Programming: A Study on Upper Primary Students' Attitude towards Education Digital Games

Mohd Lezam Lehat, Rashidah Mokhtar, Nora Mohd Basir, and Yusnita Sokman

***Abstract*—There is an emerging trend of using games for learning purposes and previous research has looked at how the concept is applied in different fields. However, little studies have been done to examine how programming affects primary school students especially in the Malaysian context. To better understand how learners respond to the use of digital games in learning programming, this exploratory case study is performed by examining the attitude of upper primary schools students towards its usage. The students were asked to perform several learning activities using games during which observations were made and questionnaires were distributed for data collection. The outcome of the study will be useful in the future development of games that are suitable to the students' age and level. By identifying the learners' preference, it can help to guide the development of digital games especially in the field of programming.**

***Index Terms*—Digital games, education, primary students, programming.**

I. Introduction

Programming is a compulsory subject for students majoring in computer science. However, Studies have shown that only 67% managed to pass [1], while several studies in Malaysia indicated that learners responded negatively to the subject. They described learning programming as boring and difficult and they claim that the materials are not interesting [2], [3]. Therefore the method of teaching programming should be improved to facilitate a better learning environment. There is also a need to introduce programming at an early age to improve logical thinking [4]. To address these two needs, this study will examine the use of digital-game-based learning among primary school students. The objective of this study is to identify the primary school students' preference towards using digital games in learning in the context of Malaysian culture. The practical implications of this study will be useful in advocating the teaching of programming through educational games.

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II. Literature Review

A. Significance of Games-Based Approach

There are several approaches to teaching programming such as example based programming [5] collaborative constructivist approach [6] problem based learning (PBL) and game-based approach. This study focuses on game based approach to suit the target group's level The significance of this approach is also highlighted in several past studies (see [7], [8]).

B. Digital Games-Based Approach

There are several types of games that can be used to introduce students to computer programming. The three main types are digital games, traditional games and hybrid games. A digital game is a system in which players engage in artificial activities that have certain rules and quantifiable outcomes using incorporated digital technology [8]. A lot of research has been done using digital games, especially for secondary school students. The games may be played in both online and offline mode using either a personal computer or mobile devices. The games discussed in this section may include prototype versions, games featured in on-going studies as well as games developed in past research. Further information related to digital games was reported through observation in Table III.

The followings are some examples of games that are used in past studies to teach programming. Lee *et al.* [9] experimented with the use of online logic game, Tic Tac Toe, produced by CTArcade. When the students see the visual patent and strategies of games, they learn the concepts of problem solving and formal logic. Other digital games like Hangman [10] asks user to guess secret numbers while Game of Nim involves strategies in numbers that can expose students to Command line, terminal I/O, random numbers, control structure, String manipulation, array and exception handling. Research on the use of Scratch, Alice is also often discussed in the teaching of programming and covers all the basics. However, the usage is more focused on high school students.

C. Computer Programming

Many researchers refer to the two major professional computing; the ACM and IEEE Computer society with the proposed ACM Curriculum released in 2013 [11]. In general the curriculum model is divided into several fractions in the field of computer science. The initial emphasis on programming was on logical thinking so that students can solve the problems step by step. There are 18 knowledge areas identified in CS2013 where Programming Languages

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(PL) and Algorithm and Complexity (AL) are part of the computer science areas. In Malaysia, each university is given the right to develop their own curriculum and the curriculums are certified by the Malaysian Qualifications Agency (MQA) under the supervision of Ministry of Higher Education. Currently there is no specific subject on computer programming that is developed for primary school students in Malaysia. The learning is also more focused towards application software. There is, however, one specific module called ICT Literacy for Primary schools (ICTL) for year 1 until year 6 which is taught under the English subject for the first 3 months of school. The ICTL module can be improved by embedding the elements in programming. Based on this study and the suggestions that fundamental programming should be taught as early as possible ([9], [12]), all the activities that have been done so far have only used the basic concept of programming or are inclined more towards logical thinking.

III. Research Methodology

The aim of this research is to identify the common digital game-based approach in introductory computer programming and to identify the students' preference towards programming via games. A further analysis is done to produce recommendations in the implementation of this method.

The first phase of the current study is the literature review relating to the subject matter as well as articles that have been published before. The result of this study is to see the common game design that has been used and discussed. The second phase is a web observation to identify the trending games in the market for learning purposes especially related to programming. For this purpose, a number of games have been identified as in the literacy study. The third phase is to examine the students' interests, in which the initial study has been done by distributing questionnaires to 49 upper primary school students of Sekolah Kebangsaan Jementah Segamat Johor. Questionnaires were administered during a special session in which the description of each item is conducted by a facilitator and the students answer the questions individually. After that, the fourth phase is done by exploration case study in which students are divided into groups to do some educational digital game activities. In this study, we used robologic [13] as the content is related to programming and it is suitable with the respondents' background.

