Research Article

Design and Development of an Online Game

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Abstract: *In general, classroom teaching and learning approaches place less emphasis on students' comprehension and more on the results of activities that do not promote students' thinking. Educators have begun to employ technology in the classroom and online as a teaching aid. This study employs a research methodology based on design and development research (DDR). The procedure consisted of three steps. The first step consisted of a needs analysis by delivering questionnaires to 500 Form Two students. The design and application development phase is the second step. It requires expert consensus on application components (constructs and items) utilising the Fuzzy Delphi Method (FDM). Eleven panels of subject matter experts utilised the FDM technique to authenticate the application's content. The study's third step is the evaluation phase. The quasi-experiment was conducted with a total of sixty students in Form Two. The first phase's findings indicated a requirement for constructing an application with a mean value of 3.382% for the perception of Form Two students' interest in online games. The second phase of the research, based on the consensus of experts, has yielded seven primary constructs and 39 elements for this application. The final phase of the trial revealed that Form Two students in the treatment group performed better than those in the control group. In turn, this could boost student interest; nevertheless, because the hypotheses were accepted, there was no significant correlation between interest and achievement in the treatment group. In conclusion, the researcher proposed that the application may be used more broadly and contribute to mathematics teaching. The consequences of the study indicate that the Ministry of Education and schools can use this application to develop applications for other topics. MathGPro is an upgraded version of MaProsil, with the game in this application being updated to include more questions and levels.*

Keywords: gamification; mathematics; design and development; m-ADDIE.

1. INTRODUCTION

In the Higher Education Development Plan 2015-2025, the Malaysian government is now training young people for the Fourth Industrial Revolution (Amirah et al., 2018). However, teachers cannot provide excellent education to rural children without proper teaching tools, and learning is unlikely to increase (Wan Afizi et al., 2014). The rapid expansion of information and communication technology (IT) and the decreased cost of employing communication technology compared to when it was initially introduced are among the elements driving this change (Warden et al., 2013). In education,

new insights learning encourages students to acquire skills and information and the resources necessary to acquire those skills and knowledge (Fisk, 2017). Consequently, learning can also be incorporated into their current environment (Hussin, 2018). Utilizing technology with online digital games is one of the learning ways that might help educational reform (Hairol, 2014). Online learning is the implementation of learning in an integrated manner with the existing curriculum through the use of online facilities as the primary medium of delivery (Muhammad Nidzam, 2017). Shute et al.(2015) and Hwang et al.(2014) found that the use of digital games in learning can enhance levels of critical thinking and problem-solving, as well as creativity, motivation, and student achievement (Hwang et al., 2014; Yang, 2012). Thus, online digital games began to gain prominence when their use was implemented at all levels of education. Therefore, the Malaysian Ministry of Education (KPM) has attempted to create various infrastructures, such as computer networks, to ease the teaching of more courses using multimedia interactive technologies and websites. The creation of mobile applications, which is predicted to increase over time, is also a factor in the advancement of education; software developers build thousands of new applications for personal use, education, and administration every day (Mohd Nazri, 2017).

1.1 Problem Statements

Students should benefit from the learning process to realise their full potential (Nesusin et al., 2014). Students have a negative view of mathematics that emphasises computation and formula learning and is limited to practises (Ismail & Zaidan, 2009). Malaysia participated in the Trends in Mathematics and Science Study (TIMSS) to evaluate school students' performance in Science and Mathematics relative to other participating nations (Mohd Erfy & Mohd Ali, 2016). Our nation has participated in the Trends in International Mathematics and Science Study (TIMSS) five times, in 1999, 2003, 2007, 2011, and 2015, but only with students from 150 randomly selected Form Two schools. From 1999 until 2011, the TIMSS test score has declined dramatically, which has been the subject of the majority of attention and discussion until today (Ministry of Education [KPM], 2013). To reverse the deteriorating trend, experts must study Form 2 students' performance and aptitude in mathematics. The presence of technology, particularly electronic devices such as calculators and computers, has altered the function of the mathematics teaching and learning process since it provides a platform for varying and enhancing the activities and presentation (Noraini, 2005). Moreover, the Internet enables students to communicate online with their peers, making the learning process more dynamic (Hsiao et al., 2014). Introducing digital games into the classroom is one technique to help pupils increase their creativity and ability to solve non-routine challenges (Nurfazliah et al., 2015). The incorporation of online games can alleviate mathematical problem-solving dullness and fatigue (Nurfazliah et al., 2015).

