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PAPER

Code Adventure: An Educational Game for Learning JAVA Programming

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ABSTRACT

The purpose of this project is to (1) develop an educational game for learning in a JAVA programming course for undergraduate students, (2) compare the learning achievements of educational games and lectures, and (3) assess learner game acceptance with learning through games. The sample used in this research were 50 first-year undergraduate students in the field of management information systems from the Department of Information Science, S University in Thailand. In game design and development, The researcher developed the game based on the concept of game flow elements, such as challenges, story, fun, beauty, and so on, in order to inspire learners to be engaged in learning through games. The tools used in the research were (1) educational game performance evaluation forms, (2) an educational game for learning JAVA programming concepts, (3) a learning achievement test, and (4) student satisfaction assessment forms. The research results showed that (1) the learning efficiency of the educational game was very good, (2) the academic achievement of learning by the educational game was higher than that of learning by lecture, and (3) the acceptance of learning with computer games by the students was excellent. Additionally, learning through games made it easier for students to absorb the subject and learn more effectively. It has been discovered that learning through games improves learning results for students.

KEYWORDS

educational game, JAVA programming, learning programming

1 INTRODUCTION

The programming and data structure course is specifically created in the JAVA programming language in the field of management information systems in the undergraduate program in information science, Department of Information Science at S University. This course aims to provide learners an understanding of

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Java programming, including the meaning of symbols and signs, knowledge about getting started in Java programming, and commands.

In this regard, teaching and learning are organized both in theory and practice. Lecturers typically use lecture methods to build knowledge, transfer knowledge and to enhance the JAVA programming skills of learners [2], [14], [15].

Research studies have found that different types of learning materials can motivate learners to attend classes and take an interest in the lessons. Learners do not interact with these materials to the same extent as they do with educational games, however, because games use narratives that immerse the learners in stories and help them have fun while learning [6], [12], [11]. Moreover, the rules of games can stimulate learners to feel that learning is challenging and interesting [12], [16], [17], [19].

This game is designed and developed based on the action game genre and consists of the game elements, game flow, fun, challenges, rewards, and feedback. The game story is written with an action style in which heroes collect points for credit by answering questions at each information level, which helps learners feel immersed and want to learn while playing the game. Therefore, the level of difficulty of the game must be suitable for the learner's learning ability level [1], [3], [4], [5], [8], [9].

The researcher used the TAM Model to assess the game's acceptability for use in learning by students, both in terms of ease of use and usefulness, in order to determine the degree to which the game was accepted by the students [13].

The researchers went to the Department of Information Science, S University, and asked lecturers and students about the various problems of learning JAVA programming in the classroom. The results showed that most of the problems were due to (1) differences in learners' background knowledge, (2) JAVA programming language being difficult to understand or to use, and (3) a lack of suitable learning material [7], [10], [14], [18].

Considering the previous studies and problems of learning in JAVA programming in the Department of Information Science, S University, the researchers are interested in developing educational games for learning JAVA programming with an adventure type called "Code Adventure" for students in the management information system undergraduate major. The benefits of educational games are that the learners have fun, they learn by playing, and they find learning challenging; the games themselves improve learning efficiency and provide learners access to self-learning anywhere, anytime [6].

2 OBJECTIVE

a) To develop an educational game for enhancing JAVA programming skills for undergraduate students.
b) To compare the learning achievement of learners between learning with games and regular lectures.
c) To study learners' acceptance of educational games.

