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Development of Computer Based Diagnostic Assessment Completed with Simple Harmonic Movement Material Remedial Program

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Abstract

Research and development of computer-based assessment is carried out to overcome the shortcomings of conventional paper-based assessment. Development is carried out by focusing on the use of isomorphic questions and improvement programs. This computer-based assessment was developed with two levels of questions. At each level there are isomorphic questions that are used as a reference in providing feedback to students about their concepts understanding. At each level there is also video material that can be used as a source of student learning before students utilize the remedial program. This computer-based assessment has been tested on 31 third-year undergraduate students in Physics Education, Universitas Negeri Malang. The results of media and material validation and the results of limited trials indicate that the computer-based assessment produced is feasible to be applied in learning.

Keywords: Computer-based Assessment; Simple Harmonious Motion; Isomorphic; Remedial

INTRODUCTION

Assessment is a comprehensive justification to find out the performance of students, or it is often interpreted as evaluation (Gloria, 2011). Assessment is needed to monitor student progress in the learning process. According to Overton (2011), assessment is a process of gathering information to monitor progress or it can also be defined as an activity to perform tests. Through assessment, the teacher can describe the progress of student learning and determine the next step of learning (Popham, 2008). In addition, the assessment also helps teachers to identify misconceptions in student knowledge so that teachers can determine strategies and efforts to overcome this problem (Sholikah, Febriyanti, & Kurniawan, 2020). This means that assessments can be made through tests and various methods such as observation, interviews, behavior monitoring, or other data collection techniques.

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Paper-based assessments have several drawbacks that are recognized by educational assessment experts. Paper-based assessments provide opportunities for students to cheat during tests, this was expressed indirectly by Mastuti (2016). Paper-based assessments were also deemed inaccurate to measure test participants with moderate to high abilities (Suyoso, Istiono, and Subroto, 2017). In addition, remedial activities or assignments carried out by educators with a paper-based assessment system take a long time (Muslich, 2011).

With due regard to some deficiencies of function paper-based assessment, a computer-based diagnostic assessment can be carrying out overcome. Diagnostic assessment is an assessment which aims to determine student weaknesses and the factors that cause them (Suwarto, 2013). The strengths and weaknesses of student learning can be obtained by utilizing information technology and in-depth analysis (Bell & Cowie, 2001; Gardner, 2012). This means that

computer-based diagnostic assessments offer the opportunity to facilitate operations in student learning assistance through the given feedback.

In general, feedback will be given after students have worked on all the questions on the assessment. The feedback received by students is in the form of learning progress and steps that need to be taken to achieve predetermined competencies (Bell & Cowie, 2001). One software that can be used to carry out computer-based diagnostic assessments is the Microsoft Power Point application. The use of Microsoft Power Point to develop computer-based diagnostic assessments was chosen because this application is a simple application and easy to master by teachers (Kurniawan, Shodiqin, Saputri, Kholifah, & Affriyenni, 2020). Therefore, it is hoped that teachers can be motivated to be able to develop computer-based assessments independently. In addition, the use of Microsoft Power Points to develop computer-based assessments also allows the development of questions equipped with video, audio visual, and animation (Sudar, Yulianto, & Wiyanto, 2014).

Doyan and Sukmantara (2014) have developed a web-based assessment. Web-based assessments have several advantages, but learning using the web will not be carried out well if the teacher is unable to integrate computers (Buabeng-Andoh & Totimeh, 2012). Computer-based assessment is an assessment system that utilizes computer technology as an assessment medium (Suyoso, Istiono, and Subroto, 2017). Computer-based assessments reduce the logistical work of educators such as distributing and storing student assessment results. In addition, the results of computer-based assessments can be seen directly by students because in computer-based assessments students work on test questions on a computer and the results of the assessment are displayed directly through the computer. Assessment of student test results is automatically carried out by a computer by comparing the input of student answers and the answer keys that have been inputted by the teacher. The speed of computer-based assessments in correcting and providing feedback allows problems to be diagnosed and resolved more quickly (Nur'aini, Lestari, & Kurniawan, 2020). Therefore, computer-based diagnostic assessment is considered more practical than paper-based assessment.

