Development of Three Tier Online Test Diagnostic of Misconception for Topic Free Fall Motion

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Article Info	ABSTRACT
	Purpose of the study: This study aimed to develop an online Three Tier Test Diagnostic of misconception in topic free fall motion. **Methodology:** This research is development research using a development model 4D by Thiagarajan (Define, Desain, Development, and Dissemination). However, the research is only limited to the Development stage because the research objectives have been achieved. The data collection instrument is a media expert validation questionnaire. The research data includes quantitative data in the form of expert validator evaluations and qualitative data in the form of comments and suggestions given by expert validators. **Main Findings:** The results showed that the product three tier online test diagnostic was feasible to use based on expert validation with a very feasible category. The resulting product has five item questions and consist of three tiers. The first tier is multiple choice questions, second is reason for answering question, and third tier is curiosity response index (CRI). **Novelty/Originality of this study:** The novelty of this research is uses an online test. This is expected to be able to support the effectiveness of further research by researchers.

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1. INTRODUCTION

Misconception is a discrepancy between a person's concepts/ideas with scientific concepts accepted by experts [1], [2], [3]. Students who are identified as experiencing misconceptions in physics do not realize that what they are experiencing is an error because it has been embedded in students' minds that the concepts, they believe are true [4], [5]. This is because misconceptions are resistant and persistent [6], [7]. This means that misconceptions are resistant to change, persistent and very difficult to change and eliminate [8], [9]. The misconceptions that occur to students also affect the related conceptions that will be taught next [10], [11].

The subject of free fall motion is a sub-subject on straight motion which is taught in grade 10th Senior High School. This material is very important because it underlies other concepts of vertical motion, namely vertical motion up and vertical motion down [12], [13], [14]. This is because each physical material cannot stand alone, but is related to one another [14], [15]. Students often experience errors in free fall motion material, especially those related to the initial velocity, time of fall, and the acceleration of Earth's gravity [16], [17]. In the early stages, identification needs to be carried out to find out the misconceptions that occur, so that researchers think it is necessary to develop a diagnostic test for misconceptions.

The development carried out is in the form of a diagnostic question of misconceptions using Three Tier equipped with an index of confidence in the answers given by students [18], [19]. Three-tier misconception diagnostic tests that are widely developed are generally still in the form of paper-based tests. Identifying misconceptions using a paper-based Three-tier test requires accuracy and takes a long time to correct (data analysis). Because it combines 3 answers from each level to analyze the misconceptions that occur. In addition, the paper-based three-tier test cannot provide sufficient feedback about each student's errors [20], [21].

To make it easier to identify misconceptions and to know specifically students' misconceptions so that they can provide treatment as early as possible to overcome these misconceptions, the researchers tried to develop an Android-based three-tier test [22], [23], [24]. The diagnostic test question was developed based on android (online) this is also due to the fact that covid-19 is still spreading in Indonesia so that learning is still using online/hybrid methods and needs adaptation in every innovation made [25], [26], [27]. it is preferable to use a three-tier diagnostic test compared to the current one which has grown to four or five tiers is based on practical considerations and efficiency in the assessment process but still considers the reliability of the device to capture and diagnose misconceptions that occur in students [28], [29], [30].

In line with previous research, student misconceptions have become an important issue to discuss because previous concepts brought by students into the classroom can influence the acquisition of new information [25], [28]. In previous research, a tool was also developed to measure and detect student misconceptions using a three-level diagnostic test, with the results of the research showing that students' understanding of concepts at State 9 Medan Junior High School in the material had a reaction rate of 35% and students' misconceptions were 40% [31], [32]. So this research was carried out as a generalization to identify and measure students' misconceptions in physics subjects, focusing on free fall movement material. This research also uses online media

This research has important implications and significant novelty in the field of physics education. By developing an Android-based Three Tier diagnostic test to identify misconceptions in free fall motion materials, this research offers a more effective and efficient solution than traditional paper-based tests. The use of online platforms not only simplifies the process of identifying and analyzing misconceptions, but also provides faster and more accurate feedback to students [33]. The novelty of this research lies in the use of digital technology to create diagnostic tools that are responsive to distance or hybrid learning needs. Thus, this research can help educators provide more targeted interventions and increase students' overall understanding of physics concepts, as well as pave the way for further development in learning evaluation that utilizes digital technology.

