

Development of a five-tier diagnostic test instrument to identify the level of understanding and misconceptions on the subject of equilibrium of rigid bodies at SMA Negeri 9 Jambi City

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Abstract

This research aims to identify students' misconceptions regarding website-based rigid body equilibrium material at SMA Negeri 9, Jambi City. This research focuses on developing a diagnostic paper-based test (PBT) in the form of a website. This research method is R&D (Research and Development) development with the ADDIE (analysis, design, development, implementation, evaluation) development model. However, this research has only reached the implementation stage. The instruments used in the research were the results of media questionnaires, instrument validation, and student responses. The research results are as follows: First, Dreamweaver, MySQL, and HTML can be used in website development. Second, the results of this product development can be used because they have been validated by media experts, namely Validator One and Validator 2, to determine the feasibility of the product being developed. Thus, a five-tier diagnostic test in the form of a paper-based test has been successfully developed into a website with a suitable category for identifying misconceptions among students regarding the equilibrium of rigid bodies.

Keywords: Misconceptions, Five-tier, Website, Rigid Body Equilibrium

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I. Introduction

Learning in the 21st century has shifted to a new pattern in the learning and teaching process that focuses on students [1]. The factor that hinders the achievement of competency through KBM (teaching and learning activities) in the classroom is the learning environment [2]. Physics subjects have a big role in life [3]. Apart from that, physics is one of the subjects that students are less interested in because it is considered difficult to understand [4]. The material on the equilibrium of rigid bodies requires high levels of reasoning regarding rotational movements as well as a clear picture of the center of gravity [5]. This creates a negative impression for students who need help understanding learning concepts, so students will construct wrong concepts, which allows these students to experience misconceptions [6].

Misconceptions can be defined as the inaccurate understanding of concepts and using concepts that need to be scientifically appropriate [7]. Misconceptions greatly influence student learning outcomes. This is proven by the latest research by Fatonah [8] with a misconception test using 98 students as samples for testing a five-tier format misconception instrument, with the result that 55.8% of students experienced misconceptions regarding the material on the equilibrium of rigid bodies [9]. The five-tier test is a development of a 4-level diagnostic test. Tier 1 is the question items and question answers in multiple choice form. Tier 2 is students' confidence in choosing answers in Tier 1. Tier 3 expresses students' reasons for choosing answers in Tier 1.

Tier 4 adds the level of confidence that students will choose to explain reasons in Tier 3. Tier 5 is where the misconception occurs [10]. Misconceptions will hinder the success of fulfilling learning objectives and the subsequent learning process. Therefore, it is necessary to identify the level of understanding of students' concepts to interfere with and resolve problems in learning.

Based on documentation analysis from literature and preliminary studies, there is an instrument used to identify students' misconceptions regarding rigid body equilibrium material, namely a five-tier format diagnostic test with questions in the form of a paper-based test (PBT) developed by Fatonah [8]. However, paper-based tests still have weaknesses, namely that they require quite a long correction time, participants may not be able to receive the results immediately, printing costs are required, fraud is easy to occur in their implementation, and sheets are easily dirty and damaged [11]. As explained, using paper-based tests is less than optimal and ineffective, judging from the existing weaknesses. Therefore, it is necessary to develop them according to needs by utilizing technology, one of which is developing a five-tier paper-based diagnostic test into a five-tier diagnostic test. -website-based tier on rigid body equilibrium material.

Developing a web-based misconception instrument will make it easier for educators to accurately identify students by Categorizing the level of conceptual understanding based on the student's conceptual understanding [12]. This web development requires the help of the Dreamweaver application, a database server in the form of MySQL. Dreamweaver is a text editor used to design and process websites and website pages [13]. MySQL is a software program for processing databases. Meanwhile, PhpMyAdmin and HTML are website programming languages that use the MySQL database server.

II. Methods

This research aims to develop a diagnostic test tool for misconceptions about rigid body equilibrium material in a website-based five-tier format. Based on the research objectives, this type of research is R&D (Research and Development) development research [14], [15]. Development research is carried out by solving main problems based on empirical needs regarding the need for a product to be designed and developed. The development model that researchers use is the ADDIE (analysis, design, development, implementation, evaluations) development model [16]–[18].

