DEVELOPMENT OF ANDROID-BASED EDU-GAMES FOR PYTHAGOREAN THEOREM

Rionaldy Ariansyah
Mathematics Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya
Email: rionaldyariansyah16030174063@mhs.unesa.ac.id

Ika Kurniasari
Mathematics Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya
Email: ikakurniasari@unesa.ac.id

Abstract
Mathematics has an important role for the development of science and technology. One of the subject in mathematics is the Pythagorean theorem. To improve students ability of understanding the Pythagorean Theorem, learning media can be used as a tool to achieve learning goals. One of learning media innovation is learning media in the form of games (edu-games). Edu-games can be transform to smartphones applications with the android operating system to make edu-games easier to access and more practical in use. The goals of this research is to develop good quality android-based edu-games for pythagorean theorem based on three criteria, i.e. valid, practical, and effective. Edu-games was developed using the Borg & Gall method which has been simplified by the Puslitjaknov Team so that it consists of four steps, i.e. planning stage, developing product, expert validation and revision, and limited trial. Development of edu-games using Adobe Flash Professional CS6. The research instruments included validation sheets, media use questionnaires, and student questionnaire responses. The edu-games trial was conducted limitedly by 10 students of grade VIII Junior High School. The results of edu-games development shows that edu-games is declared as good quality by obtaining (1) validity score are 4.038 by media experts and 3.939 by material experts from a maximum score of 5 so edu-games fulfill the valid criteria, (2) practicality percentage is 76.25% so edu-games fulfill the practical criteria, and (3) the effectiveness percentage is 80.42% so edu-games fulfill the effective criteria.

Keywords: Edu-games, Android, Phytagoreian Theorem, Adobe Flash Professional CS6.

INTRODUCTION
Mathematics is one of the basic sciences that plays an important role in the development of science and technology. This fact can be seen from the condition when the learning of mathematics as one of the subjects given at every level of education. Pythagoras’ theorem is one of the material in mathematics. Based on the 2016 Minister of Education and Culture Regulation on basic and core competencies, the Pythagorean Theorem material was taught at the VIII grade of junior high school. In geometry and measurements, the material of the Pythagorean Theorem can be used to find the diagonal length of a flat figure or a particular space figure. Based on data from the Education Research Center of the Ministry of Education and Culture (2019), at 2019 Junior high school level of National Examinations, the indicator determines the length of the rectangular diagonal only 46.56% of students who answer correctly. In the indicator of determining the diagonal length of the room only 39.44% of students answered correctly. So it can be concluded that some students have not been able to determine the diagonal length of a flat figure or a particular room. This is related to the Pythagorean Theorem material as a way to find the length of the diagonal. Learning media are intermediaries that carry information or messages that contain teaching purposes (Arsyad, 2014).

Learning media can be used as a tool to improve students’ abilities in understanding the Pythagorean Theorem material in order to achieve learning objectives. Learning media must be packaged attractively so it can increase students’ learning motivation. One of learning media innovation is learning media in the form of games. Learning media in the form of games are called educational games. Edu-games is one of the right ways to increase students’ learning motivation, because there are challenges to solving problems in the game so it makes students’ curiosity arises (Sujalwo, 2017). Through edu-games, students can still play, but the lessons still can be learned through these games. Edu-games can be developed in the form of a smartphone application to make it easier to access and more practical in its use.

According to Globalstat, in December 2019 93.22% of smartphone users in Indonesia use the Android operating system. Android is open source which allows anyone to create or develop applications that can later be downloaded for free or paid. Based on the nature of this Android, it can
be used to make Android-based Edu-games that can be downloaded for free to help students learn. Android-based Edu-games can present learning material more attractively through the help of animations, images, and sounds that are packaged in the form of games so that they can attract the attention of students. Through android-based Edu-games, students are also facilitated to play while learning whenever and wherever students want to learn. Based on the description above, researchers developed android-based edu-games for the Pythagorean Theorem material. The purpose of this research is to find out the process of developing Android-based edu-games for the Pythagorean Theorem and produce good-quality Edu-games in terms of valid, practical and effective aspects.

Learning Media
Wagiran (2009) states that instructional media is a tool that can be used to channel messages so that it can stimulate the thoughts, attention, feelings, and interests of students to improve the quality of teaching and learning. This is in line with Sadiman (2005) which states that learning media are all things that can be used to deliver messages so that they can stimulate the thoughts, feelings, attention and interests of students so that the learning process occurs.

