Journal of Physics: Theories and Applications E-ISSN: 2549-7324 / P-ISSN: 2549-7316
J. Phys.: Theor. Appl. Vol. 7 No. 2 (2023) 243-248 doi: 10.20961/jphystheor-appl.v7i2.79536

Profile of Students' Concept Understanding in Kinematics

Jeffry Handhika[1*], Saristi Widiyaningrum[2], Sukma Ayu Aprillia Denata[3]

[1,2,3]Universitas PGRI Madiun, Indonesia

jhandhika@unipma.ac.id

Received 12 March 2023, Revised 17 September 2023, Published 30 September 2023

Abstract: This research aims to profile the understanding of physics concepts in kinematics material. Teachers need information on understanding physics concepts in designing their learning. The profile of understanding the concept of kinematics is revealed by administering a concept understanding test. The total number of tests for understanding the concept of kinematics is 30 items. The concept understanding profile is categorized into five indicators: (1) interpretation, (2) classifying, (3) inference, (4) comparing, and (5) explaining—the test applies to 49 students at SMA and MA in Madiun. Based on the profile description analysis results, it was obtained that students had a good percentage of the concept understanding indicator component (39.54%) and the smallest percentage of the interpretation indicator (17.60%). These results can be used as recommendations for facilitators and researchers in determining the learning model that will be applied and the concept of understanding the research topic that will be carried out.)

Keyword : Concept Understanding, Kinematics, Interpretation.

1. Introduction

Identifying students' initial potential before learning is an essential initial activity carried out by all learning facilitators. The initial potential referred to here can be motivation, initial ability, understanding concepts, and others. Several references refer to initial potential as initial ability when it comes to material. Several factors greatly influence the teaching process, including initial ability (Diaz, 2017). Prior knowledge plays a role in learning to predict, improve, and explain competency acquisition (Bittermann et al., 2023). Research findings (Riesen et al., 2019) provide information that initial abilities influence the extent to which students benefit from effective guidance for inquiry learning in online environments. Facilitators can manage and implement appropriate learning by identifying students' initial abilities. Identifying students' initial potential can be done through interviews, diagnostic tests/tests, questionnaires, document analysis, and other data collection models. In identifying potential, students use other supporting data to triangulate the data.

Understanding concepts is one of the initial abilities that are of concern to physics education educators and researchers (Abaniel, 2021; Bukifan & Yuliati, 2021; Khoiri et al., 2022; Kola, Jacob, 2017; Sulman et al., 2023). Based on my experience teaching fundamental physics courses, many students still need to gain more knowledge and understanding of physics concepts. The results of questions and answers with students provide information that (1) learning is carried out online as a result of COVID-19, so they do not have a complete understanding of the concepts, (2) students who have a Vocational High School (SMK) background do not get physics concept comprehensively. This condition can be reduced with the assumption that identification of problems understanding concepts is carried out since the learning process in SMA/SMK and equivalent and teachers can apply learning that leads to finding problems.

In identifying students' conceptual understanding, it is necessary to determine the material (subject matter) instruments and then profile them to facilitate identifying students' conceptual understanding. Kinematics can be presented as equations, graphs, visual simulations, and the language of physics itself. Kinematics is a material that is difficult for students to understand, considering that this material contains many mathematical presentations and symbols. The similarity of symbols to physical quantities can also hinder students in understanding concepts. The research results show that students need help determining distance, average velocity, and acceleration of position equations as a function of time (Taqwa & Rivaldo, 2018). Errors in determining distance from the position equation, as a function of time, are caused by the need to understand the interpretation of mathematical functions. Research (Shodiqin & Taqwa, 2021) reveals that students still need help in graphing a(t) based on the function x(t). Further research (Jufriadi & Andinisari, 2020) revealed that when studying the concept of kinematics, students experience difficulties, especially in understanding the differences between distance and displacement, velocity and acceleration, as well as the direction of acceleration of a moving object. Research results (Sutopo et al., 2020) revealed that most students needed to determine the instantaneous velocity of two moving objects presented in a motion diagram. Students imagine that two moving objects in the same position must have the same velocity. By considering the potential for kinematics material to be difficult for students to understand, facilitators need to identify an understanding of physics concepts in kinematics material.