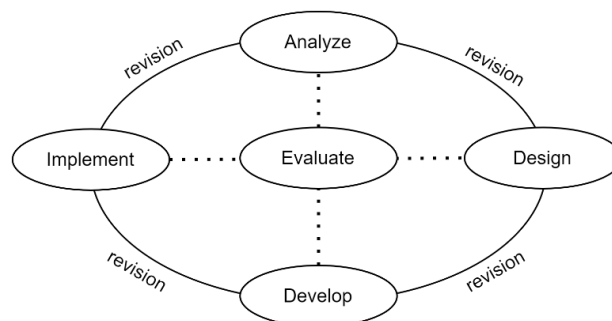


Figure 1. ADDIE model

The research design was carried out in stages: (1) documentation analysis by conducting literature and preliminary studies to identify development objectives and needs. (2) determine the development team and resources needed, namely Dreamweaver software, MySQL server, HTML, and PhpMyAdmin. (3) The development stage includes a misconception instrument consisting of 8 questions related to material on rigid body equilibrium, developed into a website with decision-making based on answers based on research [19] presented in Table 1.

The research instrument is a product validation questionnaire instrument (media expert) with four variables, namely usability, function, reliability, and efficiency related to the website system, assessment with three grids, namely content, construct, and language, and user response questionnaires with two aspects, namely interest, and ease of the website.

Data validity is obtained by validating aspects of the media and material created through a validation questionnaire sheet. For user response data in the form of a questionnaire regarding media in appearance and systems on the website. Test subjects in class 11 at SMA Negeri 9 Jambi City with a small group trial sample of 15 students. Respondents consisted of 25 students at SMA Negeri 9 Jambi City.

Table 1. Categories of student understanding based on answer choices

Tire 1	Tire 2	Tire 3	Tire 4	Category
True	Sure	True	Sure	SC
True	Sure	True	Not Sure	LK
True	Not Sure	True	Sure	LK
True	Not Sure	True	Not Sure	LK
True	Sure	False	Sure	FP
True	Sure	False	Not Sure	LK
True	Not Sure	False	Sure	LK
True	Not Sure	False	Not Sure	LK
False	Sure	True	Sure	FN
False	Sure	True	Not Sure	LK
False	Not Sure	True	Sure	LK
False	Not Sure	True	Not Sure	LK
False	Sure	False	Sure	MCS
False	Sure	False	Not Sure	LK
False	Not Sure	False	Sure	LK
False	Sure	False	Not Sure	LK

SC: Scientific Conception, LK: Lack of Knowledge, FP: False Negative, FN: False Negative, MCS: Misconception

For data analysis techniques in this research, two techniques are used, namely qualitative and quantitative data analysis. The qualitative data analysis technique is obtained from validator suggestions on validation test results using analysis according to Rijali [20], presented in Figure 2.

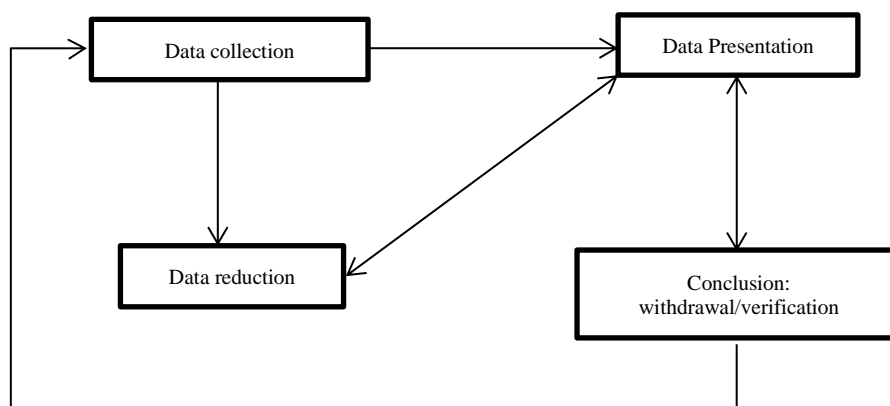


Figure 2. Qualitative data analysis process

Quantitative data analysis techniques are carried out by analyzing validation items used to revise products and user responses by giving a score to each indicator with a predetermined value on the scale used, which is then analyzed using descriptive statistics. The assessment score is then averaged using equation (1).

$$P = \frac{f}{N} \times 100\% \tag{1}$$

Where P is the percentage of eligibility, f is the average score for the assessment aspects from a Likert scale with a range of 1-5, and n is the maximum score for the assessment aspects. The criteria interpretation scale is presented in Table 2.

Table 2. Criteria Interpretation Scale

Interval Interpretation (%)	Criteria
0 – 20	Very bad
21 – 40	Not good
41 – 60	Pretty good
61 – 80	Good
81 – 100	Very good

III. Results and discussion

This research uses the ADDIE development model, with the first stage being the analysis stage using literature studies, the second stage being design by determining the website plan, and the third stage being the development stage. This development requires the Dreamweaver application as a text editor, MySQL as a database, and PhpMyadmin as a programming language. The resulting product is a five-tier diagnostic test instrument on website-based rigid body equilibrium material that can identify student misconceptions. The results of the consequent instrument development can be seen in Figure 3.

