The educational game design on relation and function materials

S A Pramuditya\textsuperscript{1,2*}, M S Noto\textsuperscript{2} and D Syaefullah\textsuperscript{2}

\textsuperscript{1} Departement of Mathematics Education, Universitas Pendidikan Indonesia, Bandung, Indonesia
\textsuperscript{2} Departement of Mathematics Education, Universitas Swadaya Gunung Djati, Cirebon, Indonesia

*Corresponding author’s e-mail: amamisurya@gmail.com

Abstract. Information technology development is certainly very helpful and important for life, especially for education. Media is always associated with technology. Media is considered important because as a tool in the learning process both inside and outside the classroom and can also be used in the framework of communication and interaction with teachers and students in the learning process. Smartphone technology is currently growing very rapidly, especially for Android platform. Game is one of the entertainment media that becomes an option to eliminate boring or just to spend a time. Educational games specifically designed to teach users a particular learning, developing concepts and understanding and guiding them in training their abilities and motivating them to play it. Game of mathematics education is a game inserted by mathematics learning content. This article discusses development research of designing educational game. The purpose of this research was to produce educational games on relation and function, which should be valid and practical. This research adapts the development model of ADDIE, restricted by analysis, design, and development. Data were collected from validation and practical sheets then were analysed descriptively. Based on the results of data analysis, our educational game was valid and practical.

1. Introduction

Information technology development is certainly very helpful and important for life. The existence of human technology and information can easily access. The current global development requires the world of education to always change the concept of thinking. Technological developments can be used for presenting a more innovative, creative, flexible learning and bring a fun learning atmosphere. Jonassen and Carr believe that in order to help students to construct their knowledge, they should be actively involved in learning with the help of Technology tools [1]. Dexter et al. indicate that the effectiveness of technology integration into education is largely dependent upon its ability to engage students in learning. Trilling and Hood believe that the key to using educational technology is to utilize meaningful activities that may engage students to construct their knowledge in different ways, not available before the technology was introduced. Studies have shown that learner engagement is paramount to learning success [1]. Media is always associated with technology. According to Acsin states that the expansion of the concept of media, where technology is not just objects, tools, or tools, but also attitudes, needs, organizations and management associated with the application of science [2]. Media is important because it becomes as a tool for learning process both inside and outside the classroom and can also be
used in the framework of communication and interaction with teachers and students in the learning process.

Technology is currently growing very rapidly especially for smartphone based on Android platform. Android is also an operating system that is open for developers to create their own applications freely. Various applications can be run with android system, not least gaming applications. Game is one of the entertainment media that becomes an option to eliminate boring or just to spend a time. Game is described as an activity that is voluntary and enjoyable, separate from the real world, uncertain, unproductive in that the activity does not produce any goods of external value, and governed by rules [3]. Games become something popular. Hence, it must be utilized into something useful and positive learning influence, not just for entertainment. Game education can be alternative attraction on learning process.

Edutainment application becomes the new concept from it paradigm. Edutainment refers to any kind of education that also entertains even though it is usually associated with video games with educational aims [4]. Educational games have advantages compared with conventional learning methods because learning process is presented with interesting moving visuals. It is the development process from “learning by hearing” to “learning by doing”. An interactive simulation will give student chance to face the issues directly and solve it with their own way. From empiric study claimed that game can become tools to improve learning a complex material. Game is more effective than the other learning method because at the same time it trains affective and cognitive process [4]. The educational game is fun, attractive and can educate the user [5]. Game of mathematics education is a game inserted by mathematics learning content. The type of game in this research is RPG (Role Playing Game), kind of game that focuses on role, story, and purpose. Player is required to talk with other players to be able to achieve the ultimate goal of the game.

2. Methods

The research method used is the development method. This research adapts the development model of ADDIE, a development model consisting of five stages including analysis, design, development, implementation, and evaluation [6]. This research restrict only to development stage. The material and questions in this game is about function and relation. Those materials are taught in senior high school.