2. Methods

The method in this research is qualitative descriptive, by profiling students who understand the concept and students who do not understand the concept of kinematics. The profile is presented in the form of a percentage for each indicator of concept understanding. The data collection technique uses a concept understanding test that has been developed in previous research. The total number of tests is 30 questions with details of representation (8 questions), classifying (3 questions), inference (8 questions), comparing (4 questions). The results are described through graphs for each indicator by displaying the percentage of students who understand and do not understand the concept. The sample consisted of 49 from two SMA/MA equivalent schools in the city of Madiun.

3. Results and Discussion

In accordance with the method that has been described, in this section the results of students' conceptual understanding profiles are presented. The student concept understanding profile for each indicator can be seen in Fig 1.

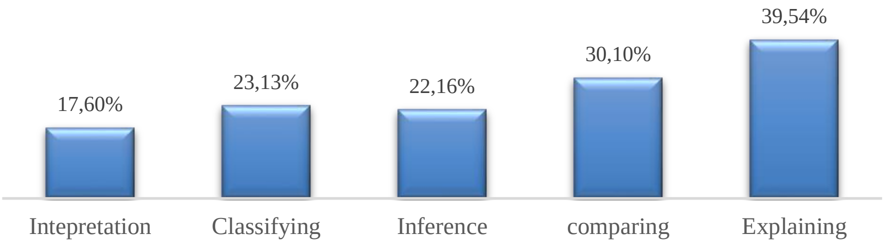
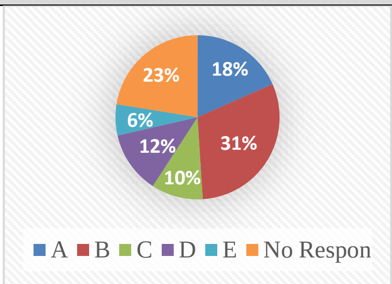


Fig 1. Profile of students' conceptual understanding of the kinematics for each indicator

` Based on Fig 1, it can be seen that the indicator explains the highest percentage (39.54%) compared to other indicators. Interpretation indicators received the lowest percentage (17.60%). Students' understanding is at most 40% in each indicator. Students better understand the criteria for understanding concepts related to indicators of explaining rather than interpreting. Category questions explain the understanding of concepts related to constructing a causal model of a system/event. Examples of student responses to the explaining indicator can be seen in Table 2.

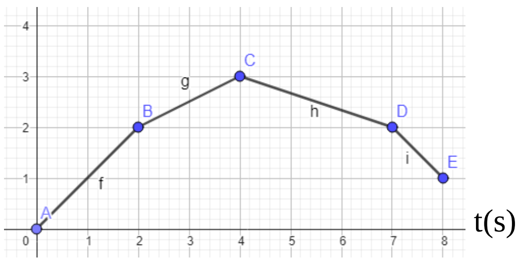
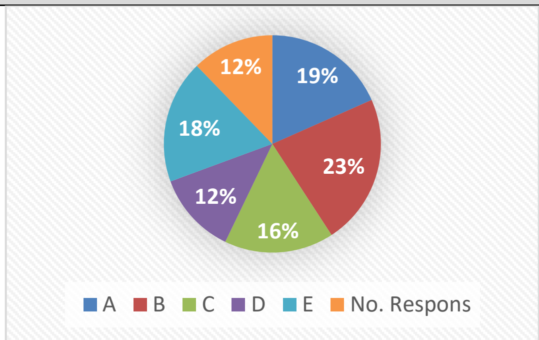
Table 2. Examples of Questions and Student Responses to the Explaining Indicator

Q (11)	Response
The basketball is thrown from the outside of the court towards the catcher. When the ball reaches its highest point, which statement is true? a. The velocity and acceleration are both zero. b. The velocity is not zero, but the acceleration is zero. c. Its velocity is perpendicular to its acceleration. d. The acceleration depends on the angle at which the ball is thrown. e. None of statements (a) to (d) are correct	

Based on Table 2, it can be seen that the percentage of students who gave correct responses to Q (11) was 10%. In Q (11), many students answered choice (B) 31%. The student guesses that they answered B in Q (11) because the student believes that the velocity at the highest point equals zero (in free fall motion). In option B, it is written, "The velocity is not zero, but the acceleration is zero." Students may also need clarification in differentiating the terms velocity and acceleration. These results follow research (Jufriadi & Andinisari, 2020) where students need help differentiating the concepts of velocity and acceleration. The description explained in the concept understanding test does not just explain the definition. Still, students must be able to construct a cause-and-effect model of a system/event, so understanding physical symbols needs to be emphasized in physics learning.

