blueprint 2013-2025 on the use of technology-enhanced learning. However, the effectiveness of such interventions is still determined by the student's participation and by the perceived usefulness of these technologies in their learning. Thus, identifying how students perceive and use mobile learning tools including quiz applications on specific modules, is crucial in improving approaches to teaching and learning. Mughal, Atkins, Morrow, and Al-Jundi (2018) pointed out that it is important to use feedback provided by students when using mobile learning applications and that it is important that the learning applications are designed based on the users. The purpose of this research shall be oriented on the pilot test results of the mobile quiz application developed for the reproductive physiology module in Universiti Teknologi MARA with the idea of enhancing the feedback gathered to improve the future roll-out of the app.

Problem Statement

Mobile quiz applications in higher learning institutions especially in medical education have been on increasing trend recently. However, there is a lack of such studies that would focus on the effects of such mobile applications on learning, especially in the context of physiology modules including the reproductive system. Even though mobile quiz apps are popular in general education, there's a lack of data on how it is viewed by medical students and whether such tools are suitable for detailed subjects like physiology. It has been observed that students require stimulating, collaborative approaches to learning, especially within the medical field, to relieve learning load pressure.

Even though a range of mobile learning tools has been integrated into numerous subject areas, no previous research has explored the use of mobile quiz applications in Malaysian public universities in the context of medical physiology modules. This gap is quite apparent in specialized fields such as the study of the human reproductive system. Consequently, the current study is needed to explore the perception of students in Malaysia's public universities towards utilizing mobile quiz applications for learning the medical physiology subject.

A pilot launch of the mobile quiz app is essential to gain initial feedback from a small scale of users before releasing it to a larger target audience. This feedback will be crucial to understand how the app is going in terms of usability, content relevance and if some kind of enhancement should be implemented. Several studies have reviewed the effectiveness of using mobile quiz applications in medical teaching and concluded that although the use of mobile quizzes is appreciated by medical students, its effectiveness in the long run has not been determined yet. (Boruff & Storie, 2014; Davies et al., 2012; Mughal, Atkins, Morrow, & Al-Jundi, 2018). For the pilot launch of this study, we focus specifically on evaluating students' initial responses to using a mobile quiz app for reproductive physiology at University Teknologi MARA.

Furthermore, while there is some literature on the use of mobile learning in education in general, much less is known about the application of mobile learning in specific subject areas relevant to medical education, such as the reproductive system in physiology. The lack of research on students' perceptions of using mobile quiz apps in this particular manner, reinforces the significance of the current study. Knowing how students responded to the pilot implementation is crucial to what should be done with such applications in the future and how they might be tailored for particular subjects in medicine. Importantly, while mobile quiz apps have been explored in various educational contexts, there is limited evidence addressing their

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effectiveness for physiology modules in the Malaysian setting. This focus is important because research concerning the local context as well as the challenges and opportunities inherent in it, is still rather limited. Conducting such research is essential to create mobile learning strategies that would fit the educational and cultural context of Malaysian medical students and improve the learning experience and productivity in teaching physiology.

Objective of the Study and Research Questions

The objective of this study is to understand and explore students' feedback about the use of a mobile quiz application on the reproductive physiology module as a pilot testing before a mass implementation and launch to the wider target. Specifically, the study seeks to answer the following research questions:

1. How do students perceive the effectiveness of a mobile quiz app for learning reproductive physiology?
2. How do students perceive the mobile quiz app's influence on their engagement and understanding of the subject matter?
3. What are the students' suggestions for improving the mobile quiz app to better support learning in the reproductive module?

Literature Review

Mobile Learning in Medical Education

Mobile learning, also referred to as m-learning, has become a central innovation in medical education due to the progressing evolution of mobile technologies. Mobile learning or as has come to be known as m-learning which involves the use of handheld devices including smart phones, tablets and other portable technologies in the delivery of content has revolutionized the way learners and instructors engage with knowledge (Briz-Ponce, Juanes-Méndez, García-Peñalvo, & Pereira, 2016).

Similarly, the use of mobile technologies in medical education has gained momentum where medical students use the features of Smartphones, tablets and other portable gadgets in order to increase the interactivity of learning experiences in classroom and clinical environments (Chase et al., 2018; Davies et al., 2012). Such devices give the learners quick access to numerous educational sources, such as anatomy references, drug data, scoring systems, and electronic books that can be useful in the clinical setting that is dynamic and fast-paced (Chase et al., 2018; Wallace, Clark, & White, 2012).