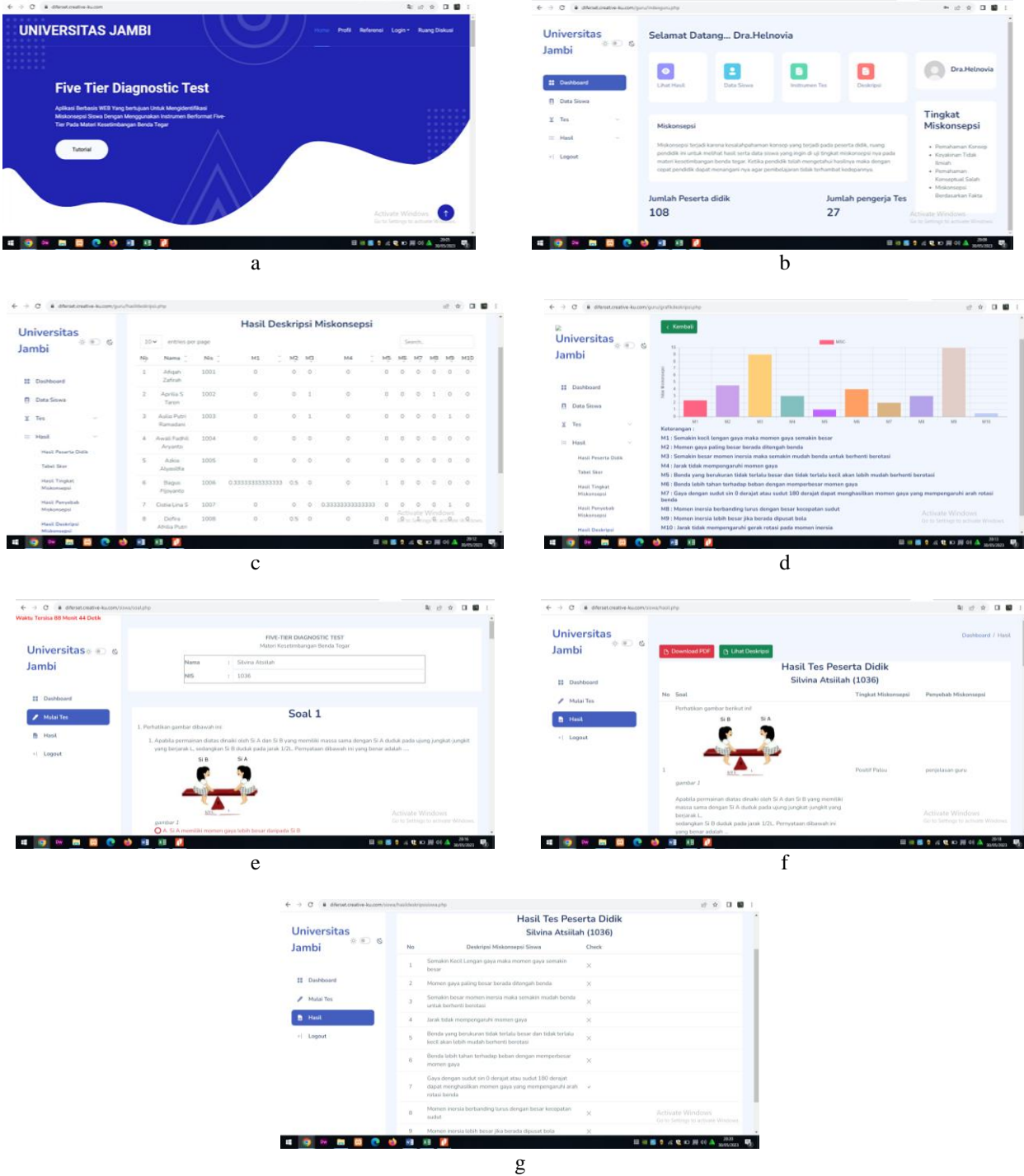


Figure 3. Qualitative data analysis process

Validation Results

After the development stage, the validation stage is then carried out, and the validation results can be seen in Table 3-5.

