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SLINGSHOOT SIMULATION: APPLICATION TO IMPROVE PARABOLIC MOTION CONCEPT COMPREHENSION FOR HIGH SCHOOL STUDENTS

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Abstract :
Science and technology have developed rapidly due to globalization. Almost everyone now has a mobile phone. Therefore the research uses the flexibility of mobile phones that will be implemented to create an application design that will become a means of learning for students. This research aim is to test the feasibility of the design of the Slingshot Simulation application as a learning medium to increase students' conceptual understanding of parabolic motion material. This study uses the ADDIE development model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. However, the authors limit this research only to the application design stage and then analyze the feasibility validation of the application design by one expert appraiser, two practitioner appraisers, and twenty-seven limited trial respondents. From the results of the feasibility validation of the application design, an average result of 94.53% is obtained. In a sense, the sling shoot simulation application design is feasible to be developed for use.

Keywords: Physics; Parabolic Motion; Slingshoot Simulation

INTRODUCTION

The development of science and technology has had an impact on all aspects of life, where almost everyone has mastered science and technology improvements to compete in improving the quality of human resources (Muhammad, 2016). The reason for the development of science and technology is due to globalization (Wiyono, 2017). Globalization has had a great influence on human life today, from an early age to old age. For example, if in the past children were synonymous with various games that had educational value for their social development. But unlike now, children are presented with various sophisticated tools as their games, this also changes children's interest in learning.

Physics is one of the subjects that studies natural phenomena that occur in the surrounding environment. Physics is part of science lessons which requires students to be able to have thinking skills, and physics is one of the sciences that has an important role in the development of science and technology (Aifah, 2019). The results of learning physics include three very important aspects so that students can improve their thinking skills to solve all problems in everyday life. These three aspects are the cognitive or knowledge domain, the psychomotor or skill domain, and the affective or attitude domain (Satria, 2017). The purpose of learning physics in high school is as a means of training students to master knowledge, concepts, principles of physics, skills and scientific attitudes (Permendiknas No. 22 of 2006).

The ability to solve problems is the ability to apply previously acquired knowledge in new conditions that require critical thinking processes (Ulya, 2016). Problem-solving skills are the capacity to find solutions to problems by applying student-driven information by following the right method to find the right answer (Dera, 2021). Learning physics is one of the most avoided lessons by students. Even physics is the most difficult subject among other subjects, so many students are less enthusiastic about learning (Nira, 2018). Students experience difficulties in learning physics due to the unattractive appearance of the book because it seems that it only contains abstract explanations and formulas and often makes it difficult for students to understand it. This is because it is not accompanied by images or phenomena in everyday life related to material, one of which is parabolic motion material which requires explanation in the form of visualization in everyday life, graphics and vectors (Satria, 2017).

Parabolic motion is a combined motion between uniform straight motion (GLB) in the horizontal direction (x) where the speed in the horizontal direction at any position is constant and uniformly changing straight motion (GLBB) in the vertical direction (y) where the acceleration is constant, then forms an elevation angle between the x-axis and the y-axis (θ) (Putu Artawan, 2014). The elevation angle affects the farthest distance an object can travel. When the elevation angle is $\theta = 45^0$ the object reaches the furthest distance compared to the elevation angle of $45^0 > \theta > 45^0$ (Rio Harapan). Parabolic motion is a superposition motion or a combination of horizontal motion and vertical motion, for example, the parabola's motion plane is a coordinate plane (x, y), with the x-axis horizontal and y-axis vertical. Acceleration of gravity only works in the direction vertical (y) and does not affect the motion of objects in the horizontal direction (x). Acceleration in the horizontal direction (x) is equal to zero, while the acceleration of gravity in the vertical direction (y) constant and negative (the direction of gravity is always downward or to the center of the earth) (Jasa Evan, 2015). In parabolic motion, the assumption that is widely used is that air friction is ignored, even though in reality air friction plays a very important role in reducing the energy of motion on objects, which ultimately reduces the size of the projectile trajectory (Puwardi, 2014). Then, in parabolic motion the effects of the Earth's spin are neglected, and the acceleration due to gravity remains constant. Then the component of the force acting on the parabolic motion is only the earth's gravitational force or gravity which is large and has a constant direction (Supardi, 2011).