IV. Analysis and Finding

A. Analysis of Respondent Profile and IT Background

49 respondents were involved in this research. 90% of them were the upper primary school students of Sekolah Kebangsaan Jementah Segamat Johor who participated in this program. 69.4% of them are male while the rest are female. This respondent profile analysis is very important to see the overall overview on IT background of the respondents in this research.

Table I summarises the respondents' IT background. Majority (73.5%) of the respondents have a personal computer. About half (48.2%) of them use the computer for information searching via the Internet and the other 37.6% use it to play games. The rest of them responded that they use the computer to do their homework and to fulfil other purposes. Almost 50% of them use the computer once a day. However, some of the respondents (14%) recorded no usage as they do not own a personal computer. From the overall background of the respondent, it can be seen that most of them use the computer for various purposes although some do not even own one even though they do not have it personally.

TABLE I: Tabulation of Overall Respondent IT Background

Item	Frequency	%
Personal Computer		
Yes	36	73.5
No	13	26.5
Purpose of Usage		
Do homework	12	14.1
Find info by internet	41	48.2
Playing games	32	37.6
Others	3	3.5

B. Analysis of Respondent Tendency toward Digital Games

Fig. 1 shows the type of games that respondents normally play with. 'Strategy game' such as Chess, Starcraft and Worms are the most preferred games followed by the 'first person shooter game' and the 'simulation game' with 25%, 22% and 20% respectively. They also play 'role playing games' (11%), 'card games' (10%), and 'graphical adventure games' (9%). Based on the result, it shows that the students have a tendency towards playing digital games that push them to think fast, critically and logically to succeed in each game level.

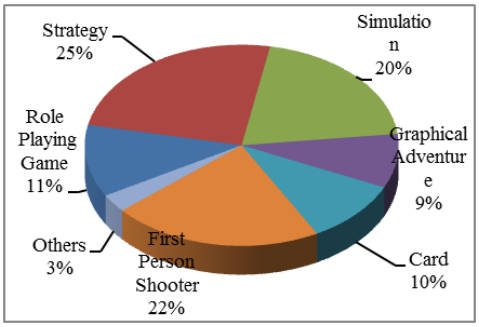

Fig. 1. Pie chart of types of digital games.

As for the devices used to play these digital games, it was found that 36 of them (67.9%) play the games using computer and tablet while another 20.8% and 11.3% use games consoles and smart phones respectively.

The respondents' preference is measured by 12 items based on their experience on the activity. Reliability test had been done to the items. From the test, Cronbach's Alpha value for the 12 item is 0.914. Since the Cronbach's Alpha value is more than 0.7, therefore all of the items can be used to measure the respondent tendency towards the digital games that has significant impact in introducing programming to upper primary students. 12 statements were

formed to measure the respondents' predisposition towards digital games, and the frequency in percentage can be seen in the table below (Table II).

TABLE II: RESPONDENT LEVEL OF TENDENCY TOWARDS DIGITAL GAMES

Statement		1	2	3	4	5	Total
I think this activity is very fun	*n* %	2 4.2	1 2.1	0 0.0	10 20.8	35 72.9	48 100
The usage of computer games makes this subject more interesting	*n* %	1 2.1	0 0.0	5 10.4	18 37.5	24 50	48 100
I can learn better by myself	*n* %	3 6.3	8 16.7	10 20.8	12 25	15 31.3	48 100
It is more flexible for me to determine my own learning time	*n* %	2 4.2	5 10.4	2 4.2	21 43.8	18 37.5	48 100
These computer games help me to think critically	*n* %	1 2.1	4 8.3	7 14.6	14 29.2	22 45.8	48 100
Solving the given problem is very interesting	*n* %	1 2.1	1 2.1	4 8.3	17 35.4	25 52.1	48 100
These games challenge my understanding of the subject	*n* %	1 2.1	0 0.0	4 8.3	19 39.6	24 50	48 100
Multimedia elements in the games are interesting	*n* %	6 12.5	1 2.1	2 4.2	13 27.1	26 54.2	48 100
I just need a very short time to know how the game is functioning	*n* %	2 4.2	3 6.3	7 14.6	17 35.4	19 39.6	48 100
Navigations and interactions are easy to use	*n* %	3 6.3	1 2.1	2 4.2	15 31.3	27 56.3	48 100
I wish I have opportunities to learning using this game approach	*n* %	2 4.2	2 4.2	4 8.3	15 31.3	25 52.1	48 100
I prefer using games to learn compared to traditional methods in class	*n* %	1 2.1	4 8.3	2 4.2	18 37.5	23 47.9	48 100

From the motivation aspect, we can see that more than 85% of them 'Agree' and 'Strongly agree' to this concept where learning using digital games is fun and makes the subject more interesting. However, this activity does not really help the students in learning better on their own. It is because only 56.3% agree with the statement given. On the other hand, 81.3% of respondents agree that it gives them flexible learning time.

