Research Article

Design and development of M@SmarT application

Norhayati Yusoff[1,*], Meor Khairul Faizal Meor Idris[2], Shafrina Haridan[3], Kuok Sook Chuen[4], Azizul Amat[5] and Saidatul Ahmad[6]

1 Matriculation College Perak; norhayatikbat2013@gmail.com; 0000-0001-6546-6424
2 Matriculation College Perak; bm-1492@moe-dl.edu.my
3 Matriculation College Perak; shaf2277@gmail.com
4 Matriculation College Perak; bm-1480@moe-dl.edu.my
5 Matriculation College Perak; azizulamat1977@gmail.com
6 Matriculation College Perak; bm-1649@moe-dl.edu.my
* Correspondence: norhayatikbat2013@gmail.com; 0194378424

Abstract: *The M@SmarT application aims to revolutionize mathematics education through innovative technology and pedagogical approaches. This study employs a comprehensive research methodology comprising three phases to develop and evaluate the application's effectiveness. In Phase 1, in-depth interviews with experts in mathematics education provide valuable insights and recommendations for the application's design and development. These interviews ensure that the application addresses the specific needs and challenges faced by students in the target demographic. Phase 2 utilizes the Fuzzy Delphi Method (FDM) to establish consensus among a panel of subject matter experts. This method allows for a systematic evaluation and validation of the application's content, constructs, and features. The input and expertise of the expert panel contribute to refining and enhancing the educational value and effectiveness of the application. Phase 3 involves interviews and a comprehensive survey to evaluate the impact and usability of the M@SmarT application. A quasi-experimental study is conducted, comparing the performance of the treatment group using the application with the control group. This evaluation phase provides valuable insights into the application's effectiveness in improving student engagement, learning outcomes, and overall learning. The findings suggest that the M@SmarT application has the potential to transform mathematics education by providing an interactive and personalized learning experience. Moreover, the research methodology and insights gained from this study can inform the development of similar educational technology tools in other subject areas. In conclusion, the M@SmarT application represents a significant advancement in mathematics education, leveraging technology, expert insights, and rigorous evaluation to enhance student engagement and learning outcomes. This research contributes to the broader field of educational technology, providing a roadmap for the design, development, and evaluation of innovative learning applications.*

Keywords: technology integration; pedagogical approaches; research methodology.

DOI: 10.5281/zenodo.8031059

1. INTRODUCTION

In an increasingly interconnected and globalized world, education plays a vital role in equipping students with the skills and knowledge necessary to thrive in diverse and complex

environments (Malik, 2018). As educational systems strive to keep pace with the demands of a rapidly changing world, the integration of technology has emerged as a powerful tool to enhance teaching and learning experiences (García-Morales et al, 2021). In today's globalized society, traditional classroom approaches often fall short in preparing students to navigate the complexities of an interconnected world (Fadel et al, 2019). The M@SmarT application fills this gap by leveraging technology to create a dynamic and interactive learning environment. By incorporating features such as real-time collaboration, multilingual support, and culturally diverse content, the application offers a unique platform for students to engage in global dialogue and gain a deeper appreciation for diverse perspectives.

The design and development of the M@SmarT application follow a comprehensive research methodology that considers the specific needs and challenges of global education. This methodology encompasses three key phases: needs analysis, design and application development, and evaluation. Through in-depth interviews with educators and experts in global education, the application is tailored to address the unique requirements of a globalized learning environment. The integration of technology in education has the potential to bridge geographical and cultural boundaries, fostering a sense of global citizenship among students (Kopish et. Al, 2020). The M@SmarT application serves as a catalyst for this transformation to a globally connected and digitally empowered education landscape. This innovation contributes to the field of global education by highlighting the significance of technological innovation in enhancing cross-cultural understanding and promoting global competency among students. The insights gained from the design and development of the M@SmarT application offer valuable lessons for educators and policymakers seeking to embrace the potential of technology in fostering global education.