Factors that influence students' interest in learning physics are teacher factors (Dira, 2017). Teachers play an important role in determining student learning outcomes. Teachers as organizers of teaching and learning activities in the current era of globalization must have competence in using information and communication technology, so that teachers can take advantage of existing technological advances to support the learning process, for example learning media based on mobile learning (Juli, 2018). However, there are still many teachers who adhere to the old paradigm of the learning process which originates from theory. Teachers carry out the process of teaching and learning activities by transferring their knowledge to students, filling students' brains with knowledge, or encouraging students to compete between individuals. In this learning paradigm, the teacher only imparts knowledge to students passively (Evan, 2015). Teachers should be able to develop learning strategies and methods to encourage students to have motivation to learn. The strategy for delivering learning material also needs to be considered, the presentation of material that is clear, simple, attractive and flexible for students needs to be implemented so that students can more easily accept the material. Then the learning media also affect student learning outcomes. Physics and games are two different things, physics is a lesson in the form of written books that are usually studied at school, such as textbooks, student work sheets, and modules that make students less enthusiastic about learning and reading them. While games are something that is very commonly liked by students, and games are a necessity as an entertainment tool (Wiyono, 2017). If these two things are collaborated to become a learning media, it will be very interesting if it is applied during the process of teaching and learning activities.

In Astra's research (2015) on making learning media through android applications in the form of laboratory simulations for high school students who get media feasibility validation results of 83.13%, this research has been equipped with material, illustrations and quizzes that can support students' understanding of the material presented. Also from Satria's research (2017) got results from expert validators, which amounted to 77.53% or the application was feasible to use, and the results of Muhammadiyah 2 High School students in Magelang City were 68.82% or feasible to use. In this study the authors utilized android learning media on parabolic motion material to be used as an alternative learning resource and could be accessed offline, as for the appearance of the media in the form of images, simulations and videos as a learning resource as well as practice questions in the form of multiple choice. Both studies utilize illustrations and simulations with limited components that are difficult to apply in real life, this can make students less understand the material presented because they cannot apply it in the real world. Illustrations and simulations that are displayed can also make students more and more bored, because they are not interesting.

Based on the problems that have been reviewed, namely the lack of student learning motivation in physics subjects, especially in parabolic motion material, the low concept of student understanding of parabolic motion, as well as from the results of a review of previous research, research questions arise in the form of how to create a learning media design that can be applied in the real world and increase understanding of the material as well as being able to get rid of boredom when learning using mobile phone-based learning media. Therefore, in this research, the author innovates a Slingshoot Simulation learning media application design that can be applied in the real world, makes it easier for students to understand the concept of parabolic motion in physics lessons, improves students' concept abilities in parabolic motion material, and attracts students' interest in learning about parabolic motion, while not boring students.

RESEARCH METHOD

The author adapts previous research to find out an overview of the right learning media, suitable for high school students, and improve the shortcomings of previous research so that output can be produced in the form of a Slingshoot Simulation application design that can support student learning outcomes related to parabolic motion material at school. This research uses the ADDIE development model method, a development model consisting of five stages, namely Analysis (analysis), Design (design), Development (development), Implementation (implementation) and Evaluating (evaluation). The ADDIE model is one of the systematic learning design models (I Made Tegeh, 2013). However, this research is limited to the Development stage of the application, because the purpose of this research is only limited to knowing the feasibility of application design to support students' concept understanding on parabolic motion material only and then analyze the feasibility of the application design validation. The first step of this research is to analyze the material and learning media and then evaluate it, then make an android-based learning media design, namely the slingshoot simulation application and evaluate it. The third step is to validate the feasibility of application design by validators and limited trial respondents. Finally, evaluation is carried out based on answers and suggestions from validators and limited trial respondents.

