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DEVELOPMENT OF AN INSTRUMENT TO TEST UNDERSTANDING KINEMATIC CONCEPTS

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Abstract

This research aims to develop an instrument for understanding kinematics concepts. Instrument development was carried out by adapting the steps (1) Writing specifications and Writing concept understanding test questions (2) Reviewing and improving concept understanding test questions (3) Implementing test questions, (4) Interpreting the results of concept understanding test analysis. The material, construction and language aspects have been declared appropriate by experts. The test was tested on students who had taken basic physics and had teaching/field work experience. Based on the results of trials using Iteman, information was obtained that thirty questions on the concept understanding test were reliable, but six questions were declared invalid. The results of the software analysis also indicate that invalid questions tend to have poor power discrimination and distracting questions below 5%.

Keywords: Understanding Concept, Instrument, Kinematics

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INTRODUCTION (10%)

Understanding the concept becomes a benchmark for students to define an event in a mathematical representation (equation). In solving physics problems, students tend to memorize equations and match them with solutions based on their knowledge. This condition is also found at the SMA/SMK and MA levels. The process of selecting equations by students is not based on event analysis but only on their habits of working on physics problems.

Understanding of concepts. Students' understanding of concepts greatly influences the learning outcomes achieved (Arief et al., 2021). Efforts to increase understanding of concepts are carried out through the application of strategies, use of media, development of tools, modules and others (Al Amin et al., 2012; Asriyadin & Muliana, 2019; Kakaly & Gustina, 2013; Rumiyatun, 2021; Sari et al., 2022; Simanjuntak, 2012; Yusuf et al., 2022; Zulhaini et al., 2016). In measuring concept understanding, an instrument is needed. Developing concept understanding test need to pay attention to the operational definition of concept understanding and the characteristics of the content.

Pengembangan instrumen pemahaman konsep telah dilakukan oleh para peneliti pendidik fisika Beberapa instrumen yang dikembangkan antara lain (Priyadi & Suryanti, 2017) mengembangkan instrumen tes pemahaman konsep gravitasi universal Newton, (Irfansyah & Sabani, 2021) hukum Newton, (Sufiani et al., 2019) gelombang, (Salma et al., 2016) fluida statis, (Zhahira Bella & Azizahwati, 2021) implus & momentum, (Bunawan & Mihardi, 2023; Rohmah et al., 2018) kinematika. Dalam pengembangan instrumen pemahaman konsep masih ditemukan beberapa definisi operasional terkait penyaamaan pemahaman konsep dan miskonsepsi. Perlu dikembangkan instrumen yang sesuai dengan definisi operasional yang telah ditetapkan untuk mendapatkan insturumen yang berkualitas.

Understanding concepts is a learning problem that is of concern to physics researchers. The research focuses on increasing students' development of concept understanding instruments, which physics education researchers have carried out. Some of the instruments developed include (Priyadi & Suryanti, 2017) developing test instruments for understanding the concept of Newton's universal gravitation, (Irfansyah & Sabani, 2021) Newton's law, (Sufiani et al., 2019) waves, (Salma et al., 2016) static fluids, ((Zhahira Bella & Azizahwati, 2021) impulse & momentum, (Bunawan & Mihardi, 2023; Rohmah et al., 2018) kinematics. Several operational definitions were still found regarding conceptual understanding and misconceptions in the development of conceptual understanding instruments. It is necessary to develop instruments that follow the operational definitions that have been determined to obtain quality instruments.

METHODS (15%)

The instrument development method is based on (Mardapi, 2008) test instrument development procedures: (1) Writing specifications and concept understanding test questions, (2) Reviewing and improving concept understanding test questions, (3) Implementing test questions, (4) Interpreting the results analysis of concept understanding tests. Five experts reviewed the test, and the analysis of test items (validity and reliability) was analyzed using Iteman. The instrument was tested on students who had taken the fundamental physics course I and had teaching experience and practical fieldwork (PPL).

RESULTS AND DISCUSSION (70%)

Research results are present in the form of graphs, tables, or descriptive. Analysis and interpretation of these results require before being discussed. The table is written in the middle or at the end of each descriptive text of research results/acquisitions. If the table's width is not enough to write in half a page, it can write a full page. The table's title is written from left to right, all words are capitalized, except for conjunctions. Suppose more than one line is composed in a single space. For example, it can see in Table 1..

