

THE PROFILE OF JUNIOR HIGH SCHOOL STUDENTS' CONCEPTUAL UNDERSTANDING OF MOTION AND FORCE

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Abstract

This research analyzed the percentage of junior high school students' conceptual understanding of the topics of motion and force. The study employed a quantitative method with a sequential explanatory design and was conducted at SMP Negeri 1 Kamal. The population consisted of all grade VII students during the 2023/2024 academic year. The sampling technique used was purposive sampling, resulting in a sample of 28 students. Data collection methods included tests, non-test instruments, observations, and documentation. The indicators of conceptual understanding in this study included interpreting, exemplifying, classifying, inferring, and explaining. Based on the results, it was concluded that: (1) The percentage of students' conceptual understanding is generally low, averaging only 25%; (2) The highest percentage was observed in the interpreting indicator at 52%, while the lowest was in the exemplifying indicator at 4%.

Keywords: *Conceptual Understanding, Motion, Force.*

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INTRODUCTION

Natural Science (IPA) is a field of study that reveals concepts, facts, and patterns related to phenomena occurring in the surrounding environment. Its teaching involves activities such as experiments and observations. Essentially, science education encompasses three aspects: knowledge, skills, and attitudes (Saputri & Djumhana, 2020). The delivery of science material must effectively convey both concepts and theories.

The topics of motion and force are part of the science curriculum for Grade VII students in the first semester. In these topics, students are expected to be able to measure physical aspects they encounter and utilize various types of motion and force. Understanding these concepts is closely related to numbers and operations. Additionally, the topics of motion and force are connected to everyday life, necessitating contextual learning. Contextual learning is expected to enhance students' comprehension and mastery of the material (Yanti, 2022).

Conceptual understanding refers to the ability of students to grasp the concepts of the material. A student is considered to have understood a concept if they can capture the meaning or essence of the material. Besides capturing the meaning, the student should also be able to explain the material using their own words (Pratiwi, Gunawan, & Ermiana, 2022). Students' understanding of science concepts is still low because teachers have not yet related the material to the surrounding environment. According to Bloom's revised taxonomy, the indicators of conceptual understanding include interpreting, classifying, exemplifying, summarizing, inferring, explaining, and comparing (Febriyana et al., 2021). Therefore, mastering conceptual understanding is crucial for students, especially in the topics of motion and force.

This research is connected to learning theories based on Jean Piaget, Ausubel, and Jerome Bruner. According to Jean Piaget's theory, students require concepts or schemas to actively process and understand something. This process is necessary to organize and interpret the experiences they acquire. From Ausubel's perspective, learning activities emphasize the provision of consequences for teaching methods. This allows students to gain knowledge and build concepts based on experiences, events, and facts they encounter. Bruner's theory suggests that students are required to actively participate in discovering concepts, principles, and theories in everyday life or through experimental activities (Haryono, 2019).

A diagnostic test is one tool used to determine students' level of conceptual understanding. Additionally, this test can be used to analyze the causes of learning difficulties that may result in low conceptual understanding (Jusriana, Yunus, & Husain, 2022). Students' difficulties in understanding concepts can be observed through essay tests they have completed, and these difficulties can also be analyzed during learning activities, although this requires significant time (Febriyana et al., 2021).

The Two-Tier Diagnostic Test is one type of diagnostic test that can be used to identify students' levels of conceptual understanding. This test is characterized by having two levels. The first level consists of multiple-choice questions where students select what they believe to be the correct answer from four options. In the second level, students choose a reason or explanation they consider correct from another set of four options. The Two-Tier Diagnostic Test is appropriate for measuring students' conceptual understanding after they have been introduced to the material or concept (Safitri et al., 2021). Additionally, the Two-Tier Diagnostic Test aligns with Piaget's theory and can be used to measure students' conceptual understanding. According to Piaget's theory, children's cognitive abilities align with their developmental stages. As they reach school age, students begin to think operationally, understanding symbols systematically and logically. As adolescents approach adulthood, through logical and systematic thinking, they can develop skills related to concepts, engage in scientific thinking, and test hypotheses through experiments (Febriyana et al., 2021).

Learning style refers to the way students acquire learning material according to their abilities. Each student has a different learning style, typically falling into one of three types: visual, auditory, and kinesthetic (Yuwanita et al., 2020). The auditory learning style is characterized by using the sense of hearing to absorb and remember material. The visual learning style relies on the sense of sight to absorb material, while the kinesthetic learning style involves learning through touch and movement. In reality, students tend to prefer one of these three learning styles (Febriyana et al., 2021). This variation in learning styles may result in differences in conceptual understanding among students. Therefore, this study is important for analyzing students' conceptual understanding of the topics of motion and force.

