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Application of a Web-Based Four-Tier Misconception Instrument on the Topic of Work and Energy: User responses

Maison[1*], Wawan Kurniawan[1], Dwi Agus Kurniawan[1], Azizah Hanum[1]

[1] *Universitas Jambi*
[*]*Corresponding author. Email: maison@unja.ac.id*

ABSTRACT
This study aims to determine the user's response to applying a web-based four-tier misconceptions instrument on the topic of work and energy (FTWEI). The method used is a mixed-method with explanatory sequential design. The subjects in this study were 30 high school students in grade ten who responded to the questionnaire. Three students and one teacher were interviewed. Quantitative data were analyzed using descriptive statistics. This quantitative data is then supported by qualitative data, which has been analyzed using qualitative procedures. The results of data analysis show that the average user response to the FTWEI is 3.36, which is in the very good category. The advantages of FTWEI are time efficiency in processing data, flexibility in access, and ease in organizing it because it does not require paper.

Keywords: *Web-based instrument, misconception, work, energy.*

1. INTRODUCTION

Physics is a fundamental science which concerned with the fundamental principle of the universe [1], has many abstract concepts [2], and justified to be a difficult subject in teaching and learning [3]. According to [4], many physics teachers do not get enough information about research findings on teaching and learning.

Physics is divided into several major areas, and one of them is mechanics. According to [5], mechanics is one of the branches of physics in which many Indonesian students have misconceptions, for example, on the topic of work and energy. Several sub-topics or matters are discussed in this topic, including potential energy and kinetic energy, general energy conservation law, mechanical energy conservation law, conservative force, and nonconservative force, and power. Scientific concepts on work and energy must be understood by students correctly and adequately so that there are no misunderstandings or commonly known as misconceptions.

The misconception becomes an obstacle for students to understand concepts and master advanced material because misconceptions are wrong. They cannot be a basis for students in learning [6]. Misconceptions are caused by various aspects, such as students' thinking, teachers, textbooks, and how teachers teach. Misconceptions are also challenging to know because students who experience misconceptions cannot directly open up how they got the wrong concept.

Misconceptions experienced by students can be measured using a misconception instrument. According to [6], several types of instruments can be used to measure misconceptions, for example, two-tier, three-tier, and four-tier instruments. According to [6], the newest instrument which is quite accurate in determining misconceptions is a four-tier instrument. The first tier is identical to a multiple-choice question with several options to measure misconceptions and one correct answer. The second tier is the level of confidence in choosing answers at the first tier. The third tier is a choice of reasons for students to answer questions on the first tier, in the form of several choices of reasons that contain misconceptions and one valid reason. The fourth tier is student confidence in choosing reasons at the third level.

Some researchers, for example [5] and [7], have researched misconceptions about work and energy. However, the instrument used was still paper-based, and the analysis technique also took a long time, so it was not immediately possible to find out the description of the misconceptions experienced by the respondents. In this study, a web-based four-level misconception instrument on the topic of work and energy (FTWEI) was applied. How do users respond to the use of the device, and what

are their misconceptions about work and energy? It is the aim of this research.

2. METHOD

This research is mixed-method research with an explanatory sequential design. According to [8], the explanatory sequential design is a mixed-method design by collecting and analyzing data that begins with quantitative data and then continues with qualitative data collection to help analyze the data obtained and explain a general picture (generalization). The quantitative data processing technique uses descriptive statistics. Descriptive statistics are the arrangement of numbers that provide an overview of the data presented in tables, diagrams, histograms, etc.

Data were collected using a user response questionnaire filled out by 30 high school students in grade ten. Students use the FTWEI misconception instrument and are asked to respond to the web-based instrument through a questionnaire consisting of 28 items. The data from the user response questionnaire is then quantified by giving a score according to the predetermined value on the Likert scale. The Likert scale score used is a scale of four, which is very good with a score of 4, good with a score of 3, bad with a score of 2, and very bad with a score of 1. The categories are presented in Table 1.

Table 1. Categories of students' response

Range	Score	Category
1.00 – 1.75	1	Very bad
1.76 – 2.50	2	Bad
2.51 – 3.25	3	Good
3.26 – 4.00	4	Very good

The interviews were conducted with three students who had filled out a user response questionnaire and one teacher. The interview used was unstructured. According to [9], [10], [8], unstructured interviews are more unrestricted in their implementation, in which discussions are carried out naturally to explore informants' ideas openly without using interview guidelines. The results of the interviews are expected to strengthen the quantitative results obtained from the user response questionnaire to the FTWEI instrument.