Following the development stages described in the method section, the results and discussion are as follows:

(1) Writing Specifications and Test Questions

Understanding is defined as follows: Conceptual understanding is the ability to build knowledge into meaningful concepts Nurhilal et al., 2018). Understanding concepts includes association, comparison, assimilation, and reorganization of new knowledge with existing knowledge and transferring it to solve new problematic situations (Saricayir et al., 2016). Indicators of concept understanding are giving

examples, categorizing, comparing, and explaining (Rosdiana & Ulya, 2020). Understanding concepts also focuses on describing knowledge in various contexts (representation). The representations are verbal representations, mathematical equations and graphs (Rane, 2017). Indicators and descriptions of concept understanding adapted from (Afifah, 2019). Indicators and question descriptions (table 1).

Table 1. Indicators and question descriptions

No.	Indicators	Descrptions	Test Number
1.	Interpretation	Reading information from one form to another (from images/graphics to written language, numbers or other forms, vice versa also applies).	2,3,4,5,8,13,14,15,
2.	Classifying	Determining something that belongs to a category.	10,11,17
3.	inference	Drawing logical conclusions from the information presented.	6,7,9,19,20,27,30
4.	Compare	Look for relationships between ideas, objects or similar things.	16,24,26,28,
5.	Explainning	Constructing a causal model of a system.	1,12,18,21,22,23,25,29

(2) Writing test Instrument

Based on the operational definition, the indicators/question grid that has been prepared, the questions are written (made) in multiple-choice form. The multiple-choice form was chosen considering the predictions of many samples tested and the analysis results obtained more quickly. For example, test question no. 2 and 4, understanding of the following concepts:

An object moves from point A to point D following the path in figure 1. (scale of 1 box = 1 m)

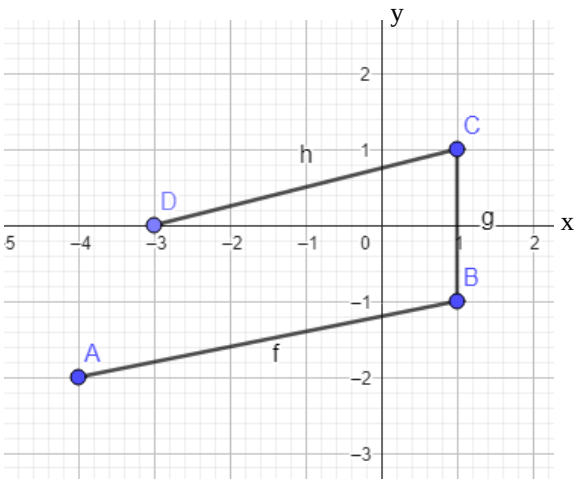

Figure 1. Movement of an object from position A to D via the i-g-l path

Based on this information, the magnitude of displacement of the object from point A to D is...

a. 12,2 m
b. 2 m
c. 11,22 m
d. 2,24 m
e. 3 m

An object moves in a circular path counterclockwise from point B to C as shown in Figure 2.

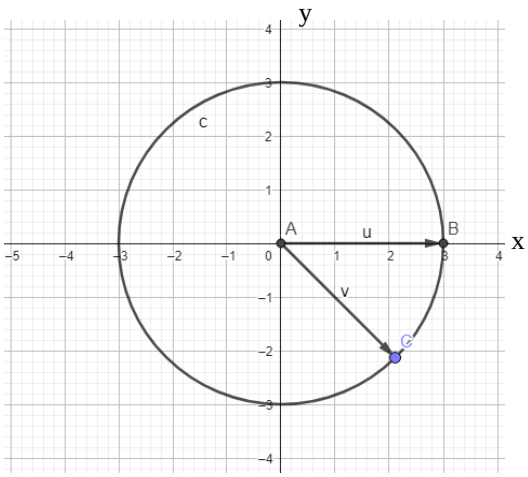

Figure 2. Objects moving in a circular path. (Circle radius 3 m).

Based on this information, the distance traveled by the object from point B to C is...

a. 12,72 m
b. 14,14 m
c. 6 m
d. 4,71 m
e. 16,76 m

(3) Validate and improve test questions

The test questions were validated by five experts and declared suitable for use, considering the material, construction, and language. The material component consists of (1) the material that has been studied by the respondent, (2) the suitability of the question items with the indicators, and (3) the question items are not interdependent. The construction component consists of (1) clarity in the writing of the question items, (2) the question items are free from multiple interpretations, (3) the question items do not depend on the answers to other question items, (4) the distractors have been well structured. The language component consists of (1) question items using good and correct language, (2) question items using communicative language, and (3) questions not using communicative language. All test questions were declared suitable for use by experts.