The use of applications for mobile learning is now integrated into the medical education process and has definite advantages for preclinical and clinical students. These tools offer convenience, cost-effectiveness and efficiency, whereby students can get the necessary materials in their coursework. The research done in different countries such as the United States, Greece, Malaysia, Germany, Spain, Australia and Republic of Barbados has emphasized the benefits of mobile apps in increasing prior knowledge and decision-making focusing the medical education field. These mobile applications have also promoted learning as they integrate theory with practical practice due to enhanced mobile technologies.

American medical students expressed high levels of satisfaction with mobile applications such as UpToDate and Epocrates which offered up-to-date medical data that enriched their clinical

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decisions. The same survey of a sample of 731 Students, revealed that 90% of the respondents found that mobile apps are useful tools for improving their clinical knowledge and patient care, especially in clinical practice where quick access to information is paramount. Quant et al., (2016) attributed the efficiency of these apps with time saved and enhanced diagnostic precision.

A study by Payne, Wharrad, and Watts (2012) conducted among medical students and junior doctors in the United Kingdom demonstrated that the common use of smartphones and medical applications among students was very high. As much as 79% of students, and 74% of other participants in the research support this. Eight percent of junior doctors admitted to owning smartphones with most using them in the management of diseases, diagnosis and other related information. They were utilized as frequently as several times a day for short durations; students mostly get it multiple times a day for learning while junior doctors use forms of it several times each day in clinical decision-making. Such mobile tools were valued for their utility since they allowed timely access to essential information and served to optimize the processes in the educational and clinical contexts.

Prados-Carmona et al. (2022) conducted a Spanish study to develop a mobile application that would help medical students learn Pathology after the transition from a preclinical to clinical setting. The components being offered within the app included lectures, self-quizzes, and peer competition. The outcome revealed that 77% of students were satisfied with the learning capabilities of the app and there was a marked rise in the interest levels and retention among the learners. The increased interactivity of the developed mobile app would be possible to recommend as an additional tool that can improve the satisfaction level and learning instead of utilizing the traditional approaches only.

In Greece, a research was conducted which showed that mobile apps usage in seven different medical schools was significantly different between preclinical and clinical students. Preclinical students also preferred relevant applications relative to anatomy such as Gray's Anatomy while the clinical students required applications such as Medscape and UpToDate for patient care. The findings of the study revealed that the usage of mobile apps became more frequent as well as diverse as students moved up the clinical level, thus highlighting the value of using apps as a teaching tool in clinical practice. Regarding the analysis of the results, it is noteworthy that clinical students benefited from diagnosis-related apps and disease management, which corresponds to the transition from the theoretical education to the practical work with patients (Kagkelaris et al., 2022).

According to Jembai et al. (2022), a study conducted among medical students in Malaysia revealed that mobile health mHealth applications offer different kinds of benefits in various categories, including medical education, health, and fitness apps and Covid-19 management apps. About 76.3% of medical students were aware of health and fitness apps while 82.7% were aware of COVID-19 management apps, affirmed by their favourable attitude towards such applications. As for all kinds of electronic applications, 35. 7% reported that medical education applications were less often used, but they were useful. Students argued that these applications offered easy to access and convenient tools to enhance students learning and management of their health especially during the COVID 19 pandemic. Also, it was discovered that the students using these educational apps are the ones with higher household income and more extended study duration.

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Several applications and software relating to learning of anatomy have revealed positive impacts these tools could have on the students in their learning process and in their mastery of the details of Anatomy. A study conducted at Ulm University, Germany, employed the eMed-App, which was designed for use in anatomy seminars and employed the use of the module on the skeletal system (Golenhofen et al., 2020). This learning app was intended to be used in conjunction with lectures and enabled the acquisition and self-assessment of anatomical material in an independent manner outside of a class setting. The findings revealed that 77 percent of the respondents had heard of or used the recommended products within the previous year. 5 percent of the students stated they have been using the app, mainly for Android-based smartphones, to revise the material that has been covered and for preparations towards seminar lessons. For instance, although most students used the app occasionally, those who used the app more often obtained better results in multiple choice tests.