The feasibility test of the slingshoot simulation application design as a learning medium on parabolic motion material was carried out by 1 competent physics education lecturer who has decades of teaching as an expert assessor and 2 physics teachers who have decades of teaching as practitioner assessors as well as 27 prospective physics teacher students as limited trial respondents. Furthermore, validators and respondents were asked to provide a general assessment and suggestions for the design of the slingshoot simulation application as a learning medium on parabolic motion material, the framework of the research method can be seen in Figure 1. The validation test includes the appearance of the application design, game simulation, parabolic motion material and exercise questions submitted. The validation of the Slingshoot Simulation learning media design aimed at expert appraisal validators, practitioner appraisers and limited trial respondents aims to assess the characteristics of the Slingshoot Simulation learning media design used. In it there is material validation which is used to determine whether the material in the Slingshoot Simulation learning application design is in accordance with the curriculum learning material used. The data analysis technique used in this research is descriptive analysis, by calculating the percentage of validation results from validators and respondents.

$$\text{Score Percentage} = \frac{\text{score obtained}}{\text{maximum score}} \times 100\%$$

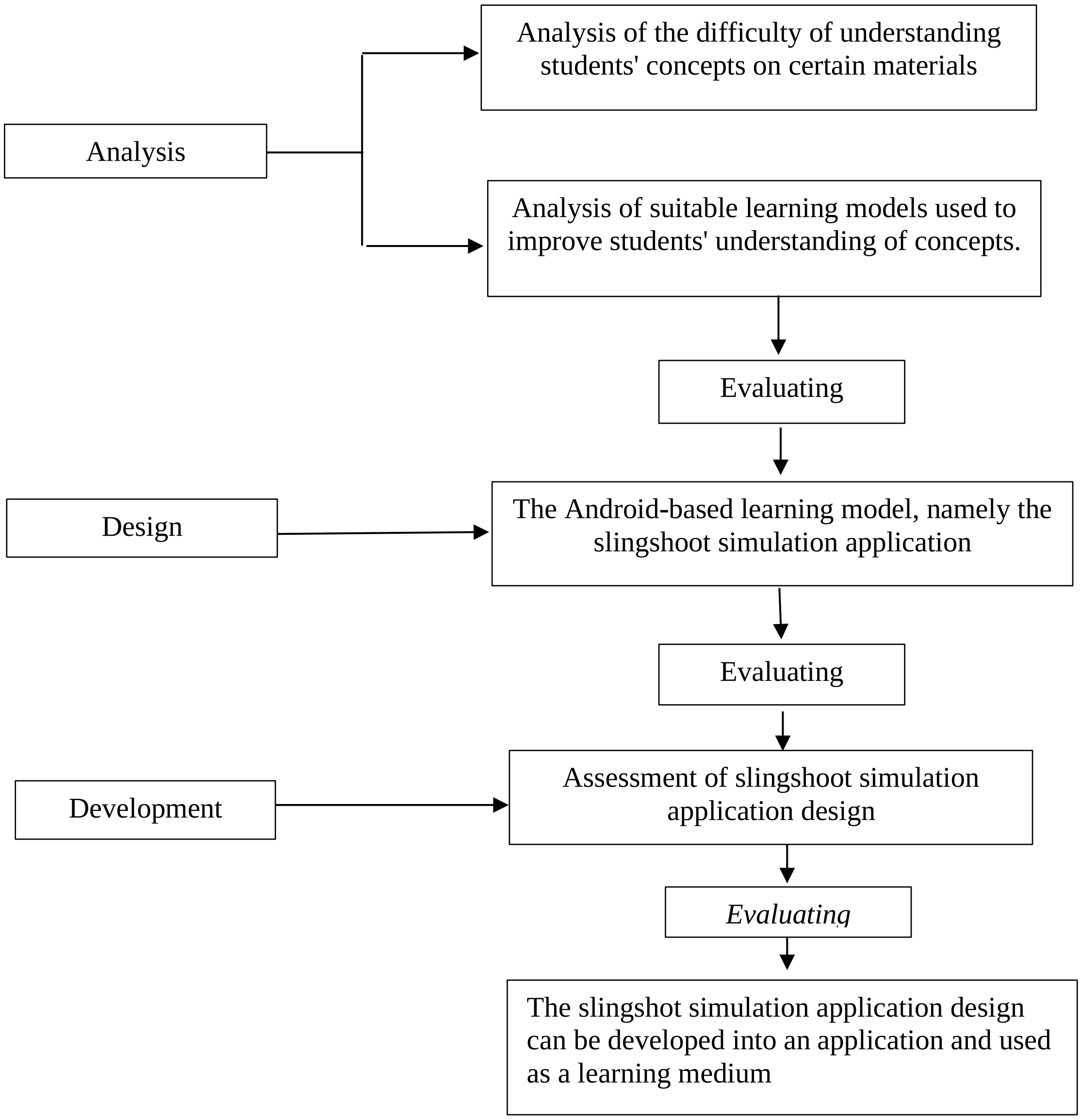


Figure 1. Slingshoot Simulation Application Design Development Stages Using the ADDIE

Every research requires a research instrument. Research instruments are basically tools used to collect data in research (Purwanto, 2018). Research instruments are made in accordance with the purpose of measurement and the theory used as a basis (Sukendra, 2020). The instrument has two forms, namely in the form of tests and non-tests, but to obtain behavioral samples from the cognitive domain, tests are used. Instruments in the form of this study are divided into two types, namely psychological tests used to measure affective aspects and psychological tests used to measure intellectual abilities. Psychological tests based on affective aspects measure a person's characteristics such as emotional statements, interpersonal relationships, motivation, interests, and attitudes. While psychological tests based on intellectual abilities are used to measure aspects of intellectual ability or called ability tests and are categorized again into two, namely aptitude tests and proficiency tests.