This research is very important for several key reasons related to education, evaluation of physics concepts, and the use of technology in learning. Misconceptions about free fall movement material often occur among students, and this research aims to develop a more sophisticated and effective diagnostic tool to identify and overcome these misconceptions [34], [35], [36]. With better understanding, students are expected to be able to master fundamental physics concepts in more depth. In addition, by utilizing online platforms, this research integrates modern technology in the learning and evaluation process, which is very relevant considering the increasingly strong trend of digitalization of education, especially in increasingly common distance or online learning situations. The use of the Three Tier Diagnostic Test is an innovative approach in learning evaluation, which includes three levels of questions: multiple choice, reasons for answering, and curiosity response index (CRI). This approach provides a more comprehensive picture of students' understanding and confidence in their answers, helping educators design more targeted interventions. This research aims to develop an online Three Tier Diagnostic Test for misconceptions about free fall motion.

2. RESEARCH METHOD

The method used in this development research is the 4D. 4D is a process that serves as a guiding framework for developing educational products and other learning resources [37], [38]. The 4D development model consists of five development steps, Define, Desain, Development, and Dissemination. However, the research is only limited to the Development stage because the research objectives have been achieved.

2.1. Analysis

In the analysis stage, the researcher analyzes the basic problems and needs that exist in the field for the development of an android-based misconception instrument. At this stage the researcher conducted a literature study and interviews with physics teachers at the school.

2.2. Design

At this stage the researcher makes a prototype, which is the initial product that is designed from the product to be produced. The type of test is the existing three-tier diagnostic test for free fall motion material, which was developed by DC. Kartiko and Habibbulloh [39] which consists of 5 questions to be further modified and applied in the google form so that it can be accessed with the android version.

2.3. Development

At the Development stage, the initial product that has been designed will be validated by an expert validator using an expert validation sheet. Validation is carried out based on content, material, language, and technical aspects. The types of data in this study are quantitative data and qualitative data. Quantitative data were obtained from expert validation sheets while qualitative data were obtained from comments or suggestions from expert validators. Expert validators come from evaluation experts, media, and physics education backgrounds. The data collection instrument used is an expert validation sheet. The data analysis techniques are: (1) qualitative data, carried out by collecting data, reducing data, presenting data as well as drawing conclusions and verification; (2) quantitative data, carried out by analyzing the statement points of the media expert validation sheet. The data from the validation results are then quantified by giving a score according to the weight that has been determined on the Likert scale. The Likert scale score used is a scale of 4. After the data is quantified, it is then analyzed using descriptive statistics. First, the percentage is calculated [20]:

$$P = \frac{f}{n} \times 100\% \ \ldots(1)$$

Information:
P = percentage of feasibility
f = number of score aspects of the assessment to be searched
n = the maximum score of the assessment aspect
After obtaining the percentage of expert validation results, then adjusted to the criteria for assessing the average score of the percentage of expert validation questionnaires and response questionnaires according to Sudijono [21] listed in Table 1.

