

## **Design and development of Basic C Language Programming Game-Based learning Application**

**Ibtisam hama, Sahidan Abdulmana, Anas Tawalbeh, Nurulhusna Abdullatif**

Faculty of Science and Technology  
Fatoni University, Pattani, Thailand

*ibtisam\_alhamadi@ftu.ac.th, sahidan@ftu.ac.th, anas.tawalbeh@ftu.ac.th,  
nurulhusna@ftu.ac.th*

### **Abstract**

*C languages is the one of most powerful general-purpose programming languages and being the compulsory subject in the field of Information technology, Fatoni University to learn. However, there are many students could not easily to understand the content of programming language concept, they always have difficulties in studying it and are little interested in it and due to the fact thus failed in course. Therefore, the purpose of this study is to design and develop an interactive mobile game-based learning application in basic C language programming concept for beginner through application to introduces and helping students understanding the programming concept and syntax. The game-based application has digest programming class and quiz into the mobile game the students can play as the main character to explore the level and the story and at the same time learn about the fundamental principles behind it. This game was developed using Unity Game Engine as development tool, Microsoft visual code studio and Adobe photoshop as its graphic design tool.*

**Keywords:** *C language programming, game-based learning*

### **1. Introduction**

C programming is the one compulsory computer programming languages taken in requirement of Information Technology department, Fatoni university. For freshmen just exits from high school where a majority of students have not been exposed to programming or deal with algorithm formulation, the students find it difficult to create solutions to programming problems. Many students could not easily to understand the content of this programming language even in the basic concept. They always have difficulties to studying and are little interested in it and due to the fact thus many students had failed in the subject and being negative perception toward learning into next programming languages to be difficult and disheartening subject.

Game-based has evolved to being used to encourage students to participate in learning while playing and make the learning more interesting and engage students in the way that traditional classroom activities simply cannot. (Al-Azawi, Al-Faliti&Al-Blushi,2016) Game-based learning can provide motivation for learners through interactive content and activities. In many studies done and on the web resource, we can find many games related strategies that aim to support learning in computer programming courses. Digital games are often used in educational contexts to attract and retain students. (Vahldick, Mendes& Marcelino,2014) Therefore, to achieve students' attention, using games can help smooth learning and engage students by providing a visual and motivating environment.

The purpose of this study is to design and develop an interactive mobile game-based learning application in basic C language programming concept for beginners through application to introduces and helping students understanding the programming concept which includes the

introduces of C Programming, variable and data type, operators and syntax and to encourage student's motivation on Computer Programming through the game-based application. The project name is "if(learn)" game application which stands for mobile game-based learning for beginners. The game application could serve as a simply supplementary tool.

The remainder of this paper is organized as follow: It starts with explained the related work to present a student's difficulty with learning computer programming and research done on game-based application to encourage student on programming then the methodology is described for this project approach, the results and conclusion are reported and discussed.

## **2. Review of Literature review / Background of Study**

Nowadays, the Computer language(coding) is important in the present 21<sup>st</sup> century skill and becoming accepted by governments and academic and being added to the elective requirement for some high school and made compulsory core subject University curricular in Thailand for Engineering, Computer Science, Information technology and related field at least one or more programming language to undergo the requirement of course standard. However, the learning is not simple for many students, they could not easily to understand the content and not keeping students interested in the subject.

Programming subject is usually taught in an early semester at Information Technology Department because it is regarded a fundamental competence as C language is the first computer programming language that all students are required to take core courses during their first year in Information Technology Department, Fatoni University to learns before laying a fundamental for other language learning. C language programming is the one of most powerful general-purpose programming languages. There are contains many contents, which are data type, operator and expression, sequential structure programming, selection structure programming, loop structure programming, array, function, pointer, structure and union, and file operator. Normally, learning programming language is about understanding syntax and the functioning of code to solve a problem, the students will first to be introduced to the concept of programming, and data structure where they are taught how to analyze problems. Next use specific techniques to represent the problem solution and validate the solution then the learners are required to convert the problem solution into a program.

