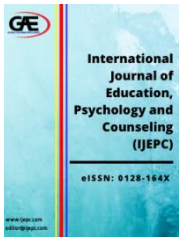
International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 7 Issue 48 (December 2022) PP. 575-585
DOI 10.35631/IJEPC.748043



INTERNATIONAL JOURNAL OF EDUCATION, PSYCHOLOGY AND COUNSELLING (IJEPC)
www.ijepc.com

RORY'S MATHEMATICS ADVENTURE'S (ROMAAD) MOBILE GAME-BASED LEARNING APPLICATION: AN EVALUATION OF USABILITY

Subashini Annamalai[1*], Azizah Che Omar[2], Sobihatun Nur Abdul Salam[3]

[1] School of Multimedia Technology and Communication, Universiti Utara Malaysia (UUM), Malaysia
Email: subashini@uum.edu.my
[2] School of Multimedia Technology and Communication, Universiti Utara Malaysia (UUM), Malaysia
Email: cheomar@uum.edu.my
[3] School of Multimedia Technology and Communication, Universiti Utara Malaysia (UUM), Malaysia
Email: sobihatun@uum.edu.my
[*] Corresponding Author

Article Info:

Article history:
Received date: 16.10.2022
Revised date: 07.11.2022
Accepted date: 22.12.2022
Published date: 31.12.2022

To cite this document:

Annamalai, S., Che Omar, A., & Abdul Salam, S. N. (2022). Rory's Mathematics Adventure's (ROMAAD) Mobile Game-Based Learning Application: An Evaluation of Usability. *International Journal of Education, Psychology and Counseling, 7* (48), 575-585.

DOI: 10.35631/IJEPC.748043

Abstract:

Literature reviews suggested that the teachers should try to incorporate digital teaching method such as game-based learning to improve the students' mathematics skills. In order to investigate and further enhance the suggestion to incorporate game-based learning into the teaching and learning process, a mobile game-based learning application named Rory's Math Adventure (ROMAAD) was designed and developed based on the Year 4 mathematics syllabus. ROMAAD is expected to help reinforce computational thinking skills as well as to motivate students to do more mathematical practices at anytime and anywhere. The mobile game-based learning application's usability was evaluated prior to the implementation to the real environment. This article presents the results of the usability evaluation of the developed application. A total of 37 Year 4 children from a national primary school participated in this usability evaluation. A questionnaire, adapted from Lund's (2011) USE questionnaire and Questionnaire for User Interface Satisfaction (QUIS) (1987) was employed as the instrument in this usability evaluation. The usability evaluation was carried out based on 5 constructs; ease of use, ease of learning, consistency, information structure, and design and satisfaction. Overall, the outcomes of this study revealed that the majority of respondents found the ROMAAD to be simple to use and learn, and that they were delighted to engage it to enhance their problem-solving computational thinking skills. ROMAAD is thought to be highly useful in reinforcing skills, and it is intended to inspire learners to practice mathematical problem-solving at any time and any place.

International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 7 Issue 48 (December 2022) PP. 575-585
DOI 10.35631/IJEPC.748043

Keywords:

Mobile Game, Mathematics, ROMAAD, Usability, Year 4

Introduction

Society views mathematics as the basis of scientific and technical knowledge, which is critical to the nation's social and economic growth. Mathematics is also a prerequisite for many renowned courses, including medicine, architecture, and engineering, among other degree programmes. Despite the importance of mathematics in developing a nation, students have historically performed poorly on tests in the discipline (Mbugua, Kibet, Muthaa, & Nkonke, 2012). Mathematics learning challenges are a widespread and serious problem among students of all ages, according to research on mathematics education (Katmada, Mavridis, & Tsiatsos, 2014). Students who established a strong conceptual mathematics foundation in primary school were more successful in higher-level mathematics courses later on. In addition, the students' academic achievement in the mathematics course significantly and positively predicts their computer thinking skill levels as well (Özgür, 2020). Research claims that educators have used improvements in technology to provide interesting interactive learning possibilities for students using game-based learning programmes, which may be a factor for students' success in the mathematics curriculum (Carr, 2012).

