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Development of A Four-Tier E-Diagnostic Test on The Topic of Momentum to Measure and Reduce Student Misconception

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Abstract

This research aims to develop a set of e-diagnostic four-tier tests on Momentum topics that can be utilized to identify students' learning difficulties and misconceptions. The tests are to be valid, reliable, and effective. This research and development (R&D) project employed the 4-D model, which encompasses the following four stages: Define, Design, Develop, and Disseminate. The Define stage entailed a comprehensive needs analysis and identification of critical issues, while the Design stage encompassed the formulation of e-diagnostic four-tier test grids and instruments. The development stage comprised the implementation of development activities, expert validation, product testing, and the final assembly of the product. The dissemination stage involved the publication of the results of the development of the e-diagnostic four-tier test. The test was constructed in the form of a five-option multiple-choice test. Each question comprises four tiers or levels, ranging from questions, confidence levels, and reasons to the subsequent confidence level. The data collection instrument includes an assessment sheet for product validity, scoring guidelines, and a Likert scale for determining the practicality of product use. The data analysis technique employs the following formulas: (1) Aiken's V for testing validity, (2) Cronbach Alpha for determining reliability, (3) probability of answering correctly to ascertain the level of difficulty of the items, (4) differentiating power to determine the differentiating power, and (5) percentage to measure the level of misconception. The outcome of this research is a series of four-level diagnostic multiple-choice tests accompanied by explanatory material designed to address potential misconceptions. The tests have been evaluated rigorously for validity, item analysis, practicality, and effectiveness.

Keywords: Momentum, four-tier multiple choice e-diagnostic

INTRODUCTION

A significant proportion of students exhibit erroneous beliefs regarding the subject matter of physics. This ultimately results in suboptimal learning outcomes in physics. Therefore, it is essential to assess students' prevailing misconceptions about physics and identify strategies for effectively addressing them. This necessitates the development of a measurement tool or instrument that can not only identify these misconceptions but also provide solutions to rectify them. The available instruments for measuring misconceptions remain limited, particularly in digital formats. Consequently, there is a clear need to create a digital diagnostic instrument that is user-friendly and readily accessible. One potential avenue for fostering students' understanding of fundamental physics concepts is constructing their knowledge (Samsudin et al., 2021). Inappropriate

construction results will lead to inappropriate initial concepts for further learning. This considerably affects the commencement of new learning (Habiddin & Page, 2019). It is a common assumption among students that their concepts align with existing theories. However, if this assumption is not supported by scientific evidence, it can result in the formation of misconceptions. (Allen, 2014).

The prevalence of misconceptions among students can be attributed to deficiencies in comprehension of the information conveyed by the instructor or educational materials during the learning process (Hakim, Kadarohman, & Syah, 2016; Kirbulut & Geban, 2014; Zlatkin-Troitschanskaia, Shavelson, & Kuhn, 2015) and previous learning outcomes (Osman, BouJaoude, & Hamdan, 2017; Suhandi et al*.,* 2020; Topalsan & Bayram, 2019). Misconceptions may arise either before or after the acquisition of new knowledge. This is due to the difficulty students experience in integrating newly obtained information with previously obtained information. The inability of students to construct knowledge based on scientific concepts represents a significant challenge in the learning process. (de Fátima Morais, 2013). If the issue is not addressed, it may result in misconceptions about the interrelated material. (Mentari, Suardana, & Subagia, 2014).

Several studies have identified the presence of misconceptions among students in secondary schools. These misconceptions have been observed in the context of various physics concepts, including waves, energy, impulse, and momentum. (Gurel, Eryilmaz, & Mcdermott, 2017; Korur, 2015; Soeharto, 2017; Taslidere, 2016). The concept of momentum material is a fundamental tenet of physics. However, its inherent complexity and the potential for misconceptions make it a challenging concept to grasp. (Amalia et al., 2019). It is, therefore, imperative that efforts be made to identify and minimize these misconceptions.

The administration of diagnostic tests to students serves the purpose of obtaining data regarding the specific difficulties encountered by the students, the subsequent actions that need to be taken, and the preparation of the foundation for further learning. The multilevel multiple-choice test is designed to identify learning difficulties and ascertain the nature of students' misconceptions. The four-tier multiple-choice diagnostic test is among the most productive multilevel diagnostic tests for identifying misconceptions. This variant represents a developmental iteration of the three-tier multiple-choice diagnostic test (Fariyani, Rusilowati, & Sugianto, 2015). Using digital instruments facilitates the acquisition of measurement results more practically.

A four-tier multiple-choice e-diagnostic is a diagnostic test that can be used to detect student misconceptions. It comprises four levels, which are presented in digital form. The initial level includes a question that prompts the concept. The subsequent level pertains to the confidence level in responding to the initial question. The third level relates to the rationale for the response provided, while the fourth level gauges student confidence in selecting the rationale. The four-tier multiple-choice diagnostic test offers several advantages, including (1) distinguishing between the level of confidence in the answer and the level of confidence in the reason, thus enabling a more profound examination of the strength of students' conceptual understanding; (2) diagnosing misconceptions experienced by students in greater depth; (3) determining the portion of the material that requires greater emphasis; and (4) facilitating the design of more effective learning strategies to reduce student misconceptions (Fariyani et al., 2015; Gurel et al., 2017).

