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Certainty of Response Index-based E-Diagnostics Assisted by Google Forms to Identify Misconceptions in Simple Harmonic Waves

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ABSTRAK

Pembelajaran fisika memegang peranan yang sangat penting dalam kehidupan sehari-hari, oleh karena itu pemahaman siswa terhadap materi fisika sangatlah penting. Siswa yang memahami konsep-konsep fisika dengan baik akan lebih mudah menerapkan konsep-konsep fisika tersebut dalam kehidupan sehari-hari. Namun, beberapa siswa mengalami kesulitan dalam memahami materi fisika, terutama ketika mereka salah memahami konsepnya. Konsep fisika membentuk jaring-jaring yang saling terhubung satu sama lain, sehingga pemahaman yang benar pada tataran sebelumnya menjadi salah satu faktor penentu keberhasilan. Tujuan dari penelitian ini adalah untuk mengembangkan e-Diagnostic berbasis Certainty of Response Index (CRI) dengan bantuan Google Forms untuk mengidentifikasi miskonsepsi siswa pada materi gerak harmonik sederhana. Jenis penelitian yang digunakan adalah Research and Development yang diadaptasi dari model Four-D. Siswa kelas 10 dijadikan subjek penelitian. Data yang dideskripsikan berupa validitas instrumen dan hasil identifikasi profil miskonsepsi pada siswa. Hasil uji validitas yang dilakukan oleh 2 ahli dan 8 rekan sejawat menyatakan bahwa instrumen tes yang dikembangkan layak untuk digunakan. Hasil identifikasi miskonsepsi yang dilakukan menunjukkan bahwa terdapat miskonsepsi pada sub pokok bahasan gaya pemulih. Kesimpulannya, e-Diagnostik yang dikembangkan layak digunakan sebagai alat untuk mengidentifikasi miskonsepsi siswa.

ABSTRACT

Physics learning plays a very important role in everyday life, therefore, students' understanding of physics material is very important. Students who understand physics concepts well will find it easier to apply these physics concepts in everyday life. However, some students had difficulty understanding physics material, especially when they misunderstood the concept. Physics concepts formed webs that were connected to one another, so that a correct understanding at the previous level was one of the determining factors for success. The purpose of this research was to develop an e-Diagnostic based on the Certainty of Response Index (CRI) with the help of Google Forms to identify students' misconceptions about simple harmonic motion material. The type of research used was Research and Development which was adapted from the Four-D model. Grade 10 students were used as research subjects. The data described were in the form of instrument validity and results of identifying misconception profiles in students. The results of the validity test conducted by 2 experts and 8 colleagues stated that the developed test instrument was feasible to use. The results of the identification of misconceptions that were carried out showed that there were misconceptions, especially in the restoration style sub-topic. In conclusion, the e-Diagnostics that was developed is feasible to use as a tool to identify student misconceptions.

1. INTRODUCTION

Physics learning plays a very important role in everyday life, therefore, students' understanding of physics material is very important (Dare et al., 2014; Erinosho, 2013; Oliveira & Oliveira, 2013). Students who understand physics concepts well will find it easier to apply these physics concepts in everyday life. However, some students had difficulty understanding physics material, especially when they misunderstood the concept (Docktor & Mestre, 2014; Sundari & Dewi, 2021). Simple harmonic motion is the basic material used at the next grade level and is closely related to everyday life, so it was important for students to understand this material (Amalia et al., 2019; Dimas et al., 2018; Mahen & Nuryanti, 2018). Students who already have an understanding outside the wrong environment, will have difficulty learning when connecting it with the scientific framework of scientists (Duman et al., 2015).

The key to the success of physics lesson lies in an effective learning approach. Achieving learning objectives can be easily done if educators focused on things that students did not understand or prior

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knowledge of students (Aina, 2017; Amelia et al., 2016). In addition, correcting misconceptions that occur in students is the key to the success of learning. Diagnostic test was one way to identify misconceptions in students (Fenditasari et al., 2020; Gurel et al., 2015). In the digital era, Google Forms became one of the solutions for educators in carrying out diagnostic tests digitally and efficiently.