However, in the recent educational environment, the traditional teaching method of chalk-and-talk and drill exercises, which focuses primarily on the teacher's instruction and gives students little information, was discovered to be the root of the issue (Pun, 2014). Traditional methods of teaching mathematics place more emphasis on memorization of rules than on problem-solving abilities (Kohn, 2010). This method of instruction will only encourage students to learn passively and heavily rely on their teachers (Tokac, Novak, & Thompson, 2019). According to researchers, teachers should make an effort to embrace digital teaching strategies like game-based learning that can enhance students' mathematical abilities, particularly their problem-solving abilities, and emphasize the importance of mathematics in the educational process (Ismail, Azizan & Azman, 2012; Izzat Syahir, Siti Mistima, & Fariza, 2020).

To investigate this claim, a mobile game-based learning application named Rory's Math Adventure (ROMAAD) was developed in order to help to enhance the performance of Year 4 primary students in mathematics subject and to improve their computational thinking. This mobile game covers all the chapters of Year 4 mathematics syllabus. The purpose of developing this mobile game is to help students who have difficulties in understanding mathematics concept and lack of strategic knowledge. In addition, this game will help Year 4 students to improve their mathematics skills as an example in answering the question in limited time and remember the method of solving mathematics questions. The users will have more opportunities to learn time management for solving mathematics question. This article presents the results of the usability evaluation of the developed application.

Issues in Learning Mathematics

Mathematics was a fundamental subject in Malaysia that must be taken in the UPSR (Ujian Pencapaian Sekolah Rendah or Primary Schooling Achievement Tests) primary school examination (Mahamad, Ibrahim, & Taib, 2010). According to a report from the Malaysian Examination Board (Lembaga Peperiksaan Malaysia, 2019), more than 35% of primary school

International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 7 Issue 48 (December 2022) PP. 575-585
DOI 10.35631/IJEPC.748043

pupils failed the subject and the post-mortem report indicated that the failure owes to a lack of desire to master the topic and the students' perception of mathematics as a difficult subject to grasp (Gafoor & Kurukkan, 2015).

According to the findings of the study, students had difficulty answering math problems (Tambychik & Meerah, 2012; Katmada, Mavridis, & Tsiatsos, 2014). The problem was found to be caused by the traditional teaching technique of chalk-and-talk and drill exercises, which focuses only on the teacher's instruction and provides students with minimal information (Pun, 2014). The traditional teaching methods only emphasize on rule-memorizing rather than promoting problem solving skills in mathematics learning (Kohn, 2010). This teaching style will only promote students to learn in a passive manner, with a high degree of reliance on teachers (Tokac, Novak, & Thompson, 2019). Researchers claim that the teachers should try to incorporate digital teaching method such as game-based learning can that can improve the students' mathematics skills, especially problem solving skills and emphasize the value of mathematics in the educational process (Ismail, Azizan & Azman, 2012; Izzat Syahir, Siti Mistima, & Fariza, 2020). Implementing digital teaching techniques, particularly game-based learning (GBL) into classes, is an effective way to inspire and engage learners with different learning styles (Vlachopoulos & Makri, 2017; Izzat Syahir, Siti Mistima, & Fariza, 2020) and also to improve their mathematical skills (Izzat Syahir, Siti Mistima, & Fariza, 2020). In long run, this will help in developing the students' computational thinking (Valovi, Ondruška, Zelenický, Chytrý & Medová, 2020).