A survey of medical students at the University of the West Indies, Cave Hill Campus Barbados conducted by Singh et al. (2021), revealed that most of the students (92%) used smartphones for academic activities, especially the use of application such as Medscape and Teach Me Anatomy in learning anatomy and any other medical related information. About 89.1% of the students supported the argument that smartphones positively impacted their learning, and 79%. 5% said that they would like to invest in other forms of mobile education applications especially if it is cost-effectiveness. The study depicted the increasing use of Smartphones and mobile educational applications in the medical field.

In general, it can be concluded that mobile learning applications have been a useful utility for teaching in the field of medicine as a result of their advantage as being cost-cutting, flexible, and interactive forms of learning. These tools have become the focal points in instilling fundamental knowledge in the preclinical years or in the clinical settings in making accurate decisions. As the number one tool that provides quick and direct access to reliable information, the use of mobile apps has enhanced the effectiveness of learning and its applicability to a wide range of learning environments, which is why it is impossible to underestimate the importance of mobile apps in modern medical education. The previous studies also found that as the integration of mobile learning progresses, the effectiveness of learning outcomes for medical students worldwide is bound to receive a boost.

Mobile Quiz Applications in Medical Education

Mobile quiz applications have been found to be important tools in medical education since they are interactive and allow for continuous assessment of knowledge. Such apps enable the learners to make their self-assessments, monitor their progress, and enhance their ability to reproduce the material through constant testing and instant feedback. The use of quiz apps at educational facilities corresponds to the concept of m-learning, as a result, students are free to study at any time and from any location. Mobile quiz apps have been evidenced to be effective in medical and health sciences courses where the content is large and comprehensive and thus needs to be refreshed frequently.

In different areas of medicine learning, mobile quiz apps have also been identified to raise the level of motivation. For example, in nursing education, there are apps such as Mini Nurse Lite which assist in making learning more fun and creatively help the learner retain a lot of knowledge through Nursing concept trivia (Handayani, 2021). In the same way, according to Suryandari and Sudarmanto (2020) there are benefits that discovered in the use of Kahoot apps

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among medial students. The interactive activities using real-time competing quizzes enhanced students' motivation, engagement, and classroom climate in. In the specialty of Otolaryngology, the ORL-App was presented in a form of a competition of multiple quizzes where the junior doctors were considered to get the most value out this app in terms of education (Johannsen, Shabli, Klußmann, Guntinas-Lichius, & Lüers, 2023). These examples show that mobile quiz applications not only capture the attention of learners but actually helps in enhancement of knowledge of various fields of medicine.

Mobile quiz apps are effective, even in a specialized medical field such as dentistry and high-fidelity simulation training. The mobile quiz app developed in the study by Lemos, Wolfart, and Rittich (2023) consisted of a set of prosthodontics quiz questions which intended to enhance dental students' knowledge. The learning outcomes that were achieved using the app were comparable to those that are achieved using paper and pencil methods, but students using the app had the impression that they were more motivated. They mentioned they used more time in learning and also that the use of the app enhanced their learning since it was more fun to use. In the context of medical simulation, mobile quiz apps were used as the pre-briefing knowledge enhancement tools before life-support simulations, positively affecting both knowledge retention and performance (Sheykhmohammadi, Atashpendar, & Zampunieris, 2024). In general, concerning all presented studies, students admitted that the usage of the mobile quiz apps enhanced their interest in learning, contributing to the extended time they devoted to mastering the material and generally resulted in positive learning outcomes.

Pilot Studies and the Importance of User Feedback in Mobile App Development

Pilot trials are particularly informative during the development of mobile applications, especially in cases where they will be used as educational tools; this is because they enable the user to ascertain how the application will perform in an operational environment as well as including important modifications from the users before going to the general market. Such preliminary testing enables developers to eradicate technical issues in the application's first stages, enhance user interface, and ensure the app meets the educational objectives. User feedback received during pilot studies is critical as it provides first-hand experiences on the usability of the app design and the relevance of the content. Such feedback allows the developers to meet the demands of the target audience and enhance the app's performance several times. Research has as well revealed that apps that receive considerable input from users throughout the pilot phase are more likely to be successful when launched in the market. For example, user-centered design that incorporates the ongoing feedback of the users, has been found effective in increasing usability and learning achievement in educational technology (Blandford, Furniss, & Makri, 2016).