The research objectives are to develop a four-tier multiple-choice e-diagnostic test on Momentum material that can be used to identify and remediate misconceptions, test the validity and reliability of the developed e-diagnostic, identify students' learning difficulties and misconceptions, and analyze the effectiveness of the product in reducing misconceptions.

METHOD

This research and development (R&D) project employed a 4-D model encompassing the following four phases: Define, Design, Develop, and Disseminate. The sequence of steps involved in the development of the research is illustrated in Figure 1.

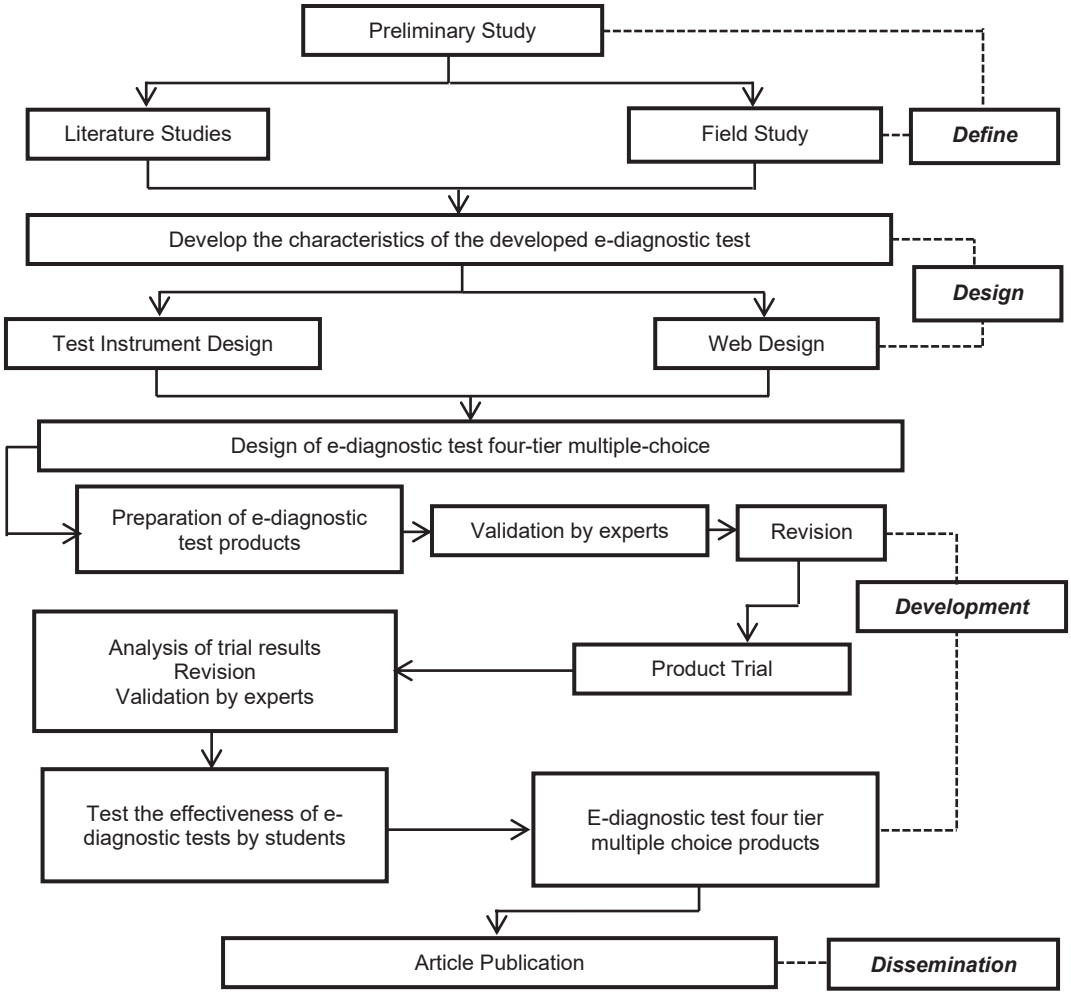


Figure 1. Research Procedure (Adapted from Thiagarajan et al., 1976)

The objective of the define stage is to identify potential issues and to collate information regarding the requirements of the learning activities. The steps undertaken at the define stage are divided into two categories. Two principal methods are employed at this stage: literature and field studies. The theories and previous research relevant to the four-tier multiple-choice e-diagnostic test were examined at the literature study stage. In the field study stage, preliminary observations were made, and problems related to student misconceptions were analyzed.

The design stage commenced with developing the characteristics of the web-based diagnostic test. The steps in the design stage included (1) the preparation of indicators and grids of diagnostic test questions, (2) the preparation of initial drafts of diagnostic test questions, and (3) the preparation of validation sheets for diagnostic test questions.

The objective of the development stage is to evaluate the products created during the design stage. At the development stage, the preliminary design of the e-diagnostic four-tier multiple-choice instrument, which was initially formulated during the design stage, is further refined. Subsequently, the test instrument is subjected to evaluation. The testing process is conducted in two phases: (1) expert validation and (2) construction of the test questions.