Mathematics is one of the most essential disciplines in which people may learn a variety of crucial thinking skills, such as the capacity to recognise and analyse patterns, logic and critical thinking, the ability to detect correlations, and problem-solving abilities (Hwa, 2018). According to research in this subject, game based learning (GBL) in mathematics has an influence on the development of these thinking skills (Izzat Syahir, Siti Mistima, & Fariza, 2020). These skills are important to develop computational thinking (Valovi, Ondruška, Zelenický, Chytrý & Medová, 2020), therefore GBL are capable in aiding the promotion of computational thinking, algorithmic thinking, and higher learning gains, which will not only be at the heart of improved issue solving, but also helps in the development and identification of challenges (Izzat Syahir, Siti Mistima, & Fariza, 2020). As a result, applying GBL in mathematics will turn a complicated topic into a simple one (Izzat Syahir, Siti Mistima, & Fariza, 2020). Furthermore, GBL incorporates numerous problem-solving features such as an uncertain result, various pathways to a goal and the building of a problem context (Hsu, Chang, & Hung, 2018), that can enhance computational thinking aspects.

Students nowadays are digital natives, having been brought up with digital devices such as smartphones, tablets, and laptops. In today's educational environment, instructors must address critical concerns such as adapting the learning process to students with varying learning styles and new needs for teaching and learning approaches. Mobile educational approaches such as game-based learning, have been shown to improve student motivation and engagement (Kiryakova, Angelova, & Yordanova, 2014). This game-thinking and game-mechanics approach also engages users and helps them solve educational issues (Zichermann & Cunningham, 2011).

According to researchers, there are several benefits to utilising GBL, particularly in the teaching and learning of mathematical abilities. GBL inspires kids to study by creating a

International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 7 Issue 48 (December 2022) PP. 575-585
DOI 10.35631/IJEPC.748043

meaningful setting for them to learn in. Students loved studying since they were allowed to engage and enjoy their education at their convenience (Jagust, Boticki, & So, 2018). It also allows for the development of a good self-concept and positive attitudes about the topic by minimising the fear of failure and inaccuracy (Yildirim, 2017). According to research, GBL in math classes has a good impact on students' emotional states, stimulates their attention, and encourages active learning (Stoyanova, Tuparova, & Samardzhiev, 2018). It causes a rise in dopamine in the midbrain, which aids with the storage and recall of knowledge (Jones, Ott, Leeuwen, & Smedt, 2013). Instead of performing arithmetic exercises in a book, students can play a mathematics educational game as an additional activity to help them enhance their math skills (Highfield & Goodwin, 2013).

Therefore, in order to incorporate game-based learning into the mathematics teaching and learning process in Malaysia, a mobile game-based learning application named Rory's Math Adventure (ROMAAD) was designed and developed based on the Year 4 mathematics syllabus. ROMAAD is expected to be a GBL tool to help reinforce skills and topics as well as to motivate students to do more mathematical problem-solving practice at anytime and anywhere, and in long run, enhancing the students' computational thinking. However, the application's usability has to be investigated prior to the implementation to the real environment. Thus, an. evaluation of usability was conducted with Year 4 students and this paper reports the evaluations results and is hoped to further support researches on the field of GBL in mathematics for primary school children.

Rory's Math Adventures (ROMAAD) Mobile Game

Rory's Maths Adventure (ROMAAD) is an educational mobile game that can be used as an interactive pedagogy tool for Year 4 mathematics learning. ROMAAD was developed based on the topics covered by the Year 4 mathematics syllabus and it can motivate students to do more mathematical problem-solving practice. This mobile game requires a 301MB download size and an Android version of 6.0 or above to install. This mobile game was created in English and can be played without an internet connection. It has 18 levels as each level represented each chapter that based on the Year 4 mathematics syllabus. Every level has a different background design that relates to different themes. So, the users can experience different theme of the game when they unlock each level. ROMAAD features a visually appealing and well-designed interface that encourages children to learn mathematics and makes the process more pleasant.

A comparative analysis was conducted prior to the usability evaluation. Table 1 summarizes the comparison of four existing mathematics games in Google Play Store namely Math Game 4th, MathMon Mental Math, KidMath Fun, and Zapzapmath.

