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Analysis of causes and strategies to reduce student misconceptions in science subjects at elementary school

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Abstract: This research is motivated by many students who feel they have understood magnetic material, but when the teacher conducts a test on magnetic material, low scores are obtained. This is certainly a challenge for teachers to teach magnetic material better so that students can understand it. This study aims to analyze students' misconceptions in learning science magnetic material at the elementary school level using the CRI (certainty of response index) method, which consists of 4 categories, namely MN (guessing), PK (understanding the concept), TPK (not understanding the concept), and M (misconception). This research uses a descriptive qualitative method to analyze the causes and solutions of misconceptions about magnetic material in depth. Data was collected through observation, interviews, and the CRI test. The results of the study stated that misconceptions were caused by students' preconceptions and imperfect understanding. In addition, this study found a link between concept understanding and misconceptions. Students who have low understanding tend to experience high misconceptions. Therefore, the ideal learning strategy in accordance with student characteristics is a conceptual learning model combined with interactive learning media.

Keywords: Causes, misconceptions, reduction, science, strategies

Abstrak: Penelitian ini dilatarbelakangi oleh banyak siswa yang merasa telah memahami materi magnet, tetapi ketika guru melakukan tes pada materi magnet diperoleh nilai yang rendah. Hal ini tentu menjadi tantangan guru untuk mengajarkan materi magnet lebih baik agar dapat dipahami siswa. Penelitian ini bertujuan untuk menganalisis miskonsepsi siswa pada pembelajaran IPA materi magnet tingkat SD (sekolah dasar) dengan menggunakan metode CRI (certainty of response index) yang terdiri dari 4 kategori yaitu MN (menebak), PK (paham konsep), TPK (tidak paham konsep), dan M (miskonsepsi). Penelitian ini menggunakan metode kualitatif deskriptif untuk menganalisis penyebab dan solusi miskonsepsi pada materi magnet secara mendalam. Pengumpulan data dilakukan dengan cara observasi, wawancara, dan tes CRI. Hasil dari penelitian menyatakan bahwa miskonsepsi disebabkan oleh prakonsepsi dan pemahaman siswa yang belum sempurna. Selain itu, dalam penelitian ini ditemukan adanya kaitan antara pemahaman konsep dan miskonsepsi. Siswa yang memiliki pemahaman yang rendah cenderung mengalami miskonsepsi yang tinggi. Oleh karena itu, strategi pembelajaran yang ideal sesuai dengan karakteristik siswa adalah model pembelajaran konseptual yang dipadukan dengan media pembelajaran yang interaktif.

Kata kunci: Penyebab, miskonsepsi, pengurangan, sains, strategi

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INTRODUCTION

Education in schools has an important role in shaping students' attitudes, behaviors, and characters so that they can develop properly (Ihsan et al., 2024). One of the lessons that must be learned in elementary school is science. Mastery of scoence as one of the learning is very important (Maison et al., 2020; Nasir, et al., 2024). Science learning is important to be taught to introduce students to the basic knowledge around them and apply it in life (Fitriyanti et al., 2025; Maryani & Atmojo, 2024). According to Nurfiyani et al. (2020), learning objectives can be achieved if science learning involves interaction between learning components. A good understanding of basic science concepts can be the foundation for learning at the next level. Students who do not understand basic concepts become increasingly confused with more complex concepts (Phandini et al., 2023). This is certainly very worrying because students consider the material taught to be increasingly difficult so that students lose interest in learning. Science requires deep understanding, critical thinking, and logical thinking (Aprillia et al., 2024). Based on the opinion of these researchers, science lessons are important to learn because the basic concepts of science are related to everyday life.

Student misconceptions in science subjects are still high (Hajiriah et al., 2019). Misconceptions or misconceptions are discrepancies between concepts and basic scientific concepts or those accepted by experts in the field (Suparno, 2005). Students have an initial concept that is different from the concept intended by experts (Fuadiah, 2016). Students more often make misconceptions unintentionally so that they can hinder subsequent learning (Didik et al., 2020). Misconceptions are a challenge, especially for 5th grade students who are starting to learn abstract science materials such as magnets. Students develop new concepts by using incorrect basic concepts.

