Designing Interactive Mathematics Educational Games using the Digital Game-Based Learning-Instructional Design (DGBL-ID) Method

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ARTICLE INFO	ABSTRACT
  	Educational games are currently widely used as supporting media in the teaching and learning process. One of the elementary school subjects that require supporting media is mathematics. In the process of making interactive mathematics educational games for elementary school students, game developers must make a design first. The appropriate design method for this research is the Digital Game-Based Learning-Instructional Design (DGBL-ID) method. The DGBL-ID method is a development method for making educational games that can be adapted to learning materials. The purpose of this research is to help game developers in making mathematical game applications that are adapted to the 2013 curriculum that is currently applied. The focus of this research is on the analysis and design stages contained in the DGBL-ID method. The results of this research are in the form of designing games-based interactive mathematics learning media that can be used as a guide for game developers in making interactive mathematics educational games. With this design, game developers can find out what educational games are needed by users according to the characteristics and objectives of learning mathematics.

1. Introduction

The Indonesian government is currently making efforts to improve the quality and quantity of education so that students can compete globally [1,2]. One of the efforts to improve the quality of education is to improve the quality of teachers, apply information technology and provide learning media that can support the teaching and learning process [3-5]. In this digital era, schools must apply information technology and interactive learning media in the teaching and learning process to increase students' interest in learning [6-11]. One type of interactive learning media that applies information technology is educational games [12]. Educational games are learning media that are designed in the form of games to help students understand the basic concepts of the subject matter presented. The subject that most often uses educational game learning media is mathematics, because this subject has a high level of difficulty to be understood by students.

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The results of the research improving math creative thinking ability by using math adventure educational game as an interactive media stated that the use of educational games in mathematics subjects could increase students' understanding by 85% [13]. Meanwhile, another research stated that educational games for mathematics subjects can help students understand the material provided and increase students' interest in learning [14,15].

Bangun ruang is one of the materials in mathematics that is difficult for students to understand. This material requires visualization and detailed formula explanations, so that with this educational game it can help students understand the shapes and formulas. The teaching materials used by teachers in the process of learning mathematics in elementary schools regarding this spatial material are in the 2013 curriculum mathematics textbooks. There are obstacles in this mathematics learning process, namely students have difficulty visualizing shapes when solving objects, students have difficulty understanding formulas which is used in every shape and the lack of interest in students' learning in mathematics. To help students increase their interest in learning mathematics, an educational game is needed that provides material for the basic concepts of building and solving spatial formulas. In designing educational games, game developers need to carry out an analysis and design process according to user needs. The results of the analysis and design process that have been adjusted to the user's needs will be a guide for game developers. The purpose of this research is to design interactive educational games for mathematics subjects using the digital game-based learning-instructional design method at the analysis and design stages that can be used by game developers.

2. Methodology

The method used in this research is the digital game-based learning-instructional design (DGBL-ID) method. The DGBL-ID method consists of five stages that need to be completed including the analysis, design, development, quality assurance, and implementation & evaluation stages. In this study, the stages that will be discussed are only the analysis and design stages. The following are the stages of the DGBL-ID method in full in Figure 1 below.

In the first stage of this method, namely analysis by collecting data through the process of observation and interviews related to the teaching materials of mathematics subject matter, analysis of needs and obstacles faced during the learning process of mathematics, determination of student characteristics, statement of learning objectives, determination of game ideas and brainstorming regarding teaching through games with teachers. The second stage is designed by making design instructions that are taken and adapted to mathematics books in elementary schools. After making design instructions, the game developer creates a game design document on the application storyboard as an illustration of the educational game that will be made.
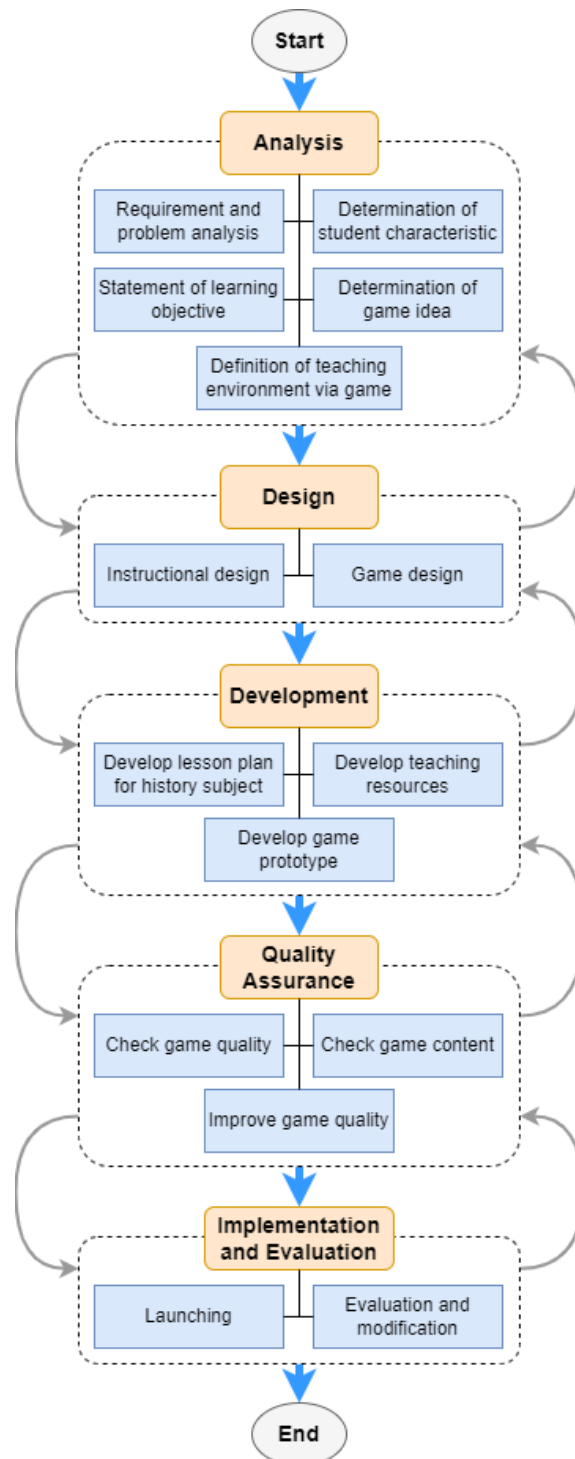
Fig. 1. DGBL-ID method