Table 1: Comparison of Existing Educational Mobile Game with ROMAAD

	Math Game 4th	**MathMon Mental Math**	**KidMath Fun**	**Zapzap Math**	**Rory's Math Adventure**
Operating System	Android	Android	Android	Android	Android
Language	English	English	English	English	English
Text	√	√	√	√	√
Graphic	√	√	√	√	√

International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 7 Issue 48 (December 2022) PP. 575-585
DOI 10.35631/IJEPC.748043

Video	X	X	X	X	√
Animation	X	√	√	√	√
Audio	√	√	√	√	√
Tutorial	X	X	X	X	√
Assessment	√	X	√	X	√
Feedback	X	√	X	√	√
Score	√	X	√	X	√
Reward	X	X	X	X	√

The comparative describes the features that are available in the five game-based educational app that covers problem solving skills in mathematic learning. The finding indicates that these mobile game apps were not developed using the Malaysian mathematics syllabus. The findings also revealed that some of the app does not embed all the multimedia elements, namely text, graphic, video, animation and audio, which is necessary for active multimedia learning. Some of the existing apps also does not feature important GBL features such as tutorials, assessments, scores and rewards, which is crucial for effective and active learning process (Aisyah Nadhirah & Mimi Hani, 2020). Whereas, ROMAAD is designed and developed to have all the important multimedia learning elements such as redundant multimedia elements and also game elements such as animated instructional videos, voice narration, background music, exercises, feedback, and scoreboard.

The following figures illustrated the interfaces of Rory's Maths Adventure mobile game.

Figure 1: Storyline

Figure 2: Main Menu

Figure 3: Game Level

Figure 4: Game Interface

Figure 5: Obstacles

Figure 6: Assessment

International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 7 Issue 48 (December 2022) PP. 575-585
DOI 10.35631/IJEPC.748043

Figure 7: Reward

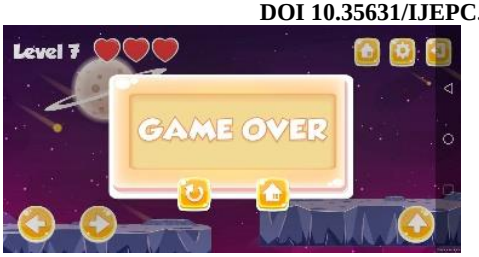


Figure 8: Game Over

Methodology

This paper reports the findings of the evaluation of usability of the mobile game-based learning application named ROMAAD from the viewpoint of 37 respondents who are Year 4 primary students from a national school in Malaysia. The data collection process which was conducted for one week. These respondents were employed using the convenience sampling method as ROMAAD idea was initially proposed by its teacher.

For the purpose of the ROMAAD usability evaluation, five aspects of usability have been evaluated, namely ease of use, ease of learning, consistency, information structure and design and satisfaction. The researchers have employed a usability questionnaire that was adopted from the USE (Usefulness, Satisfaction and Ease of Use) questionnaire (Lund, 2001) and Questionnaire for User Interface Satisfaction (QUIS) (Chin, Diehl, & Norman, 1987) as its evaluation instrument. This questionnaire which was validated by usabilitity experts comprises 17 items that require respondents to rate their responses on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) (strongly agree).

During the data collection process, the respondents were given a quick overview of the ROMAAD features as well as instructions on how to play the mobile game, prior to the GBL intervention. Then, the respondents experienced the ROMAAD individually for two days to play the game and learn the learning content. After the intervention, the respondents were given an explanation regarding answering the usability evaluation questionnaire to ensure they understands the items. They then answered the items according to their experience. Figure 9 illustrates the procedure of the data gathering process.

Because the data sets had near values and may be utilised to determine the central tendency of the data, parametric statistical methods such as descriptive analysis and mean sample were employed to evaluate the data collected during this process (Gravetter & Wallnau, 2000).