The indicator of understanding the concept that is most difficult for students to complete is interpretation. In this indicator, students are asked to be able to read information from one form to another (from images/graphs to written language, numbers, or other forms, and vice versa). Interpretation skills that require an understanding of mathematics and physics. Understanding mathematical language is one of the factors causing the representation ability to get the lowest percentage—examples of questions and student responses to representation indicators (Table 3).

Table 3. Examples of Questions and Student Responses to Interpretation Indicators

Q (18)	Response
An object moves following the graph of the relationship between positions (x) and (t) as shown in Fig. 3.  **Fig 3.** Graph of the relationship between position (x) and time (t). Based on this information, the instantaneous velocity at t = 4 s is... a. 0,2 $\hat{\imath}$ m/s b. 0,75 m/s c. 0.45 m/s d. 0,75 $\hat{\imath}$ m/s e. 1,33 m/s	

Based on Table 4, it can be seen that many students choose option (B). Choice (B) arises with the assumption that students have the concept that instantaneous velocity is the result of dividing (4) by x (m) and (3) by t (s). The neglect of mathematical symbols in instantaneous velocity solutions appears in these results—the results of understanding concepts related to graphic interpretation and weak mathematical understanding. The solution to overcome this problem has been presented briefly (Sutopo et al., 2020) by determining the velocity from the given motion diagram, using the operational definition of acceleration, and applying vectors in kinematics. This research recommends further research to improve learning programs to overcome students' difficulties in understanding kinematics concepts. The use of graphic interpretation by optimizing peer discussion (Gok & Gok, 2023) can also be recommended.

References

Abaniel, A. (2021). Enhanced Conceptual Understanding, 21st Century Skills And Learning Attitudes Through An Open Inquiry Learning Model In Physics. *Journal*

of Technology and Science Education, *11*(1), 30–43.
Bittermann, A., McNamara, D., Simonsmeier, B. A., & Schneider, M. (2023). The Landscape of Research on Prior Knowledge and Learning: a Bibliometric Analysis. In *Educational Psychology Review* (Vol. 35, Issue 2). Springer US. https://doi.org/10.1007/s10648-023-09775-9
Bukifan, D., & Yuliati, L. (2021). Conceptual understanding of physics within argument-driven inquiry learning for STEM education: Case study. *AIP Conference Proceedings*, *2330*(March). https://doi.org/10.1063/5.0043638
Diaz, K. V. L. T. (2017). Prior Knowledge: Its Role in Learning. *Unpublished Essays, March 2017*, 8–10. https://doi.org/10.13140/rg.2.2.26816.69125
Gok, T., & Gok, O. (2023). High School Students' Comprehension of Kinematics Graphs wıth Peer Instruction Approach. *Jurnal Pendidikan Fisika Indonesia*, *18*(2), 144–155. https://doi.org/10.15294/jpfi.v18i2.35028
Jufriadi, A., & Andinisari, R. (2020). JITT with assessment for learning: Investigation and improvement of students understanding of kinematics concept. *Momentum: Physics Education Journal*, *4*(2), 94–101. https://doi.org/10.21067/mpej.v4i2.4669
Khoiri, N., Ristanto, S., & Kurniawan, A. F. (2022). Profile of Students' Conceptual Understanding of Physics in Senior High School. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *8*(2), 241–248. https://doi.org/10.21009/1.08206
Kola, Jacob, A. (2017). Investigating the Conceptual Understanding of Physics through an Interactive Lecture-Engagement. *Cumhuriyet International Journal of Education-CIJE*, *6*(1), 82–96.
Riesen, S. A. N. Van, Gijlers, H., Anjewierden, A. A., Jong, T. De, & Gijlers, H. (2019). The influence of prior knowledge on the effectiveness of guided experiment design. *Interactive Learning Environments*, *0*(0), 1–17. https://doi.org/10.1080/10494820.2019.1631193
Shodiqin, M. I., & Taqwa, M. R. A. (2021). Identification of student difficulties in understanding kinematics: Focus of study on the topic of acceleration. *Journal of Physics: Conference Series*, *1918*(2), 6–11. https://doi.org/10.1088/1742-6596/1918/2/022016
Sulman, F., Yuliatai, L., Kusairi, S., Hidayat, A., Pentang, J., & Mensah, B. (2023). *Investigating concept mastery of physics students during online lectures through Rasch models on force and motion materials*. *9*(1), 95–106.
Sutopo, Hidayah, N., Wisodo, H., & Haryoto, D. (2020). Improving students' understanding of kinematics concepts through multi-representational learning. *AIP Conference Proceedings*, *2215*(April). https://doi.org/10.1063/5.0004063
Taqwa, M. R. A., & Rivaldo, L. (2018). Kinematics Conceptual Understanding: Interpretation of Position Equations as A Function of Time. *Jurnal Pendidikan Sains*, *6*(4), 120–127. http://journal.um.ac.id/index.php/jps/

