Effectiveness of Gamification Technique through Augmented Reality (AR)

Nur Dalila Abdullah, Nurul 'Afifah Razali & Rosilawati Mohamad

Department of Information & Communication Technology, Politeknik Muadzam Shah, Pahang

dalilaabdullah@yahoo.com

ABSTRACT

Technology has widely spread like a virus and it spread fast to every inch and corner in this world. The emerging of smart phone has made it possible for people to learn and develop from code in personal computer to mobile application and the existence of augmented reality (AR). Gamification element has transformed the traditional classroom to collaborative and interactive which it creates more engagement with the students. Nowadays, the students become too rely on the technology and educators need to find something to grab the student's attention. By having Basic Programming Kit app, it will enhance the understanding, motivation, performance and attitude of the students for the subject of programming. This paper will be addressing the Basic Programming Kit app functionality and discuss on the effectiveness of gamification technique through Augmented Reality (AR) towards perceived of usefulness, ease of use, attitude and skill engagement.

Key Words: Augmented Reality, gamification, learning method, Basic Programming Kit.

1. INTRODUCTION

The technologies had been evolving from the emergence of personal computer to smart phone and the presence of augmented reality (AR) has an impact to the society precisely beneficial to the learning domain. The features that are provided by the AR are the ability to express the real world objects by generating it into overlaying computer contents (Kramer, 2017). The contents example such as audio, image, video and 3D object can be embedded together with AR. Teaching for higher education level can be quite a challenge for the alpha generation as stated in the article of MD. Khambari (2018). The alpha generation growing up and introduced with the digital goods surrounding them and constantly engaging with the Information Communication Technology (ICT) in their daily life. Other than AR, games elements can also improve the learning environment and also the efficiency of learning (Zhang & Lu, 2014).

The computer science programme offers a programming language course and it is a compulsory for every student who enrols into this programme. Programming language is the most difficult to learn especially for novice students which it led to the frustration and unenjoyable experience and it is agreed by Hinds et al. (2017). Traditional learning where the educators use slides is not relevant anymore to teach the theoretical as the alpha generation have a shortened attention span (Perks, 2015). Therefore, in order to promote the cooperative learning, the Basic Programming Kit apps will be used as a tool to investigate the effectiveness of using the gamification technique through AR and game elements towards student's motivation and performance.

1.1. Problem Statement

The student's performance through the examination results indicates that the students are struggling to understand the basic programming. These are few problems that are addressed for semester 1 students who took DFC1042 Problem Solving and Program Design:
1. Students are not able to identify data type and could not classify the example for each of data type.

---

2. Students could not recognize or write the variable name by following the naming convention rules.

From the studies of Rashid (2011) and Moström (2011), it shows that programming language is the most terrified courses to be taken by students and it also shows high percentage of failure among the students. From the failures, it will lead the students to pass few courses as DFC1042 is a pre-requisite to other subject DFC2073 Programming Fundamentals. This will results the students to not graduate on time and they need to spend extra semester in order to repeat the course in order to pass.

1.2. Research Objectives

The main objectives for this research are as follows:
1. To build an interactive mobile application to learn basic programming by using game and Augmented Reality (AR).
2. To provide a platform for checking the validity of variable declaration.

1.3. Importance of Research

The AR has received tremendous attention and demand from all different types of domain which AR could create new learning environment for the students in order for them to immerse in the real object of overlaying computer generated content. The AR could be adapted in the education sector to provide a new platform for the teaching and learning purposes (Peng, Xiaolin, Wei, & Ronghuai, 2017). By incorporated AR in the classroom, Peng et al. (2017) supports that it can lead to a better performance and enhancing motivation among the students. As an addition, AR may attract and give opportunities for the students to explore. It also could improve the learning experience through enjoyment and positive attitude. It is a new strategy to capture the attention of the students to learn difficult course such as programming.

2. RESEARCH METHODOLOGY

2.1. Basic Programming Kit Application

The Basic Programming Kit application can be downloaded through Play Store for Android and Apple Store for Iphone. In the application of Basic Programming Kit it has four modules which include games, AR camera, variable checker and trophy/award room. The first module is the game elements where it has three worlds (world 1, world2 and world3). Table 1 shows the game module layout.