3 RESEARCH FRAMEWORK

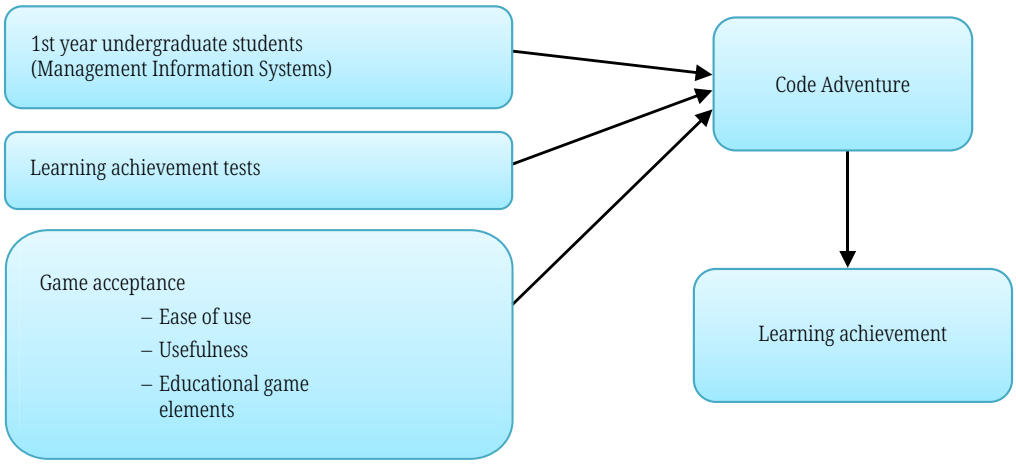

Fig. 1. The research model for developing the game for enhancing JAVA programming achievement

Figure 1 shows the in-game design and development framework to enhance JAVA programming achievement for first-year students in the management information system major. It is necessary for researchers to first understand the content of the JAVA programming language used in programming and data structure courses. Then, they develop a test according to the learning objectives used to assess learning achievements with games. The game learning acceptance factor was added to the design and was assessed by metrics of ease of use, usefulness, and educational game elements.

4 RESEARCH METHODOLOGY

4.1 Research design

This research design was intended to improve learners' perceptions and enhance their JAVA programming knowledge using the ADDIE model (analysis, design, development, implementation, and evaluation) in its development process. The five stages of this research methodology are as follows:

a) Analysis

Data collection and studying teaching and learning in JAVA programming language problems to develop a suitable educational game based on educational theory.

b) Design

The results from the analysis step were implemented, and the game was designed to enhance JAVA programming skills. Game elements and mechanisms were incorporated into the game, including having fun, challenges, rewards, and goals, because stimulated learners respond to games and lessons.

Furthermore, the researcher must create game flow controls that are appropriate for the students' learning and game playing abilities. Playing and learning with games should not be too challenging or too easy. In order to develop

motivation for learning through games for each student, the setting and individual learning ability level must be considered (personalized learning) [21], [22], [23], [24], [26], [27].

c) Development

Researchers use the results from the design step to develop games. The game was designed with 3D cartoons. The STEAM model will be utilized to improve abilities while building the game, computational reasoning and coding ability [20]. Subsequently, the evaluation game performance questionnaire was used to assess game performance. This questionnaire was sent to five specialists for game quality and performance verification.

d) Implementation

In this stage, researchers separated the students into two groups. The pretest was assigned in both groups, the control group was learning by lecture in the classroom and the experimental group was learning through games.

e) Evaluation

After finishing the class, the posttest and questionnaires were assigned to both groups. Finally, researchers collected and analyzed data from the pretest and posttest and the questionnaires to evaluate the performances of the students in the educational game group.

4.2 Research sample

The samples of this research are 50 freshmen students from the management information system major (Purposive Sampling) because none of the sampled students have skills or background knowledge in JAVA programming, and 25 learners in each group comprised the sampled members. The research environment was controlled by the researchers.

4.3 Research materials

In this experiment, the researchers developed research materials for enhancing JAVA programming academic achievement: the Code Adventure game, learning achievement tests, and learners' acceptance of educational games.

a) Code Adventure Game:

This game is designed and developed based on the action game genre and consists of educational goal, fun, challenges, rewards, and feedback. The game story is written with an action style in which heroes collect points for credit by answering questions at each information level, which helps learners feel immersed and want to learn while playing the game. Therefore, the level of difficulty of the game must be suitable for the learner's learning ability level. The details of some screens in the game are presented below (see Figures 2–8).