1.2 Novelty

First, this innovation maximises the use of ICT remotely and through self-learning, independent of location or student skill level (PPPM 2013-2025). This development employs Game-Based Learning (GBL). GBL is a strategy that stresses the use of games to facilitate the attainment of learning objectives. It will enable the learner to access learning activities independently. Students will have the opportunity to study remotely and independently. It is adaptable to the student's visual, aural, and kinesthetic learning styles through interactive learning, audio, and video. The final aspect of originality is that this innovation is flexible regarding study time, location, and desired learning environment and is not constrained by a rigid study plan.

2. METHOD & MATERIAL

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

2.1 1st Phase : Need Analysis

The needs analysis phase aims to confirm the need to construct online learning apps and themes that are challenging for students to include in their learning. At this stage, 500 students from 10 schools administered by the Bagan Datuk District Education Office in Perak participated in the questionnaire-based survey approach. This study aims to determine the challenging Form 2 mathematics themes for students, the students' perceptions of online games, and the user-friendly, interactive, and appropriate design aspects for developing online games for Form 2 mathematics courses. Utilizing a questionnaire, data were acquired by a survey. Version 26.0 of Statistical Package For The Social Science (SPSS) software was used to evaluate descriptive data, namely mean (M) and standard deviation (SD) (SD). Frequency analysis revealed that students ranked Probability as the most challenging subject. The descriptive statistical analysis revealed that students' perceptions of online gaming were moderate (M = 3.38, SP = 0.75). In contrast, analyses of characteristics such as user-friendliness revealed high levels (M = 3.58, SP = 0.97). In light of these findings, academics have decided to employ Probability as a theme in the development of online games and use user-friendly features, interactive design, and an appropriate layout to aid students learning.

2.2 2nd Phase: Design and Development

The second phase includes designing and developing or producing an application based on a previously determined design. It includes sketches that graphically depict the navigation and appearance of the interface or display that will be created. Researchers utilise storyboards to depict the overall presentation of an application. In the development phase, it contains the hardware and software required to build the programme on a laptop. Table 1 displays the MathGPro development requirements.

Table 1 Laptop Specifications Hardware and Development Software

NUM	MATERIAL	DETAILS
1	Hardware Requirements	1. Laptop/Computer (PBPDT learning application development) Specifications System: Windows 10 Pro 64-bit Processor: Intel Processor Random Access Memory (RAM): 16.00 GB Hard disk capacity (Hardisk): 465 GB Graphics: VX3276-QHD 2. Internet connection

2	Software Requirements	1. Unity3d 2. Android Studio 3. Adobe Illustration 2020 4. Adobe Premiere Pro 5. Audacity 6. asset unity store 7. YouTube.
3	Learning Content	Form two Mathematics Syllabus for Simple Probability topic

2.3 3rd Phase: Implementation and Evaluation

In the third phase, the completed prototype is implemented and tested. Before use in the field, this phase consists of four subtasks: installation, training, and testing. Throughout the development process and stages, analysis and evaluation are undertaken. This evaluation is not limited to technical issues such as the usage of computers and developed programmes but also considers the impact of application use on learning. After the application has undergone a comprehensive development procedure, its efficiency is evaluated. This summative evaluation involves a questionnaire pre and post-exam. This questionnaire evaluates the efficacy of multiple characteristics, including design, functionality, ease of use, learning capacity, satisfaction, future use, error, and reliability (Ahmad Zamzuri, 2018). For the instrument of usability assessment of learning applications, pre-and post-tests were administered to 30 second-year secondary school students to collect feedback on the application's usability and user satisfaction.