Comprehensive assessment problems are also experienced in physics learning, especially in the concept of harmonious motion. Most students still have difficulty understanding the concept of harmonious motion (Rusilowati, 2007; Husniyah, Yuliati, & Mufti., 2016; Sugara, Sutopo & Latifah, 2017). Based on research conducted by Sugara, Sutopo, and Latifah (2016), it was found that the difficulties experienced by students with simple harmonic motion material included difficulties in understanding the general form of mathematical representations of simple harmonic motion; difficulty determining factors affecting the total energy of harmonic motion; and determine the parameters that affect the size of the spring period and swing period. Therefore, there is a need for diagnostic assessment efforts that can assist students in solving problems of harmonious motion, so that the difficulties experienced by students can be resolved.

Research and development of computer-based diagnostic assessments on harmonic motion material is the most crucial choice. The development of this computer-based diagnostic assessment is directed to become a companion for students' independent learning. Products are developed by providing feedback in a small coverage of topics so that students' understanding of concepts can be diagnosed more accurately. This product also needs to be equipped with video material as a source of student learning and discussion videos to strengthen students' understanding of concepts. The existence of direct feedback and video material is expected to help teachers in identifying student concepts and correcting wrong concepts. The purpose of this research is to develop a computer-based diagnostic assessment that can identify students 'conceptual understanding and provide video material as a source of independent learning to improve students' conceptual understanding.

METHOD

A computer-based diagnostic assessment on harmonious motion material was developed with four stages adapted from Sukmadinata (2011). The four stages include: 1) Preliminary Stage, 2) Design Stage, 3) Product Development Stage, and 4) Limited Trial Phase. The four stages of development are described in more detail in Figure 1.

In the preliminary stage, the field study stage was carried out by paying attention to the content of simple harmonic motion. Literature studies related to simple harmonic motion are focused on the difficulty of understanding the concept of students. The results of field studies and literature studies are used as the basis for developing a computer-based diagnostic assessment. At the product development stage, the manufacture of computer-based diagnostic assessment products was carried out using Microsoft PowerPoint. The diagnostic assessment product is then saved in * .ppsx format so that the product can be used directly on a computer. Product validation was carried out covering the feasibility of media and materials by two Physics Lecturers of State University of Malang. Furthermore, product revisions are carried out in accordance with the validator's suggestions.

The revised product was tested limited to 31 students in the third year of the State University of Malang Physics Education Program to see the practicality of using the product. The selection of students is made with the consideration that the test subject can provide an assessment of the product using the point of view when as a student. Students are considered to have more experience in using existing assessment products. In addition, the test subject is a prospective student educator, so that the subject is deemed able to provide an assessment of the product using the point of view of being an educator in the future.

The types of data obtained in the development of this computer-based diagnostic assessment are quantitative and qualitative data. Quantitative data were obtained from product appraisal scores and qualitative data from comments and suggestions given by the validators and the test subjects. The data analysis techniques used to test the feasibility of the product is percentage formula.

Based on the results obtained, the product feasibility is then determined based on Arikunto's (2010) criteria which are presented in Table 1.

Table 1. Product Feasibility Criteria

Scores (%)	Feasibility
< 21	Very poor
21 ≤ x < 40	Not Feasible
40 ≤ x < 60	Quite Feasible
60 ≤ x < 80	Feasible
80 ≤ x ≤ 100	Very Feasible

The product practicality test is calculated by:

$$P = \frac{\sum X}{\sum X_i} \times 100\% \ldots (1)$$

With

P : Percentage

ΣX : Number of assessment answers

ΣX_i : Highest number of answers

Product practicality test criteria using the criteria proposed by Yamasari (2010) as in Table 2.

