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The development of maritime-based educational games for mathematics learning media

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Abstract. This research was intended to develop the Android-based learning media on the system of linear equations in three variables whose theme was maritime. The results of this learning media development were reviewed based on the validity, practicality, and effectiveness. The instruments used were the media validation sheets, material validation sheets, students' responses questionnaires, and test scores on the students' learning outcomes. The learning media testing was given to the students of grade X at SMK Negeri 4 Probolinggo. The results showed that it was classified as the "excellent" category. The average scores of total validity obtained were 4.43 out of 5 on the learning media experts; it was then into "very valid" category. This learning media was considered very practical since the average score obtained on the students' responses questionnaires was 4.49 out of 5. According to the test on the learning outcomes, 93.33% of the total number of students in grade X KTPI 1 scored ≥ 70 as the minimum scores. Hence, it can be said that this learning media was effective. The conclusion drawn from the research results revealed that maritime-themed educational games for mathematics learning media were valid, practical and efficient.

1. Introduction

The development of developments has been widely used in the education field as the learning media. Learning media by using computers are known as computer-based like e-learning or multimedia. E-learning refers to the innovation of learning media implemented to provide effectiveness in the learning process [1]. Nowadays, mobile learning (m-learning) becomes one of modern learning innovation. Mobile learning is developed through e-learning by using mobile phones as the learning tool. The content offered in m-learning is in the form of texts and images. However, the development of technology, the audio format content, animation and games have been well-presented and used in presenting the learning material.

The development of the learning process is important to do since it goes hand in hand with time and curriculum changes. This development adjusted the developments needed by the students who want to have superior competencies and compete globally. A teacher can conduct the learning in a more systematic, efficient, and directed way if there are available learning tools. Learning tools need a proper arrangement to improve the quality of learning and teacher professional development [2]. The development of innovative learning tools by teachers improved students' cognitive and psychomotor abilities [3]. The teacher should be initiative and creative in developing the learning tools, especially in utilizing the technology regarding the development of the 21st century [4].



Based on the interview results done to several teachers at Probolinggo Fishery Vocational High School or *SMK Perikanan Probolinggo*, the mathematics learning tools used were the worksheets of material and exercises which provided brief material. The learning model accompanied by these tools still referred to the behaviorism theory, whose learning process was still teacher-centered. This learning model made the students passive by only receiving the materials being taught as they had to memorize the material provided by the teacher. Thus, the development of student-centered learning, which developed the reasoning ability and students' motivation was needed to do.

Learning development that was able to help the students referred to learning media. In general, learning media refers to the tools used in the teaching and learning process. Gagne and Briggs pointed out that learning media covered the tools which were physically used to convey the content of teaching material, such as books, tape-recorders, tapes, videos, films, slides, photos, pictures, graphics, television and computers. Educational games were other types of learning media [5].

Educational games were the games of education and learning elements [6]. Educational games improved the students' motivation to learn [7, 8, 9]. Educational games were also capable of encouraging students to learn actively and creatively by giving them several challenges [10]. The educational games are potentially used as innovative learning media.

The game of learning media was more comfortable to develop, especially through a smartphone. The strength of a smartphone was displaying the interactive animations like what the computer did. The Android operating system referred to a mobile operating system which had been in rapid development. Android was an operating system of Linux-based mobile phones as its core [11]. Many smartphone companies are currently using android as it provides an open platform (open source) for the developers to create their own applications.

In a game, there is a system where the players interact and the conflict that is manipulated or artificial. Android is a Linux-based operating system for mobile devices covering operation system, middleware, and application [12]. Nowadays, android is the leading product of smartphone, because it provides an open-source platform for the developers to create their application. Today, there are many Android-based smartphone vendors, namely: HTC, Motorola, Samsung, LG, HKC, Huawei, Archos, Sony, Acer, and many others. Android becomes the main competitor of another smartphone, such as Apple.

Many researchers have conducted studies under the topic of educational game, which positively impacts students. The development of educational games helped improve learning outcomes and students' interest in learning mathematics [13]. The educational game also trained students' problem-solving skills as it showed that the classical completeness reached 100% [14]. Educational game-assisted contextual learning successfully helped students achieve their reasoning and mathematics disposition abilities very well [15].

Contextual learning in mathematics is closely related to the surrounded natural environment context such as maritime context. Maritime context is based on Indonesia's geographical condition, which mostly consists of waters or sea connecting islands in its territory. The aspects covered in maritime are human, natural environment and its biota [16]. Generally, maritime is everything related to the sea, including the aspects of humans, the natural environment, and its biota. Vocational high school students majoring in maritime expert are required to have the ability to solve problem pertinent to daily life, especially in the context of sea environment or maritime. Based on the background, this research aims to develop a valid, practical and effective android game-based mathematics learning media for fishery vocational high school students under the theme of maritime.

2. Method

This research was research and development with Plomp model. There were three stages in the development, namely: (1) preliminary research, (2) prototyping phase, and (3) assessment phase. The research procedure consisted of six stages: determining the potential and problem, collecting information, designing the media, reviewing and revising, validating, and trying out the products.