Table 1. Criteria of Feasibility

Range	Criteria
81.25% < score < 100%	Very Feasible
62.50% < score < 81.25%	Feasible
43.75% < score < 62.50%	Quite Feasible
25.00 % < score < 43.75%	Not Feasible

Identifying misconceptions with this three-tier online test diagnostic can be arranged based on a combination of answers and beliefs in answering these answers. The categories of the combination of answers to the three-tier diagnostic test can be seen in Table 2 [40]:

Table 2. Interpretation of Three-Tier Diagnostic Test Results

Students' Answer			Category	Abbreviation code
(First tier) Question	(Second tier) reason	(Third tier) Certainty		
True	True	Certain	know the concept	TK
True	True	Uncertain	don't know the concept (Luccy Guess)	TTK
True	False	Uncertain	don't know the concept	TTK
False	True	Uncertain	don't know the concept	TTK
False	False	Uncertain	don't know the concept	TTK
True	False	Certain	Misconception 1 (False Positive)	MK 1
False	True	Certain	Misconception 2 (False Negative)	MK 2
False	False	Certain	Misconception 3	MK 3

This instrument was developed in the third tier for certainty is to use several choices of "certain" categories with a degree 3 sure, 4 is very confident, 5 sure and "uncertain" with degree 1 is very unsure, 2 is not sure. This option is possible to be analyzed further [41], [42].

3. RESULTS AND DISCUSSION

The results of this development research are in the form of an android-based three-tier diagnostic test to identify misconceptions in free fall motion material as well as an assessment of the feasibility carried out by experts using an expert validation sheet. Validation is carried out based on content, material, language, and technicality. The results of each stage in this development research can be seen as follows:

3.1.   Analysis

Based on the results of interviews with the physics teachers team at the school, the teachers team consists of 2 senior physics teachers who teach in grade 12th and 10th, add two young physics teachers who teach in grade 10th. All teachers stated that students had difficulty understanding physics concepts, one of which was in the material of straight motion, especially free fall motion. This results in the learning outcomes of some students not reaching the specified minimum standard of completeness. The teachers said that so far there had never been a test to identify students' misconceptions, because there was no test available in schools and the teachers had never developed such a test. So that the teachers does not know what misconceptions occur in students. Especially during a pandemic that demands online learning, teachers only provide formative tests to measure student learning outcomes by transferring photo-based paper-based questions to be given to students via WhatsApp media. This is certainly very difficult in the correction process. From the results of the literature study, it is known that many identification instruments have been developed in the form of paper-based three-tier diagnostic tests. While digital-based or online is still a bit. Whereas paper-based instruments are less practical in use because they are considered less practical and require a long time for correction (data processing). While online instruments have advantages that can overcome various obstacles in the use of paper-based instruments. The results of this analysis phase indicate that an online instrument test is needed to identify the occurrence of student misconceptions in topic free fall motion.

3.2.   Design

In the development of this product, there are several stages that the researcher must do after conducting the analysis. First, the researcher compiled the required misconception diagnostic test questions. Second, do product design to be directly applied to the google form, starting with making questions, making the required tiers with the options owned by the google form. Third, tidying up the question design and setting some required settings including student emails that will be used to work on questions, how to manage forms and responses, limiting one account to work once, and links that will be shared with students so that they can be done on each student's android. The following are the results of developing a three-tier online test diagnostic to identify misconceptions in topic free fall motion:

3.2.1. The Start Page

The start page of three-tier online test diagnostic containing the student's email, name, and student identity number.

Figure 1. Initial Part of Three-Tier Online Test Diagnostic

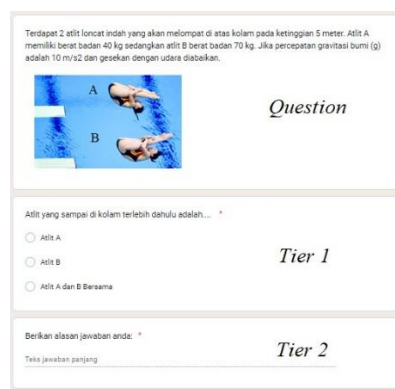#### 3.2.2.   Example questions and their parts

Figure 2. An example of a test question section that contains tier 1 and tier 2

Figure 3. Tier 3 which shows the confidence index of answers with CRI

Figure 4. Examples of Student Answers Recorded on Google Form

The developed instrument product aims to make it easier for teachers to identify misconceptions in the free fall motion material that occurs in students. The product specifications to be made are in the form of a google form that can be accessed anywhere and anytime with the student's Android. Thus, the users of this instrument are not limited, in other words, they can reach a fairly broad access. The developed product can display student answer data in an excel sheet and can be directly analyzed by the user/teacher with the following criteria in Table 2.