Table 2. Criteria for Product Practicality

Percentage	Criterias	Explanation
1 ≤ P < 25	Impractical	Can not be used
25 ≤ P < 50	Les Practical	Can be used with major revisions
50 ≤ P < 75	Practical	Can be used with minor revisions
75 ≤ P ≤ 100	Very Practical	Can be used without revision

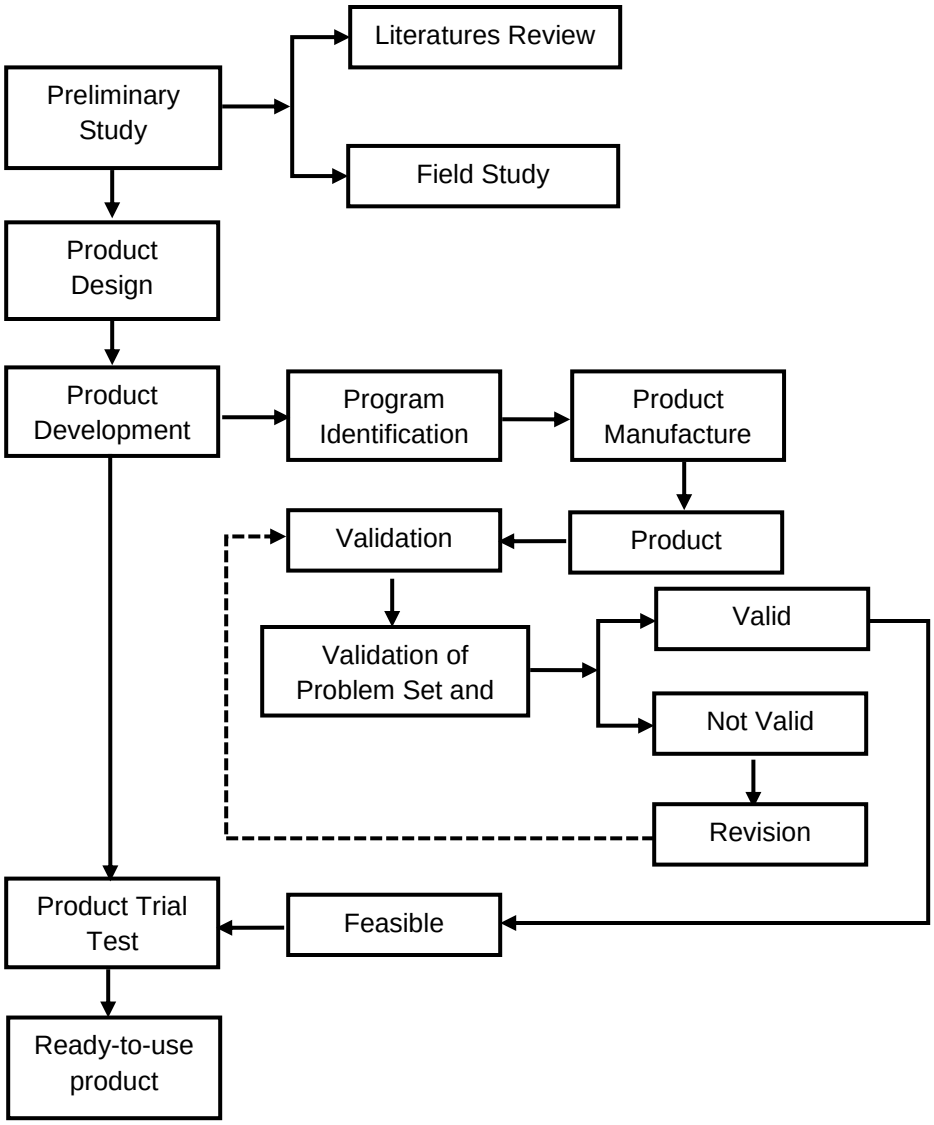

Figure 1. Development Research Stages according to Sukmadinata (2011)

RESULTS AND DISCUSSION

The process of developing a computer-based diagnostic assessment begins with a preliminary study. Preliminary study activities consist of literature studies and field studies. The literature study was carried out by identifying students' learning difficulties on simple harmonic motion material. Research by Adolphus, Alamina, & Aderonmu (2013) revealed that students' obstacles to simple harmonic motion material lie in their weak understanding of scientific terms, lack of skill in identifying quantities. In addition, students also have difficulty determining changes in direction (Parnafes, 2010) and interpreting graphs (Merhar, Planinsic, & Cepic, 2008; Testa, Monroy, & Sassi, 2002) for objects that experience simple harmonic motion.