METODE PENELITIAN

This study employs a quantitative research method. The research was conducted at SMP Negeri 1 Kamal, Kamal Subdistrict, Bangkalan Regency. During the research, there was an external factor, namely the renovation of school facilities, which may have influenced the research process. The study was conducted with seventh-grade students during the first semester of the 2023/2024 academic year. The learning model used in the classroom predominantly employed the think-pair-share model. The research design used in this study is explanatory sequential design.

The data analysis technique in this study is based on the level of students' conceptual understanding using a two-tier diagnostic test, consisting of five multiple-choice questions on the topics of motion and force. The results of the students' diagnostic tests were quantified using Equation 1, based on Zulkarnain (2014):

$$PK = \frac{\text{student's score}}{\text{maximum score}} \times 100\% \quad (1)$$

Students' conceptual understanding was then analyzed, and their answers were assessed and categorized. The scoring is shown in Table 1, while the categories of students' conceptual understanding are shown in Table 2.

Table 1. Instrument for Assessing Student’s Conceptual Understanding Test

Question Distribution		Score
Question	Reason	
Correct	Correct	1
Correct	Incorrect	0
Incorrect	Correct	0
Incorrect	Incorrect	0

Source: Modified from Nabilah et al. (2013)

Table 2. Categories for Assessing Students’ Conceptual Understanding Test

Conceptual Understanding Score (%)	Category
80 < PK ≤ 100	Very High
60 < PK ≤ 80	High
40 < PK ≤ 60	Moderate
20 < PK ≤ 40	Low
0 ≤ PK ≤ 100	Very Low

Source: Modified from Zulkarnain (2014)

The next step was to classify students' conceptual understanding into four categories: high, moderate, low, and very low. Two students from each category of conceptual understanding (very low, low, moderate, and high) were selected as research subjects. This selection was necessary for qualitative data analysis, which followed the quantitative data analysis. Qualitative data were obtained from interviews with the subjects listed in Table 3.

Table 3. List of Research Subjects

Conceptual Understanding Level	Subjects
High	MPD and ZAP
Moderate	M and LM
Low	SAP and SZA
Very Low	AS and RNA

RESEARCH RESULTS AND DISCUSSION

The research using the two-tier diagnostic test was conducted with 28 seventh-grade students from class VII-G of SMP Negeri 1 Kamal, consisting of 13 male and 15 female students. The students had already studied the science material on the concepts of motion and force, which had been taught by the teacher (researcher). The prerequisite for conducting a two-tier diagnostic test for conceptual understanding is that the students must have previously received or studied the material addressed in the test. Thus, the prerequisite for conducting the two-tier diagnostic test on conceptual understanding has been met.

The students' conceptual understanding was assessed using a two-tier diagnostic test consisting of five questions on the science concepts of motion and force. The results of this test can indicate the difficulties students face, which may result in low conceptual understanding. The results of the two-tier diagnostic test on conceptual understanding are presented in Table 4.

Table 4. Results of the Two-Tier Diagnostic Test

No	Code	Score	Maximum Score	(%)	Category
1	MPD	3	5	60	High
2	ZAP	3	5	60	High
3	LM	2	5	40	Moderate
4	M	2	5	40	Moderate
5	NF	2	5	40	Moderate
6	MRAZ	2	5	40	Moderate
7	H	1	5	20	Low
8	DWS	1	5	20	Low
9	AZS	1	5	20	Low
10	SMA	1	5	20	Low
11	ZNS	1	5	20	Low
12	RRD	1	5	20	Low
13	MA	1	5	20	Low
14	MRA	1	5	20	Low
15	SZA	1	5	20	Low
16	YAS	1	5	20	Low
17	SAP	1	5	20	Low
18	IMH	1	5	20	Low
19	RRJ	0	5	0	Very low
20	RH	0	5	0	Very low
21	MRDA	0	5	0	Very low
22	RNA	0	5	0	Very low
23	ZHN	0	5	0	Very low
24	AS	0	5	0	Very low

No	Code	Score	Maximum Score	(%)	Category
25	BSA	0	5	0	Very low
26	ZDE	0	5	0	Very low
27	DEW	0	5	0	Very low
28	HS	0	5	0	Very low

Based on the results obtained, the percentage distribution of students' conceptual understanding was categorized into four levels: high, moderate, low, and very low, as shown in Figure 1.