However, learning the basic of programming is challenging especially for freshman or novices learners. In the last decades, Learners' difficulty with computer programing language has been many research. According to Gomes and Mendes (2017) revealed that among the reasons behind the difficulty of programming is that it requires a high level of abstraction and many hours of study and practice. A study by Ismail, Ngah and Umar (2010) revealed the finding collected from the interview with lecturers and students, there are deficiencies in knowledge, understanding application of computer programming among many students and similar result with Tan, Ting and Ling (2009) it is considered of undergraduate's perspective and perception in Computer programming that learning programming has been difficult because the undergraduates' lack of understanding of how the program is executed and another study conducted by Milne and Rowe (2002) the most difficult concepts to understand in C programming language are pointers, recursion and data structures. On the other side, the major difficulty for freshmen or novices learner is students' motivation and interest. Many students don't have enough motivation to study programming, because there is an extremely negative perception connotation associated with programming that passes down from their seniors. (Gomes, Anabela, Mendes & A. J.,2007) Based on regarding, learning programming concept is related to introduces the variables, data type, operations which are arithmetic and logical and syntax are examples of these basic concepts which all learners need to learn. According to Ahmad and Ghazali(2020) argue that the strong understanding of these concepts will help the learners to code the solution of the problem. Therefore, students have to understanding syntax and the functioning of code to solve a problem in

form structure solutions to programming. To deal with the solution in interpreting the problem leads students to face with difficulties. It is a factor impact student's motivation. It is clearly identified that it is well known in the learning Computer programming in related filed Education community that students have difficulty with programming courses. It is necessary to ensure a positive attitude and instill in early to boosting the motivation towards programming subject.

Based on the issue above, to get beyond the problem this study was looking for a tool to encourage students' motivation on computer programming.

Game-based has evolved to being used to encourage students to participate in learning while playing and make the learning more interesting and engage students to understand the lesson in the way that traditional classroom activities simply cannot. (Al-Azawi,Al-Faliti&Al-Blushi,2016) According to Sung (2009) refers that one of the areas where students have been more unmotivated is computer science and argues that games integration can help to attract more their attention. Game technology has been gradually introduced in different teaching with more utilization in education. These games integration on the contents results from a strategy which aims to attract the students attention and bring them to the learning.

The Digital Game-based learning have been long used to support learning, the idea of using game to support the learning of computer programming is not new as studies done by Shellington, Humphries and Morsi(2015) was developed a mobile game that provides an engaging way for students to practice the basic syntax of C, C++ and Java, the results showed that students enjoyed the game and a modest improvement in the students' abilities to identify correct and incorrect syntax was achieved. Reference to Malik, Al-emran and Mathew (2020) developed and introduced a 'PROBSOL' application to enhance the problem-solving skills of novice programmers in an introductory programming course, the results showed students were more satisfied enabled them to accomplish tasks more quickly, and enhanced their learning productivity. Reference to Yassine, Chenouni, Berrada and Tahiri (2017) was conducts a study to identify pedagogical approaches and gameplay techniques involved in the development of serious games "Perobo" for teaching pointers, considered as a difficult concept in C programming language to make learning pointers more attractive than conventional teaching and learning method. According to those literature when games are developed and used appropriately, they provide an excellent learning tool.

### 3. Methodology

The implementation of this application used the Rapid Application Development (RAD) model was selected as part of the project development (Beynon-Davies et all.,1999). The structure of the RAD model ensures that the software needs by the users are constructed. The model consists of four phases: Requirements planning, User design, Construction and Cutover.

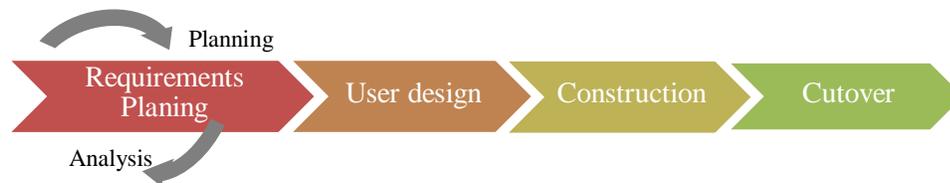


Figure 1: Phase of the RAD approach

#### A. Requirements Planning Phase

This phase combines software planning and software analysis is the main role. The developer pitch the idea and answer the question to conceptualized it with all stakeholders which are teachers and students to agree on the project need as objectives, scope, constraints and software requirements then created the initial design and game concept. And to analysis developed started to identify the gameplay to introduces and helping students understanding the C language programming by digest C language class and quiz which reference from book's name C Language Programming based on