The M@SmarT application represents a significant advancement in global education, harnessing the power of technology to create meaningful learning experiences that transcend borders. By providing a platform for collaboration, cultural exchange, and critical thinking, the application prepares students to navigate the complexities of a globalized world and become active global citizens (Kopish et. Al, 2020). The design and development process of the M@SmarT application, a groundbreaking educational solution aimed at empowering global education through technological innovation. The application combines the power of digital platforms with pedagogical strategies tailored to foster cross-cultural understanding, and critical thinking.

2. METHOD & MATERIAL

This study employs a research methodology based on Saedah et al. (2020) design and development research methodology. This innovation has three phases.

2.1 *1st Phase: Need Analysis*

The first phase of the research methodology employed in this study is the interview phase. During this phase, interviews were conducted with experts in the field of education to gather valuable insights and recommendations for the design and development of the M@SmarT application. The purpose of conducting interviews with experts is to tap into their extensive knowledge and expertise in mathematics education (Noorbergen et al, 2021). For the data collection and analysis, when the semi-structured interviews were carried out, three experts participating to the interviews were from account mathematics job focus areas (Ghoreishi et.al, 2020).

The interviews were structured and focused on specific topics related to mathematics education, such as the current issues and limitations of traditional teaching methods, the potential benefits and drawbacks of integrating technology into the classroom, and the specific needs and preferences of students in terms of learning platforms and resources. Through these interviews, the researchers gained a comprehensive understanding of the existing gaps and opportunities in account mathematics education (Maher et.al, 2020). The experts' perspectives helped shape the direction of the application's design and development, ensuring that it aligns with the needs and preferences of the target audience. The interview data were analyzed using qualitative research techniques, such as thematic analysis, to identify common themes, patterns, and recommendations (Braun, 2021). The insights gained from the interviews served as a foundation for the subsequent phases of the research methodology, informing the decisions made in the design and development of the M@SmarT application.

2.2 *2nd Phase: Design and Development*

The second phase of the research methodology employed in this study is the design and development phase. This phase involves the collaborative effort of the research team, instructional designers, and subject matter experts to create and refine the M@SmarT application.The design and development phase begins with a comprehensive review of the insights gathered from the interviews conducted in the first phase (Norhayati, 2022). These insights serve as the foundation for identifying the key components, features, and functionalities that the M@SmarT application should encompass.

Using an iterative and user-centered approach, the research team works (11 experties) closely to instructional designers and subject matter experts to design the application's user interface, content structure, and interactive elements. The design process involves wireframing, prototyping, and conducting usability tests to ensure that the application is intuitive, engaging, and aligned with the learning objectives. This phase is using Fuzzy Delphi Method (FDM). The FDM involves a panel of subject matter experts who provide their expert opinions and evaluate the application's content, constructs, and items. Through a series of iterations and feedback cycles, consensus is reached among the experts, ensuring that the application's content is accurate, comprehensive, and aligned with the intended learning outcomes (Norhayati et al,2023).The design and development phase also involves the selection and integration of technological components that enhance the learning experience. By the end of the design and development phase, the M@SmarT application undergoes rigorous testing and quality assurance procedures to ensure its functionality, usability, and reliability. The final product is a well-designed and carefully crafted application that is ready for implementation and evaluation in the subsequent phase.

2.3 *3rd Phase: Evaluation*

The third phase of the research methodology is the evaluation phase, which focuses on assessing the effectiveness of the M@SmarT application in the context of matriculation college students' learning experiences and their assignment achievement. In this phase, interviews are conducted with a sample of matriculation college students who have been using the M@SmarT application as part of their mathematics education (Perez et. al, 2022). The interviews aim to gather qualitative data about their perceptions, experiences, and attitudes towards the application. Through open-ended questions and guided discussions, the researchers explore topics such as the students' engagement, motivation, challenges encountered, and overall satisfaction with using the application (Ding, 2019).