The product developed was an android game-based learning media with a system of linear equations in three variables material for class X of vocational high school. The product was an application that

could be installed on an android-based smartphone. The feature included in the media consisted of the basic competence and game. The game in the application was a story covered a problem that must be solved by the students in each stage.

The instrument used in this research was a validation sheet for the learning media expert, score results of the test on the learning outcomes, and students' questionnaire. The analysis techniques for the learning media's validity were done by recapitulating the data, calculating the score for each indicator, calculating the score for each aspect, determining the total score, and converting the result to the validity criteria of the learning media. The conversion of the validity analysis of the learning media can be seen in the following Table 1.

Table 1. Validity criteria of the tools and instruments.

Interval	Criteria
$1 \leq \bar{V}_r < 2$	Invalid
$2 \leq \bar{V}_r < 3$	Valid enough
$3 \leq \bar{V}_r < 4$	Valid
$\bar{V}_r \geq 4$	Very Valid

Note: \bar{V}_r : overall mean of validity scores

The practicality analysis of the android-based learning media was obtained from the result of the students' questionnaire. The learning media was categorized as practical if the result of the questionnaire showed good or excellent conclusion. The score conversion from the learning media's practicality analysis can be seen in the following Table 2.

Table 2. Practicality criteria of the tools and instruments.

Interval	Criteria
$1 \leq \bar{N}_p < 2$	Poor
$2 \leq \bar{N}_p < 3$	Good enough
$3 \leq \bar{N}_p < 4$	Good
$\bar{N}_p \geq 4$	Excellent

Note: \bar{N}_p : overall mean of practicality scores

The learning media's effectiveness analysis was obtained from the result of the learning outcome test intended to reach the learning goals. The learning outcomes analysis was done by recapitulating each student's score of the test on the learning outcomes, then calculating the number of scores that achieved a score of 70 at minimum and 100 in maximum. If the presentation of the number of students who achieved a score of 70 was more or equal to 75%, then it was categorized as successful.

3. Results and Discussion

The development procedure of the learning media was based on the Plomp model. Plomp model consisted of three stages: 1) preliminary research, 2) prototyping phase and 3) assessment phase. The result obtained is explained as follow.

3.1. Preliminary Research Stage

In this stage, the information obtained was that students felt less interested in learning mathematics. The students' lack of interest was caused by the lack of use on the learning media in the mathematics learning process. Based on the result of the interview with the teacher, it showed that the mathematics grades got by the students were still low. The students' percentage who got low grade or under the Minimum Completeness Criteria (KKM) was almost more than 80% of the total number of students in the class. The students could only solve routine questions about the system of linear equations in three variables given by the teacher. Students were also still not able to solve problem-solving questions. Based on the identification results, the instructional media and research instruments were then designed. The learning

media designed were android-based educational games with the theme of maritime affairs, especially on the material for the system of linear equations in three variables.

3.2 Prototyping phase

At the prototyping phase, the learning tools that have been compiled were then viewed for its quality by testing the validity of the prototype I by two experts (validators). The validators also assessed the validity of the instruments used in the trial activities to assess the validity of the learning media. The validation results can be seen in Table 3 below.

Table 3. Results of learning media validation.

Observed Aspects	Average Value
Display Design	4,5
Quality of Media	4,5
Conformity with learning objectives	4,2
Accessibility	4,5
Overall Average	4,42

Based on the validation test results on learning media, then revisions were made so that the learning tools in the form of prototype II were obtained with the criteria that the learning tools developed were very valid with an average score of 4,42. After obtaining prototype II, then field trial was performed to determine the feasibility, practicality, and effectiveness of the developed learning tools.

3.3 Assessment Stage

At the assessment stage, the learning tools were in the form of Prototype II. A field trial was then performed to determine the feasibility, practicality, and effectiveness of the developed learning tools. In the field trial, the tools were tried out on class X students of TKPI 1 and learning was done in two meetings with the topic of the system of linear equations in three variables. Table 4 below is the result of students' responses to learning media.

Table 4. Results of learning media practicality.

Observed Aspects	Average Value
Software engineering	4,29
Learning Design	4,63
Visual Communication	4,56
Overall Average	4,56

Based on the results of students' responses after using the learning media, it can be said that the learning media used were classified as very practical because the average was at an interval of $\bar{N}_p \geq 4$.

In addition to practicality, field trial also measured the effectiveness of learning tools. The learning result test obtained showed that the student's average score was 74.4. The average scores of test on the learning outcomes on class X consisted of 28 students with a value above 70. The percentage of the achievement of the minimum score was 93.3%, which indicated that the mathematics learning tools being developed were effective. In the implementation of the field trial, there were also deficiencies in the tools (prototype II) that needed to be revised. With an increase in the average score of problem-solving equal to or more than the Minimum Completeness Criteria (KKM), the learning media were effective. Therefore, in general, in field trial activity, the learning tools developed have met the criteria of being valid, practical, and effective.

4. Conclusion

This research concluded that the development of maritime-themed educational games as learning media for mathematics in class X Vocational High School students on the system of linear equations in three variables material met the criteria of being valid, practical and effective.

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