Based on the opinion above, it can be concluded that the learning media is a means or physical aids used by teachers to convey information and messages in a learning and can increase interest in learning for students to learn and enjoy learning that takes place in order to achieve the desired learning goals.

Android-based Edu-games
Learning media in the form of games created to achieve the learning objectives can be called as Edu-games or educational games. According to Bahri (in Nugroho, 2011) Edu-games or educational games are games that aim to create an educational environment that educating students. Edu-games are games which created to stimulate the thinking power of players, improve concentration and the ability to solve problems (Handriyanti, 2009). Based on that opinion, it can be concluded that Edu-games are educational games that stimulate the power of thought so it will increase the concentration and problem solving ability of the players.

According to Sujalwo (2017) there are several advantages of using games as a learning medium, including: (1) creating active learning, because students (as players) are required to complete assignments independently, (2) providing entertainment and giving variation of learning than just listening, and (3) providing some examples directly about the topic being studied. Edu-games can be packaged in the form of an android application to be more accessible and more practical in its use.

Android is one of the operating systems found on smartphone and tablet devices (Satyaputra and Aritonang, 2014). According to Huda (2013), Android is a Linux-based operating system that is used on mobile devices. So it can be concluded that Android is an operating system that connects users with devices that they have on a smartphone or tablet. This android operating system has open source properties which means anyone can develop or create applications that can be deployed and used by other android users (Maiyana, 2018). There are several advantages of Android according to Zuliana and Irwan (2013), including: (1) complete platform, (2) android is open source, and (3) free platform. The advantages of this android provides a huge opportunity for programmers to be involved in developing and making Android applications.

Adobe Flash Professional CS6
Adobe Flash Professional CS6 is a series of Adobe Flash developed by a software company called Adobe Inc. According to Madcoms (2012), Adobe Flash Professional CS6 is a program for creating animations. The Adobe Flash Professional CS6 program has buttons that make it easy to draw objects that can later be moved or animated. Even beginners will find it easy to draw the desired art objects.

There are several features in Adobe Flash Professional CS6, such as toolbox, keyframe, actions script, movie clips, scene, timeline, masking, stage, and panel properties. Each feature is used to run flash programs, make media display movements, and execute media programming code commands. Currently, Adobe Flash has been very developed with various features that can be applied to mobile devices, especially smartphones.

The Criteria for Good Quality Learning Media
Nieveen (in Nuryadi, 2018) states that a learning medium that has good quality should have three main criteria such as valid, practical, and effective. Learning media is said to be valid if it contains good quality of learning materials, are based on the curriculum, and each learning component in them is related to each other in a good and consistent manner. To assess the validity of a learning media, we can use an assessment consist of questionnaire from two experts’ including material experts and media experts. Learning media are said to be practical if they can be used easily by teachers and students. To assess the practicality of a learning media, we can use a media questionnaire for the teachers and observers who observe students while operating the media.

Learning media can be said to be effective if the students appreciate the learning process and students want the learning to occur. This can be assessed by filling in the
media response questionnaire by the students. In addition, the media can also be said to be effective if it can help students in order to achieve learning goals. By using a test of students’ learning outcomes after using the media, it can be seen the level of effectiveness of the developed media. This study uses effectiveness in terms of feelings or attitudes of students because the purpose of this study is to develop educational games so that students’ feelings or attitudes will be assessed after using the media.

**METHOD**

The purpose of this research is to develop Android-based Edu-games on the Pythagorean Theorem material. This research is a research and development study using research procedures that are adapted to the steps of development research by Borg & Gall (2003) and have been simplified by the Research and Development Center Policy Team or Research Center for Research. (2008) with some limitations from the researcher. In this study only involved the four stages, including (1) the planning stage, (2) the development stage, (3) the validation and revision stages, and (4) small-scale field trials. The Borg & Gall development model was chosen by the researchers because it has a systematic research procedure, starting from the initial development stage to the final product stage being developed. The improvement process is carried out continuously until the target (quality standard) of the product being developed is achieved. This research was conducted in odd semester of 2020 with 10 subjects of class VIII (eight graders) students in SMP Negeri 4 Nganjuk.

**Data Collection Instruments**

This study uses data collection instruments that include validation sheets, media use questionnaires, and student response questionnaires. In data collection instruments, measurement scales, researcher used five assessment categories. The validation sheet is used to determine the validity and feasibility of the Edu-games developed before conducting a limited trial. Assessment criteria refer to criteria that have been formulated by researchers. In this study there are two types of validation sheets, namely validation sheets by material experts and validation sheets by media experts. From the validation data, it can be seen the level of validity of the media developed.