The validation process was overseen by four expert validators, two lecturers, and two physics teachers. The product was tested on a sample of students in their final year of high school.

The sample size for the limited-scale test was 30 students, while the broad-scale test included 100 students. The data collection instrument comprises an assessment sheet for product validation, scoring guidelines, and a Likert scale for determining the practicality of product use. The instrument utilized for product validation is presented in Table 1. The practicality instrument was derived from Lewis's questionnaire regarding Computer Usability Satisfaction Questionnaires. The dimensions assessed include the respondents' state or personal data, experience, knowledge, attitudes, and opinions. This instrument has been evaluated for reliability and demonstrated a reliability coefficient of 0.962, indicating a reliable category.

Table 1. Product validation grid Instrument

Dimension	Indicators
Material covered	Suitability of questions with indicators
	Suitability of the material with the competencies measured
	Suitability of questions with the cognitive domain measured
Construction	Clear work instructions
	The formulation of the main question is clear.
	Short, clear, and firm sentences
	Only one correct answer choice
	Question items do not depend on the answers to previous questions.
Language	Use correct Indonesian language rules.
	The question sentence is simple and easy to understand
	Question sentences do not use language that applies in the local area.
	Communicative question sentences

Table 2. Media Validation Grid

Dimension	Indicators
Flexibility of Media	Ease of media use
	The material and questions on the website are explicit.
	Easy to operate
Effectiveness of Media Selection	Appropriateness of choosing a platform
	Clarity of instructions for using the media
	Media packaging
	Efficient and useful
Readability of Media	Communicative (language is easy to understand, good, correct, and effective)
	Selection of type and size of letters used
	Spacing (letters, lines, and characters)
	Readability of text
	Simplicity of display
Proportion Design of Image Display	Integrity of the appearance of the images presented
	Balance of image proportions
	Image functionality to support the material
Layout Design	Layout arrangement
	Color composition
	Harmony of color choices
	Neatness of design
	Design attractiveness

Data analysis techniques have used Aiken's V formula for validation test (formula 1), Cronbach Alpha to determine reliability (formula 2), probability of correct answer to determine the level of difficulty of the items (formula 3), discrimination for differentiating power (formula 4), and percentage to measure the level of misconception.

Validation test formula

$$V = \frac{\sum s}{n\,(c-1)} \quad (1)$$

with

V : Level of validity

$s = r - l_o$

r : the number given by a rater

c : the highest number of validity ratings
lo : the lowest validity rating number
n : number of raters
Criteria for validity refer to the Aiken table. Jika $V_{count} \geq V_{table}$ with a specific significance level, then the e-diagnostic instrument is declared valid.

Reliability formula

$$r_{11} = \left(\frac{n}{n-1}\right)\left(1 \frac{\Sigma\sigma_1^2}{\sigma_1^2}\right) \quad (2)$$

with
r_{11} : item reliability
n : number of items
$\Sigma\sigma_i^2$: the sum of the variances of the scores of each question
σ_i^2 : total of variants

The interpretation criteria for the Cronbach Alpha calculation formula are:

0.00 ≤ r_{11}< 0.20 : not reliable
0.20 ≤ r_{11}< 0.40 : low
0.40 ≤ r_{11}< 0.60 : moderate
0.60 ≤ r_{11}< 0.80 : reliable
0.80 ≤ r_{11} ≤ 1.00 : very reliable

Item Difficulty formula

$$P = \frac{mean}{maximum\ score} \quad (3)$$

with
0.00 ≤ P < 0.30 : difficult
0.30 ≤ P < 0.70 : moderate
0.70 ≤ P ≤ 1.00 : easy

Distinguishing Power Formula

$$D = \frac{\bar{X}\ of\ upper\ group - \bar{X}\ of\ lower\ group}{maximum\ score} \quad (4)$$

with
D < 0,00 : very poor
0.00 ≤ D < 0, 20 : poor
0.20 ≤ D < 0,40 : moderate
0.40 ≤ D < 0.70 : good
0.70 ≤ D ≤ 1,00 : very good

Table 3 shows how to determine concept understanding.

Table 3. Concept Understanding Criteria

Answer	Level of Confidence in the answer	Reason	Level of Confidence in the reason	Categories
Correct	Sure	Correct	Sure	Scientific Knowledge (Conceptual Understanding)
Correct	Sure	False	Sure	False Positive Misconceptions
Incorrect	Sure	Correct	Sure	False Negative Misconceptions
False	Sure	False	Sure	All Misconceptions
Correct	Sure	Correct	Not Sure	Lack of Knowledge
Correct	Not Sure	Correct	Sure	
Correct	Not Sure	Correct	Not Sure	
Correct	Sure	False	Not Sure	
Correct	Not Sure	False	Sure	
Correct	Not Sure	False	Not Sure	
Incorrect	Sure	Correct	Not Sure	
False	Not Sure	Correct	Sure	
False	Not Sure	Correct	Not Sure	
Incorrect	Sure	False	Not Sure	
Incorrect	Not Sure	False	Sure	
False	Not Sure	False	Not Sure	

The dissemination stage is designed to inform the public about the e-diagnostic four-tier multiple-choice test instrument. Publish articles in academic journals and scientific meetings or

seminars achieve this. The aim is to make the instrument available as a reference for further research, particularly about the issue of misconceptions.