Despite being a relatively small-scale procedure, pilot testing acts as a vital stage in the creation of mobile applications, especially in educational applications, as it offers important information on the utility, interaction, and performance of an application. It is crucial to perform preliminary research to pinpoint the problems that might occur during large-scale implementation and collect users' feedback to improve the application. For example, QuizIt App which was built for Android mobile. Pilot study was conducted to determine this app feasibility and the results of the pilot study were analysed in terms of its usability and influence on students' responses in the classroom. The outcomes showed that students highly rated the convenience of using the app to improve learning and engage with content (Karakostas, Adam, Kioutsiouki, & Demetriadis, 2014). Likewise, the pilot study of the Q-IBADAH app suggested

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that usability testing is crucial before proceeding with the next stage of development, as the feedback collected from the users was essential to determine issues with the application, such as the layout and the organization of the content (Saidin, Mohamed, Adzmi, & Azhar, 2015)). Another pilot study that assessed the efficacy of mindfulness-based app for college students highlighted that pilot testing intervals are important in determining the suitability of app dissemination, thus ascertaining that the users of the App will be actively interacting with the content (Moffitt-Carney & Duncan, 2021).

In conclusion, such involvement of users in the pilot studies makes it easier for the developers to draw improved app designs and better functionalities. Besides, it is also necessary to note that pilot studies do not only contribute to adjusting technical features but also serve to estimate the educational outcome of the app, thus checking if the app in development addresses the learning objectives set. This cycle based on actual user experiences results in an improved performance of the edu-app as well as its appreciation by the users, which in the end results in enhanced educational outcomes.

Methodology

For this study, we designed and developed a custom built mobile quiz application using the Buildbox platform, which was specifically designed for the Reproductive Physiology module. Unlike other general-purpose quiz applications that are similar to Kahoot, this application was developed specifically for students' educational purposes, making it unique and specialized. We incorporated Buildbox, a no-code game development application to build interactive content through iconic interfaces which do not require coding knowledge (Putri, Priyawati, Arrizka, Khasanah, & Litaswari, 2023). Through a drag-and-drop interface, the game's materials, quizzes, and mechanics were designed and developed. Customization in Buildbox was also possible on several aspects of the platform. For instance, the number of levels can be set, and in this study, 2 levels for the pilot launch were designed. The design of the quiz app using Buildbox can be customized and tailored according to the developer and users.

The reproductive images that require customization were input in PNG file format to fit the Buildbox platform and incorporated into the quiz and game areas in compliance with the educational portion of the application. The game also has audio in MP3 format with all music in the background and feedback for right and wrong answers to engage the user. Repro Quiz by Medical Lecturer (Figure 1) was developed into an Android Package Kit (APK) file utilizing Android Studio for distribution on Android devices. During this initial release or pilot, APK was installed on the participant's mobile phones manually. Students are expected to download the game via the APK file since they can download it manually and gain access to the quiz and the material. This app is yet to be published and can be done in the subsequent versions available in Google Play so as to enable the convenience of installation and frequent upgrades of the app to enhance its content and functionality.

The game's format is based on a set of levels with two levels incorporated for this pilot release. The content of the levels gradually increases aiming to increase the level of engagement of the player with the concepts of reproductive physiology. A 'nyawa' (life) system was adopted, which means players begin the game with three lives, as shown in Figure 2. Every time a wrong answer is given the number of lives reduces by one, and when the concerned player is left with three lives, the level has to be played again. This system, in an affirmative way encourages

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players to concentrate on mistakes, on doing things good enough to get through a level, to have a goal of mastering content.