Google Form has many advantages as a diagnostic test tool, including effectiveness, efficiency, and attractiveness due to the development of digital technology in the 4.0 era. The use of Google Forms was also suitable for use in distance learning although it did not rule out the possibility of using it in face-to-face learning (Iqbal et al., 2018). The question items in Google Forms could be in the form of multiple choice with the level of confidence of students in choosing answers or the Certainty of Response Index (CRI). The CRI technique was simple and effective in identifying misconceptions in students (Rahmah et al., 2018; Sadhu et al., 2017; Yuberti et al., 2020). This technique could distinguish students who understood, did not know, and misconstrued.

However, further research revealed a weakness of the CRI technique. Even so, for educators who will carry out learning every week, CRI was considered more suitable because it was easy to develop (Diani et al., 2019). Identification results can be used as a reference in the development of further materials because the CRI-based diagnostic analysis process does not require extra labor in the identification process. CRI analysis can provide a clear picture of concepts that students have not yet understood. Therefore, diagnostic test using Google Forms with CRI techniques can be an effective alternative in identifying misconceptions and increasing the effectiveness of learning physics.

2. METHODS

Research was carried out by applying the research and development (R&D) method adapted from the Four-D model. Clearly, the Four-D research procedure used consisted of: (1) Define, conducting classroom observations and interviewing educators; (2) Design, making a question grid, question form, instructions for doing the questions, test questions, answer keys, discussions, scoring guidelines, and data interpretation guidelines; (3) Develop, carry out the validation of the questions developed by validating the contents of Lawshe CVR; and (4) Disseminate, valid product development results and interpreted measurement results are given to schools. The research was conducted for two months beginning with observations of the school environment, analysis of student levels, curriculum, and concepts on simple harmonic motion material. The results of observations and needs analysis were then designed according to the direction of the educator. The next step was developing an e-diagnostic test, validating its feasibility, and identifying misconceptions using the developed product. The items that were validated by 2 experts and 8 colleagues were then used in the learning process. The research was conducted at Islam Terpadu Al Irsyad Al Islamiyyah High School Purwokerto. The research was conducted in April 2021 with research subjects being 10th-grade students majoring in mathematics and natural sciences.

The data collection method used was (1) observation to determine the condition of the school environment, (2) interviews with educators to find out the educator's opinion about the product to be developed, (3) content validity as a determinant of the eligibility of the product developed using the per item validity method with content validity coefficient-Lawshe CVR, and (4) analysis of misconceptions used as the basis for identifying misconceptions in students with the CRI method (Ayre & Scally, 2014; Baghestani et al., 2017). There are 10 validators, so the minimum score was required to be 0.67 (Ayre & Scally, 2014), so test instruments that scored below the minimum limit will be revised according to the validator's suggestions. Test instruments that were valid and/or corrected according to validation suggestions can be used to obtain student misconception data. The CRI data from test results are then interpreted according to Table 1.

Table 1. Interpretation of CRI

Answer	Confidence Level	Criteria
Correct	0, 1, and 2	Do not understand
Wrong	0, 1, and 2	Do not understand
Correct	3, 4, and 5	Understand
Wrong	3, 4, and 5	Misconception

The confidence level was divided into two, namely the low confidence level and the high confidence level. The level of confidence was low if students chose a scale of 0 (all guess), 1 (partly guess), and 2 (not sure). The level of confidence was high if students chose a scale of 3 (confident), 4 (almost understood), and 5 (understand).

The data obtained were then analyzed by measuring the average misconceptions, not understanding, and understanding of each item. Data was then converted into a percentage of misconceptions before the learning activities were carried out. The results of calculations are used as a table as a visualization.

3. RESULT AND DISCUSSION

Results

The product developed was based on observations at schools, interviews with educators, and observations of activities during learning. Observations at school showed that learning was done remotely. Distance learning activities were carried out to assist the government in handling the pandemic. During distance learning activities, educators carried out learning activities on the internet network. During learning activities, both educators and students were able to carry out learning activities properly. Taking into account all that has been mentioned, the product was developed based on these conditions. The final product that was developed consisted of several sub-products. Details of the sub-products developed are described in Table 2.

