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Analysis of Physics Misconceptions Elasticity and Hooke's Law in High School Students with Certainty of Response Index Method

Ma'ruf[1], Ana Dhiqfaini Sultan[2]

[1,2]Department of Physics Education Faculty of Teacher and Training Universitas Muhammadiyah Makassar, Makassar, Indonesia.

Corresponding Author: Ma'ruf: maruf@unismuh.ac.id

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ABSTRACT

This research aims to analyze the level of understanding of students' concepts and misconceptions using the Certainty of Response Index (CRI) method in class XI elasticity and Hooke's law material at Senior High School Makassar in Indonesia. This type of research is Expost Facto with a quantitative descriptive research design. The sample was selected using a purposive sampling technique and Class. The analysis results from the research obtained show that the level of understanding of the concept of elasticity and Hooke's law in class XI MIPA students at Senior High School Makassar in Indonesia is in the low category with a percentage of 21.67%. And misconceptions are in the medium category with a percentage of 35.78%. The conclusion of this research is that the percentage level of concept understanding is in the low category and the level of misconceptions and not understanding concepts is in the medium category, so it is necessary to improve the quality of the learning process and solutions to overcome the low level of concept understanding and high levels of misconceptions experienced by students in Indonesia.

Keywords: understanding concepts, misconceptions, certainty of response index, elasticity and Hooke's law

INTRODUCTION

Education is a systematic activity carried out to form a learning process and learning conditions that can develop the potential for intelligence, religion, personality and noble morals and skills in students.

One component of the education system is learning. Learning is basically a planned activity to acquire new skills and knowledge in the form of attitudes so that it can produce changes in one's own behavior. Slameto stated that learning is a process of effort carried out by individuals to obtain a new change in behavior as a whole, as a result of the individual's own experience in interaction with the environment (Adhim et. al, 2021). Judging from constructivism theory, learning is an active activity, where students build their own knowledge, skills and behavior. Students who seek their own meaning from what they learn (Assem et. al, 2023).

Bloom defines understanding as the ability to absorb the meaning of the material or material being studied (Bahtaji, 2023). Dorothy J. Skeel states that a concept is something that is depicted in the mind, a thought, idea or understanding (Hakim et. al, 2012). So, based on this explanation, it can be concluded that conceptual understanding is a person's skill in understanding the meaning of the material obtained during the learning process so that

it becomes an idea/understanding that sticks in the mind.

The process of understanding students' concepts is not the same as the process of understanding concepts of experts/ physicists, because experts/physicists in understanding a concept will be more complex, and make many connections between concepts. If the students' conceptual understanding is similar to the conceptual understanding of experts/ physicists but made simple, then the students' conceptual understanding is not wrong (Haryono & Aini, 2021). However, if students' conceptual understanding is completely different from the conceptual understanding of experts/physicists, these students experience misconceptions.

Misconception is a cognitive structure or conception that is inherent in students which is different from the cognitive structure according to experts/physicists. This misconception can make students make mistakes in carrying out scientific explanations and understanding natural phenomena (Hasan et. al, 1999). This misconception is related to students' different understandings when understanding lessons. Differences in understanding lessons also occur before entering formal school, students already understand a concept that they have developed through their life experiences. Misconceptions can occur in students because they have difficulty connecting physics concepts with everyday life, basic concepts are not understood well, incomplete knowledge, wrong reasoning, lack of direct/practical experience and difficulty in working on questions that require a thorough understanding of concepts. Good.

There is a method for identifying understanding concepts, misconceptions and not knowing concepts, namely the method developed by Kulgemeyer & Wittwer (2023), namely CRI (Certainty Of Response Index). This method is to determine the level of certainty/confidence of respondents in providing answers to questions. CRI is based on a scale given when answering a question (Mahrani et. al, 2023).

The Certainty Of Response Index (CRI) method can be used to identify understanding of concepts, although basically this method was created to identify misconceptions, but in this method there is a mapping of criteria for understanding concepts, misconceptions and not knowing concepts, so in this study the CRI method was used to differentiate between participants. students who understand concepts and misconceptions and who do not know concepts.

The research entitled "Identification of Misconceptions of Class namely 8.38%. Misconceptions in the material of elasticity and Hooke's law are caused by inappropriate (reasoning) when answering questions, not correctly relating one concept to another concept (Maruf & Sultan, 2023). Misconceptions occur because students do not like physics lessons and are used to memorizing concepts so that new concepts cannot be understood. Misconceptions are also caused by students' low interest in learning, lack of ability to understand the material and students not being able to link initial concepts with new concepts (Ma'ruf et. al, 2020).