Table 1 Game module layout

World	Features	Level	Trophy
1	Word Scramble	1 - 5	Yes
	Memory game	6 - 10	Yes
	Quiz Game	7 - 11	Yes
2	RPG Game	No level	No
3	Under Construction	No level	No

The second module is AR camera where it has five markers to be scanned and from the marker scanner, it will produce a 3D object regarding the corresponding data type. The 3D object shows the example of value for the data type. The markers are for five data types which are string, double, float, character and integer. The third module is the variable checker where the user can declare the variable by following the C++ syntax. In the module, it provides the syntax for declaring variable and it will also shows the error output if the declaration not following the syntax. The students can check on their own without the presence of teacher to guide them regarding the declaring variable error. The last module which is the trophy/award room and in this module, it is the progress of achievement when the students completed certain task in the game module. It has nine awards that can be collected throughout playing the game module. The trophy room is to add the gamification technique as it is to promote learning motivation for student to understand the basic programming. Figure 1(a), (b), (c) below shows the screenshot of the Basic Programming Kit start screen, select game and memory game.
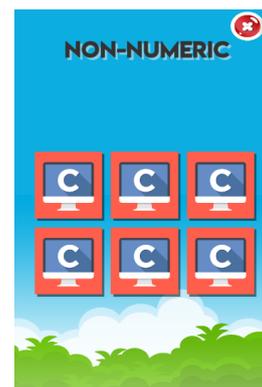
| Figure 1 (a) | Figure 1 (b) | Figure 1 (c) |

2.2. Research Instrument: Online survey

In this research study, online survey had been through Google Form technology provided by Google as it easy to distribute among the students. The respondents who participate in this online survey consist of 63 respondents where the students are from semester 1 and semester 2 (repeat course) for Software and Networking track from the department of Information Technology and Communication, Politeknik Muadzam Shah (PMS). The questionnaire consists of 32 questions and it has three parts which part A is demographic background, part B is knowledge of AR and part C is the evaluation of Basic Programming Kit application. Part C is using the Likert-scale based to shows the agreement and disagreement level to the corresponding question (McDaniel, Gates, Sivaramakrishnan, & Main, 2013). The questionnaire has been distributed by the Whatsapp application after the students had use the Basic Programming Kit app. Table 2 shows the Likert-scale based used in this research online survey.

Table 2 Likert-scale 5 point

Likert-scale	Score
Strongly disagree	1.00 – 1.50
Disagree	1.51 – 2.50
Neutral	2.51 – 3.50
Agree	3.51 – 4.50
Strongly Agree	4.51 – 5.00

2.3. Research Instrument: Pre and Post Test

Pre and post-test also had been done in this research in order to measure the effectiveness of using the Basic Programming Kit app. Pre-test had been conducted in the class after the teachers teach by using the lecture based style and it act as a base line (Papp, 2017) while post-test had been conducted in other session after the students had been introduced to the Basic Programming Kit app. In the pre and post-test, it has the same questions which had 15 questions and it had been divided into three parts (A, B and C). Part A is to identify the data type for given variable, part b is to indicate the validity of the variable given and part C is to declare variable by using the correct syntax. After the session is over for pre and post-test, quantitative analysis is used to calculate mean for each part to measure if there is an impact on students by using different method of teaching.

3. DATA ANALYSIS AND RESULTS

3.1. Pre and Post-Test Analysis

The respondents of 63 students had participated in the pre-test and post-test. The pre-test had been done by using the lecture based teaching style and it act as a base line to be compared with the result in the post-test. Every correct answer will be rewarded 2 marks and will be resulting to full mark of 30 marks. Table 3 shows the mean marks for pre-test and post-test. The result shows in part C which is 4.7 (pre-test) and 5.1 (post-test) is the most challenging part for basic programming for student to declare the variable by using the correct syntax and from the observation of answers, it can be seen that, the students did not end the declaration with semicolon which lead to error in producing output when running the program and also losing marks in the final examination. From the results in table, it

can be concluded that after using the Basic Programming Kit app as one of the teaching method, the results slightly increases from 7.8 to 8.4.