In this study, the authors used research instruments in the form of psychological tests based on affective aspects to determine the interests and attitudes of expert assessors, practitioner assessors and limited trial responses to the Slingshoot Simulation application design. The author also uses the form of objective tests or restricted answer tests and subjective tests or free answer tests by providing a column of suggestions for respondents to the Slingshoot Simulation application design at the end, including subjective and objective tests because respondents only choose one of the answers provided by the researcher and respondents have broad freedom in providing suggestions.

The feasibility level of the application design is determined by the percentage score. The higher the percentage score, the more feasible the application design is to be developed into an application and can then be used as a learning medium. The criteria for making decisions in validating the design of the slingshoot simulation application can be seen in table 1 (Ridwan, 2011).

Table 1. Application design eligibility criteria

Percentage (%)	Description
80.0 – 100.0	Good/Valid
60.0 – 79.9	Fairly Good/Valid Enough
50.0 – 59.9	Not Good/Less Valid
0.0 – 49.9	Not Good (Replaced)

RESULTS AND DISCUSSION

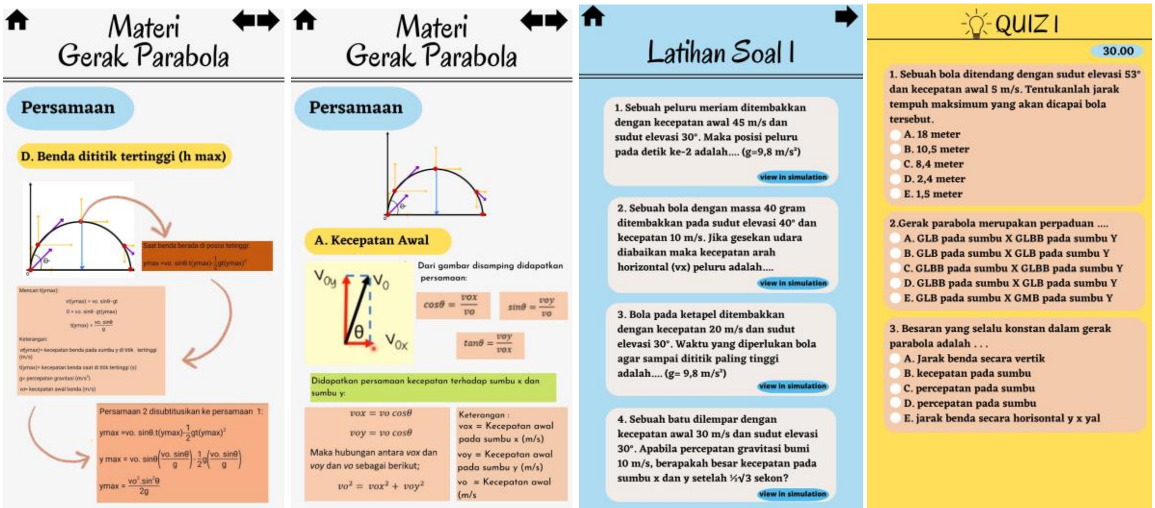
This research produces a slingshoot simulation application design as a learning media on parabolic motion material by adapting previous research to find out an overview of the right learning media, suitable for high school students, and improve the shortcomings of previous research. The design of this learning media application is designed by the author himself, with the aim of improving students' conceptual abilities on parabolic motion material. This research uses the ADDIE model learning media design model. The ADDIE model has 5 stages including Analysis, Design, Development, Implementation and Evaluation. The ADDIE model development research carried out only until Development because the purpose of this research is only limited to knowing the feasibility of application design to support students' concept understanding on parabolic motion material.