LITERATURE REVIEW

Physics Misconceptions

Understanding is defined as the ability to absorb the meaning of the material or materials studied. According to Bloom, understanding is the extent to which students are able to receive, absorb and understand the lessons given by the teacher to students, or the extent to which students can comprehend and comprehend what they read, see, experience or feel in the form of research results or direct observation. what he did (Ma'ruf et. al, 2020).

Many physics concepts have clear meanings and have been agreed upon by physicists/experts, but students have different physics concepts from others. Some students have different concepts of physics from the concepts of

physicists/experts. Experts' concepts are more complex, complicated, and connect between concepts. If the physics concept that students have is the same as the concept of physicists/experts even though it has been made simple, then the physics concept is correct. Meanwhile, if students' physics concepts are not the same as the simplified concepts of physicists/experts, then these students experience physics misconceptions. Physics misconceptions are known as students' concepts of physics that do not match the concepts of physicists/experts which are made simple, the concepts are accepted in certain cases and not accepted in other cases, cannot be generalized and do not show the relationship between physics concepts (Ma'Ruf et. al, 2021).

Causes of Misconceptions

The causes of misconceptions can be seen in several aspects, namely students, students' misconceptions are caused by students' association thoughts with everyday terms, incorrect and incomplete reasoning, wrong intuition and students' feelings can be the cause of misconceptions, the second is teachers, teacher misconceptions can be the cause of misconceptions because the teacher does not understand the concepts or material being taught. This makes students misunderstand the concept if the teacher's understanding of the concept is still low and then it is taught to the students. Teachers' failure and inability to show aspects of related concepts, as well as low ability to relate one concept to another concept, wrong teaching methods, inappropriate application of the concepts being taught, and teaching aids used that are not in accordance with the concept are the causes of misconceptions. The cause of misconceptions about books is that the language used in the book is difficult and complex. Only some can understand the concepts written in the book, so students misunderstand the meaning of the book's contents. Diagrams and pictures also cause misconceptions among students. Other causes of misconceptions are experience, everyday language, the influence of friends and so on. Friends can also cause misconceptions if they express concepts confidently even though they are wrong, students easily believe and agree to the concepts conveyed by their friends because their friends are considered smart (Maruf, 2020).

Certainty of Response Index

CRI is used in social sciences, especially in surveys, respondents are asked to provide a level of certainty/confidence regarding their ability to select and use knowledge, laws or concepts to arrive at the answer. CRI is usually based on a certain scale. For example, a six-point scale (0–5) (Nurfadila & Nurlina, 2023).

This method consists of asking for a confidence level (CRI) for each answer in the test described above. This confidence level (CRI) provides a measure of a student's level of confidence in providing an answer to each question. This level of confidence is included in the Lickert type scale. Specifically, for questions from multiple choice tests, students are directed to: (a) give the most appropriate answer from the choices provided and (b) choose a confidence level (CRI) between 0 and 5 for each answer. CRI 0 for answers guessed from selected answers, while CRI 5 is required if the answer comes from deeply embedded knowledge and skills, as believed by the respondent.

Behind the advantages of the CRI method for identifying conceptual understanding and misconceptions, there are weaknesses in this method which can occur when students have low self-confidence. Where students really understand the concept but because they have low self-confidence it will cause them to give a low CRI score, so they are categorized as guessing the answer. The solution to this problem is to use a modified CRI by adding open reasons in answering the questions given (Obafemi & Aderonmu, 2022).

MATERIALS & METHODS

The type of research used is ex post facto with a quantitative descriptive research design which aims to explain students' level of understanding of concepts and misconceptions. This research was conducted in the odd semester of the 2023/2024 academic year at Senior High School Makassar Indonesia. The population of this research is class XI MIPA students. In determining the sample using a purposive sampling technique, 28 students from class XI MIPA 3 were selected.

The instrument in this research is multiple choice questions accompanied by CRI with open reasons. The use of CRI is accompanied by reasons in this research to identify and differentiate students who understand the concept, understand the concept but are not sure, do not understand the concept and those who experience misconceptions. This research instrument has been tested for construct and content by a validator and a trial of the instrument has been carried out on class XI MIPA students who are not research subjects at the school. By using tests of validity, reliability, distinguishing power and level of difficulty, it can be concluded that there are 14 questions that can be used in this research.

Data collection techniques in this research are: (1) Formulation of problems in physics learning (2) Preparation of instruments and validation by experts (3) Testing of instruments and analysis of the results of testing of instruments (4) Stage of research implementation (5) Data on understanding concepts and student misconceptions.