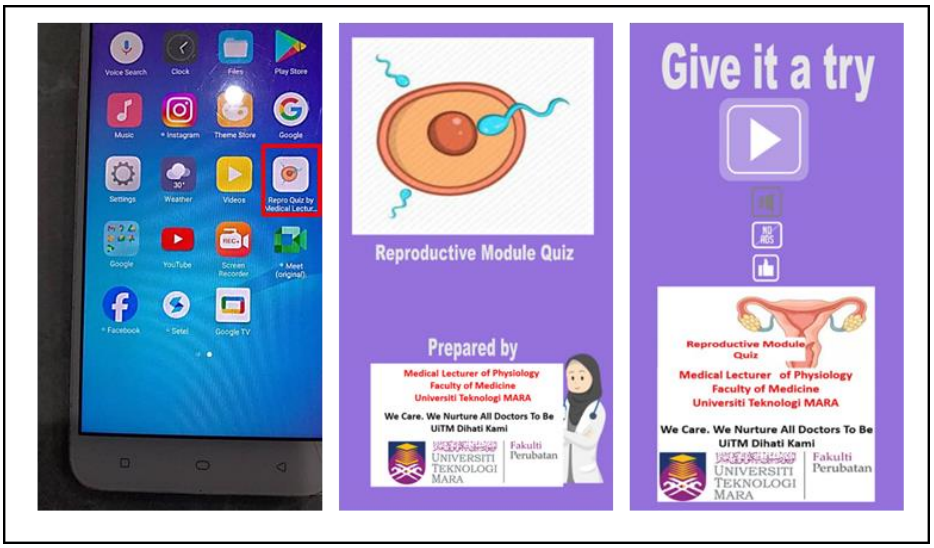

Figure 1: Repro Quiz App Icon-Home Screen, Welcome Screen, and Main Interface
Left: Smartphone screen displaying the Repro Quiz app icon (highlighted with a red rectangular box). Middle: App's welcome screen. Right: Main interface of the app before the player starts the game.

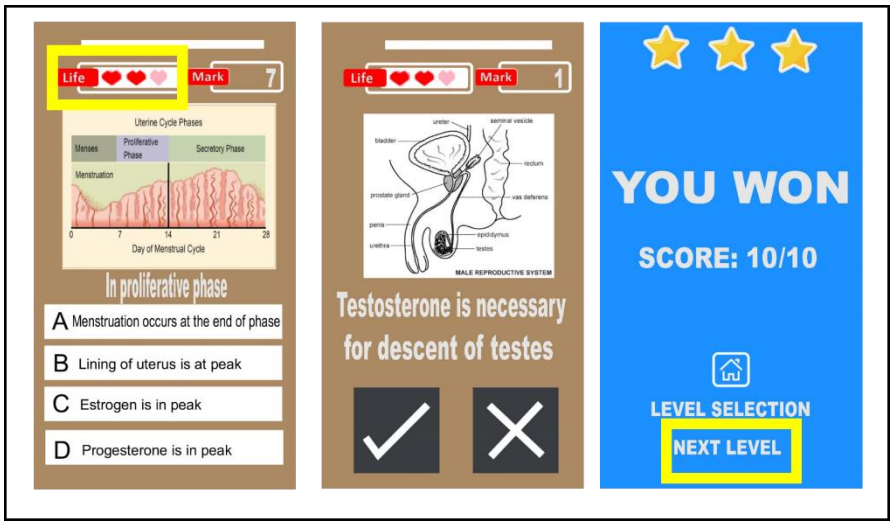

Figure 2: Overview of Repro Quiz App During Gameplay
Left: The yellow box indicates the player's remaining lives (nyawa), with 3 lives in total. The player has already lost 1 life. Questions can be customized as either single-answer or multiple-answer formats. Middle: The question is displayed in a true or false format. Right: After completing Level 1, the player can proceed to Level 2, which is highlighted by the yellow box.

The APK file was disseminated to 10 volunteered Year 2 medical students after the completion of the Reproductive Physiology module. They were required to download and install the app on their own Android devices for trial and giving their feedback. After installing the application, students were requested to utilize the quiz sections and express their opinions through a survey in Google Forms. This study used five closed-ended questions, including questions that had yes/no responses, and other open-ended questions that were included in the

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questionnaire. Closed and Open-ended questions were asked to measure the usability of the app, its impact on learning, the possibility of extending it to other modules or to get ideas to further build and improvise the App. This research utilized a combined method by including quantitative and qualitative assessments to assess user feedback regarding the mobile quiz app. Participants provided responses of 'Yes' or 'No' to close-ended questions that gathered quantitative data. This quantitative data was analyzed by calculating the percentage distribution for each option to illustrate overall trends and user satisfaction levels. Through open-ended queries, qualitative information was collected and data was analyzed via thematic analysis by Atlas.Ti software. The main ideas from the qualitative information were recognized and categorized into codes and main themes to reveal frequent trends demonstrated by the participants. This analysis added depth to the quantitative insights and summarized user feedback effectively.