RESULT AND DISCUSSION

The research findings and subsequent discussion are presented per the sequence of the research objectives. The research objectives can be classified into four categories: (1) the description of the characteristics of the Four-Tier Multiple Choice e-Diagnostic, (2) the testing of its validity and reliability, (3) the identification of students' learning difficulties and misconceptions, and (4) the analysis of the effectiveness of the Four-Tier Multiple Choice e-Diagnostic in reducing misconceptions.

1. Four-Tier Multiple Choice e-Diagnostic Characteristic

The outcomes of the Four-Tier Multiple Choice e-Diagnostic development for each phase are illustrated in Figure 1.

a. Define Results

The development process commences with the Define phase. In this phase, data is gathered regarding the accessibility of the existing four-tier multiple-choice e-diagnostic instrument. An evaluation is conducted to ascertain the necessity of its further development.

b. Design Results

The design phase yielded the preliminary product prototype in the form of an e-diagnostic four-tier multiple-choice momentum material. An e-diagnostic four-tier multiple choice test is a form of diagnostic test comprising four levels. The initial level includes a question, while the third level represents the rationale behind the answer. The second and fourth levels encompass the confidence associated with the answer and the justification for the question. This test is presented in the form of a website-based electronic media. At this juncture, an expert validation test was conducted, and the results demonstrated that the product was valid. Input from the validator, in-question writing, and sentence coherence were employed to refine the product prototype.

c. Development Results

The development stage yielded a product prepared for testing on both a small and large scale in a real-world setting. The final product development results are available for review on the website https://ediagnostic-misconception.com/.

The inaugural presentation of the Four-Tier Multiple Choice e-Diagnostic website is illustrated in Figure 2. The initial display contains information regarding the e-Diagnostic Misconception, a home menu, a list of available services, and a section on the website's history and background. At the outset, the website offers login and registration buttons, allowing new users to register before accessing other features. Figure 3 depicts the registration page. Two distinct registration options are available: one for teachers and another for students. An example of the e-Diagnostic Four-Tier Multiple Choice question display is presented in Figure 4, in the form of questions and confidence levels. Figure 5 illustrates the rationale and associated confidence level.