Table 3 Pre-test and post-test mean marks

Pre-Test				Post-Test			
Part A	Part B	Part C	**Average**	Part A	Part B	Part C	**Average**
9.1	9.5	4.7	**7.8**	9.6	9.5	5.1	**8.4**

3.2. Demographic Analysis

The demographic analysis is mainly for the background of the respondent, interest of using technology, the possession of smart phone and the usage of smart phone. Table 4 shows the total respondents of 63 students involved in the online survey by using the Google form. There are 33 respondents (52.4%) who are male and 30 respondents (47.6%) who are female.

Table 4 Gender Analysis

Gender	Number of respondents	Percentage
Male	33	52.4
Female	30	47.6

Table 5 shows the analysis of class involved in the online survey. There are seven class involved and this programming language course should be taken on their first semester but due to the failing on the final examination, semester 2 and semester 3 students need pass this course as it is a pre-requisite for other course.

Table 5 Class Analysis

Class	Number of respondents	Percentage
DDT1A	20	31.7
DDT1B	18	28.5
DDT1C	20	31.7
DDT2A	1	1.6
DDT2B	2	3.2
DDT2D	1	1.6
DDT3A	1	1.6

Table 6 shows the qualification they use in order to enrol into polytechnic. There are two qualifications which are Sijil Pelajaran Malaysia (SPM) and Sijil/Kolej Komuniti resulting 29 respondents (46%) and 35 respondents (54%) respectively. There are more Sijil/Community Colleague qualification as in December 2018 session due to they just graduated from the Community Colleague and applied to enrol to polytechnic on middle of November-December period.

Table 6 Qualification analysis

Qualification	Number of respondents	Percentage
Sijil Pelajaran Malaysia (SPM)	29	46
Sijil / Community Colleague	35	54

For question number 5 and 6 which are interest towards technology and possession of smart phone, all 65 respondents (100%) agreed that they are interest with the technology and they all have smart phone that they bring to class and anywhere they go. Figure 2 shows the usage of smart phone that are collected from the online survey. The most frequent usage is to surf for social networking which is 54 (85.7%) and the next usage after surfing is the students use smart phone is to use the tools for them to learn resulting 52 (82.5%). It is proved that the students spend most of their time to use the learning tool help them learn.
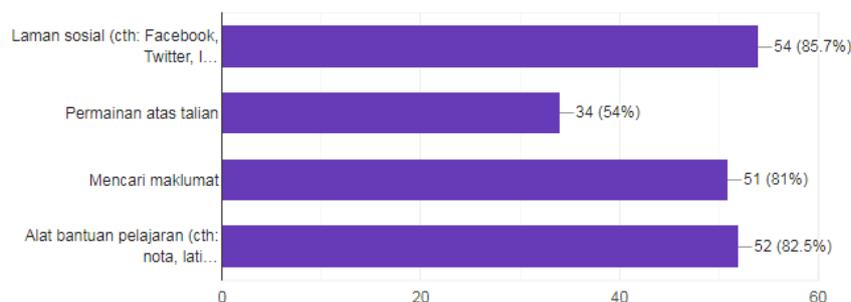
Figure 2 Usage of smart phone

3.2. Perceived of Usefulness Analysis

From the results in Table 7, the highest mean (4.56) shows that in item 4 which is "Using the Basic Programming Kit is useful in my learning". For the overall mean for the perceived of usefulness of the app is 4.48 which the students agrees that using the Basic Programming Kit can be beneficial to them and can be used during the class.