3. FINDINGS

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

3.1 1st Phase : Need Analysis

This need analysis included a questionnaire derived from Normilawati and Azliza (2014). Before performing the primary investigation, a pilot study was conducted with 30 randomly selected participants from the study population. A pilot study was done to evaluate the instrument's reliability coefficient using Cronbach's Alpha. The investigation found that the acquired reliability coefficient is more significant than 0.60, which is 0.770, indicating that the instrument is reliable and may be utilised in actual studies (Darusalam & Hussin, 2016). In the analysis of the most challenging topic in mathematics, respondents were able to select thirteen themes. Respondents were requested to rank the issues as follows: number one (most challenging), number two (moderately challenging), and number three (least challenging) (difficult). The responder statistics were reported in Table 2 based on analysis:

Table 2 Frequency of the Most Difficult Topic in Mathematics

No.	Topic	Frequency (%)
1	Simple Probability	20.4
2	Circle	13.8
3	Factorisation and Algebraic Fractions	12.0
4	Patterns and Sequences	10.6

5	Isometric Transformation	5.6
6	Coordinates	4.8
7	Graphs of Functions	3.0
8	Speed and Acceleration	3.0
9	Three-Dimensional Geometrical Shapes	2.8
10	Polygon	2.8
11	Measures of Central Tendencies	2.8
12	Gradient of a Straight Line	1.2
13	Algebraic Formulae	1.2

According to the findings of this survey, the topic in second-grade mathematics that students perceive as the most challenging is simple probability.

3.2 2nd Phase: Design and Development

This phase is the most important of the three phases involved in developing apps (Saedah et al., 2020). Mohd Nikzam bases question formulation in this step on book highlights and questionnaire modification (2017). This phase is also a continuation of the findings of the first part of the study, which highlighted actual proof that MathGPro apps are required. The results for the Overall Findings of Construct FDM Techniques are displayed in Table 3.

Table 3: Overall Findings of Construct FDM Techniques

Num	Main construct	Mark (d) Threshold	Expert panel agreement percentage (%)	Fuzzy score (A)	Expert agreement
1	Hardware	0.128	86	0.9100	ACCEPT
2	Student needs	0.140	86	0.9031	ACCEPT
3	Teaching objectives	0.140	86	0.6860	ACCEPT
4	Application content	0.051	98	0.9450	ACCEPT
5	Intermediate display arrangement	0.069	97	0.9350	ACCEPT
6	Filling order activity	0.078	95	0.9310	ACCEPT
7	Learning assessment	0.139	87	0.9327	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.

3.3 3rd Phase: Implementation and Evaluation

It used a quasi-experimental design (pre-test and post-test) with one pilot school, one control school, and one treatment school. The post-test achievement of both groups increased, but the achievement of the treatment group was 15% higher than that of the control group. The pre-test mean score for the treatment group is 4.8667 (SP = 2.51524), while the post-test mean score is 40.6333 (SP = 7.02451). This indicates that the average score on the post-test is higher than the average score on the pre-test. This indicates a considerable rise in the mean value, as seen in Table 4, by as much as 35.76667.

Table 4 Descriptive Analysis of Pre-Test and Post-Test for Treatment Groups

Test Type	N	Mean	Standard Deviation
Pre test	30	4.8667	2.51524
Post test	30	40.6333	7.02451

3.4 Practical and Usability

This final evaluation demonstrates the efficacy of this innovative product. The post-test scores of students using MathGPro are higher than those using another application. It saves the educator time in preparing teaching materials for this topic. This product is available for free download on Google Play. It can also boost productivity in and out of the classroom and provide user pleasure.

4. CONCLUSION

Given that most students use smartphones today, the concept of designing the application corresponds with the needs of students today. The developed application is a departure from previously established ideas and models. This innovation also highlights new aspects, like games and simulations appropriate for Malaysian students' comprehension. Concurrently, this will aid teachers and the Ministry of Education in introducing a new learning method that is more creative, inventive, informative, practical, on-trend, and current. In addition, this application will aid students in achieving success in mathematics education and highlight the benefits of mobile learning.

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