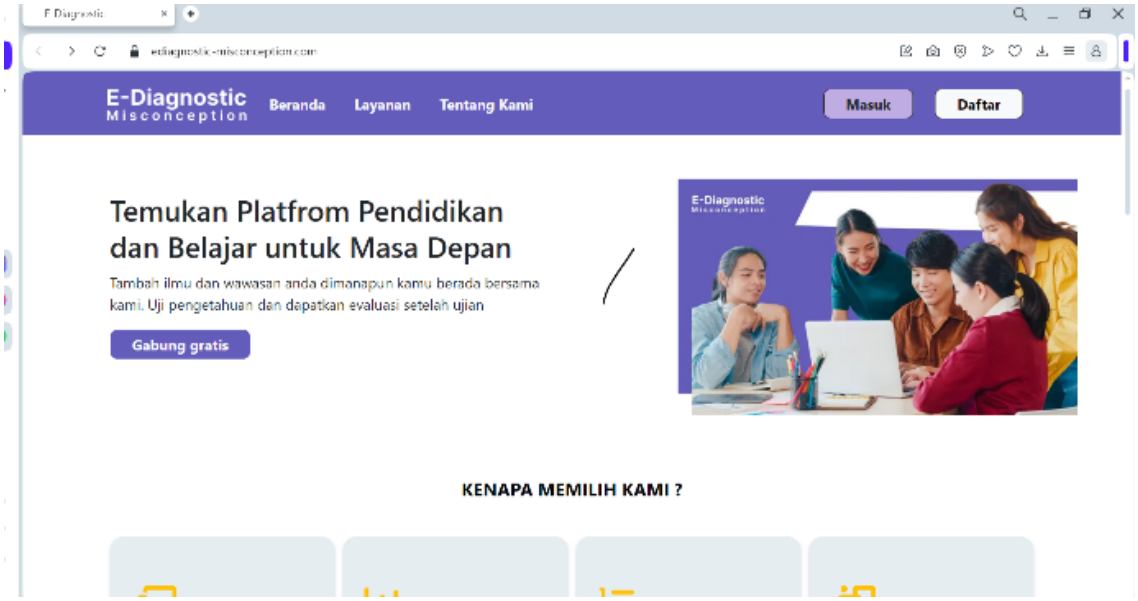


Figure 2. Initial View of e-Diagnostic Web

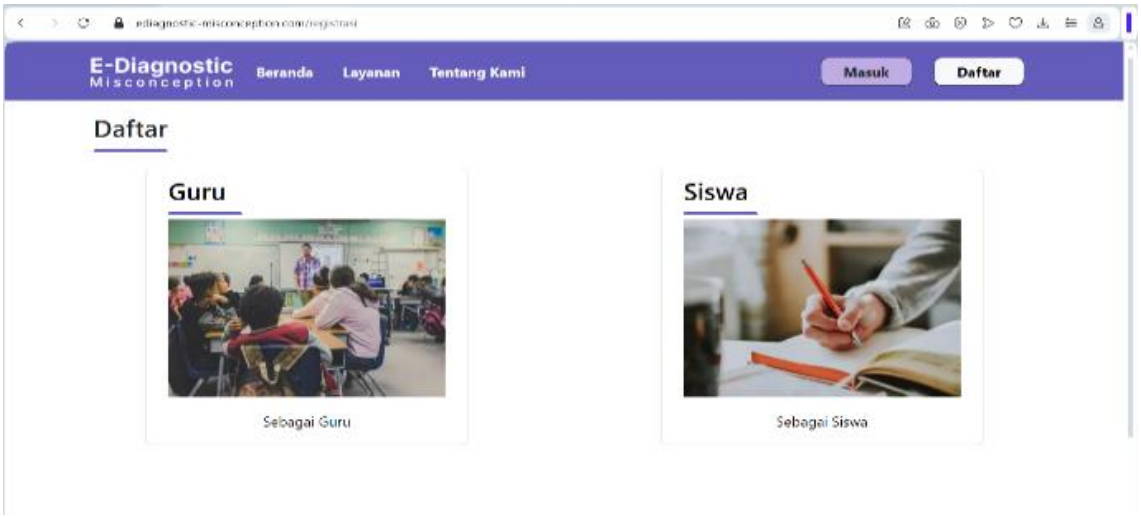


Figure 3. Display for Log in/Register

The diagnostic test developed 16 questions to identify students' misconceptions about momentum material. The summary of the development results can be seen in Table 4.

Table 4. Summary of Development Results

Aspects	Description
Material	Momentum, Impulse, Collision
Bloom's Taxonomy	C2 = 1 question. C3 = 11 questions. C4 = 2 questions. C5 = 2 questions
Difficulty Level	Problem: easy = 7 questions, medium nine questions;
Distinguishing Power	Reason: easy = 4 questions, medium 12 questions

Examples of e-Diagnostic Four-Tier Multiple Choice test questions are as follows:

Problem (tier 1)

A baseball has a mass of 150 g. It is thrown towards the bat with a speed of 20 m/s. It turns out that the batter can hit the baseball with a speed of 30 m/s. The magnitude of the impulse that occurs on the baseball is .....Ns.

A. 0.5
B. 1.5
C. 2.0
D. 2.5
E. 3.0

Answer Confidence Level (tier 2)

a. Sure b. Not Sure

Reason (tier 3)

A. The amount of impulse depends on the magnitude of the force acting on the object.
B. The mass of the object does not affect the amount of impulse
C. The amount of impulse does not depend on changes in time
D. Impulse occurs because the object has mass
E. The amount of impulse is equal to the change in momentum

Confidence level of reasoning (tier 4)

a. Sure b. Not sure

This e-Diagnostic Four-Tier Multiple Choice test product is designed to remediate these misconceptions by providing students with tips and tricks to deepen their understanding of the material. This approach aims to reduce the occurrence of misconceptions among students regarding Momentum material. In the example above, the tips and tricks are

Tips

a. The problem above is an application of collision with objects. The solution to the problem can be solved using the concept of Law of Conservation of Momentum.
b. Remember the Law of Conservation of Momentum again: "if there is no external force at work in the system, then the system's momentum before and after the collision is the same."
c. Remember the formula:

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$$

with m: mass, v: velocity of the object before impact, and v': the speed of the object after impact.

Tricks

a. Identify what is known
b. Determine what to solve
c. Identify a suitable formula to complete
d. Do the calculation

The student activities that can be carried out in the classroom setting include a preliminary test (pre-test), tips and tricks, and a final test (post-test). The teacher can monitor the student's activities based on the class details. Details of the class content can be seen in Figure 4.