The initial stage of the research is to conduct interviews questions and sheet. It analyzes competence and needs of students that include problems and characteristics of student learning styles. It also prepared the material and valid questions. Design is stage that made story board adapted by materials and questions that will be contained in the game. The game is made by software RPG game maker MV. This software can create map and event that will be used on game. Map describe environment on game with building, cave, castle, etc. Event is created for inserting story board to the game. After the game finished, then deploy it to apk. So, it can be played at android smartphone. The running game, then were validated by 5 validators consisting of 2 expert media validators, 2 material expert validators, and 1 colleague validator (student). The media validation sheet show in table 1.

| Table 1. Media Validation Question |
|-----------------------------------|
| Form of Instrument Questionnaire  | Indicator                                          |
| Media Validation                  | Relevance                                          |
|                                   | 1. Material relevant to the competence that must be mastered by students. |
|                                   | 2. Material presented coherently from beginning to end.  |
|                                   | 3. Problems in the game relevant to the material presented and the competencies that must be mastered students. |
|                                   | 4. Number of questions is enough                   |
| Systematics dish                  | Systematics dish                                   |
|                                   | 1. The groove of matter in the game follows the flow of thought from simple to complex.  |
|                                   | 2. Groove structured and organized game.            |
Form of Instrument Questionnaire | Indicator
--- | ---
Conformity of the presentation with the demands of student-centered learning. | 1. Encourage curiosity from students.  
2. Encourage the interaction between students with the games presented.  
3. Encourage students to build their own knowledge.
Game design | 1. Display the game  
2. Game storyline
Compatibility | 1. Games can be operated on more than one platform.

It also test user practicality by 9 respondents who are 3 students with high ability, 3 people with medium ability, and 3 people with low ability. The following user practice sheet show in Table 2.

**Table 2. User Practical Questionnaire**

| Form of Instrument Questionnaire | Indicator |
|---|---|
| Convenience | 1. Easy to understand.  
2. Systematic, coherent, and clear logic. |
| Language | 1. Clear and easy to understand  
2. The story scenario is easy to understand |
| User Practices | 1. Simple and interesting  
2. Interactive  
3. Material and questions are clear and easy to understand |
| Satisfaction | 1. Increase the spirit  
2. Learn math easier  
3. Educate |

3. Results and Discussion

3.1. Stage Analysis
The problems and characteristics of the learning style students can be known by interviews teachers and some students. The result of interviews with teachers is generally the students still have a lot of difficulty in learning the material relations and functions. Learning process centred to teachers and rarely using the media. There were not much different results when interview some students. They said still feel a little difficult both in terms of distinguishing between relations and functions or different kinds of functions. Media could make them better understand the material. Some indicators relation and function material will be used on game. That was differentiating between relations and function, determining the domain, codomain, and range and describing the various functions on the material relations and functions.

3.2. Design Phase
The game is made telling the main character of a knight named Carpi adventure toward the royal palace to meet a daughter of functional relation kingdom. However, in his adventure, Carpi encountered many obstacles. That must solve problem and answer several question about relationships and functions. It will be proposed by people who met during his adventures. The main character must face the monster. The monster will give a question about relationships and functions material. If Carpi got wrong answer then he would be killed immediately.
3.2.1. *Mapping Creation*. The map on the prologue as shown in Figure 1.

![Figure 1. Map Prolog](image)

The map on stage 1 illustrates the front yard atmosphere, in this map there are 5 characters that must be met by the main character. It is shown in Figure 2.

![Figure 2. Map Stage 1](image)

The map on stage 2 depicts the atmosphere inside the house, on this map there are 3 characters that must be met by the main character. It is shown in Figure 3.

![Figure 3. Map Stage 2](image)

The map on stage 3 still describes the atmosphere inside the house, on this map there are 5 characters that must be met by the main character. It is shown in Figure 4.

![Figure 4. Map Stage 3](image)

The map on stage 4 describes the grassland atmosphere, on this map, there are 5 characters that must be met by the main character. It is shown in Figure 5.
Figure 5. Map Stage 4

The map on stage 5 describes the atmosphere of the beach, on this map, there are 3 characters that must be met by the main character. It is shown in Figure 6.

Figure 6. Map Stage 5

The map on stage 6 describes the atmosphere in front of the royal palace, on this map, there is only 1 figure that must be met by the main character. It is shown in Figure 7.

Figure 7. Map Stage 6

The map on stage 7 describes the atmosphere inside the royal palace, on this map, there are only 2 characters that must be met by the main character. It is shown in Figure 8.

Figure 8. Map Stage 7

This final folder contains the composer's gratitude as well as the identity of the authors.