(4) Implement and interpret tests

The test is given to students who have taken fundamental physics I and have teaching and/or PPL experience. Of the 60 respondents, 39 respondents responded. The test response results were then tested again using Iteman reliability, different tests, difficulty level, and validity. The overall level test results of the conceptual understanding test questions provide information on a Mean P of 0.436 (medium level of difficulty), the overall differential power of the Mean Rpbis questions is 0.389 (satisfactory category), and reliability (Alpha) of 0.856, (very high) with a standard error of measurement. 2,092.

As a result of the analysis of the items, information was obtained that thirty questions on the concept understanding test were reliable, and six questions were declared invalid. The results of the analysis with Iteman software also provide

information that invalid questions tend to have poor discrimination and distracting questions below 5% (less effective) (table 1).

Table 1. Recapitulation of Iteman Analysis Results

No	Val.	Inf.	Real.	Inf.	DF (P)	Inf.	DP (Total Rpbis)	Inf	Options				
									A	B	C	D	E
10	0,249	invalid	0,867	Very high	0,974	Low	0,094	P	0.000	0,974	0.000	0.000	0,026
17	0,143	invalid	0,860	Very high	0,538	Mediun	0,114	P	0,538	0,128	0,179	0,128	0,026
20	0,241	invalid	0,858	Very high	0,615	Mediun	0,190	P	0,282	0,077	0,026	0,615	0.000
21	0,232	invalid	0,858	Very high	0,333	Mediun	0,179	P	0,154	0,103	0,333	0,359	0,051
24	0,253	invalid	0,857	Very high	0,846	Low	0,166	P	0,077	0,026	0,846	0,051	0.000
25	0,188	invalid	0,859	Very high	0,692	Mediun	0,143	P	0,077	0,128	0,692	0,077	0,026

Val. = Validity; Inf. : Information; Real.; = Reability; DF = difficulty level; DP = different power; P= poor

Table 1 shows that the six invalid questions have poor discrimination power, and apart from question number 21, the distractors are less effective. Problem number 10 has three ineffective distractors.

1) Discussion of question no. 10

10. The following are the characteristics of straight motion:
1) Zero acceleration
2) Constant Acceleration
3) Constant Velocity
4) No displacement
What is characteristic of straight motion with constant velocity is...
a. 1 only c. 2 and 4
b. 1 and 3 d. 1,2,3,4 e. none of that is true

This question is in the low category (in the classifying category). Respondents can quickly determine the correct answer, considering that the respondent has taken the fundamental Physics I course and has teaching experience. Applying the test to different respondents (high school/vocational school students or equivalent) may give different results. By considering the indicators and respondents who will be tested in the future (high school/vocational school students or equivalent), the questions will be maintained by modifying the answer choices.

2) Discussion Number 21.

21. A car starts moving from rest at t = 0 and reaches a final speed v at time t. If the car's acceleration remains constant during this time, which of the following statements is true?
a. The car travels a distance of vt.
b. The average speed of the car is v/2.
c. The magnitude of acceleration of the car is v/t.
d. The velocity of the car remains constant.
e. None of statements (a) to (d) are correct.

From the distractor side, question number 21 is in the effective category, where the respondent's answer is not focused on one answer choice. Still, from the

results of Iteman's analysis, this question needs better discrimination power, where respondents who are assumed to have good knowledge can give an appropriate response wrong, and vice versa. This question is still used with the assumption of increasing the number of respondents in further research.

Based on the results presented, even though it has gone through expert testing, the instrument developed still has the potential to get invalid test results in analyzing the questions. This result depends on the selection and determination of the number of respondents. An instrument that has been well designed, if applied to many respondents who understand the concept, certainly has the potential to provide an "easy" level of difficulty category. Other results could be found in implementing the test on different respondents.

CONCLUSION (5%)

Based on the analysis and discussion results, it was found that the concept understanding test had been declared feasible by experts. From the results of the analysis with Iteman, thirty reliable concept understanding test questions were obtained, but six questions were declared invalid. When developing an instrument for understanding concepts, you are expected to pay attention to proportions and distracting questions. In this research, the concept understanding test that has been developed still needs to be improved in relation to the ratio and distraction of questions in each indicator and paying attention to the time for completing the test questions. Based on the results of Iteman's analysis, invalid questions tend to have a low category and distracting questions below 5% (less effective). This tendency is not absolute. The selection and determination of the number of respondents is also a determining factor in analyzing question items. This research has limitations; it needs to be more consistent in determining the time for taking the test. In the next stage of instrument development, the time for working on questions will be applied consistently.

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