Misconceptions occur due to self, learning methods, teachers, and the learning environment (Afidah, 2020). Misconceptions that occur due to self factors such as preconceptions in learning. Students build their own concepts based on previous experience and knowledge (Zulkarnaen, 2020). The concepts that students bring before receiving learning are often misunderstood. The misconceptions that occur are caused by students who answer according to their intuition (Awal et al., 2018). In addition, inappropriate learning methods cause misconceptions to occur. Methods are closely related to learning models. The selection of the right learning model aims to achieve the established assessment standards (Sembiring et al., 2021). The way teachers teach is also one of the factors that cause misconceptions among students. The teacher as a person who interacts directly with students and influences how students complete tasks (Wijayanti & Ngazizah, 2023). Students must learn, so they need to be active in learning (Isrokatun et al., 2023). Other research conducted by Chen and Andersson (2023) on science needs to provide opportunities for students to be active in learning. The more teachers provide space for students to think critically, the higher the students' understanding. Lack of opportunities for students to interact with concrete objects due to teacher-centered learning (Pambudi et al., 2022).

Previous research on science has been done. Research by Awal et al. (2018) found that there were misconceptions in microbiology material, especially question number 13, which was 55%. Other research discusses the basic concepts of science in elementary school teacher education students showing a high level of misconceptions (Subayani, 2016). This research shows that misconceptions still often occur in science materials from various levels of education. Musni et al. (2021) have researched more specifically regarding magnets. They found that high misconceptions were found in junior high school students. Based on this research, misconceptions about magnets have occurred since junior high school. Meanwhile, the most basic learning of magnetic material has been taught since primary school. This raises the suspicion that misconceptions occur at the elementary level. Therefore, it is necessary to conduct research to analyze misconceptions, especially the material 'magnetism, electricity, and technology for life' in grade 5 in one of the private elementary schools in Purworejo.

Currently, science learning in grade 5 elementary schools, especially the material 'magnetism, electricity, and technology for life' in one of the private elementary schools in Purworejo, is still focused on the material in the package book. The use of a teacher-centered learning model. This causes students to be passive and lack understanding of the material (Nuriyah et al., 2024). Many students are not active in asking questions and are shy to express their opinions (Annisa et al., 2024). Teacher-focused learning causes students to lose motivation to learn magnetic materials. When the teacher asks whether all students have understood what the teacher has said, students will answer that they have understood. Many students are not active in asking questions and are shy to express their opinions. At the end of the lesson, the teacher will conduct a learning evaluation to measure the extent of students' understanding (Ota et al., 2023). However, when the teacher conducts an evaluation on magnetic material, students get low scores so the teacher needs to do remedial so that students reach the expected target value. The low quality of education, especially science subjects, is determined by the quality of education at the previous level (Awal et al., 2018).

Based on several sources, the impact of misconceptions is divided into two points of view, namely negative and positive. Misconceptions are seen as another term so that they can be used to solve the same problem with different solutions (Hamza & Wickman, 2008). Meanwhile, other studies say the opposite. Misconceptions as a problem that hinders the learning process (Zulkarnaen, 2020). This is supported by an article recently discussed in an online community about junior high school students who cannot read and write. A junior high school teacher was shocked that many students still did not understand the basic concepts of reading and writing (Fadillah, 2023). These different perspectives will be studied in depth to determine the right learning model.

The right learning model is needed to reduce misconceptions (Mufit et al., 2023). The conceptual change learning model has been proven effective in building student understanding (Rohmah & Fadly, 2021). Research shows a correlation between conceptual change and conceptual understanding (Addido et al., 2022). Misconceptions can be corrected using CCM (Conceptual Change Model) (Samsudin et al., 2024). Interviews provide information related to the development of effective assessment and learning strategies to facilitate conceptual change that benefits students in learning (Ding et al., 2024).

CRI (Certainty of Response Index) as a technique for analyzing misconceptions is present to measure the level of student confidence in answering questions (Chen & Andersson, 2023). To detect misconceptions, a study was conducted using the CRI technique. The CRI test technique was developed by Hasan Saleem Bagoyoko (Tayubi, 2014). The CRI technique has been used for a long time to analyze misconceptions that occur in various fields, especially science. This technique allows students to answer questions about the tested material equipped with a CRI scale to determine the level of student confidence in determining the answer. Many studies have analyzed misconceptions using CRI because it can be divided into four categories, namely guessing, understanding the concept, not understanding the concept, and misconceptions (Disnawati & Deda, 2022). So that the CRI technique is proven to be able to analyze misconceptions well. However, the use of the CRI technique has the disadvantage of ignoring response errors so that it has low sensitivity when analyzing complex data (Chen & Andersson, 2023). Therefore, the use of the CRI technique in analyzing questions on material in elementary schools can facilitate teachers in analyzing the form of questions more simply.

