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Analysis of high school students' misconceptions in Bantul District on the material of the human movement system using the CRI method

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Abstract. This study aims to (1) analyze the level of misconceptions of class XI students that occur in the material of the Human Movement System in Bantul Regency using the Certainty of Response Index (CRI) method; (2) analyze which sub-materials students experience the most misconceptions in the material of the Human Movement System. This study is descriptive and uses a quantitative approach. The population in this study was class XI students of State Senior High Schools in Bantul Regency. The sample was determined using the cluster random sampling technique. The data collection technique used was the Certainty of Response Index (CRI) method, and the data collection instrument used was Selected Response Items in the form of multiple-choice tests. The results of the study showed that students' misconceptions in the Human Movement System material averaged 41.7% overall, falling within the moderate category. The percentage of misconceptions in the sub-concepts (1) structure and function of bones, (2) structure, function, and mechanism of muscle contraction, (3) structure and function of joints, and (4) disorders and abnormalities in the human movement system, respectively, were 44.75%; 40.25%; 35.31%; and 46.48%. This research is crucial for identifying misconceptions among high school students, thereby improving the quality of learning.
Kata Kunci: Certainty of Response Index (CRI), Human Movement System, Misconceptions

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INTRODUCTION

Jean Piaget explained that in the process of learning, a person will experience the process of forming or constructing knowledge from the experiences they have gone through. The situations he experiences will then be interrelated to form knowledge and become concepts that are understood by him. This process will take place continuously so that a student will gain a new understanding of the results of the construction process through coordination and association between the situations they have (Barana et al., 2023).

The process of knowledge construction has occurred long before students enter formal education in schools (Krisgiyanti & Pratama, 2023; Susilo et al., 2020). This causes students to have different knowledge and mindsets from each other, which as a result can form different pre-concepts in each individual (Putrisari & Subiantoro, 2022). The difficulties that are often faced in the formation of different pre-concepts are one of them that trigger misconceptions in students. Misconception is defined by Suparno (2013) as a condition in which a concept is not in accordance with scientific understanding or that accepted by experts in the field.

Misconception is one of the factors that contribute to low student learning outcomes. This is in line with the results of research by Mardana & Yasa (2021), which revealed that the high level of misconception experienced by students will be inversely proportional to student learning outcomes. So it can be said that students' misconceptions will lead to low student learning outcomes.

Wilantika et al (2013) stated that various factors can cause misconceptions experienced by students, including mistakes that come from the students themselves, mistakes that come from the textbooks used, mistakes from the teacher in explaining the material, errors in the context that occur, and errors in the teaching methods applied by the teacher during the learning

process. In addition, misconceptions can be caused by misunderstandings arising from inadequate initial or pre-conceptual knowledge in students (Apriani & Sudrajat, 2025; Lestari & Pertiwi, 2025).

Analysis of misconceptions that occur in students needs to be carried out as an evaluation step for the implementation of the learning process in schools (Tsai et al., 2023). In addition, misconception analysis is also important to determine appropriate learning strategies to be applied by biology teachers so that they can improve student learning outcomes (Macías Villegas et al., 2020). The results of the study by Thompson et al (2016) found that analyzing student misconceptions is important to identify which material concepts are susceptible to misconceptions in students and require further study by teachers.

There are various methods for analyzing students' misconceptions, including the *Certainty of Response Index* (CRI) method. The CRI method developed by Hasan et al (1999) is one of the methods used to analyze students' misconceptions. Not only that, but this method can also be used to distinguish students who have misconceptions, do not understand concepts, and understand concepts. This method uses the principle of measuring student misconceptions by having students' confidence serve as the respondents when answering all the questions provided.