3. RESULTS AND DISCUSSION

Table 2. The results of students' responses

Range	Frequency	%	Category
1.00 – 1.75	0	0	Very bad
1.76 – 2.50	0	0	Bad
2.51 – 3.25	12	40	Good
3.26 – 4.00	18	60	Very good

User responses to the FTWEI instrument are shown in Table 2. Based on the analysis, the mean value was 3.36, median 3.22, max 3.78, and min 2.75. The percentage of user responses shows that 40% of user responses have a good response to FTWEI, and 60% of user responses have a very good response.

Respondents assessed four indicators: design, language, display, and utilization or advantage. Based on the data that has been analyzed, the percentage of each indicator is obtained. For design indicators, respondents rated font color, font size, appropriateness of chart size, and graphic clarity. It is received a mean of 3.28 with 60% in the good category and 40% in the very good category. For the language indicator, by assessing the language and grammar used, it was obtained a mean of 3.20 with 60% in the good category and 40% in the very good category. For display indicators by assessing the instrument's attractiveness and ease of use, it was obtained a mean of 3.36 with 40% in the good category and 60% in the very good category. For the utilization indicator, which assesses the advantage of using web-based instruments, a mean of 3.23 is obtained, with 50% in the good category and 50% in the very good category. Based on this response, it can be concluded that users have a good response to applying the web-based four-tier misconception instrument on the topic of work and energy (FTWEI).

The quantitative user responses are supported by the results of interviews that overall support web-based misconception instruments on work and energy because web-based assessments have many advantages, namely reducing the use of paper logistics and is more economical.

> "I am interested in this web-based misconception identification instrument because it is easy to use" (RES-1)

> "I agree with the existence of this web-based misconception instrument because it is practical and does not require paper" (RES-2)

Annisak, Astalini, and Pathoni (2017) state that web-based instruments can be used by the general public and shorten the time to identify misconceptions. According to Astalini et al. (2019), web-based assessments are essential because they are practical and efficient for conducting assessments and are in line with the 4.0 revolution.

> "This web-based assessment is very efficient in its use because the results of the assessment come out straight away, making it easier and faster for teachers to identify and reduce misconceptions that occur in their students" (TCHR-1)

Based on the results of the interviews that have been conducted, it can be concluded that the respondents gave good responses to the application of FTWEI. Respondents stated that web-based misconception instruments on work and energy topics are more efficient in collecting and organizing data because it does not

require paper anymore. In addition, it can also provide faster and more precise results, making it easier for teachers to diagnose and reduce misconceptions that occur in students.

Web-based assessments have significant advantages on cost, ease of use, reliability, scoring, results, and data management. Digital assessment can measure with high reliability, and there is no subjectivity when processing data (Hamid, 2016). It is also stated by Buzzeto & Alade (2006) that new technologies such as the web provide features that can make assessment design and implementation more efficient, timely, and sophisticated. The following is a display of the web-based misconception instrument on work and energy materials.

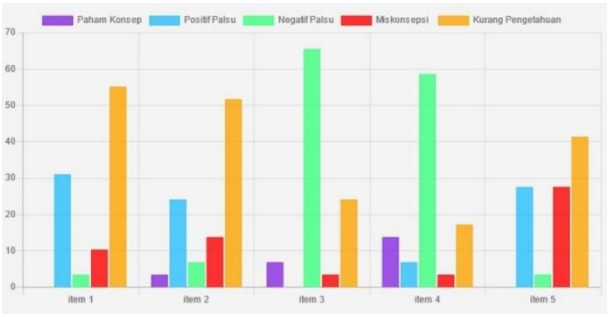

Figure 1. The display of FTWEI results

The percentage of correct scores, false positives, false negatives, lack of knowledge, and misconceptions, can be displayed in tables and graphs. Figure 1 is a graphical display, colored purple for correct scores, blue for false positives, green for false negatives, red for misconceptions, and orange for lack of knowledge.

The advantage of using this product is that it is easy and flexible to operate. This product can be easily used because there are complete and clear instructions. In addition, this product can classify students' misconceptions according to the categories and descriptions of misconceptions experienced by students who have been tested. So that teachers easily know the profile of misconceptions that occur in students and provide fast and appropriate solutions for students who experience misconceptions. In addition, digital-based instruments of the misconception of work and energy topics can be accessed via smartphones so that they are easily accessible to users.

4. CONCLUSION

Based on the results of quantitative analysis followed by a qualitative analysis that has been conducted, it can be concluded that users have a very good response to the application of web-based misconceptions on work and energy topics. The user argues that the advantages of using web-based assessments are time efficiency in processing data, flexibility in access, and ease of organizing, and does not require sheets of paper.

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