International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 7 Issue 48 (December 2022) PP. 575-585
DOI 10.35631/IJEPC.748043

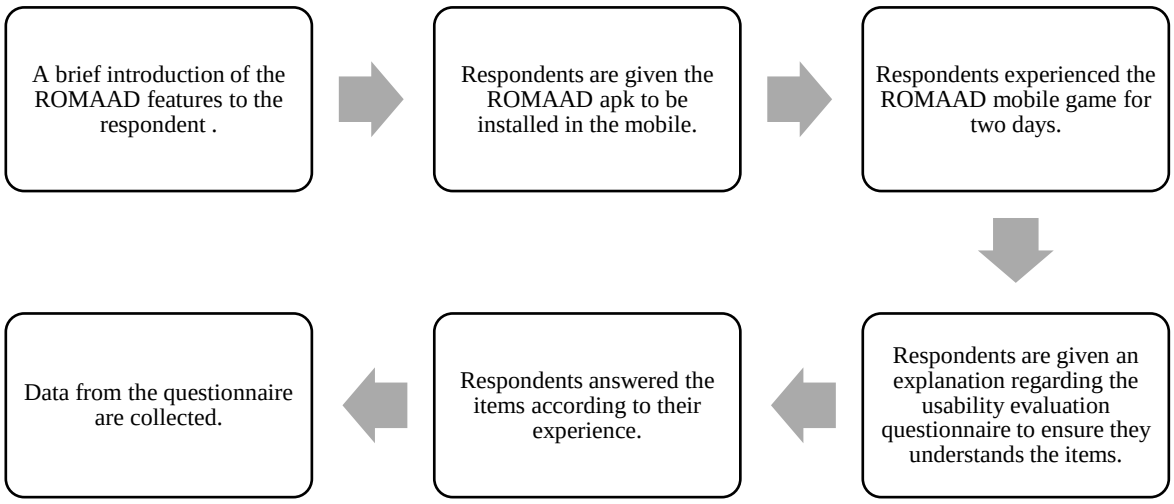


Figure 9: Procedure of The Data Gathering Process

Findings

The aim of this paper is to report the findings of the usability evaluation done on the developed mobile game-based application called Rory's Maths Adventure, which is also known as ROMAAD. This GBL application is designed as a learning tool to improve mathematics skills of Year 4 students. 37 respondents responded to the research by evaluating the mobile application using a usability questionnaire. 13 of the total respondents are male and 24 respondents are female. Among the constructs that are evaluated are ease of use, ease of learning, consistency, information structure and design and satisfaction.

The statistical analysis of the respondent's viewpoint on the usability of the ROMAAD mobile application is presented in Table 2. The researchers added the responses 'strongly disagree' and 'disagree' for descriptive reasons since they convey a comparable perspective.

The findings for the descriptive analysis done on the collected data revealed that all the usability aspects evaluated scored an overall mean score which is higher than 4.00 indicating that the students all agree the ROMAAD mobile game has positive outcome on the ease of use, ease of learning, consistency, information structure and design and satisfaction aspect. The assessments for the ease of use construct focus on easy to use, user pleasant, and can use effectively every time, as well as inconsistency of usage. The total mean for this aspect is 4.36. Ease of learning means how fast a user who has never seen the user interface before can accomplish basic tasks (Aniobi & Alu, 2016), and this construct has a total mean of 4.49. Meanwhile, consistency involved the evaluation on display interface format, standard of button used, consistency of labels used, wordings used and user guidance. As for the consistency construct, the total mean is 4.72. In the information structure and design activities construct, the affective of multimedia technology and colours used were evaluated and the students scored a total mean of 4.59. The last construct that was evaluated was satisfaction which includes the pleasure of learning, the pleasantness of being utilised for educational goals, and the engages of enjoyable learning. This constructs scores a total mean of 4.64.