The media use questionnaire sheet is used to determine the level of students’ ability to use the developed media. Questionnaire sheets are given to students to be filled in accordance with the choice of answers listed after students use the media. From the data obtained, it can be seen whether the media is easy to use or difficult to use by students. Questionnaire responses of students are used to determine the feelings or attitudes of students after using the developed media. There are several questions aimed at students’ response questionnaire. Students’ responses are needed to determine the effectiveness of the media developed.

**Data analysis technique**

In this study the data obtained will be analyzed to find out whether the media is valid, practical, and effective criteria or not. The media is said to be valid if it obtains an average score $\geq 3$ from a maximum average score of 5. The media is said to be practical if it can be used without revision or with little revision and in practice there is no use or there is little difficulty in the operation of the media by students. The media is said to be practical if it gets an average percentage of the results of the media use questionnaire $\geq 60\%$. The media is said to be effective if it gets a percentage of students’ positive responses after using the media $\geq 60\%$.

**RESULTS AND DISCUSSION**

The Following information are the process and results of developing android-based Edu-games for the Pythagorean Theorem material.

1. **Planning**

   In this planning stage, a study of various literature, research journals, books, articles and information from the internet and the formulation of the objectives of making learning media related to the topic of the study is the Pythagorean Theorem. Based on the study conducted, there are still many students who have not been able to determine the diagonal length of a flat figure or a particular room. This is related to the Pythagorean Theorem material as a way to find the length of the diagonal.

   Based on a visit to SMP Negeri 4 Nganjuk, the curriculum used was the 2013 curriculum. Based on an interview with one of the mathematics teachers, in class learning rarely uses the media as a teaching aid process. This causes a decrease in student interest and motivation in learning mathematics. The majority of students at the school already have a smartphone, but have not been used as a means of supporting teaching and learning activities. Based on some of the things that have been described, the Pythagorean Theorem material was chosen which will be packaged in the form of educational games to help students in learning.

2. **Developing products**

   This stage aims to develop Edu-games based on supporting information that has been obtained. Edu-games developed were named Detective Gampy. Edu-games are designed to make it easier for students to understand the Pythagorean Theorem material. The use of simple buttons and icons that can be understood into consideration of the development of Edu-games.
Besides that the Edu-games story line is also designed not to make the students confuse when using the media. Developed games take detective themes that are packaged with the help of animations, images, and sounds to attract the attention of students. Edu-games were created using the help of Adobe Flash Professional CS6.

Adobe Flash was chosen because in it there is an action script that makes it easier for researchers as beginner programmers to create applications. ActionScript is a programming language that works in Adobe Flash applications. With the help of action script, it can minimize the use of frames in Edu-games so that the resulting application size is not large. Animations in Edu-games can also be created using ActionScript, such as object rotation, object movement, and so on. With this advantage, it is expected that Edu-games which developed can attract the attention of students through their appearance, however, the result application still can be small in size so it does not require large storage space to be installed on students’ smartphones.

Next Edu-games are packaged in the form of applications (apk) so can be downloaded and installed on the user's smartphone. This application includes Adobe AIR as a support for running applications so users do not have to bother to install applications again. The following is the display of edu-games developed

![Figure 1. Home Page](image1.png)

The following display Edu-games developed on the home page there is the name of Edu-games, icons or mascots of Edu-games, sound settings button, "play" button, "about" menu button, and "help" menu button. The sound settings button functions to activate or deactivate background noise from Edu-games. The "play" button functions to start the game. The "about" menu button functions to move to the explanation section about Edu-games. The "help" menu button functions to move to the explanation section about the function of buttons in Edu-games.

![Figure 2. About Edu-games](image2.png)

![Figure 3. Help](image3.png)

![Figure 4. Story Introduction](image4.png)

![Figure 5. City Map](image5.png)
The above display will appear after passing through the introductory dialogue. In this section contains a map of the city in which there are location points. A blue location dot indicates the location of the detective agency, while a red dot indicates the location of a crime case. There are five locations of crime cases. The first location contains the problem of applying the Pythagorean Theorem formula \( c^2 = a^2 + b^2 \). The second location contains the problem of determining the type of triangle using the Pythagorean Theorem. The third location contains questions about triple Pythagorean. The fourth location contains the side ratio of a right triangle. The fifth location contains the side ratio of the triangles with angles of 30°, 60°, and 90°. Users are required to solve all crime cases at each location in order to win this game.