The advantage of using the CRI method is that it is simple and easy to apply, yet effective for analyzing the misconceptions that occur. Several studies on misconceptions among students using the CRI method were conducted in various schools in Indonesia, including several in Bantul Regency. The results of a study conducted by Cahyusari (2019) using the CRI method indicate a misconception in the Fungi material in class X at SMAN 1 Srandakan Bantul. Muntiani (2015), in his research using the CRI method, also found a misconception among students at SMAN 2 Banguntapan, Bantul, regarding the structure and function of animal tissues. The results of each of these studies revealed a misconception in the concept of biology experienced by high school students in the Bantul Regency area

The results of several studies mentioned earlier show that cases of student misconceptions were found in several high schools in Bantul Regency. However, it is not clear whether cases of misconception have been found in other high schools in Bantul Regency; therefore, there is a need to analyze student misconceptions across the Bantul Regency as a whole. These efforts are expected to be evaluated in the education sector to improve and further optimize it. Therefore, this study aims to analyze the level of misconceptions among grade XI students in the Human Motion System material in Bantul Regency using the Certainty of Response Index (CRI) method, and to identify which sub-materials students experience the most misconceptions.

METHODS

This research is descriptive with a quantitative approach. This research was conducted at a State High School in the Bantul Regency, Special Region of Yogyakarta Province. The implementation of the research by choosing a location at the State High School by considering the equality in the learning materials and the curriculum applied. The implementation time of this research is in the even semester of the 2022/2023 school year, namely February-July 2023.

The population in this study comprises all grade XI students at State High School in Bantul Regency. The sample in this study was determined using *a cluster random sampling technique,* which was carried out by conducting *cluster sampling* and then continuing with *a random sampling* technique (Cohen et al., 2018). The total sample size was 324 students, obtained from 10 high schools in Bantul Regency.

The data collection technique used in this study is a test using the Certainty of Response Index (CRI) method to identify students who have misconceptions, do not know the concepts,

and know the concepts. The test is administered via a Google Form to grade XI students at State High School in Bantul Regency who have studied the Human Motion System Material.

The instrument used in this study is a test consisting of Selected Response Items in the form of multiple-choice questions with 5 answer choices, and each item is equipped with a Certainty of Response Index (CRI) scale. Multiple-choice tests are objective, so students receive a score of 1 for each correct answer and 0 for each incorrect answer. The validity test of the instrument used in this study is the content validity test conducted by experts (*expert judgement*).

The data analyzed are the results of the questions administered to students, as well as the CRI scores they provided for each answer. The test result data that has been obtained from students is then analyzed through several stages: (1) data assessment, (2) data grouping, (3) data calculation, and (4) determination of the level of misconception categories. The results of the calculation of student misconceptions can then be categorized by percentage into three categories (Table 1) (Novitasari & Susantini, 2021).

Table 1. Misconception Category Levels by Percentage

Percentage (%)	Categiry
0 – 30	Low
31 – 60	Moderate
61 – 100	High

RESULTS AND DISCUSSION

Results

The data collected in the form of answers and students' confidence levels are then analyzed and grouped into three categories of understanding: Concept Understanding (P), Misconception (M), and Not Understanding Concepts (TP) (Figure 1).

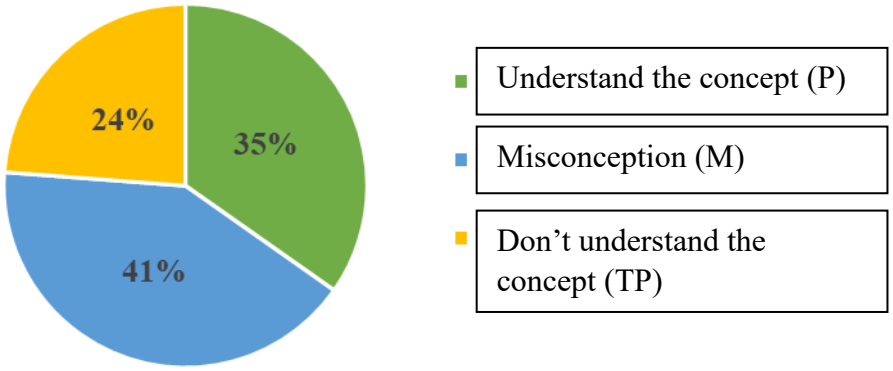

Figure 1. Percentage of Students' Understanding of Human Motion System Material

Based on the results of the analysis of the overall student answer results on each question item that has been collected, as many as 41.7% of the answers can be categorized as misconception (M) answers. Furthermore, 34.98% of the answers were categorized as understanding concepts (P), and the remaining 23.97% were categorized as not understanding concepts (TP). Based on Table 3, the percentage of misconceptions experienced by students in the overall motion system material falls within the medium range.