Field studies by analyzing student conditions found that students tended to enjoy technology-based learning such as computers. However, field observations indicate that the assessment system used by teachers is generally in the form of paper-based assessment. A similar observation was reported by Pantiwati (2016). Field studies on the application of conventional

assessment show that conventional assessment has shortcomings such as time efficiency and effectiveness of assessment results feedback. In addition, conventional assessment allows students to cheat (Mastuti, 2016; Kurniawan, Suyudi, Nurhidayah, Fawaiz, & Purwaningsih, 2020). Suyoso, Istiono, and Subroto (2017) founded that conventional assessment is not accurate to measure test takers with moderate to high abilities.

Based on preliminary studies, computer-based diagnostic assessment products were further developed. The product is developed using Microsoft PowerPoint which is then saved in * .ppsx format. In this product the assessment is carried out using isomorphic questions. Isomorphic questions can be used to identify students' mistakes in understanding concepts (Nadhiif Diantoro, & Sutopo, 2015). There are two forms of isomorphic questions that have been developed, namely isomorphic with two items (Lin & Singh, 2011) and three items (Nguyen & Rebello, 2011). The product developed in this study used isomorphic questions with three items at each level. The question presented aims to determine the student's ability to determine the spring-mass frequency. There are two levels, namely level 1 and level 2. At level 1, there are three isomorphic questions with a true false question format with indicators presented in Table 3. At level 2 there are three isomorphic questions in a multiple choice question format with question indicators presented in Table 4.

The product was developed as a student learning companion with the aim of diagnosing students' understanding of the concept of simple harmonic motion on springs. If students diagnosed with an error in understanding the concept of simple harmonic motion on a spring, a video display of the material will be provided. If students are diagnosed with understanding the concept of simple harmonic motion on a spring, a strengthening of student understanding will be provided through questions and discussion. Students are categorized as having understood the concept if students are able to answer three isomorphic questions correctly, but if there are errors in working on isomorphic questions then students are categorized as not understanding the concept. Students who do not understand the concept can take part in the remedial program by first learning through the videos provided. More clearly, the categorization of students' understanding is presented in Figure 2.

Table 3. Indicators for level 1 questions

Number	Indicators
1	Students can use their understanding regarding the factors that affect the spring-mass frequency in different cases of deviation.
2	Students can use their understanding of the factors that affect the mass-spring frequency in the case of different mass of objects.
3	Students can use their understanding of the factors that affect the mass-spring period in the case of different mass of objects.

Table 4. Indicators for level 2 questions

Number	Indicators
1	Students can determine the ratio of the spring-mass frequency in three spring systems with different initial deviations.
2	Students can determine the ratio of the spring-mass frequency in two spring systems with different load masses
3	Students can determine the spring-mass period in two states with different load masses

The opening screen of the computer-based diagnostic assessment is presented in Figure 3. The questions used were adapted from the research of Sugara, Sutopo, and Latifah (2017). The questions are presented in two levels. The display of questions at level 1 is presented in Figure 4. The three questions presented are about the concept of frequency and period in the spring system. If the student is able to answer the three questions correctly, then at the end of the third question the student is declared to have mastered the concept and can continue at level 2.If between

the three questions the student is wrong in answering or even wrong in all three, then the student is declared not mastering the concept and a video is provided. material as a source of student learning.

At level 2 three questions are presented which are the same as in level 1, but with a multiple choice format. Problem at level 2 is a consolidation of the concept presented at level 1.The display of questions at level 2 is presented in Figure 5.