Then the data analysis techniques used are:

Determination of CRI values

Table 1. CRI and its criteria

CRI	Criteria
0	*Totally guessed answer*
1	*Almost guess*
2	*Not Sure*
3	*Sure*
4	*Almost certain*
5	*Certain*

Determining the category of understanding from answer choices, CRI and reasons.

Table 2. Modification of Comprehension level categories

Answer	Reason	CRI value	Description
Correct	Correct	>2.5	Understand the concept well
Correct	Correct	<2.5	Understand the concept but not sure
Correct	Incorrect	>2.5	Misconceptions
Correct	Incorrect	<2.5	Don't know the concept
Incorrect	Correct	>2.5	Misconceptions
Incorrect	Correct	<2.5	Don't know the concept
Incorrect	Incorrect	>2.5	Misconceptions
Incorrect	Incorrect	<2.5	Don't know the concept

RESULT

Based on the results of multiple choice tests with reasons accompanied by CRI, it shows that in the concept of elasticity and Hooke's law, students do not understand the concept well. Moreover, many students do not understand the concept and experience misconceptions. The following is the percentage of understanding categories for class XI MIPA students at Senior High School Makassar in table 3.

Table 3. Percentage of Understanding Categories for Class XI MIPA Students

No.	Indicator	Question number	Category (%)			
			Understand the Concept	Understand the concept but not sure	Misconceptions	Don't Understand the Concept
1	Identify elastic and plastic objects	1	**60,70**	**0,00**	**39,30**	**0,00**
2	Analyze stress, strain and modulus of elasticity	2	3,60	0,00	75,00	21,40
		3	0,00	0,00	71,40	28,60
		4	3,60	3,60	60,70	32,10
		5	3,60	7,10	28,60	60,70
	Average		**2,68**	**2,68**	**58,93**	**35,71**

3	Analyze the relationship between force and length increase	6	28,60	0,00	28,60	42,90
		7	0,00	7,10	28,60	64,30
		8	3,60	7,10	28,60	60,70
	Average		**10,71**	**4,76**	**28,57**	**55,95**
4	Formulate Hooke's law equation for springs arranged in series and parallel	9	3,60	0,00	50,00	46,4
		10	0,00	0,00	17,90	82,1
		11	3,60	0,00	35,70	60,7
		12	0,00	0,00	25,00	75,0
		13	3,60	14,30	25,00	57,1
	Average		**2,14**	**2,86**	**30,71**	**64,29**
5	Demonstrates the use of internal elastic objects	14	**32,10**	**0,00**	**21,40**	**46,40**
Total average			**21,67**	**2,06**	**35,78**	**40,47**

Based on table 3. The category of students' understanding of the concept of elasticity and Hooke's law for class less sure, namely 2.06%. The percentage level of understanding in the concept understanding category was 21.67% and in the Misconceptions category 35.78%. The percentage of students' understanding for each indicator can be seen in Figure 1 below.