References

Abaniel, A. (2021). Enhanced Conceptual Understanding, 21st Century Skills And Learning Attitudes Through An Open Inquiry Learning Model In Physics. *Journal of Technology and Science Education*, *11*(1), 30–43.
Bittermann, A., McNamara, D., Simonsmeier, B. A., & Schneider, M. (2023). The Landscape of Research on Prior Knowledge and Learning: a Bibliometric Analysis. In *Educational Psychology Review* (Vol. 35, Issue 2). Springer US. https://doi.org/10.1007/s10648-023-09775-9
Bukifan, D., & Yuliati, L. (2021). Conceptual understanding of physics within argument-

driven inquiry learning for STEM education: Case study. *AIP Conference Proceedings*, *2330*(March). https://doi.org/10.1063/5.0043638

Diaz, K. V. L. T. (2017). Prior Knowledge: Its Role in Learning. *Unpublished Essays, March 2017*, 8–10. https://doi.org/10.13140/rg.2.2.26816.69125

Gok, T., & Gok, O. (2023). High School Students' Comprehension of Kinematics Graphs wıth Peer Instruction Approach. *Jurnal Pendidikan Fisika Indonesia*, *18*(2), 144–155. https://doi.org/10.15294/jpfi.v18i2.35028

Jufriadi, A., & Andinisari, R. (2020). JITT with assessment for learning: Investigation and improvement of students understanding of kinematics concept. *Momentum: Physics Education Journal*, *4*(2), 94–101. https://doi.org/10.21067/mpej.v4i2.4669

Khoiri, N., Ristanto, S., & Kurniawan, A. F. (2022). Profile of Students' Conceptual Understanding of Physics in Senior High School. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *8*(2), 241–248. https://doi.org/10.21009/1.08206

Kola, Jacob, A. (2017). Investigating the Conceptual Understanding of Physics through an Interactive Lecture-Engagement. *Cumhuriyet International Journal of Education-CIJE*, *6*(1), 82–96.

Riesen, S. A. N. Van, Gijlers, H., Anjewierden, A. A., Jong, T. De, & Gijlers, H. (2019). The influence of prior knowledge on the effectiveness of guided experiment design. *Interactive Learning Environments*, *0*(0), 1–17. https://doi.org/10.1080/10494820.2019.1631193

Shodiqin, M. I., & Taqwa, M. R. A. (2021). Identification of student difficulties in understanding kinematics: Focus of study on the topic of acceleration. *Journal of Physics: Conference Series*, *1918*(2), 6–11. https://doi.org/10.1088/1742-6596/1918/2/022016

Sulman, F., Yuliatai, L., Kusairi, S., Hidayat, A., Pentang, J., & Mensah, B. (2023). *Investigating concept mastery of physics students during online lectures through Rasch models on force and motion materials*. *9*(1), 95–106.

Sutopo, Hidayah, N., Wisodo, H., & Haryoto, D. (2020). Improving students' understanding of kinematics concepts through multi-representational learning. *AIP Conference Proceedings*, *2215*(April). https://doi.org/10.1063/5.0004063

Taqwa, M. R. A., & Rivaldo, L. (2018). Kinematics Conceptual Understanding: Interpretation of Position Equations as A Function of Time. *Jurnal Pendidikan Sains*, *6*(4), 120–127. http://journal.um.ac.id/index.php/jps/