Findings

The collected close-ended responses from the questionnaire were then described in a tabular form for descriptive analysis. The results were then quantified by computing the percentage proportions and presented in the form of a pie chart to depict the students' feedback on the use of the app.

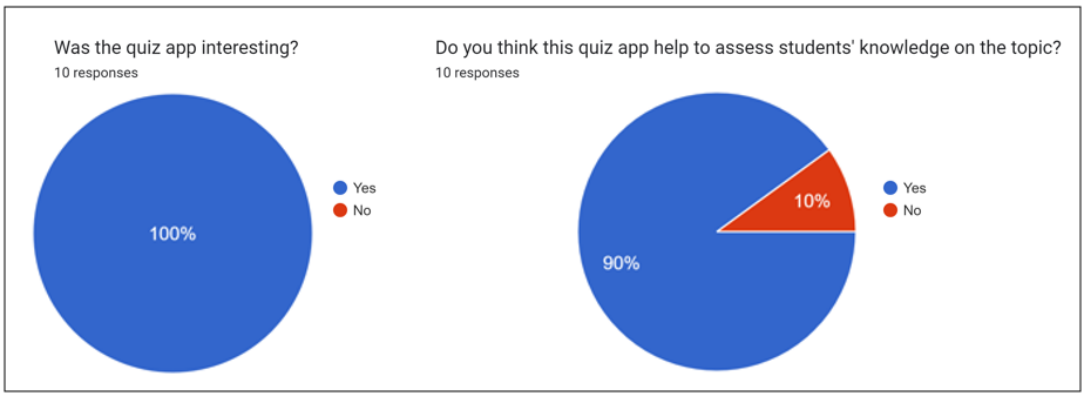

Figure 3: Student Feedback on the Repro Quiz App

Figure 3 presents two pie charts summarizing student feedback on the app. The first pie chart shows that 100 percent of the students were interested in the quiz app and the second pie chart shows that 90 percent of the students believed that the quiz app helped to assess knowledge about the topic. These results capture their views on the use of the quiz app and its efficiency in gauging knowledge as well as their engagement on using the quiz app.

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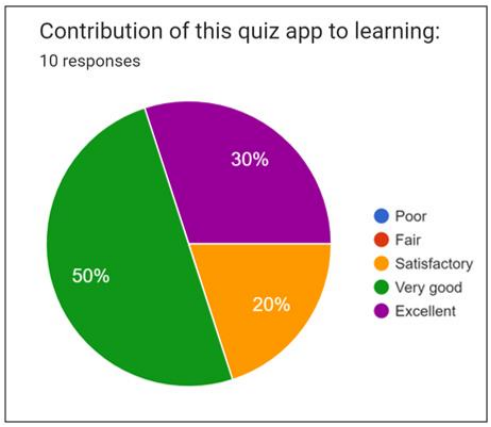

Figure 4: Contribution of the Quiz App to Learning

The pie chart in Figure 4 captures students' perception of how this quiz app enhanced their learning. From the feedback received, 50% of the respondents were very satisfied with the contribution made by the app and scored as excellent; 30% were also satisfied and scored as very good while the remaining 20% were only satisfied. From these scores, it can be interpreted that the overall impression of the students towards the app was positive since 80% of them, through the combined score between excellent and very good perceived the use of the app had a positive effect on their learning experience.