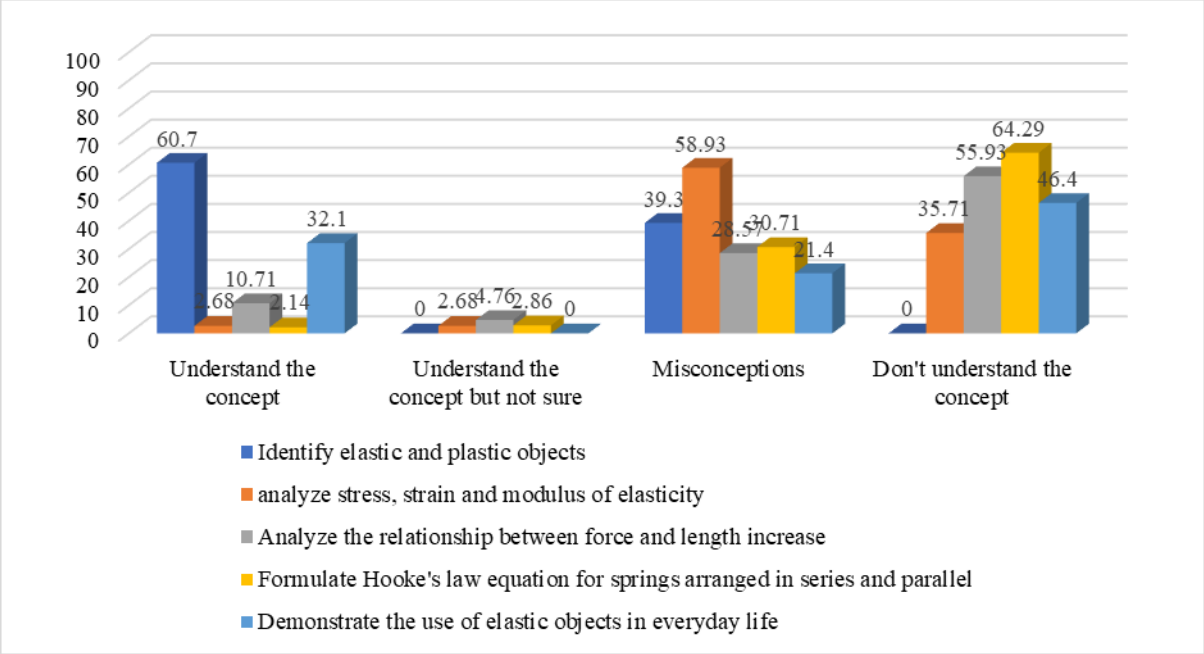

Figure 1. Percentage of Student Understanding for Each Indicator

Based on the graph above, it is known that the dominant percentage of understanding for each indicator is in the category of not understanding the concept. The percentage of understanding in the dominant misconception category is in the second indicator and the percentage of understanding in the category of not understanding the dominant concept is in the third and fourth indicators. For the category of understanding the dominant concept in the first indicator. Thus, it is known that only a few students understand the concept and understand the concept, but it is not certain that most of the students do not understand the concept.

After obtaining data on student understanding of concepts and misconceptions, an analysis of the distribution of understanding of concepts and misconceptions on each indicator is then carried out and identification of the causes.

The comparison of understanding of each item in the categories of understanding the concept, understanding the concept but not sure, misconceptions, and not understanding the concept aims to see the overall level of

students' understanding of the items on the concept of elasticity and Hooke's law, which can be seen in Figure 2 below.

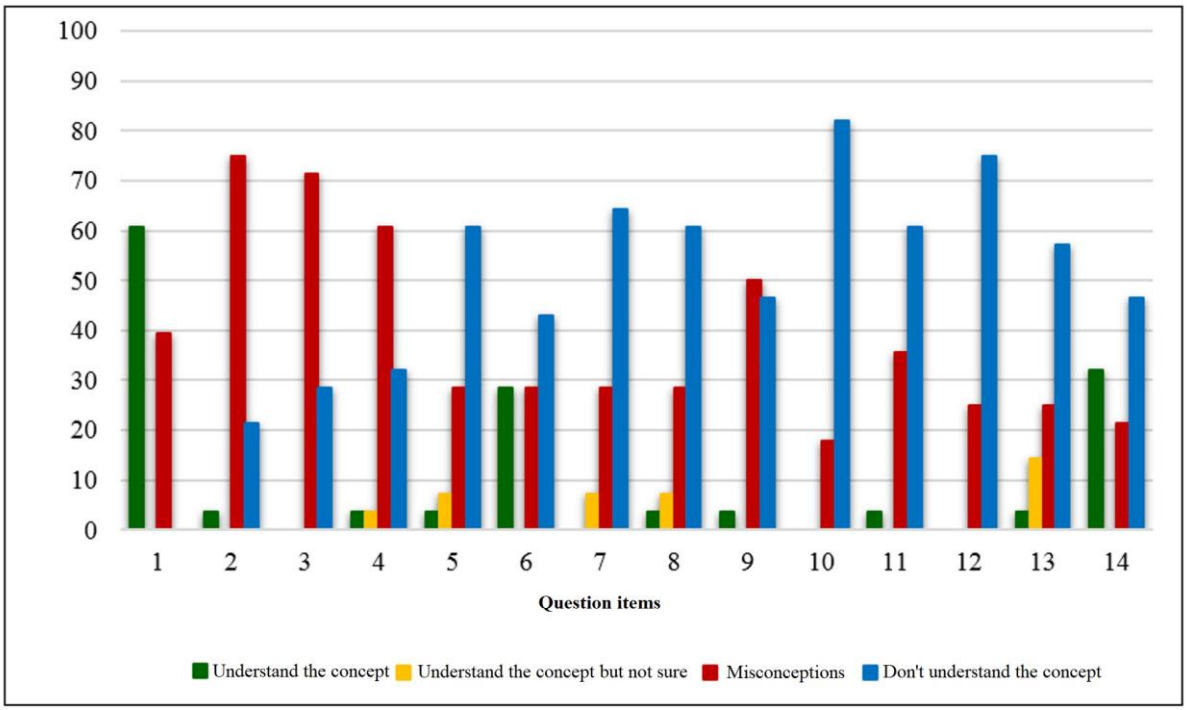

Figure 2. Recapitulation of the Percentage of Students' Understanding Categories on the Concept of Elasticity and Hooke's Law

From the picture above, it is known that the percentage of students' understanding in the category of understanding the concept in questions number 1, 6 and 14 exceeds 20%, the category of understanding the concept but is not sure is only in question number 13 which exceeds 10%, the rest is below 10% in the question items. numbers 4, 5, 7, and 8, for the misconception category, almost all of the questions exceed 20% except for item number 10 and the most dominant is items number 2, 3, 4 and 9, for the category of not understanding the concept, all of the questions are above 20% and is most dominant in questions number 5, 7, 8, 10, 11, 12 and 13.