The first step to uncovering misconceptions is uncovering misconceptions (Hamdani, 2020). Therefore, research needs to be done to analyze students' misconceptions on magnetic materials. The purpose of this study was to determine the level of students' misconceptions on magnetic material in grade 5 of one of the private elementary schools in Purworejo. In addition, this study aims to determine the causes of misconceptions, the impact of misconceptions, and provide input on appropriate learning strategies.

METHOD

The method in this research is qualitative research which is described in descriptive form. Qualitative research prioritizes natural settings and natural methods (Moleong, 2021). The research allows in-depth analysis so as to find the causes and recommend learning strategies to reduce misconceptions on magnetic materials. The research was carried out with observations and interviews to find out the problems faced in magnetic materials. Furthermore, the researchers analyzed misconceptions on magnetic materials by giving students multiple-choice questions that have been equipped with a CRI scale. The data from the CRI test was then analyzed to determine the level of misconceptions in one of the private elementary schools in Purworejo Regency.

This research was conducted from August to September 2024. The place of this research was grade 5 in one of the private elementary schools in Purworejo Regency. The population of this study were students of private elementary schools in Purworejo Regency. Application of the sample with purposive sampling technique. This technique allows researchers to determine the sample based on the criteria set by the researcher. There were 29 5th grade students of Purworejo Regency Private Elementary School as the research sample. The research process is divided into three stages, namely the preparation, implementation, and data analysis stages.

Preparation

The preparation stage was carried out by preparing observation instruments, interviews, and CRI questions to get clearer data about the problems faced. After the observation and interview data were collected, the next step was to make a CRI (certainty of Response Index) test instrument. The questions are arranged based on indicators from the science learning book on magnetic material (Ghaniem et al., 2021).

Table 1: Indicators of magnetism, electricity, and technology for life materials

Variables	Indicator	Sub-Indicators
Magnet Material Indicator	Explaining the Definition of Magnetism	1. Explain the meaning of magnetism and its properties 2. Identify the types of magnets, including natural and artificial magnets 3. Identify the strength of magnetic attraction

	Explaining Magnetic Poles	4. Explain the concept of the north pole and south pole of a magnet 5. Identify magnetic poles that attract and repel each other 5.
	Identify materials that can be Attracted by magnets	6. List the materials that can be attracted by magnets (ferromagnetic) 7. Classify objects based on magnetic attraction. 8. Analyze the interaction of magnets with various materials
	Explaining magnetic field	9. Draw the magnetic field and magnetic lines of force 10. Explain how a magnetic field is formed around a magnet 11. Explain the effect of a magnetic field on surrounding objects
	Explaining how to make a magnet	12. Explain the relationship between electrical energy and magnetism 13. Identify ways of making magnets, such as induction, using electric current, and rubbing. 14. Analyze the process of making a simple magnet
	Explaining the use of magnets in everyday life	15. List the uses of magnets in everyday life, such as compasses, electric motors, and electronic devices 16. Explain the benefits of magnets in technology and industry

The indicators in table 1 were analyzed and then made into 16 items. Each question is equipped with a CRI scale to analyze the level of student confidence in answering the question.

Implementation

This stage is the stage where data is collected through multiple-choice types equipped with a CRI scale. Students were given 20 minutes to answer 16 questions by putting a cross on the selected option. In addition, students were also asked to fill in the CRI scale to determine the level of student confidence in answering the question. After the test was completed, student answer sheets were collected as raw data used for further analysis.

Analysis of Misconceptions

Student answer sheets that have been collected are then assessed to determine correct and incorrect answers. After completion, then enter the data analysis stage of the students' answers by grouping the CRI answers. Data analysis is adjusted to the type of conception. The scale used in the CRI technique is 0 to 5. Awal et al. (2018) explains tha the results of the data analysis of the answers produced answers.

1. Guessing if the student answers the question correctly with the confidence level of the CRI scale choosing to guess, almost guess, or not sure.

2. Understand the concept if the student answers correctly with the confidence level of the CRI scale choosing sure, almost right, or right.
3. Do not Understand the Concept if the student answers incorrectly with the confidence level of the CRI scale choosing guessing, almost guessing, or not sure.
4. Misconception if the student answers incorrectly with the confidence level of the CRI scale choosing sure, almost right, or right.