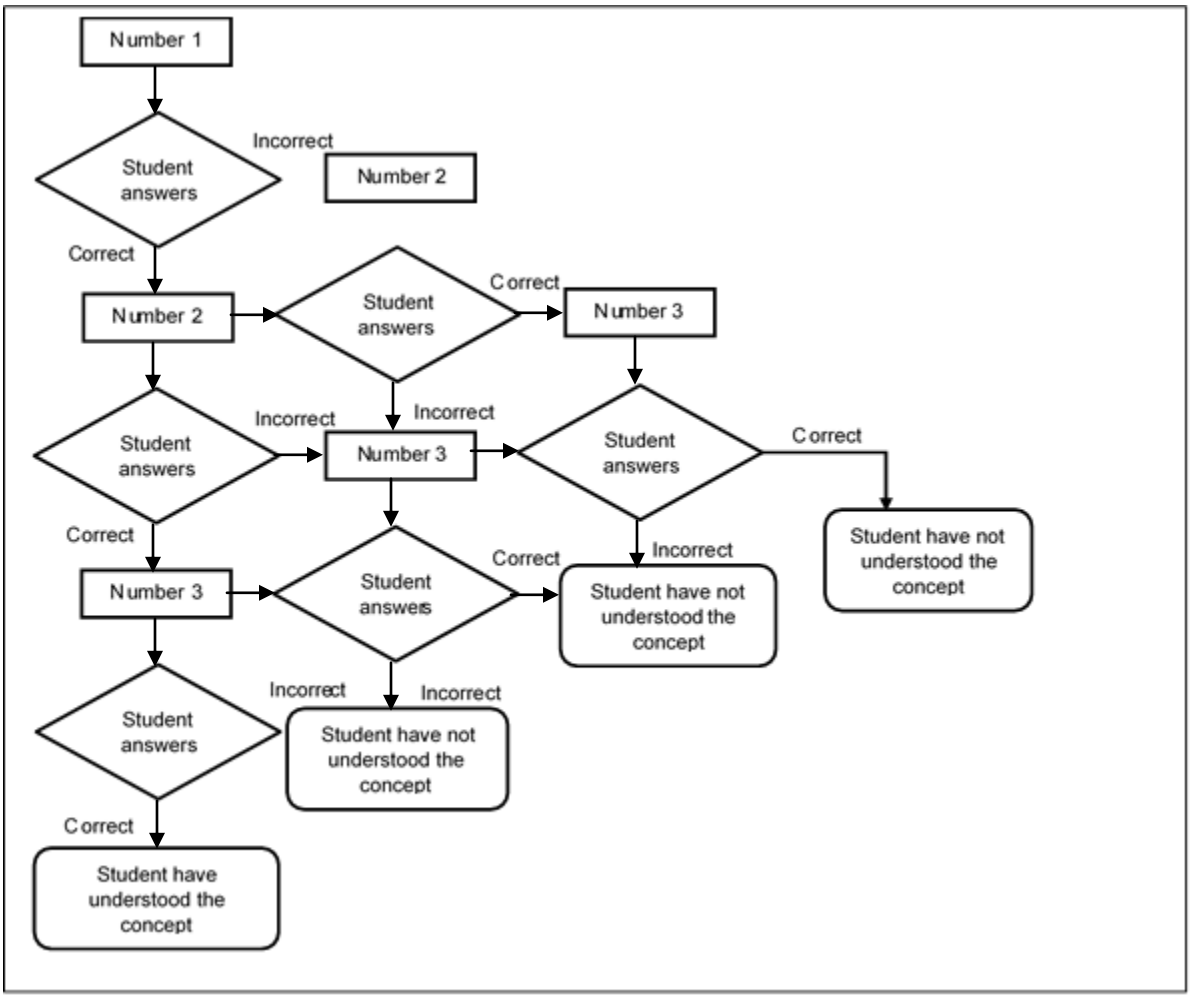

Figure 2. Flow of Student Understanding Categories

Figure 3. Opening Display

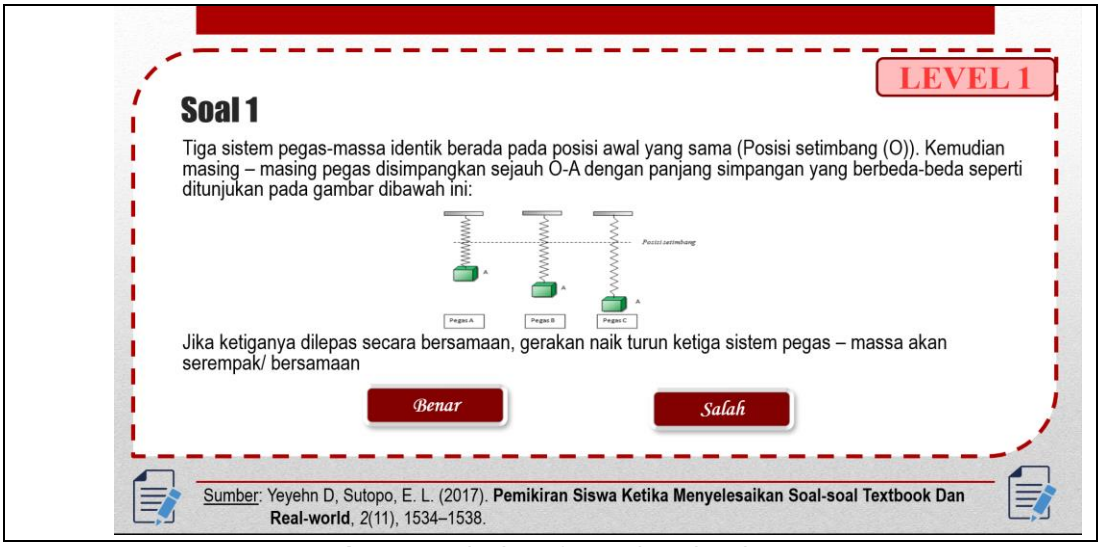

Figure 4. Display of questions level 1

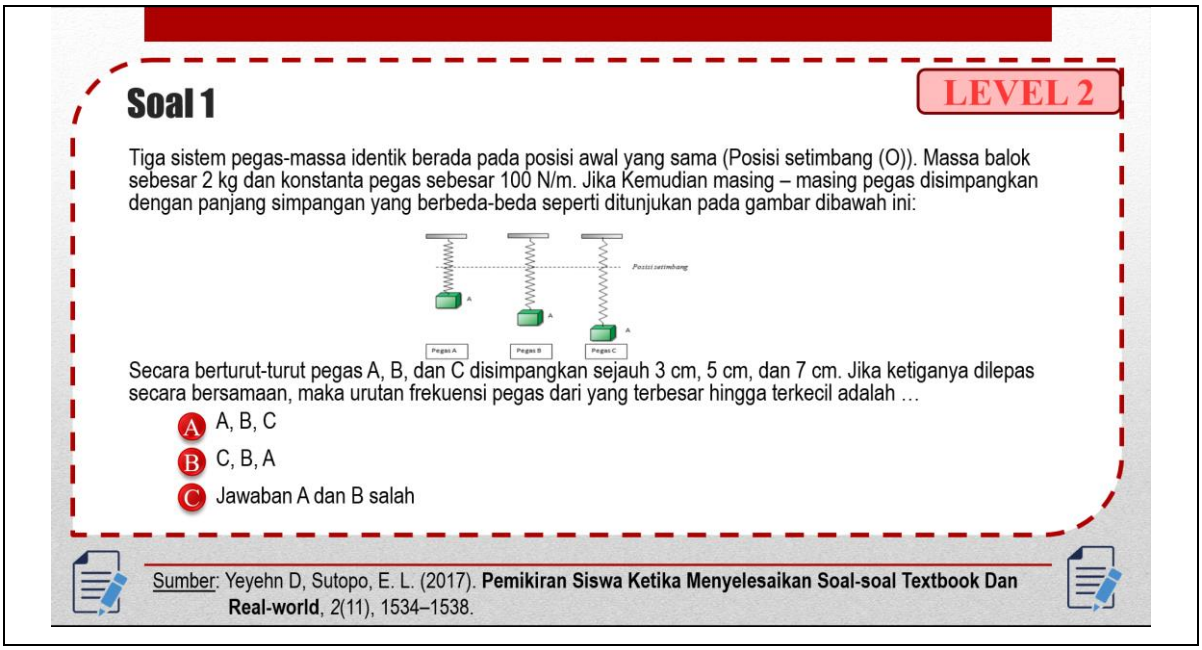

Figure 5. Display of questions level 2

If students can answer the three questions correctly, then at the end of the three questions the students are declared to have mastered the concept and can follow the discussion provided in video format. If among the three questions the student is wrong in answering or even wrong in all three, then the student is declared to have not mastered the concept and a material video is provided as a source of student learning. Students can access the learning video by clicking the video material icon as shown in Figure 6. After learning through the video material, students can take part in the remedial program.