DISCUSSION

From the recapitulation of the understanding category, it is known that the concept understanding category has a low average percentage, namely 21.67%. After conducting the test, it was discovered that the questions with a dominant percentage of concept understanding were in questions number 1, 6 and 14 which were above 20%, with the remaining percentage in the concept understanding category being very low. For the misconception category, the average percentage is quite high, namely 35.78%. It is known that there are questions with a dominant percentage of misconceptions found in questions number 2, 3 and 4.

Question number 2 concerns the interpretation of a graph showing a steel bar that is necking with a percentage of 75.00%. Based on the data obtained, in general students gave answers that were not in accordance with scientific concepts, students who experienced misconceptions gave answers that the area that showed the steel bar was shrinking (necking) was the BC area because the graph curved deeper downwards than the DE area. From a physical concept, point B is the elastic limit, the material will experience a permanent change in shape (deformation) and will not return to its original shape. In the BC area, ductile material will experience changes in shape (deformation) without any additional load. This phenomenon is called yieldening,

which shows the material's ability to withstand permanent changes in shape (deformation). The steel bar experiences necking (localized deformation) in the DE area, in this case the material cannot stretch any longer and finally breaks when it reaches point E.

Question number 3 is about the modulus of elasticity of a material with a misconception percentage of 71.4%. Based on the data obtained, several students experienced misconceptions. Some students answered correctly (B) but gave reasons that were not in accordance with scientific concepts and their CRI level was high so they were said to be misconceptions. some answered (C), namely the modulus of elasticity for each material is the same but the stress and strain are different. Students understand that from the graph the modulus of elasticity of each material is the same but the stress and strain are different, whereas from the modulus of elasticity equation it can be seen that when the stress and strain of a material are different, the modulus of elasticity will also be different.

Question number 4 is about the modulus of elasticity with a misconception percentage of 60.7%. Some students who experienced misconceptions, most of them answered (B). Students assume that based on the graph it is known that the magnitudes of stress and strain are the same, so students conclude that the relationship is the same as (=), even though the relationship between stress and strain is proportional ($\propto$).

The analysis of this research is to determine the level of students' understanding of concepts and misconceptions after they have studied the concept of elasticity and Hooke's law. Research that has been conducted using multiple choice test instruments accompanied by CRI with reasons grouped into categories of level of understanding based on students' answers, namely understanding the concept, understanding the concept but not sure, misconceptions and not understanding the concept of the 14 questions tested.

The recapitulation results of the understanding category show that there are more students who do not understand the concept than those who understand the concept, this shows that the quality of learning and interest in learning that students have is low. The quality of learning can be in the form of the learning methods applied by the teacher (Sultan, 2021). The right teaching method will make students understand the concepts given. On the other hand, inappropriate teaching methods can cause students to experience misconceptions (Sultan et. al, 2023). Apart from that, another factor that causes many students not to understand concepts and misconceptions is due to low interest in learning. Students who have no interest in learning tend not to pay attention and listen to the entire material taught by the teacher, they will ignore what the teacher teaches. The research entitled "Identification of Misconceptions of Class This misconception occurs in the concept of elastic energy and elastic modulus/Young's modulus. The students' misconceptions were 51.05% and the level of conceptual understanding was 40.57% (Rafika & Syuhendri, 2021).

The research results obtained are in line with the results of previous research which shows that the misconceptions that occur are greater than the students' understanding of the concepts. There are questions that show the percentage of dominant concept understanding and several questions that show the percentage of misconceptions (Resbiantoro & Setiani, 2022). This shows the need to improve the quality of the learning process as well as solutions to overcome the low level of understanding of concepts and the high level of misconceptions experienced by students.

CONCLUSION

Based on the results of the research analysis obtained, it can be concluded that the level of understanding of the concept of elasticity and Hooke's law of class XI MIPA students at Senior High School Makassar is in the low category with a percentage of 21.67%

and misconceptions are in the medium category with a percentage of 35.78%.

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