3. Expert validation and revision
At this stage the Edu-games validation is carried out by a validator consisting of material experts and media experts. Based on the results of validation by material experts, an average score of 4.04 is obtained from a maximum score of 5. Media validation includes two aspects, including software aspects and aspects visual communication. While the validation results from media experts, an average score of 3.94 was obtained from the maximum score of 5. Then the average score of the validation results was matched with the media validity category. Based on the validity of the media category, the results of the validation of the material experts are included in the very valid category and the results of the validation of the media experts are included in the valid category. So it can be concluded that Edu-games got valid criteria.

4. Limited trial test
The Activities which carried out at this stage are limited trials after Edu-games are declared valid and revised according to the validator's suggestions and comments. The trial was conducted in the odd semester of the 2019/2020 school year with 10 students of class VIII (eighth grader students) of SMPN 4 Nganjuk as the test subjects. The trial run is done online by sending the Edu-games application file to students. This was done because of the Covid-19 pandemic constraint so that data retrieval could not be done directly. Questionnaire for the use of media and questionnaire responses of students filled out through Google Form to facilitate students. After using Edu-games, students fill out a questionnaire using the media used to assess the practicality of Edu-games.
The results of the average percentage of the total questionnaire for media use was 76.25%. The percentage obtained is matched to the practicality category of the media. Based on these categories, the average percentage of total media use questionnaires included in the practical category so Edu-games got practical criteria. Students also filled out the Edu-games responses questionnaire which is used to assess the effectiveness of Edu-games. The results of the average percentage of students' responses was 80.42%. The percentage obtained is matched to the category of media effectiveness. Based on these categories, the average percentage of students' responses, Edu-games got the effective criteria and included in the highly effective category.

CLOSURE
Conclusions
It is obtained a conclusion in this study in order to answer the research questions. The following information are some conclusions that can be drawn by researchers, including:

a) The researcher develops Android-based games using the simplified Borg and Gall development model by the Puslitjakov Team (center for research, policy, and innovation) which consists of four stages including:

1) Planning
At this stage, problems is found in understanding the Pythagorean Theorem material so learning media needs to be developed to help students in understanding the Pythagorean Theorem material. The curriculum used is the 2013 curriculum. The majority of students have a smartphone so it can be utilized that the media developed is more practical and easy to use.

2) Develop a product
At this stage, Edu-games are developed with the help of Adobe Flash Professional CS6 software. Edu-games are developed by paying attention to the needs and conditions of students. Edu-games are packaged in the form of an Android application so that they are easy to download and install on students' smartphone devices.

3) Expert validation and revision
At this stage, Edu-games developed are validated by media experts and material experts. There are three aspects to the validation of the material which include the implementation of learning, aspects of language, and aspects of content. Media validation includes two aspects including software aspects and visual communication aspects.

4) Limited trial test
At this stage, the trial is done after the games has been declared as valid and revised according to the validator's suggestions and comments. After using edu-games, the participants filled the questionnaire about the use of the media in order to measure the level of practicality of the games. The students also filled out the responses of the games in order to measure the effectiveness of the edu-games.

b) This development research produces android-based Edu-games for good quality Pythagorean Theorem material based on three aspects consisting of valid, practical, and effective. This study obtained the validation results with average score of 4.04 conducted by material experts and the results of validation carried out by media experts, Edu-games obtained an average score of 3.94 from a maximum score of 5 so it can be concluded that Edu-games is categorized as valid. The results of the use of media questionnaire shows that Edu-games get a percentage of 76.25% so Edu-games are categorized as practical. The results of the questionnaire responses of students shows Edu-games get a percentage of 80.42% so Edu-games are categorized effective. It can be concluded that Edu-games developed by the researcher are included in good quality. Indeed, it has fulfilled three aspects consist of valid, practical, and effective.

Suggestion
Based on the above conclusions, Edu-games developed got the criteria of good quality learning media so they can be used more broadly. In media development, there are few obstacles when exporting Edu-games from Adobe Flash CS6 professionals to Android applications, therefore other researchers who want to develop similar media can try other software which is easier to use. Edu-games can still be developed even better by other researchers.

REFERENCES
GlobalStats. 2019. Mobile Operating System Market Share Indonesia, (Online), (https://gs.statcounter.com/os-market-share/mobile/indonesia, diakses 15 Desember 2019);