Additionally, the evaluation phase includes an assessment of the students' achievement in their assignments. The researchers collect data on the students' assignment scores or grades, comparing the performance of those who have used the M@SmarT application with those who have not. This quantitative data allows for a direct comparison of the application's impact on assignment achievement. By analyzing the differences in scores between the two groups, the researchers can evaluate the effectiveness of the application in enhancing students' performance in their assignments (Albashtawi et. Al, 2020). The combination of qualitative interview data and quantitative assignment scores provides a comprehensive understanding of the M@SmarT application's effectiveness in supporting matriculation college students' learning and assignment achievement.

3. FINDINGS

The design and development research findings are also presented in three phases.

3.1 1st Phase: Need Analysis

The expert interviews conducted during Phase one of the research methodology offered valuable insights that greatly influenced the design and development of the M@SmarT application. Each expert provided unique recommendations and perspectives that helped shape the application to meet the needs of students effectively.

Expert 1 emphasized the significance of creating an interactive and user-friendly interface for the application. They stressed that student engagement could be enhanced through an interface that is intuitive and easy to navigate. Additionally, the expert recommended incorporating real-life examples and problem-solving scenarios into the application to make it more relatable and practical. They also suggested using multimedia elements like videos and animations to effectively explain complex mathematical concepts. These recommendations highlight the importance of creating an engaging and visually appealing learning experience.

Expert 2 highlighted the importance of aligning the application with the national mathematics curriculum to ensure its relevance and applicability. This recommendation ensures that the content and learning objectives of the application align with the educational standards set by the curriculum. The expert also emphasized the need for adaptive learning features that personalize the learning experience for individual students. Furthermore, they stressed the importance of clear learning objectives and outcomes in the application to guide students' progress effectively. These recommendations focus on tailoring the application to meet the specific needs and learning styles of each student.

Expert 3 stressed the significance of incorporating gamification elements into the application to enhance student motivation and enjoyment. They suggested interactive quizzes and challenges that provide opportunities for students to apply their mathematical knowledge actively. Furthermore, they encouraged the integration of a progress tracking system that allows students to monitor their learning achievements. These recommendations highlight the importance of creating a fun and rewarding learning environment that keeps students engaged and motivated.

The insights and recommendations provided by the three experts played a crucial role in guiding the design and development of the M@SmarT application. Their suggestions emphasized the importance of a user-friendly interface, curriculum alignment, adaptability, and gamification elements. By incorporating these recommendations, the researchers ensured the creation of an effective and engaging mathematics learning tool.

3.2 2nd Phase: Design and Development

Phase two of the research methodology involved utilizing the Fuzzy Delphi Method (FDM) to establish consensus among a panel of subject matter experts. The instrument for this method are adapt from Norhayati (2022). The expert panel achieved consensus on the key components of the application, including its constructs and items. This phase is the most important of the three phases involved in developing apps (Saedah et al., 2020).

Through the FDM process, the expert panel established 39 crucial elements and features for the application.The input from the expert panel was instrumental in refining and enhancing the application's design and content. The results for the overall findings of Construct FDM Techniques are displayed in Table 1.

Table 3: Overall Findings of Construct FDM Techniques

Num	Contruct	Mark (d) threshold	Expert panel agreement percentage (%)	Fuzzy score (A)	Expert agrement
1	Student needs	0.121	85	0.911	Accept
2	Teaching objectives	0.172	100	0.948	Accept
3	Application content	0.073	96	0.933	Accept
4	Intermediate display arrangement	0.054	95	0.945	Accept
5	Filling order activity	0.114	87	0.915	Accept
6	Learning assessment	0.094	90	0.923	Accept

All accepted constructions have a high consensus among experts and satisfy the stipulated requirements. Threshold value (d), expert consensus %, and defuzzification of the fuzzy score value (A) for the items indicates that the seventh and seventh iterations of the construct are approved by rejecting specific previously rejected item.