IT course. (Tang-opakun & Polsawat,2018) This study was designed and developed an interactive game-based learning application, the game application covered of 3 chapters are introduction of C programming(structure), variable and data type, operator and expression. Each chapter includes 3 levels, 9 levels in total to achieve a game. User could learn and play as the main character to explore the level will grasp a knowledge behind it. Figure 3 shows the flowchart of this game

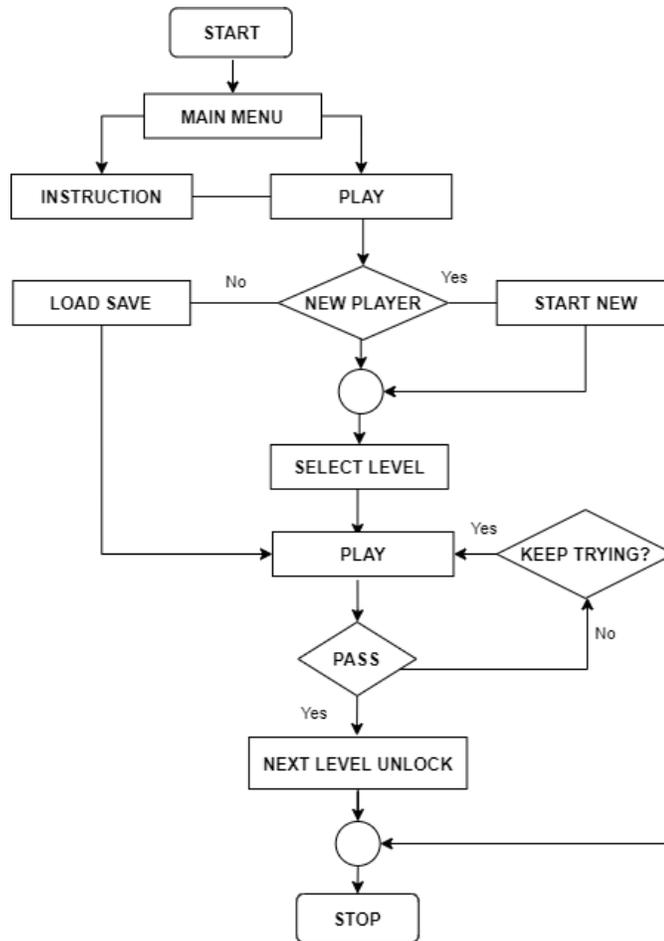


Figure 2: The flowchart of this game :if(learn)

### B. User Design Phase

In this User Design Phase will be carried out all the designs based on Requirement Planning Phase. The process of designing started with a storyboard that illustrates the story, actors, assets, icons, and UI design which to easy and user-friendly suite with the targets. The designing was created in Adobe Photoshop as a tool. There are essential functions that the game requires, the main menu contains play, education and setting and exit as Figure 3-4 shows the screens of main menu page and education page are display information for a user to further learn about C language.



Figure 3: main menu page



Figure 4: Education Page

After the user chooses to play the screen will appear as Figure 5-6 users can navigate the level with arrows key left and right and click on level icon to access the level. The blue icon on each chapter indicates, it is comic and the white icon indicates its normal level, user can explore the level as a main character, learn and play the content which defines on each chapter behind it as Figure 7-11



Figure 5: Chapter Map Navigation Page



Figure 6: Story Comic Page



Figure 7: Level Page (dialogue)