Fig. 2. The main screen of the game

Fig. 3. The screen shows how to play the game

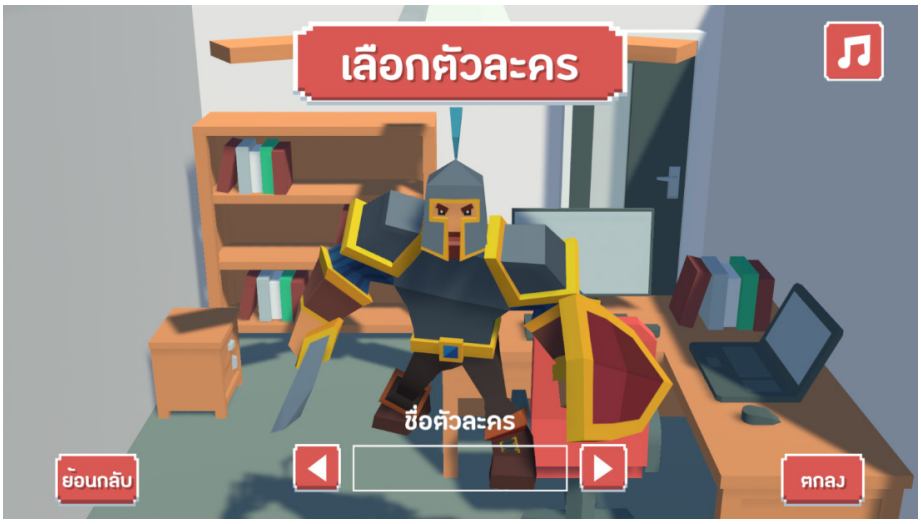

Fig. 4. The screen shows hero selection, and learners can type their name

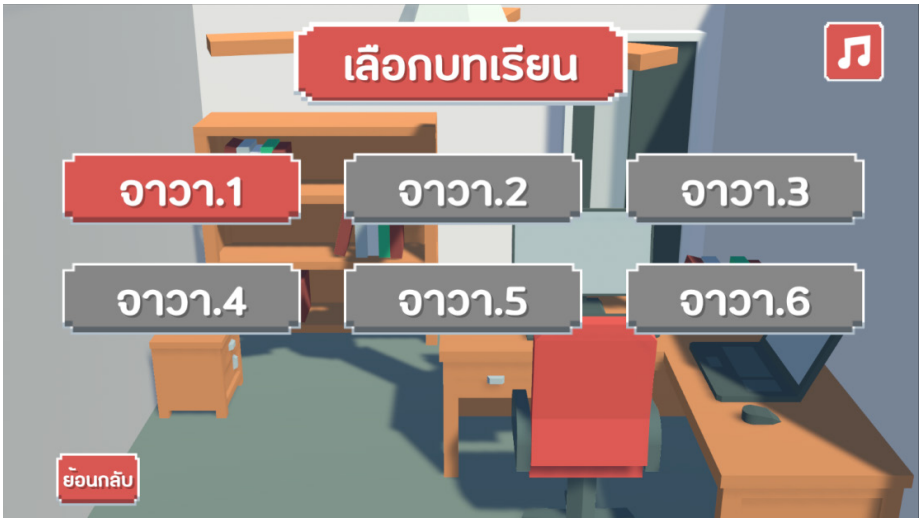

Fig. 5. The screen shows lesson selection

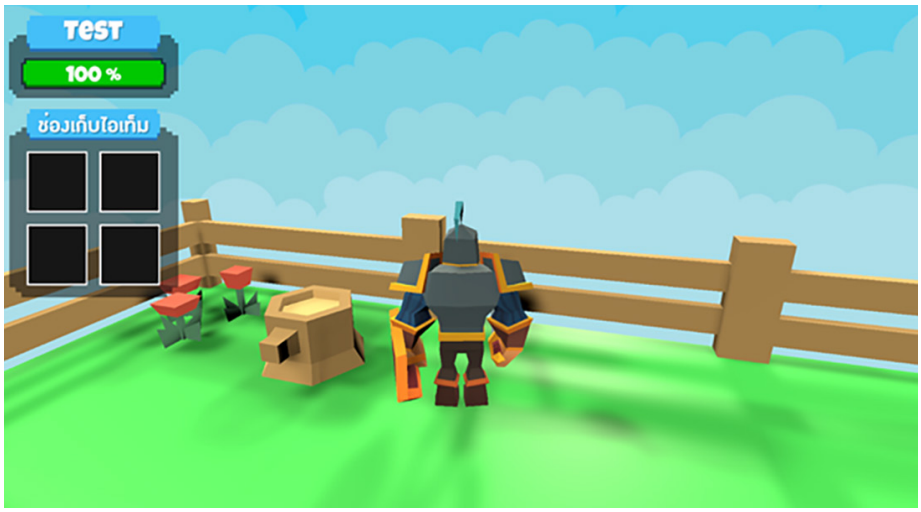

Fig. 6. The screen shows details of points and credits in the game

Fig. 7. The screen shows details of contents in the game

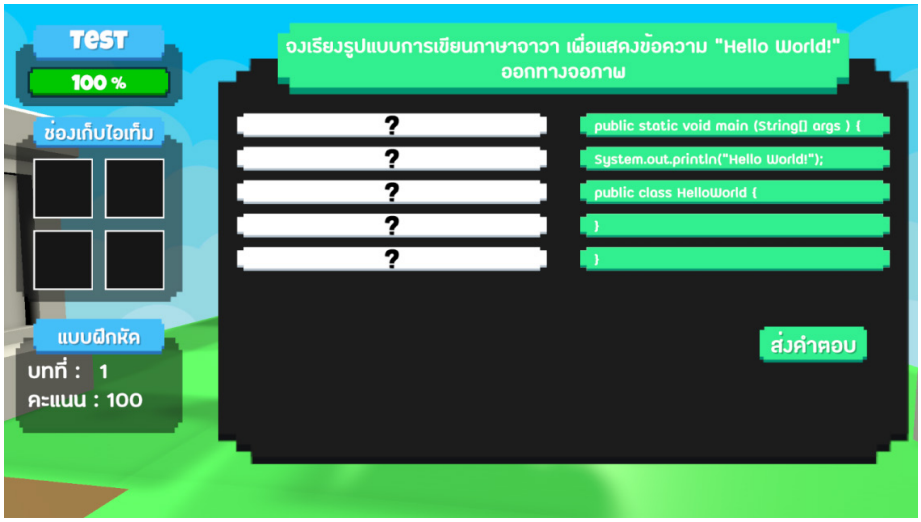

Fig. 8. The screen shows detail of playing the game

b) Learning achievement tests

In this experiment, the researcher developed a test of learning achievement divided into 30 pre-study questions and 30 post-study quizzes, ordered by the level of difficulty of the questions**.**

c) Game acceptance questionnaire

The game acceptance questionnaire was developed to evaluate learners' game acceptance using a 5-point Likert scale, from strongly agree to strongly disagree, which can be interpreted at each level according to the average score as follows [25]:

4.21–5.00 = strongly agree
3.41–4.20 = agree
2.61–3.40 = neither agree nor disagree
1.81–2.60 = disagree
1.00–1.80 = strongly disagree

5 FINDINGS

The researcher used an independent t-test to test the research hypothesis: "The experimental group that studied with games had an achievement level that was not different from that of the control group." The hypothesis test results are shown in Table 1.

Table 1. The results from learning achievement tests using independent t-test

	Number (N)	Mean ($\bar{x}$)	S.D.	t	df	Sig.
Control	25	21.36	2.11	4.40	24	.000
Experiment	25	25.04	2.76			

Table 1 shows that the experimental group had a mean score of 25.04, while the control group had a mean score of 21.36. Therefore, it can be concluded that the experimental group had a significantly higher level of academic achievement than the control group at the .05 level.