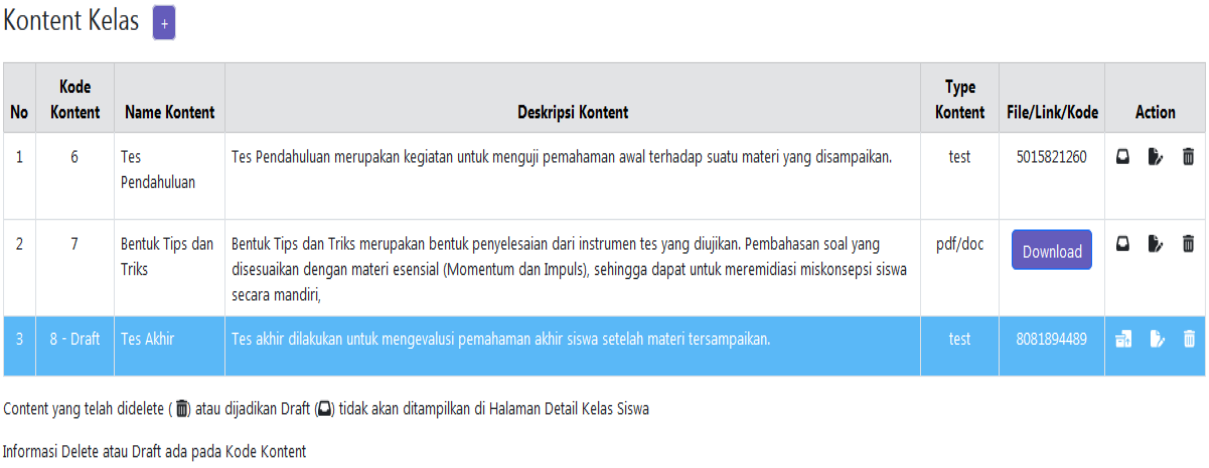
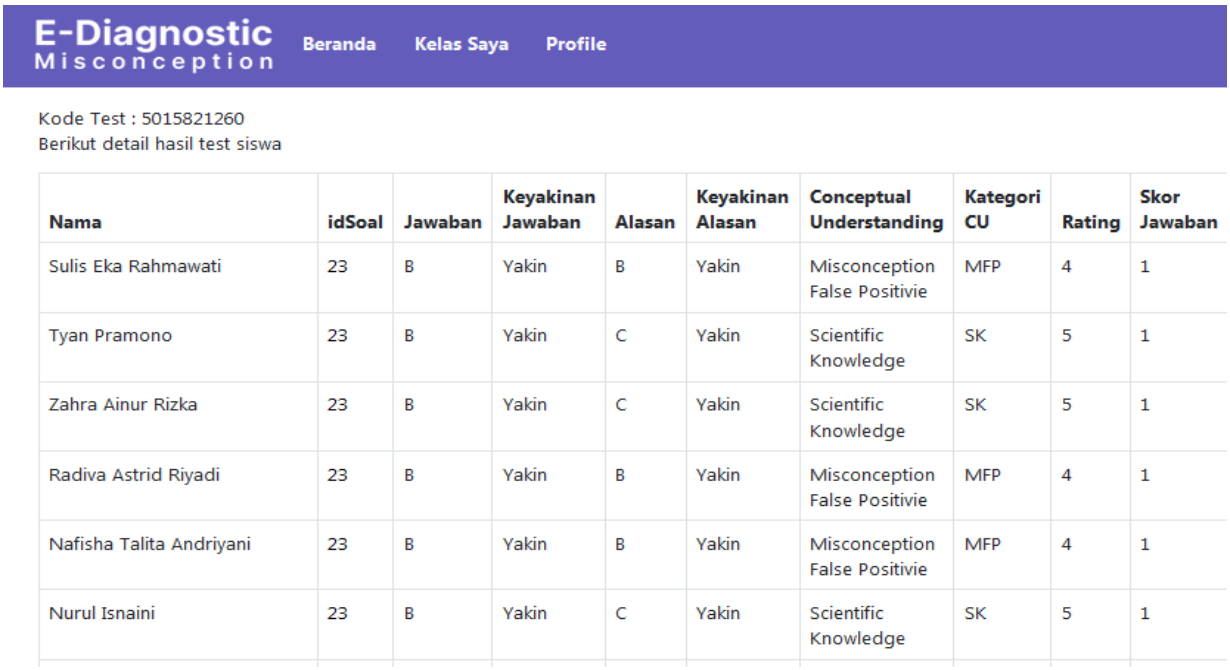


Figure 4. Class content details

The e-diagnostic four-tier multiple-choice test product also has an automatic misconception detection system. Students can see the results in real-time, and so can the teacher. An example of the results of identifying student misconceptions is shown in Figure 5.



Nama	idSoal	Jawaban	Keyakinan Jawaban	Alasan	Keyakinan Alasan	Conceptual Understanding	Kategori CU	Rating	Skor Jawaban
Sulis Eka Rahmawati	23	B	Yakin	B	Yakin	Misconception False Positivie	MFP	4	1
Tyan Pramono	23	B	Yakin	C	Yakin	Scientific Knowledge	SK	5	1
Zahra Ainur Rizka	23	B	Yakin	C	Yakin	Scientific Knowledge	SK	5	1
Radiva Astrid Riyadi	23	B	Yakin	B	Yakin	Misconception False Positivie	MFP	4	1
Nafisha Talita Andriyani	23	B	Yakin	B	Yakin	Misconception False Positivie	MFP	4	1
Nurul Isnaini	23	B	Yakin	C	Yakin	Scientific Knowledge	SK	5	1

Figure 5. Results of Misconception Identification in Students

The results allow students to identify areas for improvement in specific indicators or materials while teachers can prepare and implement appropriate actions to facilitate further learning.

a. Dissemination of Results

The dissemination stage produces articles that are ready for publication in journals. Additionally, results are disseminated by providing services to Physics MGMP groups at the community level.

The Four-Tier Multiple Choice e-Diagnostic website provides a valuable resource for teachers and students, offering a convenient platform to identify and address potential misconceptions about momentum. The momentum material tested on students encompasses a range of sub-themes, including momentum, impulse, the relationship between impulse and momentum, applications of impulse, and collisions.