Table 2. List of Developed Products

Number	Developed Products	Contents
1	Question grid	Sub-topics, question indicators, number of questions
2	Instructions for questioning	Instructions for students in working on questions and rules
3	CRI-Based E-diagnostic Test	Title, subject, class, subject, working time, questions, answer choices, level of confidence in answering
4	Answer key	Numbers, correct answer choices, and discussion
5	Scoring guidelines and interpretation of results	Guidelines for giving scores and determining grades as well as guidelines for classifying students' understanding

The product development of e-diagnostic test instruments on the simple harmonic motion was divided into 3 sub-topics. The division of sub-subject aims to find out the parts that are students' misconceptions. The subtopic of simple harmonic motion material can be seen in Table 3.

Table 3. Sub-topics of Simple Harmonic Motion Material

Subject Matter	Sub-Topics
Simple Harmonic Motion	The restoring force Equations of position, velocity, and acceleration of simple harmonic motion Equation for the period of simple harmonic motion for a spring and a pendulum

Sub-topic became a reference in the development of e-diagnostic test instruments. Each of the sub-topics has been represented by several questions. The results of the e-diagnostic test instrument that was developed were then applied to Google Forms as a medium for questions and answer sheets.

Test items were developed with a focus on answers and the level of confidence of students. Questions were in the form of multiple choices with 1 correct answer and 4 distracted answers. The test was possible in the form of multiple-choice tests for many students and at a certain time compared to interviews which required a long time (Kamcharean & Wattanakasiwich, 2016). Then, questions were equipped with the level of confidence of students with 6 levels. Confidence level scale answers from lowest to highest sequentially were: (1) all guessing, (2) some guessing, (3) not sure, (4) sure, (5) almost understand, and (6) understand (Kusumawati et al., 2022; Putri et al., 2021). The form of the e-diagnostic question that was developed considered that educators could imitate the material at the next meeting with a different material.

The score for a correct answer was 1 and 0 for an incorrect answer. Scores on the confidence level index consisted of 0, 1, and 2 for the low category. While the scales 3, 4, and 5 on the confidence level index for the high category. The low category for right or wrong answers showed that students did not understand the concept. The high category and the correct answer informed that students understood the concept. Meanwhile, in the high category, the wrong answers indicated that students had misconceptions. The items that were developed were then validated.

Validation was carried out using the Content Validity Coefficient–CVR Lawshe. The Method was used because the time required to assess each item was short so that it could be imitated by educators in developing e-diagnostics in subsequent material. Apart from this, the "important" or "unimportant" assessment of each question given by each validator can make it easier to make improvements to items deemed to need improvement. After knowing the content validation coefficient ratio, we continued by calculating the test Validation Coefficient Index (CVI) by calculating the average CVR on only valid questions. Validators consisted of 2 experts and 8 colleagues. Validation was carried out so that it could be seen that the product being developed was feasible for use in identifying students' misconceptions. Misconceptions identified in the matter of harmonic motion. The results of the validation analysis in detail can be observed in Table 4.

Table 4. Analysis of Validation Results

Question Item Number	1	2	3	4	5	6	7	8	9	10
CVR	1.00	1.00	1.00	1.00	0.80	0.80	1.00	1.00	0.60	0.80
Category	Good	Good	Good	Good	Good	Good	Good	Good	Not Good	Good
CVI	0.93									

The test results that were done by students were then interpreted to identify misconceptions. The interpretation was carried out on all the answers of each student and each item. The results of the interpretation of misconceptions are then reported to educators as reference material in learning activities so that they can be reduced.

Misconceptions that occurred in students will make it difficult to understand the subject matter (Qian & Lehman, 2017). The concept that was wrong and embedded will be considered correct by students. Because of that, it was important to reduce misconceptions in students after being diagnosed. However, before knowing the parts of the material that need to be emphasized by educators, educators need to look at the results of the identification of misconceptions. The results of identifying misconceptions using the e-diagnostic test that was carried out are shown in Table 5.

Table 5. Interpretation Results of e-Diagnostic Test based on CRI

Category	Highest (%)	Lowest (%)	Average (%)
Understand	76	0	31
Do not understand	86	16	53
Misconception	38	50	16

The identification of misconceptions that were known was then translated based on the sub-topics. This was done so that educators can easily carry out the treatment. A more detailed description based on sub-topics can be observed in Table 6.