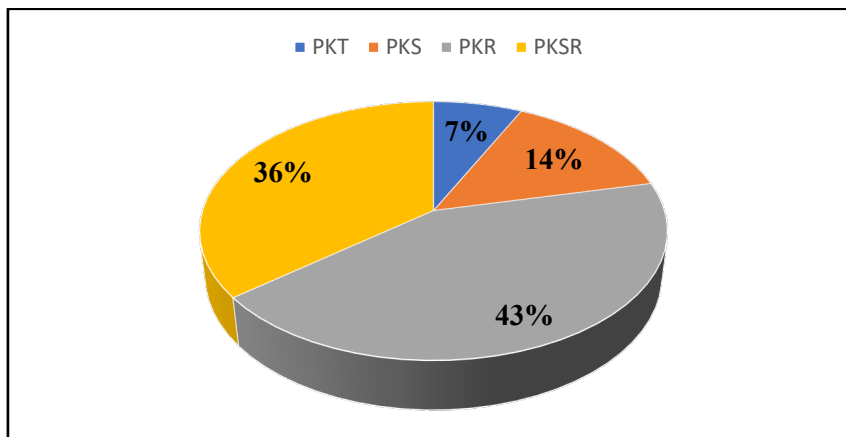


Figure 1. Percentage Distribution of Students' Conceptual Understanding

Students' conceptual understanding abilities for each indicator are shown in Table 5.

Table 5. Percentage of Student's Conceptual Understanding by Indicator

Topic	Indicator	Question No.	Σ Total Score	Percentage (%)
Distance, displacement, speed, velocity, acceleration	Explain	1	6	24
	Classify	2	3	12
Newton's First, Second, and Third Laws	Interpret	3	13	52
	Exemplify	4	1	4
Displacement	Conclude	5	2	8
Total			25	

Based on Table 5, it can be concluded that the highest percentage of students' conceptual understanding was on the indicator "Interpret," at 52%, while the lowest was on the indicator "Exemplify," at 4%. The percentage of students' conceptual understanding for each question is shown in Figure 2.

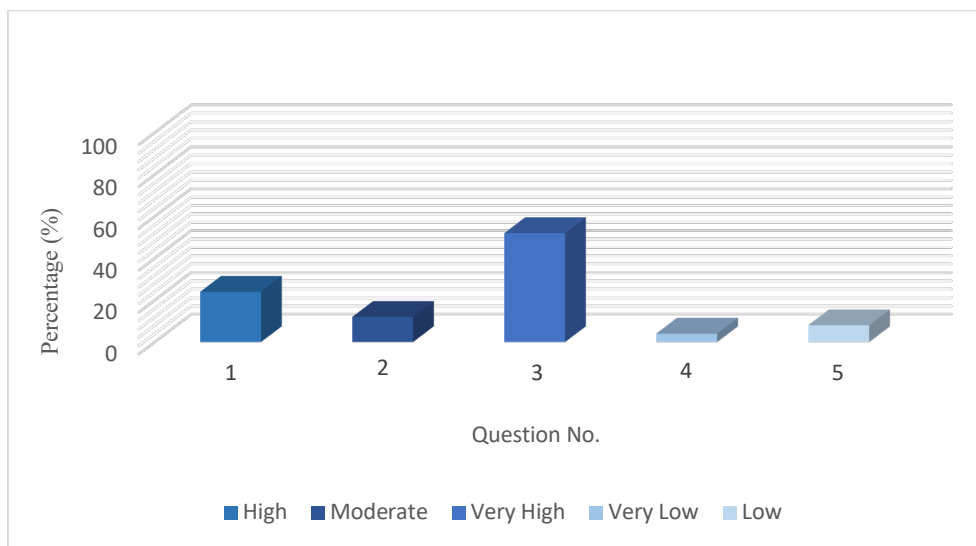


Figure 2. Percentage of Student’s Conceptual Understanding by Question

The analysis of the five questions from the two-tier diagnostic test, followed by quantitative data analysis, revealed the levels of students' conceptual understanding. Each student's answers were matched with the two-tier diagnostic test scoring rubric in Table 2 (Nabilah et al., 2013) to determine the percentage of students' conceptual understanding. Using the formula for categorizing conceptual understanding, students' understanding was classified into five levels: very high, high, moderate, low, and very low. The analysis showed that 7% of students were in the high category, 14% in the moderate category, 43% in the low category, and 43% in the very low category.

The percentage of students' conceptual understanding for each question is shown in Table 5. The highest percentage, 52%, was on the indicator "Interpret," while the lowest, 4%, was on the indicator "Exemplify." These results indicate that students were able to answer questions related to the interrelationship of variables and could identify patterns from a concept they had learned. However, students struggled to provide examples of a learned theory. The question with the "Interpret" indicator was Question 3 (distance traveled), where 52% of students (13 students) answered correctly, and 48% (15 students) answered incorrectly. These 15 students found it difficult to interpret the interrelationship of variables in the concept, particularly in distance traveled.