Furthermore, conceptions were analyzed in the form of percentages. Data analysis was reviewed from the percentage of conception on each item and analysis of the overall conception of the question. Percentage of conception on magnetic material using percentage calculation according to Putri and Desstya (2024) as follows:

$$\text{Percentage} = \frac{f}{n} \times 100\% \qquad (1)$$

Information
P = Percentage of Concept
f = Number of Conception Scores
n = Total Score

Misconceptions are categorized into three levels based on the percentage value, namely low, medium and high. The higher the percentage in one of the magnetic material indicators, the more students who experience misconceptions so that it requires special attention to analyze the causes and determine the right strategy to reduce misconceptions. The level of misconception according to (Handayani & Rukmana, 2018) are in table 2.

Table 2: Misconception levels

Percentage	**Category**
1%-30%	Low
31%-60%	Medium
61%-100%	High

RESULTS AND DISCUSSION

The results of misconceptions of magnetic material include the description of each indicator and each item. The data analyzed includes the categories of guessing, not understanding the concept, understanding the concept, and misconceptions. Based on students' diagnostic test answers, the following is the classification of conceptions on each indicator.

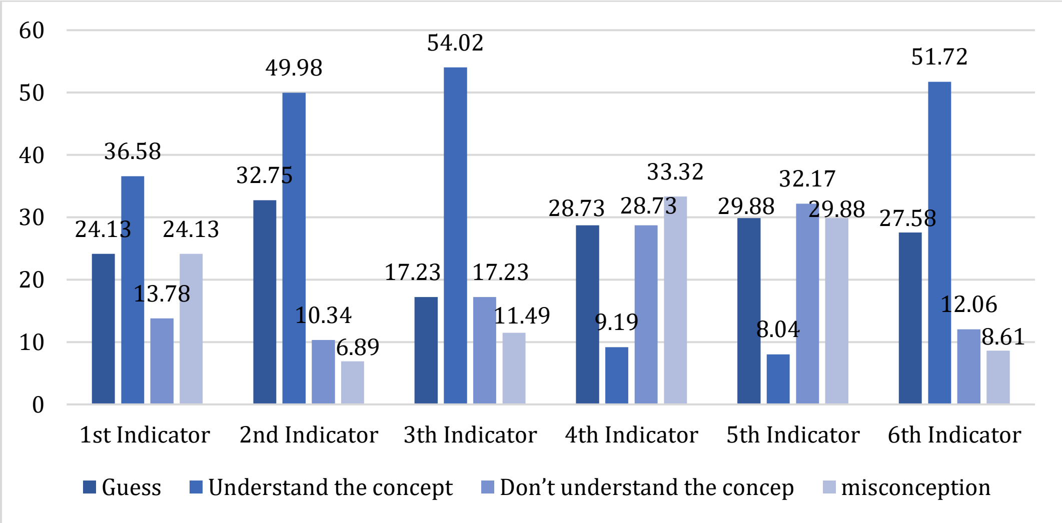


Fig.1. CRI test percentage results for each indicator

The first indicator is understanding the meaning of magnetism. Students are expected to be able to understand the meaning of magnets; identify types of magnets; and determine the strength of magnetic attraction. Based on the results of Figure 1, students' understanding of the concept of magnetism reached 36.58%. Many students have understood the basic concept of magnetism. However, the percentage of students who guess and experience misconceptions is equally large. The high student understanding of the magnetic understanding indicator is due to the material discussed is still in the easy category.

The second indicator is explaining magnetic poles. Students are expected to be able to understand the poles on the magnet and the interaction between the two poles. Almost 50% of students have understood the concept of poles in magnets. The misconception with the smallest percentage was in the second indicator with a percentage of 6.89%. The highest percentage of guessing was in the second indicator at 32%. This shows that most students have mastered the poles on the magnet and the magnetic properties of the two poles. However, there are still many students who feel less confident in determining the CRI confidence scale.

The third indicator is identifying magnetic materials. In this indicator, students are expected to be able to distinguish materials that can be attracted by magnets and cannot be attracted by magnets; classify objects based on magnetic attraction; and analyze the interaction of magnets with certain materials. The results of Figure 1 show the highest concept understanding compared to other indicators, which is 54.02%. This concept understanding is supported by the low misconceptions and incomprehension of students. Based on the results of teacher interviews, students have indeed done practicum related to ferromagnetic materials. This direct test was carried out by involving active student involvement in the teaching and learning process.