3rd Phase: Evaluation

The findings of the evaluation phase indicate positive outcomes and high ratings for the M@SmarT application. The M@SmarT application received excellent ratings for student engagement. The application effectively captured their attention and made learning enjoyable. The evaluation demonstrated significant improvements in learning outcomes for students using the M@SmarT application. They exhibited a better understanding of mathematical concepts, problem-solving skills, and application of knowledge. The interactive quizzes and real-life examples within the application were praised for their contribution to enhanced learning outcomes.The M@SmarT application received outstanding ratings for usability and user experience. Students found it easy to navigate, intuitive, and user-friendly. They appreciated the clear learning objectives, progress tracking, and availability of multimedia resources. Overall, the application provided a positive and satisfactory user experience. Students who utilized the M@SmarT application achieved significantly higher scores in their assignments compared to the control group. The application's interactive learning approach, coupled with practice opportunities, positively impacted their performance. The application proved to be an effective tool for supporting assignment achievements.Based on the evaluation results, the M@SmarT application demonstrated its effectiveness in terms of student engagement, learning outcomes, usability, and achievement in assignments. The positive ratings and feedback from students highlight its value as a valuable educational tool in the context of mathematics education.

4. DISCUSSION

The discussion section of the research focuses on interpreting and analyzing the findings from the different phases of the study, as well as discussing implications and significance.The findings of this research highlight the potential of the M@SmarT application to revolutionize mathematics account education. By utilizing innovative technology and pedagogical approaches, the application offers an interactive and personalized learning experience for students. The positive impact on student engagement, learning outcomes, and achievement in assignments suggests that the application can effectively address the limitations of traditional teaching methods.

The involvement of subject matter experts in the development of the application through interviews and the Fuzzy Delphi Method (FDM) was crucial in ensuring its alignment with best practices in mathematics education. The consensus achieved among the experts on the application's components, constructs, and features adds credibility and validity to its educational value. The evaluation findings reveal that students using the M@SmarT application reported higher levels of engagement and demonstrated improved learning outcomes compared to the control group. The application's ability to promote deeper understanding, critical thinking, and problem-solving skills resulted in improved performance in assignments.

The positive feedback regarding the usability and user experience of the M@SmarT application is an important aspect of its success. The user-friendly interface, clear learning objectives, progress tracking, and multimedia resources contributed to a positive learning experience for students. The application's design and features were well-received, indicating that it can effectively cater to the needs and preferences of students in the Matriculation College context. The M@SmarT application can be integrated into mathematics classrooms and serve as a valuable tool for teachers and students. The research methodology employed in this study can also guide the design, development, and evaluation of similar educational technology tools in other subject areas. Further research can explore the long-term effects of using the M@SmarT application, as well as investigate its implementation in different educational settings.

5. CONCLUSION

The research on the M@SmarT application for mathematics education has provided valuable insights into its potential to transform traditional teaching approaches. The application leverages innovative technology and pedagogical approaches to create an interactive and personalized learning experience for students. The three phases of the research methodology, including expert interviews, Fuzzy Delphi Method (FDM) consensus, and evaluation with students, have provided a comprehensive understanding of the application's effectiveness.

The findings from the research indicate that the M@SmarT application has the potential to revolutionize mathematics education by addressing the limitations of traditional teaching methods. The involvement of subject matter experts in the development process ensures that the application aligns with best practices in mathematics education and enhances its educational value.The evaluation phase of the research demonstrates the positive impact of the M@SmarT application on student engagement, learning outcomes, and achievement in assignments. The interactive nature of the application, coupled with its user-friendly interface and multimedia resources, contributes to enhanced student interest, motivation, and critical thinking skills. The positive feedback on usability and user experience further supports the application's effectiveness in supporting student learning.

In summary, the M@SmarT application represents a significant advancement in mathematics account education, offering an interactive and personalized learning experience for students. The research findings highlight its potential to transform teaching and learning practices, improve student engagement and learning outcomes, and provide a roadmap for the development of innovative

learning applications. By leveraging technology and expert insights, the M@SmarT application contributes to the broader field of educational technology and sets the stage for future advancements in global education.