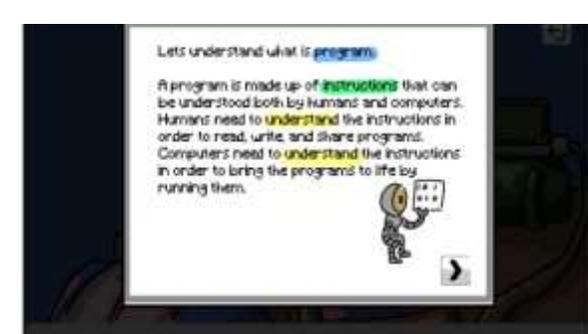


Figure 8: Level Page (tutorial)



Figure 9: Quiz Game Page (quiz navigate)

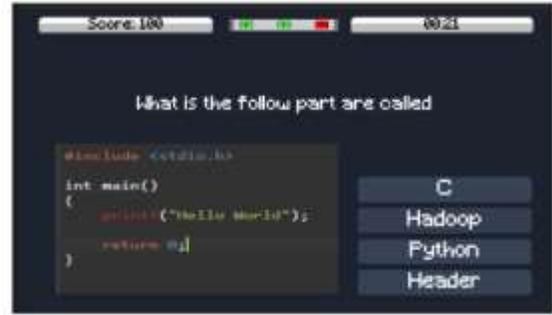
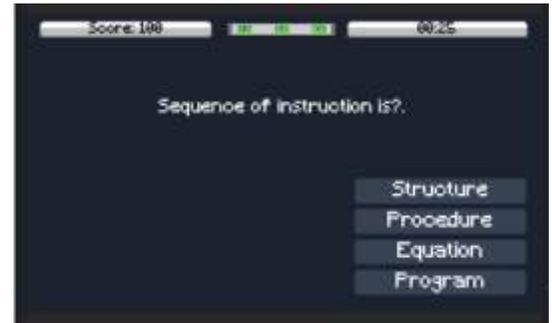


Figure 10: Quiz Game Page (gameplay)



Figure 11: Game Ends



### C. Construction Phase

In this Construction Phase was demonstrate through of Mobile devices. The game was developed using Unity game engine and Microsoft visual code studio as development tool, and Adobe photoshop as its graphic design tool. The developer list all the requirements and break them into small chunks for each iteration. Beginning the prototype with UI, and one level. From there the features and content would be added in every iteration. All of the feedback and experiment would be included in the requirement added in the development.

### D. Cutover Phase

This Phase is about the implementation of the project. It was performed the user testing to evaluation the quality of functional and usefulness on the game application developed. During the testing, a developer would do a round of self-testing to find any visible bug. After it is bug-free, user testing would be conducted. For user acceptance testing was conducted among 10 students of 1<sup>st</sup> year student from Information Technology, Fatoni University to joined in testing then responded with a Questionnaire. The scale was prepared as a five score Likert type, Likert scales are shown in Table 1 below and the list of questions and findings of data collected from the respondent on the project study is shown in Table 2.

Table 1: Scoring rang of likert scale of survey

Scale	Range-values	Verbal Interpretation
1	1.00 – 1.80	Strongly Disagree
2	1.81 – 2.60	Disagree
3	2.61 – 3.40	Neutral
4	3.41 – 4.20	Agree
5	4.21 – 5.00	Strongly Agree

Table 2: The Questionair User acceptance of if(learn) app

No	Items	Mean	SD	Verbal Interpretation
Q1	User interface is friendly and easy to use	4.2	0.79	Strongly Agree
Q2	Functions of the game are complete such as	4.5	0.53	Strongly Agree
Q3	I enjoy playing this game	4.0	0.47	Agree
Q4	My knowledge about C language concept improves after using the application.	3.6	0.52	Agree
Q5	This game application helpful to helps me to understand basic C programming concept	4.1	0.32	Agree
Q6	It would be beneficial to new beginner before learning to program.	4.6	0.53	Strongly Agree

#### 4. Results and Discussion/ Analysis

Based on user tested to evaluation the functional and usefulness on the game application developed, the result from respondents shows the positive acceptance toward on the game application as Table 2 above. The functional used in-game application which includes a User interface is friendly and easy to use and the completely the game with mean of 4.2 and 4.5 both of which can be verbally interpreted as strongly agree and user enjoying on playing this game got a mean of 4.0 which can be interpreted as agree. And the concerned of usefulness on the game application which includes the knowledge about basic C language concept improves after using the application and the game application helpful to help understand it with mean of 3.6 and 4.1 that verbal interpretation of agree and it would be beneficial to a new beginner before learning to program with mean 4.6 which can be verbal Interpretation as strongly agree, indicating that students were acceptance with the game application developed.