Figure 6. Icon Video Material

The diagnostic assessment product developed in this study is equipped with two video material for two level questions. In the first video, the explanation of the video is more focused on understanding the concepts related to the factors that affect the frequency and period of the pendulum and spring. While the second video focuses more on mathematical equations as shown in Figure 7. The preparation of video material refers to the difficulties and misconceptions found in the research of Rusilowati (2007) as well as Sugara, Sutopo, and Latifah (2016).

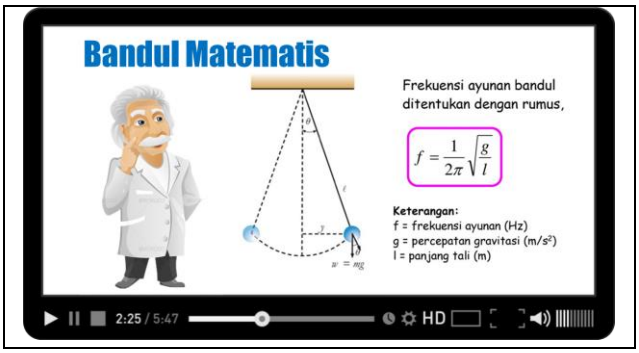

Figure 7. Display of video material

The product validation test was carried out by a physics lecturer at the State University of Malang including a media feasibility test and a

material feasibility test. The indicators used in the media feasibility test include appearance, animation, navigation, motivation, grammar, while the material feasibility test criteria include the suitability of the material, the correctness of the concept and the selection of questions. The validation test results obtained the feasibility of the media 93.18% and 83.33% of the material feasibility. Based on the results of the validation test, the product was declared very feasible in appearance and material. In more detail the results of the media validation are presented in Figure 7 and the validation of the material in Figure 8.