Table 7 Mean of Perceived of usefulness

No.	Item	Mean	Mean Interpreter
1	Using the Basic Programming Kit improves my learning performance	4.46	Agree
2	Using the Basic Programming Kit increases my learning outcome	4.49	Agree
3	Using the Basic Programming Kit enhances my desire to produce desired result in my learning	4.43	Agree
4	Using the Basic Programming Kit is useful in my learning	4.56	Strongly Agree
	Overall Mean	4.48	Agree

3.3. Perceived of Ease of Use Analysis

Data analysis shows that the highest mean (4.52) for perceived of ease of use is item 9: "Overall, the Basic Programming Kit is easy to use". It can be concluded that the interface and functionality is clear and can be understandable when accessing the content of the application. It shows here that students is more into interactive learning rather than using traditional method by using worksheet to do their assessment. The overall mean for perceived of ease of use is 4.48 and they agreed that the Basic Programming Kit is easy to be used.

Table 8 Mean of Ease of Use

No.	Item	Mean	Mean Interpreter
5	The Basic Programming Kit to be flexible to be used anytime	4.46	Agree
6	The Basic Programming Kit functionality and interface is clear and understandable	4.51	Strongly Agree
7	I love to learn by using the Basic Programming Kit compare to the worksheet	4.44	Agree
8	I love the interactive content of the Basic Programming Kit	4.44	Agree
9	Overall, the Basic Programming Kit is easy to use	4.52	Strongly Agree
	Overall Mean	4.48	Agree

3.4. Attitude Analysis

This section is to investigate the student's attitude towards the course and attitude while learning in class. The highest mean (4.56) shows in item 14: "Make sure that I can declare variable using correct syntax". From the problem statement stated, the Basic Programming Kit clearly could help student to solve the problem of declaring variable using correct syntax by using the variable checker in the application. The students do not need to wait for next class in order to ask the teachers regarding the

error they encountered during writing a program. The overall mean for attitude is 4.50 which it really has an impact on the attitude of the students.

Table 9 Mean of Attitude

No.	Item	Mean	Mean Interpreter
10	The Basic Programming Kit is a good idea to be used	4.51	Strongly Agree
11	Can understand basic programming clearly	4.43	Agree
12	Can motivate myself to be more excellent in programming course	4.46	Agree
13	Make sure I can differentiate data type	4.54	Strongly Agree
14	Make sure that I can declare variable using correct syntax	4.56	Strongly Agree
15	Make sure I can concentrate in class	4.49	Agree
	Overall Mean	4.50	Strongly Agree

3.5. Skill Engagement Analysis

From the results in Table 10, the highest mean (4.44) shows in item 19: "Give cooperation with friends when interacting with the application". In the class, it is hard to make student participate in an activity if using worksheet, they tends to chat with their friends and has no sense of exploring the content of the worksheet but when the students engage with the application, they become actively in class and give cooperation between their friends and they have sense of exploring and trying new things. This will make them less chat on the unnecessary things. Overall, the mean score for skill engagement is 4.38 and the students agree that by using the Basic Programming Kit, they enhance their skill engagement between their friends and teachers. Figure 3 shows the summary of overall mean score across four categories.

Table 10 Mean of Skill Engagement

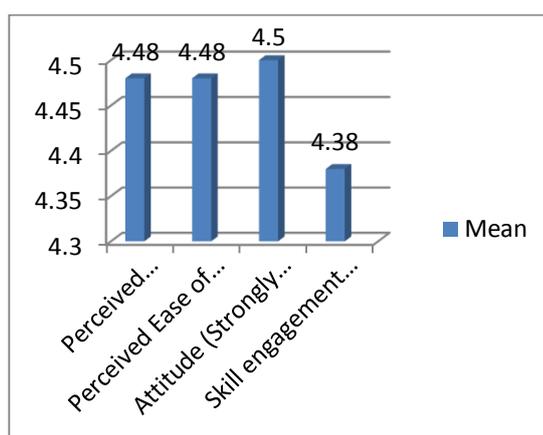| No.	Item	Mean	Mean Interpreter
16	The Augmented Reality content interest me to learn and focus	4.40	Agree
17	Having fun time in class	4.38	Agree
18	Participate in small group actively	4.37	Agree
19	Give cooperation with friends when interacting with the application	4.44	Agree
20	Asking question when I did not understand	4.33	Agree
	Overall Mean	4.38	Agree