The data obtained (Table 2) shows that, as a whole, it can be seen that students who experience misconceptions in each sub-concept of material include (1) bone structure and function, (2) muscle structure, function, and mechanism of contraction, (3) joint structure and function, and (4) disorders and abnormalities in the human movement system. The results of the analysis also showed that all 20 questions in the test instrument involved students who experienced misconceptions. The following is a detailed table of the percentages of concept

understanding (P), misconceptions (M), and not understanding the concept (TP) for each question item.

Table 2. Percentage of Understanding of Grade XI Students in Bantul Regency on Human Motion System Material

No.	Indicator	Question number	Percentage (%)		
			P	M	TP
1.	Analyze bone structure and function	1	71.30	14.81	13.89
		2	26.23	45.99	27.78
		3	40.43	40.43	19.14
		4	17.90	62.35	19.75
		5	20.06	60.19	19.75
	Average		**35.19**	**44.75**	**19.69**
2.	Analyze the structure, function, and mechanism of muscle contraction	6	19.75	55.86	24.38
		7	63.27	17.28	19.44
		8	31.48	38.89	29.63
		9	20.68	45.37	33.95
		10	22.84	43.83	33.33
	Average		**31.60**	**40.25**	**28.15**
3.	Analyze joint structure and function	11	76.54	13.58	9.88
		12	30.56	51.23	18.21
		13	43.21	38.58	18.21
		14	48.77	32.10	19.14
		15	22.84	41.05	36.11
	Average		**44.38**	**35.31**	**20.31**
4.	Analyze disorders and abnormalities in the human system of motion	16	7.72	59.26	33.02
		17	22.84	53.09	24.07
		18	36.42	35.19	28.40
		19	44.75	34.26	20.99
		20	32.10	50.62	17.28
	Average		**28.77**	**46.48**	**27.72**
Average			**34.98**	**41.70**	**23.97**

Based on the data presented in Table 4, it can be seen that there is a percentage variation in each category of understanding in each question number. The average percentage of understanding of grade XI students in Bantul Regency on the material of the human motion system in each sub-concept of the material is presented in Figure 2.

The highest average misconception experienced by students, with a percentage of 46.48%, occurred in the sub-concept of disorders and abnormalities in the human movement system. Meanwhile, the lowest misconception experienced by students, with an average percentage of 35.31%, occurred in the sub-concept of joint structure and function. Both sub-concepts can be categorized as having a moderate level of misconception.

The highest percentage of concept understanding, at 44.38%, is observed in the sub-concept of joint structure and function. Then, the lowest percentage of concept understanding, with an average of 28.77%, was found in the sub-concept of disorders and abnormalities in the human movement system. In the category of not understanding the concept, the highest percentage was observed in the sub-concept of muscle structure, function, and mechanism, at 28.15%. Meanwhile, the category of not understanding the lowest concept is found in the sub-concept of bone structure and function, with an average percentage of 19.69%.

Students experienced the most misconceptions on question 4, with a 62.35% misconception rate, placing them in the high-misconception category. This problem is found in the sub-concept of bone structure and function. Meanwhile, the question with the lowest misconception rate was number 11, at 13.58%, and was included in the low-misconception category. This question is one of those in the sub-concept of joint structure and function.