Furthermore, 75% of the respondents 'Agree' and 'Strongly agree' to the statement that digital game helps them to think critically. 87.5% said the 'Robologic Games' makes the problem solving process more interesting and challenges their understanding on the subject (89.5%). It shows that digital games really improve their thinking level that is good in exposing the programming language.

As for the game interface, 81.3% of the respondents agree that the multimedia elements in the games are interesting (81.3%). In terms of the time needed to learn the game, 75% agree that they just need a very short time learn how to play the game while 87.6% agree that the navigations and instructions are easy to use. This high percentage of disagree gives a guide to the future development of digital games to be more sensitive of the respondents' level of understanding.

When it comes to expectation, 83.4% of the respondents wish to have more opportunities to learn using this game approach and 85.4% of them prefer using games to learn compared to the traditional method in class. This shows that they are really interested in using digital games and hope that such games will be used in the class session.

From the findings above, we can say that the upper primary students' favour the use of digital games as the games make learning easy and the interesting interface motivate them in learning the subject. Learning with games can also encourage the students to think critically besides challenging their understanding to solve the problem in a fun way.

TABLE III: GAMES APPLICATION

Game Concept	Example	Skill	Level
Click and drag visual programming command to the workspace.	LightBot Robologic Dr. Brain brain Bill the robot	logic, conditional statement, loop, function, recursive, basic command.	Primary Schools, High schools, University.
Guess number or text.	Jefferson Lab (http://education.jlab.org/) (More than 10 games available here with the same concept)	Terminal I/O, random numbers, control structure, array, passing array	Primary schools, High schools,
Solve the problem by moving an object	Apple app (http://www.apple.com/itunes/) Google play (https://play.google.com/) (http://mathplayground.com) (More than 100 logical games available) (http://www.learninggamesforkids.com/) (More than 10 logical games available)	logic,	Primary Schools,

C. Games Observation

There are many educational games that have been developed. The examples in Table III are categorized according to programming concepts and the categorized accordance with the similar or nearly similar concept of implementation and has been widely used.

Based on the observation, the trend in educational programming game is done through instructions with some basic visuals and commands used to solve a problem. This approach can help to explain basic concepts in programming and to train the students' logical thinking. There is a simple method for introducing programming where they just need to move certain objects to solve problems and this method can only increase the logical thinking of students. Many games developed will directly involve the users because they have an impact on the learning process and this has been studied by many researchers such as [14] and mostly require the students to select or drag the objects to produce results.

The discussion in this study is more on digital games application with the concept of programming. However there is little review on the environment for game development through visual programming as in Table IV to see the trends in the exposure of programming.

TABLE IV: LEARNING ENVIRONMENT

Game Concept	Example	Skill	Level
Dragging & drop program elements(code) to animate object.	Alice (www.alice.org), Scratch (www.scratc.mit.edu) GreenFoot (http://www.greenfoot.org/)	Logic thinking and support most of the modern programming environment	High Schools, University.
Select object & action to make animation using visual logic.	Kodu (http://fuse.microsoft.com/projects/kodu) Terrarium (http://terrarium2.codeplex.com)		

There are some other games that are not listed here. However, based on the trends of game development, the environment is based on two main forms, either from a visual code or using visual objects to produce games and animations. Since the target is for developing the primary school student's visual techniques, drag and drop are popular choices to facilitate the students in understanding the concept of programming and most of the games are more to object-oriented programming. The final output is usually in the form of animations or simple games with some rules.

Based on the discussion done in 2010 ACM SIGCSE Symposium on Computer Science Education involving Alice, Scratch and Greenfoot when it comes to programming, Kooling [15] agrees that the earlier learning process of programming is better, but there is a boundary between cognitive development of a concept and technology. Therefore the use of programming syntax such as Scratch and Greenfoot is not intended for persons under 13 years of age.

V. CONCLUSION

Based on the findings from the several methods discussed above, a specific approach can be introduced in the development of digital games, especially in Malaysia. The use of digital methods will be able to attract students to learn the basics of programming. This can be done as early as in the primary school level by focusing on their preference towards digital games. The growing percentage of students who have computers and gadgets also contributed to this development and should be fully utilized for learning programming. The trend in the development of digital games can be practiced and adapted with the upper primary school students based on their knowledge and age level.

VI. FUTURE WORK

The current study only focuses on investigating the upper primary school students' preferences for digital-based games as well as analysing the latest trends in digital games development. In the future, the study will be expanded to develop and propose a complete framework in the development of digital games in order to introduce programming especially for the Malaysian learning environment.

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