#### 5. Conclusion and Recommendation

In conclusion, this C programming language game-based application design has been developed. The purpose of this study was to designed and developed an interactive mobile game-based learning application in basic C programming language concepts for a beginner to introduces and helping students understanding the programming concept and syntax and to encourage student’s motivation on Computer Programming through the game-based application. The game application could serve as a simply supplementary tool, it is beneficial for students in mastering learning programming. According to the experimental results, it found that using game application was acceptance positively toward on learning. For first prototype of this study was project name “if(learn) game application, the concentration is to get understanding the basic C programming concept such as introduction of C Programming, variable and data type, operator and expression and syntax through quiz game that stands for mobile. However, the type of gameplay was not diverse. It is just a form of multiple choices to drag and drop the answer over until fully grasp. In a recommendation for future improvement, there are many things that can be enhanced from the first prototype. For example, it should cover all important elements in C programming such as the part of problem-solving, algorithm thinking to solve the problem solution with more interesting games and variety of gameplay mode.

## References

- ISMAIL, M. N., NGAH, N. A., & UMAR, I. N.(2010). Instructional Strategy in the Teaching of Computer Programming: A need assessment analyses. *TOJET: The Turkish Online Journal of Educational Technology*, 9(2), 126-131.
- Yang, T-C., Yang, S. J. H., & Hwang, G-W.(2014). Development of an Interactive Test System for Students' Improving Learning Outcomes in a Computer Programming Course. *IEEE 14th International Conference on Advanced Learning Technologies*, 14, 627-639
- Vahldick, A., Mendes, A. J. & Marcelino, M. J.(2014). A Review of Games Designed to Improve Introductory Computer Programming Competencies. *2014IEEE Frontiers in Education Conference (FIE) Proceedings*,14. 1-7
- Gomes, Anabela, M., & A. J.(2007) Learning to program - difficulties and solutions. *International Conference on Engineering Education – ICEE 2007* Coimbra, Portugal, 283-287
- Gomes, & Mendes, A. J. (2007). An Environment to Improve Programming Education, *Proceedings of the 2007 International Conference on Computer Systems and Technologies*, New York, NY, USA, 2007, p. 88:1–88:6.
- Ahmad, S. N., & Ghazali, J. (2020).Programming Teaching and Learning: Issues and Challenges. *Proceeding of ICITS 2020 6th International Conference on Information Technology & Society*
- Sung, K. (2009).Computer Games and Tradicional CS Courses.*Communications of the ACM* 2009(52)
- Malik, S. I., Al-Emran, M., Mathew, R.,Tawafak, R. M., & AlFarsi, G. (2020). Comparison of E-Learning, M-Learning and Game-based Learning in Programming Education. *International Journal of Emerging Technologies in Learning (iJET)*,15(15),133-146
- Shellington, W. A.,Humphries, T. O. ,Morsi, R., &Rizvi, M. A. E. (2015). Syntax circuitry: A mobile game for practicing programming language syntax, *2015 IEEE Frontiers in Education Conference (FIE)*, 2015, 1-4
- Beynon-Davies, P., Carne, C.,Mackay, H.(2019). Rapid application development(RAD): an empirical review. *EurJ Inf Syst*, 8, 211-233.
- Yassine, A.,Chenouni, D., Berrada, B.& Tahiri. A.(2017). A Serious Game for Learning C Programming Language Concepts Using Solo Taxonomy. *March 2017International Journal of Emerging Technologies in Learning (iJET)* 12(03):110
- Kraisorn Tang-opakun and Kitinan Polsawat.(2018). Complete C language program guide (คู่มือเขียนเขียนโปรแกรมภาษา C ฉบับสมบูรณ์). Bangkok:IDC Premium.