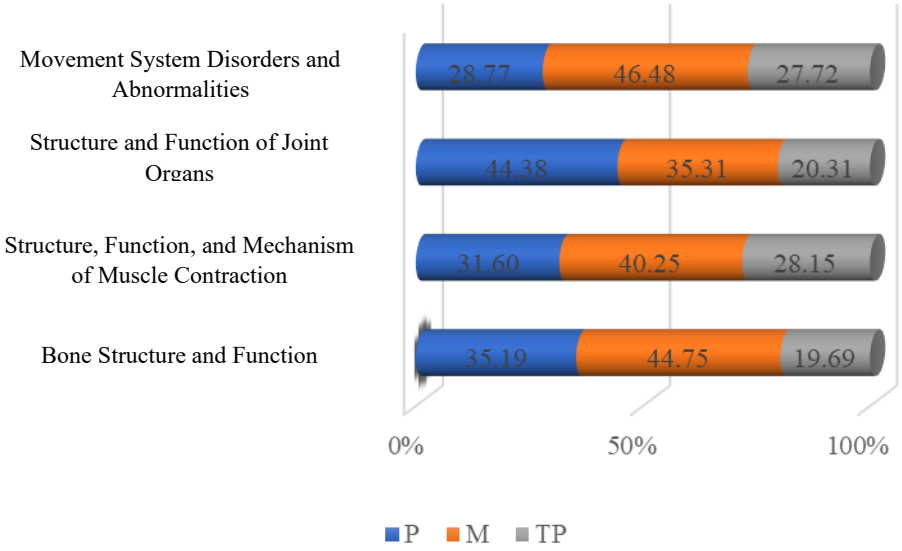

Figure 2. Average Chart of the Percentage of Understanding of Grade XI Students in Bantul Regency on Human Movement System Material

The question with the highest percentage of concept understanding is question 11, at 76.54%. As for the question with the lowest percentage of concept understanding, namely, question number 16. Then, in question 15, it is the highest category of not understanding the concept, with a percentage of 36.11%, and the lowest, 9.88%, is found in question 11.

Discussion

This study aims to analyze the percentage of misconceptions among grade XI students in Bantul Regency regarding the human movement system. The sample of respondents in this study comprised students from ten State High Schools in Bantul Regency, with each school contributing one science class.

This research was carried out by administering the Selected Response Items test instrument to students in the form of a multiple-choice test with 5 answer choices and equipped with a CRI scale. The test instruments are distributed to students via Google Forms, which can be accessed on each student's device. The answers and the level of confidence collected are then analyzed and further classified into one of the categories of student understanding: concepts, misconceptions, or not understanding concepts.

In the first sub-concept, namely Bone Structure and Function, the percentage of misconceptions was 44.75%, which fell within the medium category. This percentage is higher than the percentages for understanding the concept (35.19%) and not understanding the concept (16.69%). In this sub-concept of bone structure and function, there are five multiple-choice test questions for students. Misconceptions in high categories were found in two questions, namely 4 and 5. The highest percentage was found in question 4, at 62.35%, and it also had the highest percentage of misconceptions among the 20 questions given to students. This number also has the lowest percentage of concept understanding when compared to other numbers.

Indicator number 4 is to analyze the structure of the tissue and its function in the bones. Students are presented with questions about how nutrients are channeled in compact bones and their association with bone structure. Most students who experience misconceptions understand that compact bones, composed of a dense matrix, provide nutrients for osteocytes by receiving nutrients from the spinal cord, which are channeled through the cavities in the spongy bone. This understanding is a misconception because, according to Nisa (2021), bone cells in the lacunae obtain nutrients from blood vessels in the Haversian canal through small canals.

Question item 5 has the second-highest percentage of misconceptions (60.19%) and is also in the high category. The indicator for the question is that students will be presented with a picture, then analyze the type of bone based on its shape, and group it into short or flat bones. The misunderstanding of the concept experienced by students in question item number 5 is because students understand that the spine is classified as a flat bone. This is an incorrect understanding because, in a study, Ginting et al (2022) stated that the spine, or os vertebrae, is included among the types of irregular bone (irregular ossa) because it has an erratic shape.