International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 7 Issue 48 (December 2022) PP. 575-585
DOI 10.35631/IJEPC.748043

Table 2: Respondents' Perspectives on the Usability of ROMAAD

Item	Disagree*	Neutral*	Agree*	Strongly Agree*	Mean	Overall Mean
Ease of Use						
ROMAAD is easy to use.	0	5	11	21	4.43	4.36
ROMAAD is user friendly	0	6	11	20	4.38	
I can use ROMAAD successfully every time	0	4	11	22	4.24	
I don't notice any inconsistencies as I use ROMAAD	0	8	5	24	4.41	
Ease of learning						
I learned to use ROMAAD quickly	0	4	11	22	4.49	4.49
I easily remember how to use ROOMAAD	0	8	5	24	4.43	
ROMAAD is easy to learn to use it	0	4	8	25	4.57	
I quickly became skilful with ROMAAD	0	4	11	22	4.49	
Consistency						
The display interface format is consistent.	0	1	6	30	4.78	4.72
The button used in ROMAAD is standard	0	4	6	27	4.62	
The labels used in ROMAAD is consistent	0	1	6	30	4.78	
The wordings used in ROMAAD is consistent with user guidance	0	2	7	28	4.70	
Information Structure and Design						
The multimedia technology (e.g. animation, graphic, sound, video) contributes to the affective appeal of ROMAAD.	0	5	8	24	4.51	4.59
The colours used in the ROMAAD are appropriate.	0	2	7	27	4.76	
Satisfaction						
I am satisfied to learn with ROMAAD	0	4	7	26	4.59	4.64
ROMAAD is pleasant to be used for learning purposes	0	3	5	29	4.70	
ROMAAD engages for fun learning	0	2	9	26	4.65	

* number of respondents

Discussion

The findings show that ROOMAD is an instructional mobile game that is simple to learn and utilise. This is because ROMAAD is user-friendly, which means that the user may play the game at any moment without experiencing any difficulties.

Furthermore, ROOMAD may be classified as a simple learning game in which users can quickly learn and retain the game's information. According to the findings, ROMAAD is a game in which users may quickly understand and respond to the game environment since the content is simple to comprehend.

All the game components, such as buttons, labels, language, and, most importantly, the interface structure, are highly consistent in ROMAAD. The interface is one of the most important part in the game, where it holds a major part in attracting users to play the game. From the results, interface of ROMAAD has the ability to attract users. However, not all of them have the same view on certain things and there are some users who are not satisfied with the ROOMAD's interface format consistency. This evaluation found that the overall consistency of ROMAAD is very good since all the button used in the game is standard and suitable and same goes to all the labels, while the wordings that was used is consistent with user guidance.

International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 7 Issue 48 (December 2022) PP. 575-585
DOI 10.35631/IJEPC.748043

In terms of ROMAAD's Information Structure and Design Activities, the data show that the game drew in users and increased their desire to play the game, since ROMAAD contain all the multimedia technology elements, that is animations, graphics, sound, video and also text which contribute to the affective appeal of ROMAAD. Even the colours that were used in ROMAAD is suitable and appropriate according to the theme of the game.

Overall, ROMAAD is an excellent educational tool since it is entertaining and promotes a positive learning environment. Aside from that, ROMAAD is a fun tool to use for learning because it not only has questions, but also tutorials to help users through the learning process. The vast majority of ROMAAD users are happy with the game's content. According to this assessment, a well-designed educational mobile game should have not just engaging game play that is simple to use and understand, but also some enjoyable learning components.

GBL applications should contains the implementation of game elements such as avatars, narrative context, story, feedback, reputations (divided into rank/leaderboard and levels), marketplaces, competition, teams, communication systems, and time pressure (Beck, Chitalia & Rai, 2019). A good and usable application should be easy to be used, easy to be learned, have consistent features throughout the application, the information given and its design should be structured, and the users should find satisfaction in using the application satisfactory (Lund, 2001). ROMAAD fulfils the requirement of both good and usable GBL mobile application. The findings of this research also reveals that it is consistent with the findings of other researches on the usability evaluation of GBL mobile app for mathematic learning (Ferguson, 2014; Pratama & Setyaningrum, 2018).