Table 2. Learners' satisfaction with educational game after learning

No	Question	Mean	S.D.	Interpreted
Ease of use				
1	The installation of the program is very convenient and fast.	4.64	0.49	strongly agree
2	The game is very convenient and easy to use.	4.60	0.50	strongly agree
3	The game can be processed quickly.	4.56	0.51	strongly agree
4	The game is stable, does not lag, no crash.	4.48	0.59	strongly agree
5	The game can be played continuously.	4.56	0.58	strongly agree
	Average	**4.57**	**0.53**	**strongly agree**
Usefulness				
6	Content is appropriate and consistent with learning objectives.	4.60	0.58	strongly agree
7	The content is complete and correct.	4.68	0.56	strongly agree
8	The content is difficult, suitable for the level of the learners.	4.60	0.50	strongly agree
9	There is an appropriate ranking of content that is easy to understand.	4.32	0.63	strongly agree
10	The content gained from playing games is useful for learning.	4.52	0.59	strongly agree
11	Language and grammar in the game are correct.	4.48	0.65	strongly agree
	Average	**4.53**	**0.59**	**strongly agree**
Education game elements				
12	Graphics and illustrations are attractive and beautiful.	4.52	0.59	strongly agree
13	The music and background music are clear.	4.68	0.48	strongly agree
14	The game design is beautiful, interesting.	4.52	0.59	strongly agree
15	The game has elements that create challenges that will entice you to play.	4.60	0.65	strongly agree
16	The game has various difficulty levels, which will attract you to use.	4.60	0.65	strongly agree
17	The game has elements that generate curiosity that will entice you to play.	4.60	0.50	strongly agree
18	The game is so fun that it makes you forget the time.	4.48	0.51	strongly agree
19	The game contains content that can make learning fun.	4.48	0.65	strongly agree
20	The games interact appropriately with learners.	4.76	0.60	strongly agree
21	The games are presented in a challenging, engaging and enjoyable presentation.	4.56	0.51	strongly agree
22	The game encourages the imagination to learn in harmony with the content.	4.56	0.51	strongly agree
23	The game has clear appropriate instructions.	4.60	0.50	strongly agree
	Average	**4.58**	**0.56**	**strongly agree**

Table 2 shows that the elements within the game are important factors that encourage the learner to accept game-based learning. Because games help learners interact more with the lessons, it is easier to talk and exchange ideas with friends. The level of difficulty of the game is appropriate.

The music within the game also makes players feel fun and relaxed. There are easy rules. Learners can recognize the ease of use. Learning with games feels fluent because there are no time or place restrictions.

Learners feel the ease of use. This enables learners to realize the benefits of game-based learning. As a result, learners have a positive attitude toward learning using games.

6 DISCUSSION

From the research results, it can be concluded that most learners find it difficult to learn JAVA programming and that there is still a lack of appropriate materials for learning JAVA programming. Using games to encourage learning is the most effective method because learning by games is interesting, fun, and not boring [4], [5]. The game can help learners have a positive attitude toward learning JAVA programming; for example, it makes learning JAVA programming less difficult, improving self-efficacy [1], and as a result, it is easier for learners to accept learning with games.

Educational game design takes into account the game's content, pictures, music, and in-game rules, encouraging learner interest and motivating them to continue studying until the end of the game. The level of internal challenges also impacts learners' learning. If the game level is too difficult, it will make students nervous. If the game is too easy, however, it will bore students. Having the appropriate level of difficulty will enable learners to interact better with games and lessons.

Moreover, the gameplay within the game must be straightforward, requiring simple and clear instructions. Learners should be able to install and understand the game independently.

7 CONCLUSIONS

This project aims to develop an educational game for undergraduate student learning in JAVA programming courses. In the first step, researchers interviewed most students in the field of management information systems at S University to identify JAVA programming learning problems. The results showed that most students felt that learning JAVA programming was hard to understand and not interesting to them. The researchers then created game content based on the curriculum of the classroom lessons and chose the adventure game genre to develop an educational game named "Code Adventure" [3]. In the second step, researchers developed learning achievement evaluation and game acceptance questionnaires. In the last step, a sample group of students tested this game and answered the questionnaire.

The research results showed that (1) the learning efficacy of the educational game was very good, (2) the academic achievement attained by learning through the educational game was higher than that attained by learning in lectures and (3) the acceptance of students to learn with computer games was excellent.

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