The research stages are Analysis, the analysis stage carried out consists of analyzing the difficulty of understanding students' concepts in certain materials and learning models that are suitable for improving students' understanding of concepts. From the analysis, it was found that the characteristics of android-based learning media on parabolic motion material for high school students are operated on the android operating system at least version 5.0 (Satria 2017).

Design, at the design stage carried out namely, 1) designing applications that will be used for learning media, 2) customizing, designing materials, making practice questions, designing game simulations, 3) validation sheets for expert appraisers, practitioner appraisers, and respondents limited trial. The initial display image of the Slingshoot Simulation application design contains 3 parts, namely the first image contains the login display or entry to the application, the second image contains registration stage if the user has not been registered with the application, and the third image contains various menus in the application

Figure 2. Initial Appearance of the Application

The second part consists of a display containing parabolic motion material (first and second images), a display containing practice questions and buttons to view the simulation (third image), and a display containing quizzes (fourth image).



Then, the third section contains a parabolic motion game simulation, in which there is a section for setting the initial speed, a ruler for measuring length, a section for zooming in and out of the game simulation display, a section for changing the mass of the object, a section for setting the initial height of the object from the ground, a section for reading the elevation angle, a parabolic trajectory that can be seen its components (time, distance, height, object speed on the x-axis and y-axis) at each point of the trajectory, and a section for setting the distance of the destination object. In the parabolic motion game simulation there is also a section that can be used to start, pause, rewind, continue and reset the simulation.

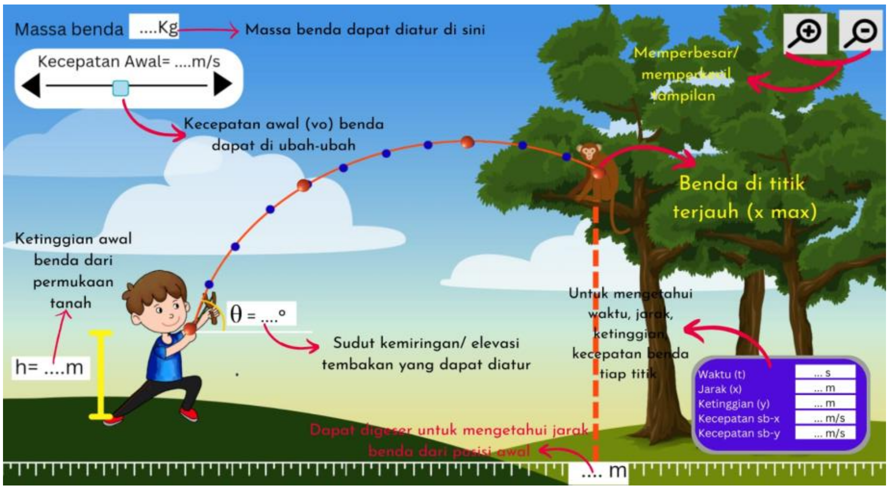


Figure 3. Display of Material, Practice Questions, and Quiz

Figure 4. Display Game Simulation

The application design feasibility validation questionnaire includes 4 proposed statements, namely the appearance of the application design can attract students' interest in learning, the game simulation design in the application design is in accordance with the parabolic motion learning concept, the game simulation design can attract students' interest in learning parabolic motion, the material is in accordance with parabolic motion learning and the delivery of material can be understood, and practice questions and quizzes can improve students' understanding of concepts in parabolic motion learning.