3.2.2. Character creation. The characters used in the game can be made as you wish. The illustration can be seen in Figure 9.
3.2.3. Deployment. Next thing to do is deploy the game so it can be played either on PC or android smartphone. The appearance is available in Figure 10.

3.3. Development Stage

3.3.1. Game results. The initial appearance and the prologue view of the game can be seen in the Figure 11 and Figure 12, respectively.

Figure 9. Character Creation

a. Coding
   1) Show Text. It is used to display text. It also can display prolog text or also conversations between characters.
   2) Show Choices. It is used to display a matter of multiple choice questions.
   3) Show Picture. It is used to display images in games.
   4) Battle Processing. It is used to display battles inside the game.
   5) Transfer Player. It is used to move characters from one place to another.

b. Preparation of materials and problems in the game
   The game material includes an indicator of distinguishing between relations and functions, outlining the various functions, determining the domain, codomain, and range. Problems and question on the game are made in accordance with the material.

Figure 10. Deployment

Figure 11. Game Initial View

Figure 12. Display Prolog

Figure 13 (a) provides an example when the main character is given material relations and functions. An example of game’s appearance when the main character is given a question of multiple choice questions is available in Figure 13 (b).
In this game, there are several tests with some questions that got wrong answer then the game will met game over. This picture will appear when the main character failed on his adventure (see Figure 14 (a)). When the main character successfully completed the adventure it will appear as in the Figure 14 (b).

3.3.2. Media validation results. Media was validated by 5 validators including 2 validators as media experts, 2 validators as material experts, and 1 validator from students (peers). The result of validation shown in Table 3.

| Validator | Validation Criteria |
|-----------|----------------------|
| 1st       | 90.8 %               |
| 2nd       | 97.4 %               |
| 3rd       | 100 %                |
| 4th       | 100 %                |
| 5th       | 97.4 %               |

Validator 1 and 2: Media Expert, Validator 3 and 4: Materials Expert, Validator 5: Friends

3.3.3. User practicality results. This research also tested user's practicality. Subjects test were 9 students which consist of 3 students with high ability, 3 students with middle ability, and 3 students with low ability. The result of user practices shown in Table 4.
Table 4. User Practical Results

| Capability Level | Evaluator | Percentage (%) | Average Each Capability Level (%) |
|------------------|-----------|----------------|-----------------------------------|
| High             | S-1       | 95.3           |                                   |
|                  | S-2       | 89.1           | 94.3                              |
|                  | S-3       | 98.4           |                                   |
|                  | S-4       | 93.8           |                                   |
| Moderate         | S-5       | 93.8           | 92.2                              |
|                  | S-6       | 89.1           |                                   |
|                  | S-7       | 92.2           |                                   |
| Low              | S-8       | 90.6           | 92.2                              |
|                  | S-9       | 93.8           |                                   |

4. Conclusion
Based on the results of data analysis, it can be concluded as follows.
1. The educational game was very valid. This is indicated by the average percentage of 97.12% of the total value of media expert and material expert validator.
2. The educational game was very practical. This is indicated by the average percentage for students with high ability level of 94.3%, students with middle ability level of 92.2%, and students with low ability level of 92.2%.

5. References
[1] T Sadik 2008 Digital storytelling: a meaningful technology-integrated approach for engaged student learning *Education Tech Research Dev* 56 487–506
[2] Azhar 2015 *Media Pembelajaran* (Jakarta: Rajagrafindo Persada)
[3] Garris, Ahlers and Driskell 2008 Games, motivation, and learning: A research and practice model *Simulation & Gaming Journal* 33 441-467
[4] Wirawan, Muhammad, Saifudin, Ibrahim, dan Agushinta 2013 Analysis of Child Computer Interaction in Edutainment and Simulation Games Application on Android Platform in Indonesia (IJACSA) *International Journal of Advanced Computer Science and Applications.* 4 174-178
[5] Battou A, Baz O and Mammass D 2017 Toward a Framework for Designing Adaptive Educational Hypermedia System Based on Agile Learning Design Approach In *Europe and MENA Cooperation Advances in Information and Communication Technologies* 113-123
[6] Pramuditya S A, Noto M S and Syaefullah D 2017 Game Edukasi RPG Matematika *Eduma: Mathematics Education Learning and Teaching* 6 1

Acknowledgments
Thanks to Cita Dwi Rosita and Anggita Maharani (UPI graduate student, the program as a doctor) already provide feedback on this article and assisting during the research process.