This research, however, have a few limitations that need to be addressed in future research. The researches have only conducted the usability evaluation of the ROMAAD mobile app in one school. Future research should approach more schools to conduct the evaluation. Secondly, the time given to the respondents could be longer compared to two days.

Conclusion

The findings of the study reveal that ROMAAD is an effective educational mobile game for teaching Years 4 mathematics in game-based learning (GBL). By incorporating ROMAAD into mathematics lessons, students get benefits and develop a positive attitude toward mathematics, allowing them to improve their mathematical skills and computational thinking skills. ROMAAD also increase the students' motivation, active participation and interest among the teachers. Besides, teachers can take full advantage of ROMAAD to teach mathematics with more effectively because with the help of audio, video, text, image and animation effects can motivate the students to learn mathematics quickly and effectively. The utilization of ROMAAD in classrooms improves teaching contents and makes the best of class time for students. For example, the use of ROMAAD focuses on the active participation of students and improve the interaction between teachers and students. As a result, ROMAAD provided a novel and desired type of learning experience for students, as well as an opportunity to improve on the standard classroom teaching paradigm.

However, this study was only conducted on one set of respondents. The researchers would recommend that future investigations should consider a larger scale of sampling population to generalize the results.

International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 7 Issue 48 (December 2022) PP. 575-585
DOI 10.35631/IJEPC.748043

Acknowledgements

The authors would like to acknowledge Ministry of Higher Education Malaysia (MOHE) for the financial support of this research. This research is supported by MOHE through the FUNDAMENTAL RESEARCH GRANT SCHEME FOR RESEARCH ACCULTURATION OF EARLY CAREER RESEARCHERS (FRGS - RACER) with project code: RACER/1/2019/ICT01/UUM//4 (Project ID: 15296) (S/O Code: 14439). They also would like to send their appreciation to their students, Azmath Begam Abdul Aziz and Lee Ying Xuan for their effort to design and develop the ROMAAD mobile game application. Special mention also goes the experts and all the respondents who participated in this study.

References

Aisyah Nadhirah, J. & Mimi Hani, A. B., (2020). Popular Game Elements Used in Designing Game-Based Learning STEM Application for School Students – A Review, *Jurnal Kejuruteraan, 32*(4), 1-10.

Alias, N., Zakariah, Z., Ismail, N. Z., & Aziz, M. N. A. (2012). E-Learning Successful Elements for Higher Learning Institution in Malaysia. *Procedia - Social and Behavioral Sciences*, *67*, 484–489.

Beck, A., Chitalia, S. & Rai, V. (2019). Not so gameful: A critical review of gamification in mobile energy applications. *Energy Research & Social Science, 51*, 32-39.

Carr, J. (2012). Does Math Achievement h'APP'en when iPads and Game-Based Learning Are Incorporated into Fifth-Grade Mathematics Instruction? *Journal of Information Technology Education, 11, 269-286*.

Ferguson, T. (2014). Mathematics achievement with digital game-based learning in high school algebra 1 classes. (PhD Dissertation), Liberty University.

Gravetter, F.J., & Wallnau, L.B., (2000). Statistics for the behavioral sciences. 5th ed. Belmont: Wadsworth – Thomson Learning.

Highfield, K., & Goodwin, K. (2013). Apps for mathematics learning: a review of "educational" apps from the iTunes app store. In Proceeding of The 36th Annual Conference of Mathematics Education Research Group of Australasia, pp. 378–385.

Howard-Jones, P., Ott, M., van Leeuwen, T., & De Smedt, B. (2015). The potential relevance of cognitive neuroscience for the development and use of technology-enhanced learning. *Learning, Media & Technology*, *40*(2), 131–151.

Hsu, T. C., Chang, S. C. & Hung, Y. T., (2018). How to learn and how to teach computational thinking: Suggestions based on a review of the literature. *Computers and Education 126*(July), 296–310.