The class content feature presents a series of questions and provides a repository of tips and tricks, offering corrective solutions for students who may have encountered difficulties due to misconceptions. Teachers can create classes to test students. The objective of establishing a class is to discern the erroneous beliefs held by students within a given class and to provide remediation directly to students by demonstrating techniques and strategies for comprehending a concept. Furthermore, educators can monitor student progress on the aforementioned digital resources. The information system provided by the developed media can assist educators in identifying students who are experiencing misconceptions at the earliest possible stage. Furthermore, the developed product has a camera feature that allows the teacher to view the captured results from the camera for students who engage in academic dishonesty when working on problems. This finding is consistent with several previous studies, which indicate that the website can facilitate a rapid and accurate diagnosis of student misconceptions. (Wardhani & Rinaningsih, 2012), the automated grading system (Yoanita & Akhlis, 2015) and encourage teachers and students

to use digital technology (Rusilowati, Darsono, & Sekarningtias, 2023)

1. Validity and reliability of the e-Diagnostic four-tier multiple-choice test

The e-diagnostic four-tier multiple-choice test is validated by materials, evaluation, and media experts, as well as teachers in the field of physics. Five validators performed the validation. This expert test aims to determine the validity of the e-diagnostic four-tier multiple-choice test. The results of the validation scale to the validator were then analyzed using Aiken's V formula. The web validity was obtained by using a V_{count} of 0.85. This result is more significant than that obtained by $V_{table,}$ with a significance level of 0.05 for five raters, which is 0.80. It can be concluded that the developed instrument and the website are in the valid category. Overall, the indicators of the evaluation items show that the developed products obtain very valid average results in both instrument and media evaluations. This indicates that the product can be valid for measuring misconceptions and re-imagining students' misconceptions about Momentum material.

Cronbach's alpha formula determines the reliability of the test. The calculation results obtained a reliability coefficient of 0.721 in the reliable category. The probability of a correct answer determines the difficulty of the item. The analysis showed that the e-diagnostic consisted of 7 easy, eight medium, and one difficult item questions. Regarding discriminative power, the diagnostic test has 11 items with good discriminative power and five items with poor discriminative power. Items that are not good are revised in terms of sentences. The developed test is suitable for diagnostic testing to measure students' misconceptions.

An individual who responds to one of the questions with a high level of confidence is deemed to have a misconception (Fariyani et al., 2015). The findings of this study show that the detailed measurement of misconceptions is more comprehensive than that obtained from the three-tier diagnostic test. The results of the three-tier diagnostic test development provide a narrower level of insight into the nature of misconceptions than the four-tier (Cheung & Yang, 2018; Mushthofa, Rusilowati, Sulhadi, Marwoto, & Mindyarto, 2020).

The four-tier multiple-choice e-diagnostic test product has also been evaluated for its practicality. The results of the primitivity test indicate that the product is straightforward to navigate and that students are at ease when taking the test.

1. Identifying learning difficulties is achieved through categorizing the interpretation of the results of students' answers into five comprehension types. The categories of scientific knowledge (SK) include understanding concepts, misconception false positives (MFP), misconception false negatives (MFN), all misconception (AM), and lack of knowledge (LoK). (Abdul, Hamdi*, Pikoli, Abdullah, & Panigoro, 2021). In the MFP category, students tend to answer correctly at the initial level but incorrectly at the third level. Additionally, they often select reasons and levels of confidence that align with their certainty. In the MFN category, students provide correct responses at the third level but incorrect responses at the first level. The selected confidence level is "confident." It would appear that LoK students lack an understanding of the concept. In the AM category, students provide incorrect responses at each level and select a confident level for each response.

The results of the assessment are displayed in Figure 7. It would appear that three students have experienced MFP and demonstrated an understanding of the concept of three people in response to question 23. The results of the concept understanding assessment using e-diagnostics are presented in Table 3.

Table 5. E-Diagnostics Understanding Measurement

Categories Understanding	Number of respondents (%)
Scientific Knowledge (SK)	25
Misconception False Positive (MFP)	29.70
Misconception False Negative (MFN)	3.12
Lack of Knowledge (LoK)	3.12
All Misconceptions (AM)	39.06

As many as 75% of students still have difficulty learning Momentum material, with only 25% understanding the concept well—learning difficulties in the MFP, MFN, LoK, and AM categories.

This finding is consistent with the results of the research conducted by Mushthofa (2022). A significant proportion of high school students (70.68%) misunderstand the concept of style material. Only a minority (3.64%) demonstrate an accurate understanding of this concept, while the majority (25.68%) lack the requisite knowledge. The diagnostic assessment results are presented by Sholihat, Samsudin, & Nugraha (2017), with 28% of students who participated in the study exhibiting misconceptions regarding the Continuity Principle sub-material. Among the remaining students, 35% demonstrated partial understanding, 6% showed complete understanding, and 30% lacked comprehension. These results indicate that a significant proportion of students continue to encounter misconceptions when learning physics.

2. The efficacy of the product in reducing misperceptions

The product, the Four-Tier Multiple Choice E-Diagnostic Test, in addition to diagnostic tests, also includes materials designed to address and correct the misconceptions that students may encounter. The efficacy of this product in reducing misconceptions is evidenced by a decline in the prevalence of these erroneous beliefs both before and after the administration of the e-diagnostics.