The fourth indicator is about magnetic fields. Students are expected to be able to understand magnetic lines of force; explain how magnetic fields are formed; and explain the effect of magnetic fields on surrounding objects. The fourth indicator experienced the highest misconception with a percentage of 33.32%. Many students do not understand the concept of magnetic lines of force. This can be seen from the low percentage of student understanding of 9.19%. Based on the material listed in the textbook, the magnetic lines of force are actually imaginary lines. This causes many students to misunderstand the concept.

The fifth indicator discusses how to make a magnet. Students are expected to be able to explain the relationship between electrical and magnetic energy; identify how to make a magnet; and analyze simple magnet making. The results of data analysis show that the highest aspect of not understanding the concept is focused on the fifth indicator with a percentage of 32.17%. The high percentage of not understanding the concept is directly proportional to the misconceptions that are quite high at 29.88%. Based on the interviews conducted, this is due to the infrequent frequency of magnet making practice.

The last indicator discusses the use of magnets in everyday life. Students are expected to be able to correctly mention the use of magnets in everyday life and explain the benefits of magnets in industrial technology. The results of the analysis showed that students' high understanding reached 51.72%. This concept understanding is inversely proportional to the level of misconceptions and not understanding the concept. This is interesting to discuss because it raises new questions. How can students be able to give examples of the use of magnets in everyday life while their understanding of the magnetic field and how to make magnets has high misconceptions? It turns out that students are able to mention the use in everyday life because they often see the use of magnets in their homes such as refrigerators and compasses. The reason why misconceptions continue to occur in learning is because misconceptions help students in their daily lives (Suparno, 2005).

Based on the results of the analysis above, the misconceptions of fifth grade students in one of the private elementary schools in Purworejo in the fourth indicator amounted to 33.32%. The results of the analysis show that there is a relationship between the aspects of understanding the concept and misconceptions. To discuss the material more deeply, the misconception analysis is discussed based on each item. The percentage analysis of the CRI test in terms of each question number is presented in Table 3.

Table 3. Percentage results of the CRI test

Question	Guess	Understand Concept	No Understand Concept	Misconceptions
1.	8 (27,58%)	13 (44,82%)	1 (3,44%)	7 (24,13%)
2.	7 (24,13%)	14 (48,25%)	4 (13,79%)	4 (13,79%)
3.	6 (20,68%)	6 (20,68%)	7 (24,13%)	10 (34,48%)
4.	12 (41,37%)	14 (48,25%)	3 (6,89%)	1 (3,44%)
5.	7 (24,13%)	16 (51,72%)	4 (13,79%)	3 (10,34%)
6.	5 (17,24%)	10 (34,48%)	9 (31,03%)	5 (17,24%)
7.	3 (10,34%)	21 (72,41%)	2 (6,89%)	3 (10,34%)
8.	7 (24,13%)	16 (55,17%)	4 (13,79%)	2 (6,89%)
9.	8 (27,58%)	2 6,89%	14 44,82%	6 20,68%
10.	11 (37,93%)	4 (13,79%)	7 (24,13%)	7 (24,13%)
11.	6 (20,68%)	2 (6,89%)	5 (17,24%)	16 (55,17%)
12.	12 (41,37%)	5 (17,24%)	7 (24,13%)	5 (17,24%)
13.	5 (17,24%)	2 (6,89%)	12 (41,37%)	10 (34,48%)
14.	9 (31,03%)	0 (0%)	9 (31,03%)	11 37,93%
15.	5 (17,24%)	20 (68,96%)	2 (6,89%)	2 (6,89%)
16.	11 (37,93%)	10 (34,48%)	5 (17,24%)	3 (10,34%)

Based on the results of the analysis in Table 3, an analysis of misconceptions in each question number 1 to 16 on magnetic material is shown. Problem number 1 presents a question about the definition of a magnet as presented in Figure 2. A simple question about the definition of a magnet is designed with four choices that trick students. If students do not understand magnetic material, students can be fooled by other answers. Based on the results of the analysis of table 3, 13 students were able to understand question number 1. This can be seen from the level of student understanding reaching 44.82% and the level of misconception is less than 30%. However, there were still 8 students who guessed because they were unsure of the answer they chose. Based on the interview results, students have low self-confidence, potentially hesitant in answering questions.