3. Results
3.1 Analysis Stage
3.1.1 Requirement and problem analysis

Lack of student interest in learning mathematics, especially in the material of building space. After interviews and observations were made, students had difficulty understanding the shape of the space, the nature of the shape and the formula used in solving the practice questions. Therefore, it is necessary to explain the material of building space that is packaged into games so that students

can learn while playing so that students' interest in learning about mathematics in building materials can increase.

3.1.2 Determination of student characteristics

This research was conducted on 35 female students and 25 male grade VI elementary school students aged 11-12 years. At this stage, an analysis of the student's character is carried out when carrying out the mathematics learning process.

3.1.3 Statement of learning objective

The purpose of learning to build space is so that students can understand the shape, nature, formula, surface area and volume of the shape. There are five types of shapes that are discussed in this educational game, namely prisms, tubes, pyramids, cones and spheres.

3.1.4 Determination of game idea

The idea of this educational game is that there is a journey of a child named "Banru" into a mysterious room. Inside the mysterious room there are several locked treasure boxes. To open the treasure box, you just have to complete the mission by listening to an explanation about one type of wake, shape, volume and formula. After that, you just have to face the enemy by solving space-building exercises. If successful then you will go to the next level, but if you fail then you will be given 3 chances to complete the mission correctly.

3.1.5 Definition of teaching environment via games

To make it easier for students to access this educational game, this game is provided in the form of an android. The selection of educational games is in the form of android because currently students already have mobile phone facilities that are used for the learning process.

3.2 Design Stage
3.2.1 Instructional design

The design instructions were obtained from the math book on building materials for grade VI elementary school curriculum 2013.

3.2.2 Game design

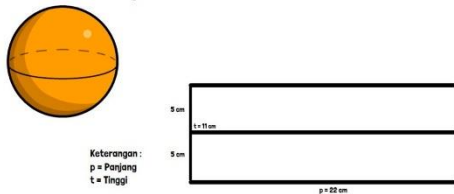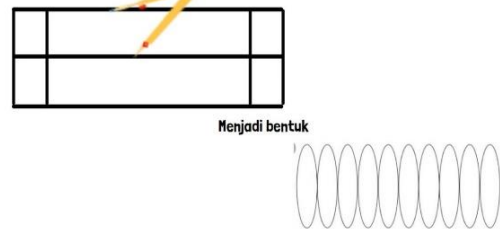Game designs used in educational games to complete space-building missions are as shown in Figure 2 below.
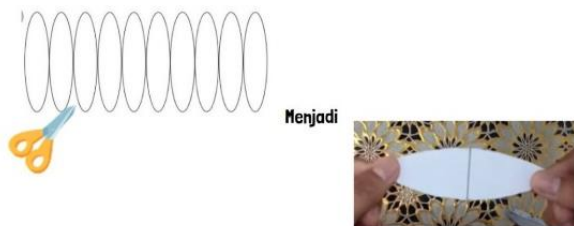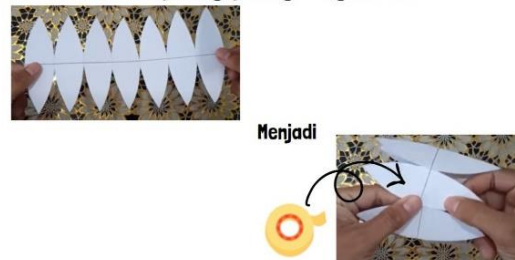
Fig. 2. Game design "mission"

4. Conclusions

The design of this interactive mathematics educational game can help students in the process of learning mathematics in building materials. The learning process becomes more interesting because it is packaged in the form of a game so that student's interest in learning mathematics in spatial building materials increases. This educational game, it can make it easier for students to learn independently.

Acknowledgement

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