Student misconceptions about bone structure and function can result from decreased memory for previously learned concepts. The concept of bone structure and function also contains many terms that are difficult for students to remember. This can make it difficult for students to integrate their knowledge of the structure and function of bones. Then, in a study conducted by Fajriana et al (2016), concepts related to bones in the motion system materials are also among the concepts often misconceived in student textbooks. Misconceptions in student textbooks can be a cause of misconceptions experienced by students.

In the second sub-concept, namely Structure, Function, and Mechanism of Muscle Contraction, the percentage of student misconceptions was in the medium category at 40.25%. This percentage is higher than the percentage of students who understand concepts and those who do not. Students were given five questions on muscle contraction, structure, function, and mechanism.

The highest percentage of misconceptions in this sub-concept is found in question 6, at 55.86%, and it can be categorized as moderate. The indicator in question is that students are presented with a picture and then asked to analyze the types of muscle movements it shows. In the image of the athlete throwing a basketball, a misconception is that students think the movement of raising their shoulders when throwing the ball into the hoop is an adduction movement. This understanding is wrong because adduction is the movement that brings the limbs closer to the body's midpoint. Meanwhile, the shrug-raising movement is a movement away from the body's midpoint, so it is not an adduction movement. The misconception in number 6 may be due to students not remembering or having difficulty distinguishing between the terms abduction and adduction.

Then the average percentage of students who do not understand the concept, 28.15%, is the largest among the four sub-concepts. The percentage of students who do not understand the concept in this sub-concept is highest for question 9, which concerns the mechanism of muscle contraction. Furthermore, within the sub-concept of Joint Structure and Function, it was found that students exhibited misconceptions at 35.31%, placing them in the medium category. This percentage is the lowest among the sub-concepts, or, more precisely, the student misconceptions in this sub-concept as a whole are the lowest. Then, if you look at the percentage, it is known that there is one question item that is included in the misconception with a low category, namely, in question 11, and the rest are in the medium category.

The misconception among students with the highest percentage in this sub-concept occurred in question 12, with 51.23%. The indicator of the question is that students are asked to analyze the type of joint based on the movement of the joint between the pubic and pelvic bones. Students who experience misconceptions partly understand that the joint is a diarthrosis joint, while some other students understand that the joint is an amphiarthrosis joint that can be moved freely. The joint between the pubic symphysis and the pelvic bone, according to Erliana (2023), is an amphiarthrosis, also known as a cartilaginous joint. This joint is a cartilage joint that connects bones without a joint cavity, so it has very limited movement.

Misconceptions can be caused by poor student memory. Students have difficulty remembering foreign terms found in joint material, such as diarthrosis, amphiarthrosis, and synarthrosis. It is also revealed by Jayanti & Susantini (2021) that foreign terms that are difficult for students to remember or understand will be one of the causes of misconceptions.

Research by Widiastutik & Isnawati (2021) also revealed that student retention and memory play a major role in the misconceptions experienced by students. Students whose retention or memory begins to decline will find it difficult to integrate the concepts they have learned, which can lead to misunderstandings. Meanwhile, students with high memory capacity will find it easier to remember previously learned concepts.

In the sub-concept of Disorders and Disorders in the Human Movement System, it was found that students held misconceptions in the medium category, with an average percentage of 46.48%. This sub-concept has the highest percentage of misconceptions among the four sub-concepts in the matter of motion systems. As for the percentage of concept understanding in this sub-concept, it is the lowest at 28.77%. The question with the highest percentage of student misconceptions, 59.26%, is at number 16. The question indicates analysis of disorders in human muscles, specifically muscle atrophy. Students who hold misconceptions about this number, on average, understand that polio immunization is not among the measures that can prevent muscle atrophy. This is a misunderstanding because complete polio immunization from infancy can be a preventive measure against poliovirus, which can cause atrophy. Trifani et al (2018) stated that polio is an infectious disease caused by viral infection of anterior spinal cord cells and the motor nucleus in the brainstem, which can cause paralysis and muscle atrophy.