Table 3. Media Validation Results

Assessment Aspects	Information
Usability	4.12
Functionality	4.19
Visual Communication	4.10
Average	4.14
Percentage	82.80%
Category	Very good

Table 4. Assessment Validation Results

Assessment Aspects	Information
Relevance to learning material and objectives	3
Interactivity	3
Content Clarity	3
Ease of understanding for users	3
Systematic	3
Quality of question items	3
Practicality	3
Average	3.00
Percentage	100%
Category	Very good

Table 5. Practitioner Validation Results

Assessment Aspects	Information
Functionality	4.00
Reliability	4.00
Usability	4.25
Efficiency	4.20
Average	4.11
Percentage	82.20%
Category	Very good

Every validation carried out has received a very good category, where it can be concluded that the instrument developed can be used. The next stage is product testing. The test subjects for developing this instrument were class XI students at SMA Negeri 9 Jambi City. This trial was carried out in small groups of 15 students. This trial aims to determine the user response and the suitability of this product for students. The results of the trial can be seen in Table 6.

Table 6. User Response Results

Assessment Aspects	Information
Material	4.32
Language	4.40
Appearance	4.35
Benefit	4.42
Average	4.11
Percentage	87.45%
Category	Very good

Discussion

The research results show that the five-tier diagnostic test misconception instrument on equilibrium material was successfully developed to be website-based with the help of the Dreamweaver, MySQL, and PhpMyadmin applications, which were very helpful in the development process. This is supported by CSS, HTML, and PHP as programming languages. This website-based five-tier diagnostic test instrument [21] on rigid body equilibrium material has been validated by material experts, media experts, and assessment experts, obtaining an average result of 82% for each validation obtained in the "Very Good" category and can be used to identify misconceptions among students.

Apart from that, this website product has been tested for its suitability on students of class XI Science 1 SMA Negeri 9 Jambi City with the website results can be seen in Figure 4.



No	Nama	Soal 1	Soal 2	Soal 3	Soal 4	Soal 5
1	Afiqah Zafrah	Kurang Pengetahuan (penjelasan guru)	Kurang Pengetahuan (buku/modul)	Kurang Pengetahuan (penjelasan guru)	Kurang Pengetahuan (penjelasan guru)	Kurang Pengetahuan (penjelasan guru)
2	Aprilia S Taren	Paham Konsep (pemikiran pribadi)	Paham Konsep (buku/modul)	Miskonsepsi (pemikiran pribadi)	Miskonsepsi (buku/modul)	Paham Konsep (penjelasan guru)
3	Aulia Putri Ramadani	Paham Konsep (pemikiran pribadi)	Miskonsepsi (buku/modul)	Miskonsepsi (hasil pengamatan/percobaan)	Paham Konsep (hasil pengamatan/percobaan)	Paham Konsep (penjelasan guru)
4	Awali Fadhil Aryanto	Kurang Pengetahuan (internet)	Kurang Pengetahuan (internet)	Kurang Pengetahuan (pemikiran pribadi)	Kurang Pengetahuan (pemikiran pribadi)	Kurang Pengetahuan (pemikiran pribadi)
5	Azkiya Alyasilfia	Kurang Pengetahuan (pemikiran pribadi)	Positif Palsu (pemikiran pribadi)	Kurang Pengetahuan (pemikiran pribadi)	Kurang Pengetahuan (pemikiran pribadi)	Paham Konsep (penjelasan guru)
6	Bagus Fijoyanto	Miskonsepsi (internet)	Negatif Palsu (pemikiran pribadi)	Miskonsepsi (pemikiran pribadi)	Paham Konsep (hasil pengamatan/percobaan)	Miskonsepsi (hasil pengamatan/percobaan)

Figure 4. Website results of student work

From Figure 4, the instrument product that has been developed provides positive benefits for educators, namely, knowing students' understanding. The advantage of this development is that when students experience misconceptions, educators can immediately provide students with a correct understanding of the concept so that the occurring misconceptions last only a short time. This website is designed to make it easier for students to understand concepts in the material on equilibrium of rigid bodies. At the same time, educators will immediately receive the results of students' understanding of the tests that have been developed. After conducting trials and distributing user response questionnaires, "Very Good" was obtained in every aspect, and the highest aspect was in the benefits aspect. Developing misconception instruments in the material of rigid body equilibrium is beneficial for students. The weakness of this product is that it is only limited to identifying misconceptions in the material of rigid body equilibrium among students.

IV. Conclusions

This research has successfully produced a five-tier diagnostic misconception instrument on website-based rigid body equilibrium material. Each validation received the "Very Good" category and is suitable for use. Suggestions for researchers for further research are expected to develop other misconception instruments on physics material so that they can reduce the misconception problems that occur.

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