Acknowledgments: The authors would like to express their sincere gratitude to Tuan Pengarah Matrikulasi Perak for their support and permission to conduct this research study. We would also like to extend our appreciation to the Ketua Jabatan Matematik and Ketua Unit Matematik for their valuable guidance and assistance throughout the research process.Their expertise and insights were instrumental in shaping the research methodology and ensuring its alignment with the objectives of mathematics education in Matrikulasi Perak. Their input and feedback during the design and development phases were invaluable in refining the M@SmarT application and enhancing its educational value.We would also like to thank all the students and participants who willingly took part in this research. Their cooperation and willingness to provide feedback and insights were crucial in evaluating the effectiveness of the application and validating the research findings.Finally, we would like to express our gratitude to all individuals who supported us in various ways during this research journey. Their contributions, whether big or small, have played a significant role in the successful completion of this study. Thank you all for your valuable contributions and support.

References

Albashtawi, A., & Al Bataineh, K. (2020). The effectiveness of google classroom among EFL students in Jordan: An innovative teaching and learning online platform. International Journal of Emerging Technologies in Learning (iJET), 15(11), 78-88.

Braun, V., & Clarke, V. (2021). To saturate or not to saturate? Questioning data saturation as a useful concept for thematic analysis and sample-size rationales. Qualitative research in sport, exercise and health, 13(2), 201-216.

Ding, L. (2019). Applying gamifications to asynchronous online discussions: A mixed methods study. Computers in Human Behavior, 91, 1-11.

Fadel, C., & Groff, J. S. (2019). Four-dimensional education for sustainable societies. Sustainability, human well-being, and the future of education, 269-281.

García-Morales, V. J., Garrido-Moreno, A., & Martín-Rojas, R. (2021). The transformation of higher education after the COVID disruption: Emerging challenges in an online learning scenario. Frontiers in psychology, 12, 616059.

Ghoreishi, M., & Happonen, A. (2020, May). Key enablers for deploying artificial intelligence for circular economy embracing sustainable product design: Three case studies. In AIP conference proceedings (Vol. 2233, No. 1, p. 050008). AIP Publishing LLC.

Kopish, M., & Marques, W. (2020). Leveraging technology to promote global citizenship in teacher education in the United States and Brazil. Research in Social Sciences and Technology, 5(1), 45-69.

Maher, C. A., & Sigley, R. (2020). Task-based interviews in mathematics education. Encyclopedia of mathematics education, 821-824.

Malik, R. S. (2018). Educational challenges in 21st century and sustainable development. Journal of Sustainable Development Education and Research, 2(1), 9-20.

Noorbergen, T. J., Adam, M. T., Teubner, T., & Collins, C. E. (2021). Using co-design in mobile health system development: a qualitative study with experts in co-design and mobile health system development. JMIR mHealth and uHealth, 9(11), e27896.

Norhayati Yusoff (2022).Pembangunan aplikasi pembelajaran berasaskan permainan dalam talian (pbpdt) bagi topik kebarangkalian mudah dan kesannya terhadap pencapaian murid tingkatan dua (Tesis Sarjana). Tanjung malim, Perak. Universiti Pendidikan Sultan Idris.

Norhayati Yusoff, Marzita Puteh, Azman Mokhtar, Sukor Beram, Norzalina Noor, Abdul Halim Ismail, & Wong Wei Lun. (2023). Design and Development of an Online Game. Malaysia Journal of Invention and Innovation, 2(2), 50–56.

Perez, N., & Farruggia, S. P. (2022). Pathways to early departure from college: the interrelated and precarious role of finances among Black and Latinx students. Race Ethnicity and Education, 25(2), 155-172.

Saedah Siraj, Muhammad Ridhuan Tony Lim & Rozaini Muhamad Rozkee. (2020). Pendekatan Penyelidikan Rekabentuk dan Pembangunan: Aplikasi Kepada Penyelidikan Pendidikan. Tanjung Malim Perak: UPSI Press.