Development resulted in validation scores from expert appraisers, practitioner appraisers, and limited trial respondents.

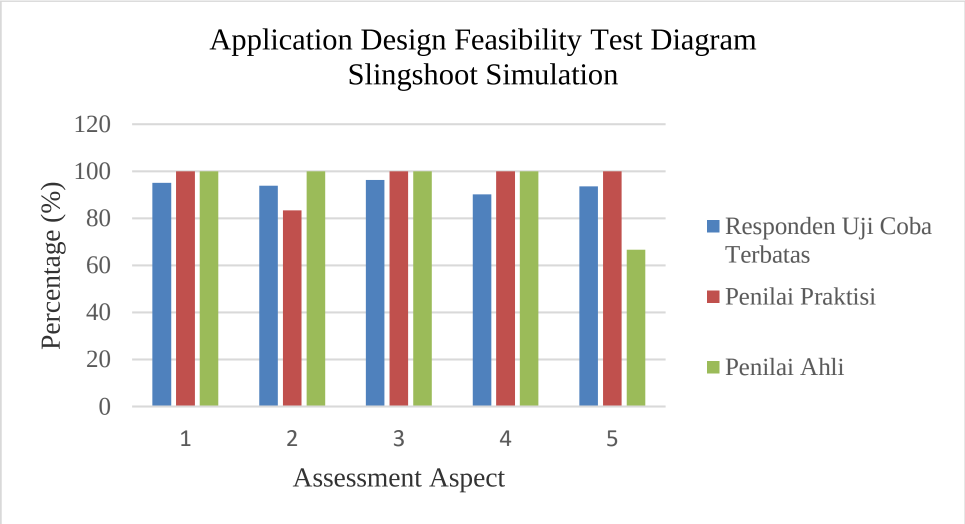


Figure 5. Slingshoot Simulation Application Design Feasibility Test Diagram

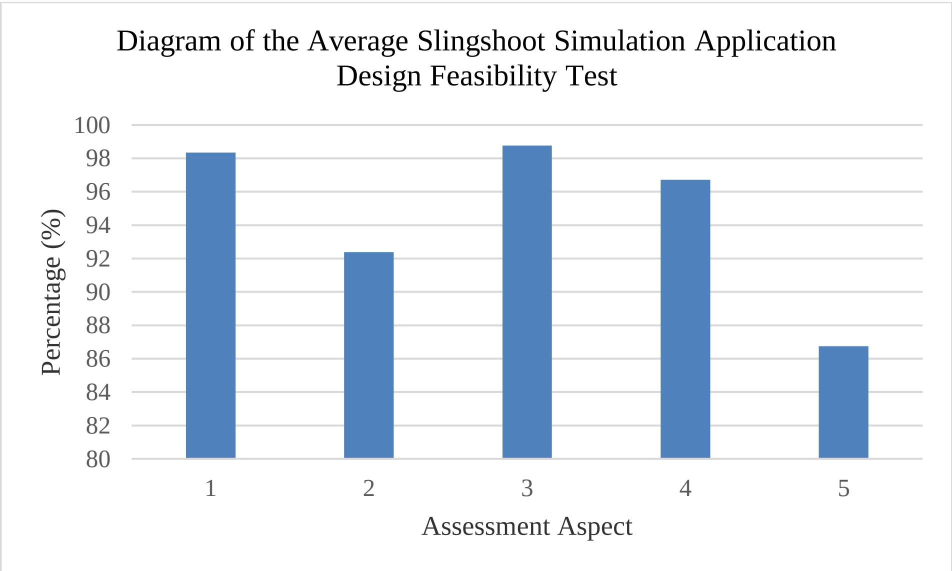


Figure 6. Average Feasibility Test Diagram for the Slingshoot Simulation Application Design

Information:
1: The appearance of the application design can attract students' interest in learning.
2: Game Simulation Design in the application design is in accordance with the parabolic motion learning concept.
3: Game Simulation Design can attract students' interest in learning parabolic motion.
4: The material is in accordance with parabolic motion learning and the delivery of the material can be understood.
5: Practice questions and quizzes can improve students' understanding of concepts in parabolic motion learning.