3.3. Development

At this stage, expert validation is carried out using an expert validation sheet. Aspects assessed include content, material, language, and technical. Validation was carried out with two expert validators. The validation results are shown in table 3:

Table 3. Expert Validation Results

Aspects assessed	Average score of assessment (%)	Criteria
Contents	92.5	Very feasible
Theory	95.0	Very feasible
Language	78.1	Feasible
Technical	95.8	Very feasible
overall average	90.4	Very feasible
conclusion: the developed instrument is feasible to use with some improvements		

Comments and suggestions from expert validators include:
1. Improve the initial appearance of the identity and adjust the research needs
2. Recheck the wrong word
3. To make it easier for students to access, use the modified shorty link
4. Widen the space for student answers on tier 2
5. Adjust the theme on the form so that it looks more attractive to students
6. Recheck the equation of free fall motion. Make it clear.

After making product improvements/ revisions in accordance with the comments and suggestions of the validator, the instrument can be tested. Based on the results of expert validation data analysis, the instrument can be used to identify students' misconceptions about the free fall motion material. This three-tier online test diagnostic is expected to make it easier for teachers to identify misconceptions experienced by students.

In line with previous research which found that the three-level test developed was able to identify student misconceptions quickly and accurately [29], [43]. Therefore, the three-level diagnostic test tool developed to diagnose student misconceptions about temperature and heat can identify student misconceptions quickly and accurately [29]. The results of previous research support the results of this research, namely by using an Android-based three-level diagnostic test in physics learning regarding free fall movement, it can detect and measure student misconceptions so that appropriate action can be taken to overcome student misconceptions.

This research has significant novelty in the field of physics education and learning technology. First, this study developed an Android-based three-level diagnostic test, which is a step up from traditional paper-based instruments. This digital approach not only simplifies the process of identifying and analyzing misconceptions, but also provides faster and more accurate feedback to students and educators. Second, the development of this test was carried out using the Google Forms platform, which allows broad and flexible access for students to take tests anywhere and at any time using students' Android devices.

This research has several important implications for the world of education. First, the development of an Android-based three-level diagnostic test allows teachers to identify student misconceptions more quickly and accurately, thereby helping to design more targeted learning interventions. Second, the use of digital platforms such as Google Forms provides flexibility for students to access tests anytime and anywhere, supporting increasingly common distance and hybrid learning. Third, the integration of the confidence index (CRI) in this test provides deeper insight into students' confidence in their answers, helping teachers understand students' level of understanding more comprehensively. In addition, validation by experts shows that the instrument is highly suitable for use, giving potential users confidence regarding its quality and reliability.

However, this study also has several limitations. First, this study is limited to free fall material and the context of online learning in Indonesia, so the results may not be fully generalizable to other materials or contexts. Second, validation of the instrument was only carried out by two experts, which may not be enough to ensure its broad reliability. Third, use of Android-based instruments requires access to devices and the internet, which may not be available to all students, especially in remote or less developed areas.

4. CONCLUSION

Based on the description of the results and discussion, it can be concluded that three-tier online test diagnostic has been developed to identify students' misconceptions about concept of free fall motion. The resulting product has five item questions and consist of three tiers. The first tier is multiple choice questions, second is reason for answering question, and third tier is curiosity response index (CRI). The results of the development of an Android-based three-tier diagnostic test can be used to identify students' misconceptions about free fall motion material with a feasibility score of 90.4% with the criteria "Very Feasible". The research carried out still has shortcomings, so the suggestions that the author can give are the development of the next misconception identification instrument to be further refined by adding an explanation or discussion of each question so that it can help reduce students' misconceptions.

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