Table 6. Percentage of Misconceptions Based on Sub-Topics

Sub-topics	Misconception (%)
The restoring force	17
Equations of position, velocity, and acceleration of simple harmonic motion	16
Equation for the period of simple harmonic motion for a spring and a pendulum	15

Discussion

The choice of Google Form as the quiz media was due to the results of observations and interviews, educators were used to using it during the learning process. Apart from that, during the pandemic, was a must for carrying out distance learning. Even though the research was done at the time of distance learning, it does not rule out the possibility that the product being developed can also be used in face-to-face learning. Product development must be easy so that educators can develop the same product as the next learning material.

The CVR value of more than 0.80 indicates that item is valid. Validation results showed that 9 out of 10 items were valid. The lowest CVR score was on item number 9. According to the validator's notes, that number was considered too difficult to be tested as an e-diagnostic question because students had not received advanced learning material. Based on the table, the test items developed to indicate a validation

coefficient (CVI) of 0.93, or 93% of the items are good. Because of that, improvements were made to every suggestion given by the validator so that all questions could be used. Results showed that the product was by the content of class X simple harmonic motion material and could be used to identify students' misconceptions.

The average percentage of not understanding which refers to Table 5 was in first place. Results showed reasonable because the test was carried out before the learning activities. The ability of students to do an e-diagnostic test was based on their memory when they obtained previous learning. The knowledge that was previously obtained, caused students to come not as blank white papers. However, there were still misconceptions that occurred to students during the e-diagnostic test. The thing was caused by erroneous prior knowledge, carelessness in answering, and fragmented memories. Students already had an initial concept of concept before participating in learning (Nurulwati et al., 2014). Therefore, it was necessary to improve students' concepts carried out by educators.

Based on the percentage of misconceptions about the sub-topics in Table 6, restoring force was the sub-topic that experienced the most misconceptions. Other studies have shown the same thing, restoring force, became one of the topics of discussion in their findings (Somroob & Wattanakasiwich, 2017). The results of the student's answers, the students already know that the direction of the restoring force is the opposite of the direction of the external force. However, some students had a misunderstanding thinking that the working force is twice the external force. This was because the students thought that the spring force that appeared when given an external force was greater.

Another misconception found, in the second sub-topic, the students already knew the equations that emerged and the operational definition of a variable. Overall, students remembered the similarities but did not pay attention to the concepts given in the problem (Hudha et al., 2019). The cause of occurrence was that students had faced questions with almost similar forms, so the daily experience was one of the causes of misconceptions.

The third sub-topic was based on the answers of students who had experienced misconceptions, the physical meaning could not be understood. Mistakes in interpreting the physical meaning of an equation will lead to misconceptions when receiving learning. Students knew each variable in the equation, but students could not understand the relationship between one variable and another. Thus, the misconception was caused by low mathematical representation abilities.

Based on the results of research, educators who already know the misconceptions that occur in students need to make reductions when learning activities take place. As for the reduction carried out by educators, it can be done in various ways. Methods for reducing misconceptions or increasing students' conceptual understanding based on previous research include: using certain learning processes (Iradat & Alatas, 2017; Tompo et al., 2016), developing mobile learning applications (Pambayun et al., 2019), using media (Wibowo et al., 2015), and so on. Therefore, educators or other researchers could develop other materials and continue research on the reduction of misconceptions to find out the best way, especially in schools that are the subject of research.

4. CONCLUSION

Based on the learning innovations that have been implemented, it can be concluded that a CRI-based e-diagnostic test has been developed with the help of Google Forms to identify misconceptions. E-diagnostic test was suitable for use based on validation of the contents of Lawshe CVR by 2 experts and 8 colleagues. There were still students who had misconceptions about simple harmonic motion material. The highest misconception for simple harmonic motion material was in the restoring force sub-topic. Factors that cause misconceptions in research include: 1) memory when obtaining previous learning, 2) daily experiences, 3) low ability of mathematical representation. Several ways to reduce misconceptions that can be carried out by educators are the use of certain learning processes, the development of mobile learning applications, and the use of media. The e-diagnostic product developed as a result of research and development has become a valuable infrastructure or tool for educators in identifying students' misconceptions at the beginning of learning.

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