1. Apa yang dimaksud dengan magnet?
   X Magnet adalah suatu logam yang memiliki kemampuan menarik benda lain yang memiliki unsur plastik
   b. Magnet adalah suatu logam yang memiliki kemampuan menarik benda lain yang memiliki unsur besi
   c. Magnet adalah suatu logam yang memiliki kemampuan menarik benda lain yang memiliki unsur perak
   d. Magnet adalah suatu logam yang memiliki kemampuan menarik benda lain yang memiliki unsur tembaga

CRI (*Certainty of Response Index*):

Menebak (0)	Hampir Menebak (1)	Tidak Yakin (2)	Yakin (3)	Hampir Benar (4)	Benar (5)
			X		

Fig. 2. Example of answer to question number 1

The next question discusses natural magnets and artificial magnets. The problem is presented in the form of a story related to natural magnetism in Figure 3. The test results in table 3 show that most students have understood artificial magnets and natural magnets. This can be seen from the value of student understanding is higher than the other values, which is 48.25%. Meanwhile, there were 7 students who answered correctly but lacked confidence in their answers. So that their answers are categorized as guessing answers. Based on the interview results, low confidence can occur because these students have a closed nature and are rarely involved in the learning process.

2. Arina mendapatkan magnet yang terbuat dari batuan alam di daerah Magnesia. Benda yang dimaksud merupakan jenis magnet…
   a. Buatan
   b. Sementara
   X Alami
   d. Tetap

CRI (*Certainty of Response Index*):

Menebak (0)	Hampir Menebak (1)	Tidak Yakin (2)	Yakin (3)	Hampir Benar (4)	Benar (5)
			X		

Fig. 3. Example of answer to question number 2

In question number 3, misconceptions occurred in 10 students with a score of 34.48% and students who understood the concept were 6 students or 20.68% of students. One example of a student's answer that has misconceptions is presented in Figure 4. Based on the results of the analysis, question number 3 is categorized into moderate misconceptions. Nevertheless, the misconceptions in this question need to be studied in depth to find out the causes. The interview results show that many students assume that the strongest magnetic field force is centered in the middle of the magnet. This can happen because students assume that all parts of the magnet can attract iron. This misconception can be minimized by providing students with a deeper understanding of the indicators of understanding the meaning of magnets, especially identifying the strength of magnetic attraction.

3. Gaya magnet terkuat terletak pada bagian…
   a. Kutub utara
   ~~b.~~ Tengah
   c. Kutub selatan
   d. Kedua kutub

CRI (*Certainty of Response Index*):

Menebak (0)	Hampir Menebak (1)	Tidak Yakin (2)	Yakin (3)	Hampir Benar (4)	Benar (5)
			X		

Fig. 4. Example of answer to question number 3

Problem number 4 discusses the concept of north and south poles. One example of a student answer is presented in Figure 5. The question presented discusses the definition of the south pole of a magnet. Based on the results in Table 3, some students were able to explain the concept well. However, many students also guessed due to the students' low level of confidence so they were hesitant in answering the questions.

4. Apa yang dimaksud dengan kutub selatan pada magnet?
   a. Bagian magnet yang menunjuk ke utara
   ~~b.~~ Bagian magnet yang menunjuk ke selatan
   c. Bagian magnet yang berwarna biru
   d. Bagian magnet yang tidak mempengaruhi arah kompas

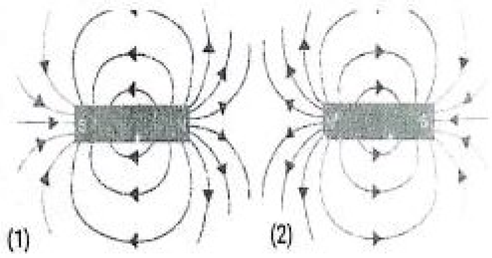
CRI (*Certainty of Response Index*):

Menebak (0)	Hampir Menebak (1)	Tidak Yakin (2)	Yakin (3)	Hampir Benar (4)	Benar (5)
		X			

Fig. 5. Example of answer to question number 4

The same thing happened in question number 5 about identifying magnetic poles that attract and repel each other. The problem presented in Figure 6 shows a picture of two magnets with the same poles brought closer together. The drawing of the magnetic lines of force shows the repulsive reaction between the two magnets. Students are asked to analyze the picture and give the most appropriate answer. Most students have understood the concept, but there are still quite a lot of guesses. Based on the interview results, many students were afraid to show their confidence because if the answer was wrong, they would receive consequences from the teacher. Therefore, in addition to solidifying students' understanding, teachers need to build the confidence of students who have a shy nature by involving them in learning.