Hwa, S. P. (2018). Pedagogical change in mathematics learning. *Educational Technology and Society*, *21*(4), 259–276.

Izzat Syahir, M. R., Siti Mistima, M., & Fariza, K., (2020). Game-Based Learning In Mathematics: A Systematic Review, *International Journal of Advanced Science and Technology, 29*(3), 7223 – 7229.

Katmada, A., Mavridis, A., & Tsiatsos, T. (2014). Implementing a game for supporting learning in mathematics. *Electronic Journal of E-Learning, 12*(3), 230–242.

Kiryakova, G., Angelova, N., & Yordanova, L., (2014), Gamification in Education. Retrieved from http://dspace.uni-sz.bg/bitstream/123456789/12/1/293-Kiryakova.pdf

Kohn, A. , (2010), The School Our Children Deserves: Moving Beyond Traditional Classrooms and 'Tougher Standard', New York: Houghton Mifflin Company.

Lembaga Peperiksaan Malaysia, (2019), Laporan Prestasi UPSR 2019, Kuala Lumpur: Kementerian Pendidikan Malaysia.

International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 7 Issue 48 (December 2022) PP. 575-585
DOI 10.35631/IJEPC.748043

Mahamad, S., Ibrahim, M.N., & Taib, S.M., (2010). M-Learning: A New Paradigm of Learning Mathematics in Malaysia. *International journal of computer science & information Technology, 2*, 76-86.

Manikandan S. (2011). Measures of central tendency: The mean. *Journal of Pharmacology and Pharmacotherapeutics, 2*, 140-142.

Mbugua, Z. Z. K., Kibet, K., Muthaa, G. G. M., & Nkonke, G. (2012). Factors Contributing To Students' Poor Performance in Mathematics at Kenya Certificate of Secondary Education in Kenya: A Case of Baringo County, Kenya. *Aijcrnet.Com*, *2*(6), 87–91.

Nielsen, J. (2012). Usability 101: Introduction to Usability. *Nielsen Norman Group*. Retrieved from http://dockerby.com/web/Unit%206%20Validating/Usability%20101_%20Introduction%20to%20Usability.pdf

Özgür, H. (2020). Relationships between computational thinking skills, ways of thinking and demographic variables: A structural equation modeling. International Journal of Research in Education and Science (IJRES), 6(2), 299-314.

Pratama, L., & Setyaningrum, W. (2018). Game-Based Learning: The effects on student cognitive and affective aspects. Journal of Physics: Conference Series, 1097, 101-111

Pun, M. (2014). The Use of Multimedia Technology in English Language Teaching: A Global Perspective. *Crossing the Border: International Journal of Interdisciplinary Studies*, 1(1), 29-38

Stoyanova, M., Tuparova, D., & Samardzhiev, K. (2018). Impact of Motivation, Gamification and Learning Style on Students' Interest in Maths Classes – A Study in 11 High School Grade, In: Auer M., Guralnick D., Simonics I. (eds), Teaching and Learning in a Digital World, Chambodia: Springer.

Tambychik, T., & Meerah, T. S. M. (2010). Students' difficulties in mathematics problem-solving: What do they say? In *Procedia - Social and Behavioral Sciences*, 8, 142–151.

Tokac U., Novak E., & Thompson C.G. (2019), Effects of game-based learning on students' mathematics achievement: A meta-analysis. *Journal of Computer Assisted Learning*, 1–14.

Valovi, L., Ondruška, J., Zelenický, L., Chytrý, V., & Medová, J. (2020). Enhancing Computational Thinking through Interdisciplinary STEAM Activities Using Tablets, *Mathematics,* 8, 21-28.

Vlachopoulos, D., & Makri, A. (2017). The effect of games and simulations on higher education: a systematic literature review. *International Journal of Educational Technology in Higher Education*, 1-33.

Yildirim I, (2017), The effects of gamification-based teaching practices on student achievement and students' attitudes toward lessons, *The Internet and Higher Education*, 33, 86-92.