Based on Figures 5 and 6, the feasibility test diagram for the slingshoot simulation application design, the first statement obtained a validation percentage of 100% from expert appraisers and practitioner appraisers, 95.06% of limited trial respondents. The second statement obtained a validation percentage of 100% from expert assessors, 83% from practitioner assessors, and 93.83% from limited trial respondents. The third statement obtained a validation percentage of 100% from expert appraisers and practitioner appraisers, 96.30% from limited trial respondents. The fourth statement obtained validation results of 100% from expert appraisers and practitioner appraisers, 90.12% from limited trial respondents. The fifth statement obtained a percentage of 66.67% from expert appraisers, 100% from practitioner appraisers, and 90.12% from limited trial respondents

Based on the results of the validation analysis of expert appraisers regarding the design of the slingshoot simulation application as a learning medium for parabolic motion, it produces an average percentage of 93.4%. Things that are assessed include the appearance of the application design, the given game simulation, material, and practice questions. Suggestions from the validator are that the application design is good but it needs to be added to the quiz question randomizer application, so if students try to do the quiz again they don't memorize the form of the questions and their answers.

Based on the results of the validation analysis of practitioner appraisers regarding the design of the slingshot simulation application as a learning medium for parabolic motion, it produces an average percentage of 96.6%. Things that are assessed include the appearance of the application design, the given game simulation, material, and practice questions. Suggestions from the validator are that the application design is good, but it is necessary to pay attention to the use of colors that do not vary too much so that it is not too crowded.

Based on the results of the validation analysis of limited trial respondents regarding the design of the slingshot simulation application as a parabolic motion learning medium, the average percentage was 93.58%. Things that are assessed include the appearance of the application design, the given game simulation, material, and practice questions. Suggestions from respondents in the limited trial were already good, but the selection of fonts was neater and more attractive. Then in terms of content, it would be better if at the beginning it was given examples of questions accompanied by practice questions with similar forms and types to the sample questions, and after the quiz there should be a clear discussion.

The average validation from expert appraisers, practitioner appraisers, and limited trial respondents was obtained at 94.53% with a valid or good category as shown in table (Ridwan 2011) range 80% - 100% Good/Valid. Then the design of the slingshot simulation application as a learning medium for parabolic motion is feasible to use to increase students' understanding of concepts.

From the results of the research that has been done, a simulation game with features offered in the form of real-life implications is expected to make students better understand the material presented, also with the features that can be varied in the game can attract students' interest in learning physics, as well as being able to get rid of boredom when playing games while learning to understand the concept of parabolic motion in physics subjects and motivate students that physics is fun. In the last section there are simulation games that are very interesting, here the researcher uses objects commonly played by children so that students can apply and try it directly and make students more sensitive to the surrounding environment and realize that in learning physics can be done anywhere, not only fixated in books and classroom learning only. In addition, in the simulation games section, researchers also added several components that were deemed necessary to support the theory in the previous section of previous research, so that students can analyze and know many components in parabolic motion, namely initial velocity, velocity at a certain point, height, distance, angle, time and the simulation games display can also be zoomed in or zoomed out by students, besides that teachers can also observe student learning outcomes if students log in with school email.

CONCLUSION

From this research, it can be concluded that the Slingshoot Simulation application design is feasible to use as a learning media for parabolic motion, based on the results of the study, the average percentage data obtained is 94.53% with a valid category, validation data obtained from expert assessors, practitioner assessors and limited trial respondents. With a learning model that contains game simulations in it, the author hopes that through this application design it can improve students' concept understanding of parabolic motion material and make it easier for students to apply parabolic motion in real life when it has been realized into the application.

For further research, it is hoped that the slingshoot simulation application design can be developed into a learning application, so that the effectiveness of the application can be known, then it can be implemented to students and help educators when teaching. From this research, it is also hoped that other ideas can emerge regarding other physics topics, and are suitable as supporting learning media.

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