The "Exemplify" indicator was in Question 4 (Newton's First, Second, and Third Laws), with a result of 4%, meaning only one student answered correctly, while 27 students answered incorrectly. Most students could not provide a correct response to the second-tier reasoning part of the question.

The highest percentage of conceptual understanding was on Question 3 (distance traveled) at 52%, while the lowest was on Question 4 (Newton's Laws) at 4%. The indicator in Question 3 was interpreting the distance traveled in the concept of motion, and 13 out of 28 students answered correctly. This question relates to the initial material on the concept of motion with the question: "Dian walks east for 4 meters and then turns north for 3 meters. The distance traveled by Dian is ... based on your answer, the correct reasoning is ..." This allowed students to answer Question 3 correctly. In contrast, Question 4 had the lowest percentage regarding Newton's Laws, with 27 out of 28 students answering incorrectly. The indicator in Question 4 was exemplifying with the question: "Based on the table above, the correct pair is ... based on your answer, the correct reasoning is ..." Students still struggled to exemplify each of Newton's First, Second, and Third Laws.

From the interviews, it was found that two students with high conceptual understanding and one student with the initial M from the moderate category had an auditory learning style. Students with this learning style have the advantage of remembering and imitating words spoken by others in a short time and can present something well. However, auditory learners can be easily distracted by surrounding noise (Azzahrah Putri et al., 2021) and may find it difficult to answer questions presented in the form of images.

Another student interviewed with the initials LM was found to have a kinesthetic learning style, meaning they better understand material through tactile senses and movement. LM remains focused on learning even in a noisy environment. During the interview, LM frequently used hand gestures to convey specific meanings while communicating. The results of interviews with two students in the low conceptual understanding category showed that they had a visual learning style. Visual learners better understand material through their sense of sight, which aligns with Jean Piaget's theory. According to Piaget, students actively

understand the world using schemas, and these schemas, as concepts, organize knowledge based on students' experiences. This makes it easier for them to answer questions when presented with images.

The results obtained from interviews with two students with very low conceptual understanding revealed that one student, referred to as AS, has a visual learning style. This was evident during the interview, as the student frequently focused on their appearance. During lessons, this student found it easier to answer questions presented in a visual format. Another student interviewed, referred to as RNA, was found to have a kinesthetic learning style. This student learns through touch and movement. Kinesthetic learners tend to understand concepts better when they engage in hands-on activities or directly participate in the learning process.

According to Jerome Bruner's theory, when students actively participate in observation and direct experimentation, they are more likely to acquire and develop concepts during the learning process. During the school's facility improvements, the teaching method shifted towards blended learning, affecting the overall effectiveness of instruction. This required students to be not only active in the classroom but also independently engaged at home by completing assignments given by their teachers. However, instead of reviewing classroom materials, students often resorted to using Google to find answers while working on homework. Furthermore, the choice of instructional models also influenced students' conceptual understanding. During lessons, the think-pair-share model was predominantly used, with limited opportunities for direct experimentation. This led to students having restricted problem-solving experiences, contributing to their low conceptual understanding in the subject (Dorisno, 2021).

Yuwanita et al. (2020) stated that each student has a unique learning style, and teachers must apply teaching models that align with these learning styles. This approach can enhance the efficiency and effectiveness of material comprehension. However, blended learning can limit students' motivation to learn to its full potential, ultimately impacting their conceptual understanding.

CONCLUSION AND SUGGESTION

A. Conclusion

The results of the two-tier diagnostic test to measure the conceptual understanding of 7th-grade students from SMP Negeri 1 Kamal indicate that most students' understanding of the concepts of motion and force falls into the low to very low categories. The two-tier diagnostic test revealed that only 7% of students achieved a high understanding category, with the best understanding on the indicator of interpreting (52%) and the lowest on the indicator of exemplifying (4%). Analysis of learning styles suggests a correlation between learning style types and conceptual understanding, with auditory learners demonstrating better results compared to visual and kinesthetic learners. External factors, such as improvements in school facilities and the implementation of blended learning, also influence learning outcomes.

B. Suggestion

This study's recommendations are aimed at students and educators to enhance motivation during blended learning due to the limited classroom time. Students need to actively study at home to complete assignments independently without relying on Google. Further research is also necessary to analyze students' conceptual understanding of motion and force in relation to different instructional models.

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