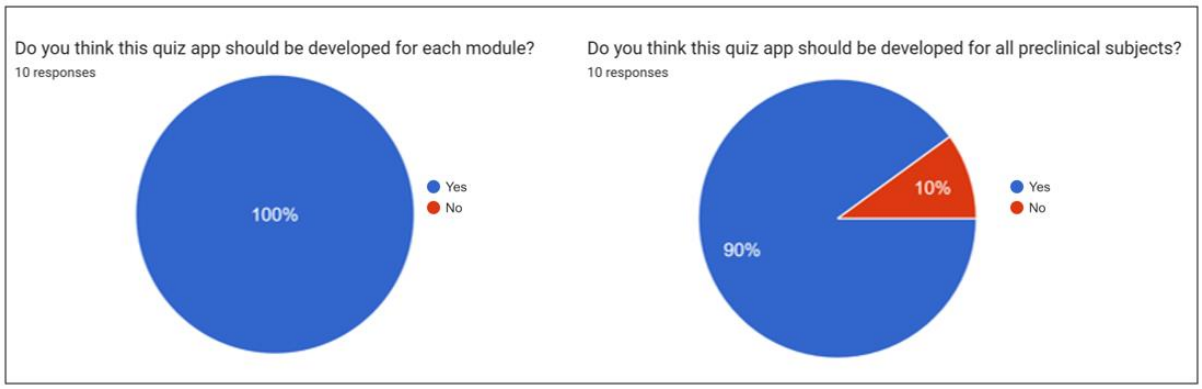

Figure 5: Student Feedback on Developing the Quiz App for Other Modules and Subjects

Figure 5 combines two pie charts summarizing student responses regarding the future development of the quiz app: The first pie chart shows that 100% of students agreed that the quiz app should be developed for all 11 modules within the Physiology subject itself. The second pie chart indicates that 90% of students supported the development of the quiz app for all preclinical subjects, while 10% did not. Based on the students' feedback, there is unanimous support for extending the development of the quiz app to all modules within Physiology, and strong support for expanding it to all preclinical subjects. These results suggest that the quiz app has potential for broader application, and further development of similar quiz apps across other preclinical should be conducted to enhance student learning.

To analyze the results of the open-ended questions, we performed a qualitative analysis using Atlas.Ti 24 to provide insights about the quiz app among the students. The responses were coded and analyzed under different thematic categories. The first question focused on the features of the quiz app which the students found useful or interesting and the second question

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aimed at ways in which the app could be improved by asking students to recommend how the app could be improvised. Through thematic analysis, emerging patterns and themes were recognized and searched for repetition, and this process gave an understanding of the positive aspects of the app as well as its areas for improvement. Table 1 presents the categorisation of the open-ended responses by the developed themes, the associated codes as well as example excerpts from the students. The themes retrieved for the first question are usability and design, learning enhancement and engagement and motivation. For question no 2, the theme discovered focused on the user experience and functional improvements.

Table 1: Thematic Analysis of Open-Ended Responses on the Repro Quiz App

Theme	Code	Example Excerpts
Usability and Design	Good design User-friendly interface Simplicity and practicality Appropriate background music No advertisement	*"Simple, practical & functional. UI is user-friendly. Suitable music"* *"Easy to access and low data usage"* *"A simple app….. no ads"*
Learning Enhancement	Recall the knowledge Key concept reinforcement MCQ practices Self-assessment tool Guiding image	*"useful for me to recap the knowledge of that module…to know more reasons why the answer is correct or wrong"* *"images ….quite helpful for some student with imaginary learning method"* *"….questions focused on the basic concept that should be remembered and know by the students"*
Engagement and Motivation	Challenge-based progression Peer learning	*"I like the fact the question is not going to proceed until it gets the right answer"* *"…when they are bored, they can answer with friends"*
User Experience and Functional Improvements	Delayed feedback preference Extended time preference Request for detailed explanation Variety in question types Randomized question order Immediate feedback preference Improved design and interface Adjustable volume preference Cross-device compatibility	*"the time is quite not enough…to read, understand and find the answers…. But if they answered after studying, they may answer it fast"* *"Give answer after we answer them wrongly"* *"Fonts need to be adjusted"* *"Lowering the volume of the song"* *"user interface could be improved"*

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Discussion

The majority of students found the quiz app engaging and effective in assessing their knowledge of reproductive physiology. In particular, 100% of students rated the app as interesting, while 90% believed it helped them assess their knowledge effectively. Importantly, 80% of the students experience a positive impact on their learning experience by using this app. All students proposed that this quiz app should be introduced in all modules of physiology and not only covering reproductive module. Apart from that, 90% suggested that other preclinical subjects should explore this quiz app.