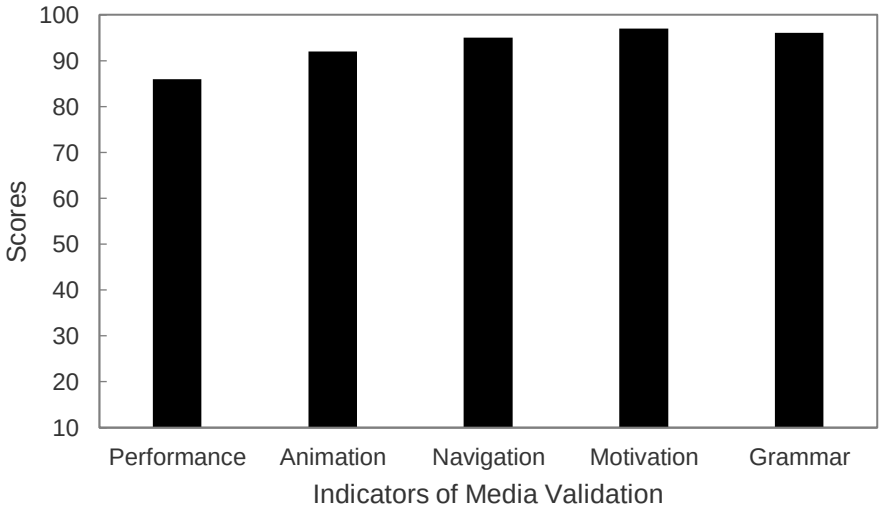

Figure 8. Media Validation Results

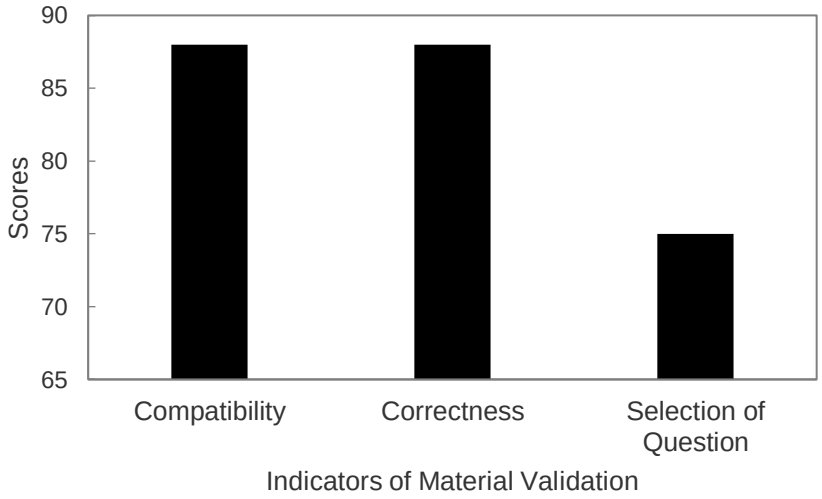

Figure 9. Material Validation Results

The suggestions for improvement given by the validator are presented in Table 5.

Table 5. Suggestions from the validator

Num.	Suggestion
1.	Use less of a button-like image.
2.	On the instructions page, it is necessary to add information about the characteristics of the quiz provided

Limited trials were conducted on 31 third year students of S1 Physics Education State University of Malang by distributing questionnaires to test the practicality of the product. There are six components that must be responded to by students. These components include ease of use of the media, instructions for use, navigation, video material, questions to use, and the form of feedback provided. The product practicality test results obtained a percentage of 74.19%. Based on practicality tests, computer-based diagnostic assessment products have practical criteria with minor revisions. The input from respondents is presented in Table 6.

Table 6. Suggestions from respondents

Num.	Suggestion
1.	Given background music to make it more attractive.
2.	Animated to make it more interesting
3.	Produced in apk format so that it can be used on android

Limited trials were also carried out to diagnose the understanding of simple harmonic motion on springs along with changes in student understanding. In the first process, 14 students were able to solve questions at level 1. A total of 17 students who were unable to solve problems at level 1 studied the material through the video provided. After they felt ready, 17 students then tried to rework the questions at level 1. The results of the second work, 15 students were able to finish, while 2 students were able to complete the level 1 questions on the third work.

At level 2, there were 14 students who were able to do level 1 on the first task, it turned out that only 5 students were able to complete level 2 on the first task. This shows that only 5 students have understood the concept of simple harmonic motion on springs. A total of 23 students were able to complete the level 2 questions on the second work, while 3 students completed them on the third work. More briefly, the data on the number of students who were able to solve the questions correctly at each level is presented in Table 7.

Table 7. Data on the number of students who are able to solve questions at each level

Question Level	Work to -		
	1	2	3
Level 1	14	15	2
Level 2	5	23	3

Based on the data in Table 7, it appears that most students have not been able to complete the first task. most students were able to complete the second course of action. Students are categorized as being able to understand the overall concept if they can complete level 1 and 2 on the first work correctly. Based on data on the first work, it appears that only 5 students (16%) understand the concept correctly. Students who are unable to complete the first work, review the material provided so that they can complete the questions correctly on the 2nd and 3rd work. This shows that the product developed can identify student conceptual understanding and the remedial program is able to improve student understanding.

CONCLUSION

Based on the results of the product feasibility test, it was found that the feasibility of the media was 93.18% and the feasibility of the contents was 83.33%. Limited trials related to product practicality obtained a percentage of 74.19%. So it can be concluded that the product of computer-based diagnostic assessment of simple

harmonic motion on the spring fulfills the criteria for feasibility and practical use. The results of trials with students also show that the product that has been developed is able to identify student conceptual understanding and is able to improve student understanding of concepts. As a further research effort, the product being developed can be tested on a large scale. The development of computer-based diagnostic assessments also needs to be developed using the Android platform. In addition, a diagnostic assessment can be developed using other sub-materials. The development of diagnostic assessment at the sub-topic level is expected to be able to diagnose students 'understanding starting from a small scope, so that students' misconceptions cannot be resolved immediately.

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