Figure 3 Overall mean across four categories

4. DISCUSSION AND CONCLUSION

The study discovered that by using the Basic Programming Kit it could have impacted greatly on the student's attitude which the mean score value 4.50 and the overall mean score across four categories score the mean value of 4.46. This shows that students agreed that Basic Programming Kit is useful for them to be used in class to check the declaration of variable by using correct syntax and also they

enhance their communication skills and cooperate among themselves to discuss and solve the problem that were given to them. The student can easily be frustrated if they could not understand the basic programming and it could lead to poor performance (Franzwa, Tang, Johnson, & Bielefeldt, 2014) and it is supported in the article of Khaliza, Mohd Hassani, & Abdul Said (2016) that the teachers plays an important role to change the teaching method to interactive learning and promotes fun learning environment in the class.

The traditional learning for programming language course bored the students in class where they are listening and writing on the whiteboard, instead of using this method, the Basic Programming Kit provides for them to execute the declaration by using the smart phone device making them learn programming in new experience (Tillmann et al., 2012). Therefore, the mobile technologies with the newly Augmented Technologies has a great potential and more innovative educational method to be taught and used in classroom (Sung, Chang, & Liu, 2016).

REFERENCES

Franzwa, C., Tang, Y., Johnson, A., & Bielefeldt, T. (2014). Balancing Fun and Learning in a Serious Game Design. *International Journal of Game-Based Learning*, *4*(4), 37–57.

Hinds, M., Baghaei, N., Ragon, P., Lambert, J., Rajakaruna, T., Houghton, T., … Casey, J. (2017). Designing a Novel Educational Game for Teaching C# Programming. *Proceedings of the 9th International Conference on Computer Supported Education*, *2*(Csedu), 81–86.

Khaliza, S., Mohd Hassani, M., & Abdul Said, A. (2016). Peranan Guru Cemerlang Malaysia Di Sekolah. *Jurnal Pusat Penataran Ilmu & Bahasa*, *24*, 161–177.

Kramer, N. C. (2017). The Immersive Power of Social Interaction Using New Media and Technology to Foster Learning by Means of Social Immersion, 55–70. https://doi.org/10.1007/978-981-10-5490-7

McDaniel, C., Gates, R., Sivaramakrishnan, S., & Main, K. (2013). *Marketing Research Essentials (Print book)*. John Wiley & Sons Canada, Limited, 2013.

MD. Khambari, M. N. (2018). Blending Gamification and Augmented Reality in XploreRAFE + Module : Intriguing Excitement and Promoting Collaborative Learning among Learners in Higher Education, 625–630.

Moström, J. E. (2011). *A study of Student Problems in Learning to Program*.

Papp, T. A. (2017). Gamification Effects on Motivation and Learning : Application to Primary and College Students, *8*(3), 3193–3201.

Peng, C., Xiaolin, L., Wei, C., & Ronghuai, H. (2017). A review of using Augmented Reality in Education from 2011 to 2016. *Lecture Notes in Educational Technology*, 109–115.

Perks, S. (2015). Game Based Learning of C Programming on the Android Platform : Pedagogical Approaches and Learning Styles, (July 2014).

Rashid, N. (2011). Keberkesanan Konsep BUDDY dalam Meningkatkan Keyakinan Pelajar dalam Pembelajaran Pengaturcaraan Komputer. *Persidangan Kebangsaan Penyelidikan Dan Inovasi Dalam Pendidikan Dan Latihan Teknik Dan Vokasional 2011*, 0–10.

Sung, Y. T., Chang, K. E., & Liu, T. C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. *Computers and Education*, *94*, 252–275.

Tillmann, N., Moskal, M., de Halleux, J., Fahndrich, M., Bishop, J., Samuel, A., & Xie, T. (2012). The future of teaching programming is on mobile devices. *Proceedings of the 17th ACM Annual Conference on Innovation and Technology in Computer Science Education - ITiCSE '12*, 156.

Zhang, J., & Lu, J. (2014). Using Mobile Serious Games for Learning Programming. *… 2014, The Fourth International Conference on …*, (c), 24–29.