Students who experience misconceptions in this material are because they do not fully understand polio. Polio is a disease that can cause muscle atrophy and paralysis. Students consider polio and muscle atrophy to be two different diseases. Based on research conducted by Novitasari & Susantini (2021), one cause of misconceptions is students' incomplete understanding of the material. Students who only partially understand concepts will tend to deduce their own concepts from the results of reasoning and relate them to concepts they remember. When working on a problem, students with an incomplete understanding will reason and conclude inappropriately, ending up with a misconception.

Misconceptions experienced by students in the material on human motion systems can be influenced by various factors, both within the students themselves and from outside. One factor that can cause students to experience misconceptions is forgetting the material taught due to the time lag between students receiving the material and the implementation of the misconception analysis, which is quite long. Research conducted by Kusairi & Zulaikah (2016) revealed that students are unable to recall the material they have learned due to poor retention or memory of these concepts. Poor memory can also lead to different understandings, potentially resulting in misconceptions, because students are unable to properly abstract a previously studied concept.

Misconceptions among students can also be caused by limited conceptual understanding, as they do not seek deeper information related to the material they are studying. Students sometimes find it difficult to understand a concept, but they do not have the courage to ask questions to the teacher, which can make their understanding of a concept less good (Novitasari & Susantini, 2021). This will ultimately mean that students, from the beginning, do not have a good understanding of the material on the human movement system, which will have an impact on their future. The material taught by the teacher becomes less relevant to the students, so the existing concepts are not well understood.

Misconception analysis can also be used as a process of teacher improvement. This is inseparable from the factors that lead to misconceptions, one of which can be teachers. Novitasari & Susantini (2021) explained that teachers can also be a factor in causing misconceptions due to improper learning methods, poor mastery of the material, and a lack of ability to explain the material to students. Research by Guerra-Reyes et al (2024) reveals that students' misconceptions can stem from teachers' misconceptions. Teachers who experience misconceptions are very likely to cause students to experience them. In general, teacher misconceptions stem from the teacher's own thinking, arising from misinterpretations when

reading textbooks. In addition, teachers' misconceptions can be influenced by misconceptions in the textbooks they read.

Students can face obstacles in learning due to misconceptions. The results of the misconception analysis can identify the locations of misconceptions, enabling teachers to address those experienced by students (Sari et al., 2022). Suparno (2013) stated that, in an effort to overcome misconceptions, three steps can be taken: identifying the form of the misconception, analyzing the causes of the misconception, and applying the most appropriate methods to correct it.

Teachers who already know the location of the misconception in students can then take corrective steps to overcome the misconception. Students who face the same obstacles or difficulties can be grouped together so that teachers can provide the same treatment to overcome the misconceptions they experience. This is also described by Sari et al. (2022), who state that teachers can provide different methods and treatments to students according to needs or difficulties previously identified by the teacher, as an effort to improve activities. For example, providing repetition in learning related to the concept, or applying other learning methods such as group discussions, case studies, or other learning media, can help students understand the concept.

CONCLUSION

The results of the analysis of misconceptions among grade XI students in Bantul Regency on the Human Motion Systems material, using the Certainty of Response Index (CRI) method, are 41.7%, which falls within the medium category. When viewed as a whole, the results of the study showed that students who did not understand the concepts were 34.98%, and those who did were 23.97%. The misconception of the Human Movement System material experienced by grade XI students in Bantul Regency is found in the sub-concepts (1) structure and function of bones, (2) the structure, function, and mechanism of muscle contraction, (3) joint structure and function, and (4) disorders and abnormalities in the human movement system. The most common misconception concerned the number of sub-concepts of disorders and abnormalities in the human movement system, at 46.48%. This research is very important as a basis for teachers to improve misconceptions in biology learning, especially in the material of human motion systems.

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