These results are consistent with the literature on the effectiveness of gamification in education, which states that the quiz app is useful in reviewing material and stimulating students' interest. Research has shown that audiences of platforms such as Quizlet and Duolingo experience higher motivation and self-evaluation while adopting gamified learning platforms makes the experience engaging and fun (Hellín, Calles-Esteban, Valledor, Gómez, Otón-Tortosa, & Tayebi, 2023). Using gamification in classroom practice has been proposed as a powerful tool in education, as it has the potential to increase student motivation and engagement while the process of teaching and learning takes place in a more enjoyable manner (Alsadoon, 2023; Buckley & Doyle, 2014). Quantitative research has indicated that the use of gamification in learning environments can contribute positively to the achievement of learning objectives (Zhan, He, Tong, Liang, Guo, & Lan, 2022). Quiz platforms such as Kahoot have been adopted in classrooms to apply gamification in quizzing activities (Bicen & Kocakoyun, 2018).

Data from existing studies have established substantial and significant evidence on the need and benefits of creating and using mobile quiz applications in educational settings, especially to boost students' engagement, interest, and learning. The findings also reveal that outcome measures, including quiz scores and certainty of response, both enhance cognitive and metacognitive quizzes in both short-term and long-term learning conditions (Areed, Amasha, Abougalala, Alkhalaf, & Khairy, 2021). This applies well with our reproductive physiology quiz app that adopts mastery learning or challenge hence requiring multiple attempts to master the content. The "nyawa" or life-based system featured in our app forces the students to attempt the questions again if they get an incorrect answer, thereby increasing engagement with the content. The immediate feedback mechanism embedded in our app is justified by the argument coming from the study conducted by Rüth, Breuer, Zimmermann, and Kaspar (2021) explaining how feedback helps students to countercheck their metacognition mistakes and enhance memory recall. This feedback mechanism is important to correct wrong information and for the students to identify mistakes and learn from them instantly; thus, incorporating feedback into the learning/teaching process is extremely vital.

Moreover, the learning app designed under Buildbox provides flexibility along with course customization and it is less generalized in comparison to the app like Kahoot. This learning app is more targeted and focused on the course learning objectives. Quiz applications that have been developed and tailored for specific learning objectives were observed to have superior effects than the commonly used multiple-choice quizzes (Ihekweazu, Lester, & Zhou, 2022). This study supports the potential impact of our app design in improving student performance and knowledge retention in reproductive physiology. Due to the flexibility and customization features during the development process, Buildbox allows the developer to incorporate extra features not in the usual quiz app, including a timer for each question, feedback on the answers, and explanations of right or wrong, which can be adapted to suit medical learning.

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The students provided several suggestions for the app improvement, for example, more types of questions; the sequence of the questions should be randomized; user interface and functionality; and more explanation regarding the answer provided. Such suggestions imply the need to fine-tune the proposed models to meet the peculiarities of the identified learning styles. This is in concordance with other mobile learning application studies in which users advocate for better interaction options, improved design, and more flexibility in the type of questions presented and the time when feedback is provided (Moffitt-Carney & Duncan, 2021; Saidin, Mohamed, Adzmi, & Azhar, 2015). Such improvements would enhance the functionality and usability of the app to its users to a great extent.

Conclusion

This study showed that through the development of the Repro Quiz app, mobile quiz apps in medical education can effectively supplement traditional classroom teaching by strengthening knowledge retention and increasing students' participation as well as self-testing. Overall, the study findings revealed that students are satisfied with the usability of the app, learning, and engagement aspects. But what has also emerged from this study is a discussion on the ways that it can be improved further. In summary, this study indicates that mobile quiz apps, especially the ones that are custom-designed to address some of the various course objectives, could be useful in enhancing learners' experiences in medical learning and this reflects the achievable objectives from this pilot study.

As such, for future work, it will be important to extend the current study to examine the effectiveness of mobile quiz apps in learning beyond the current medical modules and subjects in medical education. Future improvements proposed for the Repro Quiz app include randomization of questions, an extension of time limits, and adding further descriptions of answers. Also, the compatibility of the app across the different platforms and devices used by the learners should be enhanced. Importantly, on a greater scale, studies that include larger and more diverse groups of students would shed more light on the efficiency of the app and its possibilities for scaling in medical education.

This study was conducted with 10 students, and this is the current limitation. Therefore, it would be difficult to generalize the results of this study to another medical cohort. However, as this was a pilot study, the aim was to assess the level of engagement among a small sample of students, with a view to modifying the features of the app based on the experience of the users before rolling it out to a wider group of consumers. Further studies shall, therefore, employ a larger sample size and include objective evaluations of the learning effects of the app.

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