The identification of misconceptions is achieved through the administration of a diagnostic test. The reduction or elimination of misconceptions can be achieved by providing explanations and identifying the areas that may contribute to the formation of these erroneous beliefs. It is hypothesized that the developed product will effectively reduce student misconceptions. The impact of the product on the reduction of misconceptions is illustrated in Table 4.

Following the utilization of the developed product, there was a 22.19% increase in students' comprehension of the concept of momentum, accompanied by a reduction in the number of students who held erroneous beliefs about the subject matter. This is attributable to the "Tips and Tricks" feature incorporated into the four-tier multiple-choice e-diagnostics.

Table 6. Reduction in the Number of Students with Misconceptions

Categories of misconceptions	Number of respondents who experienced misconceptions (%)		
	Before the treatment	After the treatment	Reduction
MFP	29.70	15.64	14.06
MFN	3.12	2.81	0.31
AM	39.06	31.25	7.81

Following the utilization of the developed product, there was a 22.19% increase in students' comprehension of the concept of momentum, accompanied by a reduction in the number of students who held erroneous beliefs about the subject matter. This is attributable to the "Tips and Tricks" feature incorporated into the four-tier multiple-choice e-diagnostics.

The study results demonstrate that the four-tier multiple-choice e-diagnostic product effectively identifies learning difficulties, including misconceptions. Additionally, the "Tips and Tricks" feature has effectively reduced the prevalence of misconceptions. Providing treatment to students experiencing misconceptions Momentum with the developed products has been shown to reduce the number of students experiencing misconceptions in each category. The findings of this study align with those of previous research in measuring misconceptions.

Previously, instruments such as interview tests were employed to diagnose any potential misconceptions. (Gurel *et al.,* 2015), Open Ended Test, Multiple Choice and Multiple Choice Test Graded (Gurel *et al.,* 2017) CRI Method Diagnostic Instruments (Hakim et al., 2016; Mushthofa et al., 2020; Yuberti, Suryani, & ..., 2020), one tier (Adi, Sugiyanto, & Rusilowati, 2018; Supriyadi, Lia, Rusilowati, Isnaeni, Endang, & Suraji, 2022), two tier (Rintayati, Lukitasari, & Syawaludin, 2021; Xiao, Han, Koenig, Xiong, & Bao, 2018), three tier (Cheung & Yang, 2018; Mushthofa, Rusilowati, Sulhadi, Marwoto, & Mindiyarto, 2021; Rusilowat &i Susanti et al., 2023; Wahyuningsih, Rusilowati, & Hindarto, 2017), four tier (Yang & Lin, 2015; Fariyani, Rusilowati, & Sugiyono 2017; Gurel et al.,

2017; Soeharto, Csapó, Sarimanah, Dewi, & Sabri, 2019; Yuberti *et al.,* 2020; Celikkanli & Kizilcik, 2022; Dwandaru, Ayub, & Saepuzaman, 2023), five tier (Anam, Widodo, Sopandi, Amp, & Wu, 2019), The results of the development of electronic-based diagnostic tests, which have been carried out thus far, include: The development of web-assisted diagnostic tests for temperature and heat materials has yielded the following results. (Zafitri, Fitriyanto, & Yahya, 2018), Using Adobe Flash applications on Business and Energy materials (Anam et al., 2019), Illustrated e-diagnostics (Mushthofa et al., 2021; Ramberg & Modin, 2019). Research on the means of overcoming misconceptions has been conducted by Gurel et al. (2017); Jannah & Rahmi (2020); Maison, Astalini, Kurniawan, & Siahaan (2021); Putra, Mindyarto, & Sulhadi (2022); Rohmah & Handhika (2018); & Rusilowati (2015). The question of how to overcome misconceptions has been investigated (Depdiknas, 2007).

The prevalence of misconceptions can be reduced through various methods, including using a four-tier multiple-choice e-diagnostic test and detailed material explanations. These findings align with previous research, indicating that the Interactive Demonstration learning model is a practical approach for correcting students' misconceptions about the Law of Thermodynamics.

CONCLUSION

The study's findings were presented as an e-diagnostic four-tier multiple-choice test and a detailed explanation of the material to reduce potential misconceptions. As mentioned earlier, the test is provided in the format of a website-based electronic test that can be accessed via the page. https://ediagnostic-misconception.com/. The examination comprises 16 items, which assess knowledge of the following three areas: momentum, impulse, and collision. The measured cognitive levels correspond to levels C2 to C5 of the Bloom Revised Taxonomy. The results of the e-diagnostic testing are deemed to be valid and reliable. All e-diagnostic items demonstrate satisfactory differential validity. The difficulty level is classified as "easy" or "moderate." Utilizing the website in the practical category, in conjunction with the material explanation, namely the "Tips and Tricks" feature accompanying the e-diagnostic, proved to be a productive strategy for reducing misconceptions. The following recommendations can be implemented in light of the research findings: (1) Implement a four-tier diagnostic assessment to identify students' learning difficulties and misconceptions about physics concepts. (2) It is recommended that concept understanding be emphasized when teaching momentum, as students' comprehension of the material remains inadequate, and many exhibit misconceptions. (3) Guide how to reduce students' misconceptions about the physics material. Examples of such guidance can be found on the website above: https://ediagnostic-misconception.com/.

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