5. Perhatikan gambar berikut!



Apa yang akan terjadi jika dua kutub utara magnet didekatkan satu sama lain?

a. Magnet 1 menolak magnet 2
b. Magnet 1 menarik magnet 2
c. Tidak ada interaksi yang terjadi antara magnet 1 dan 2
d. Mereka akan berputar mengelilingi satu sama lain

CRI (Certainty of Response Index):

Menebak (0)	Hampir Menebak (1)	Tidak Yakin (2)	Yakin (3)	Hampir Benar (4)	Benar (5)

Fig. 6. Example of answer to question number 5

Problem number 6 discusses materials that can be attracted by magnets. In Figure 7, students are asked to choose which materials can be attracted by magnets. Based on the results of Table 3 analysis, the number of students who understand the concept and do not understand the concept is almost the same. A total of 10 students have understood the concept and 9 students have not understood the concept of ferromagnetics. Based on the observation during the CRI test, many students were fooled by the answer 'Cobalt' as a material that can be attracted by a magnet. Thus, many students chose the wrong answer.

6. Bahan mana yang tidak dapat ditarik oleh magnet (ferromagnetik)?

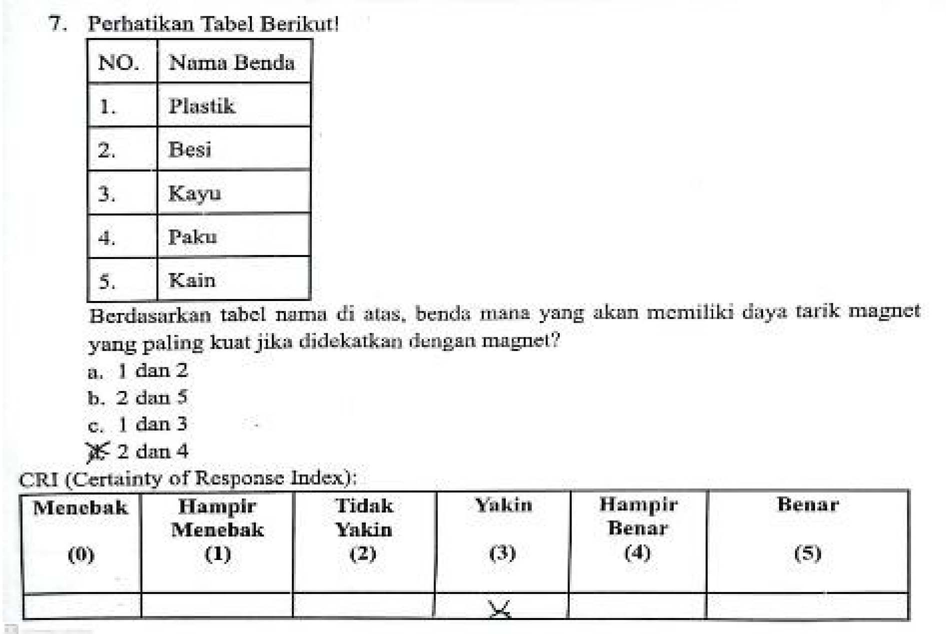
a. Besi
b. Nikel
c. Alumunium
d. Kobalt

CRI (Certainty of Response Index):

Menebak (0)	Hampir Menebak (1)	Tidak Yakin (2)	Yakin (3)	Hampir Benar (4)	Benar (5)

Fig. 7. Example of answer to question number 6

Problem number 7 discusses the grouping of objects based on magnetic attraction. The data is presented in the form of a table and then students are asked to analyze the table as in Figure 8. Students are asked to classify objects that can be attracted by magnets. The test results show that students' understanding has reached 72.41%. Based on the analysis results, most students have understood the concept of ferromagnetic materials. This can be seen from the low misconception data and high concept understanding. This shows that the teacher successfully conveys the material to students so that it can improve learning outcomes.



7. Perhatikan Tabel Berikut!

NO.	Nama Benda
1.	Plastik
2.	Besi
3.	Kayu
4.	Paku
5.	Kain

Berdasarkan tabel nama di atas, benda mana yang akan memiliki daya tarik magnet yang paling kuat jika didekatkan dengan magnet?

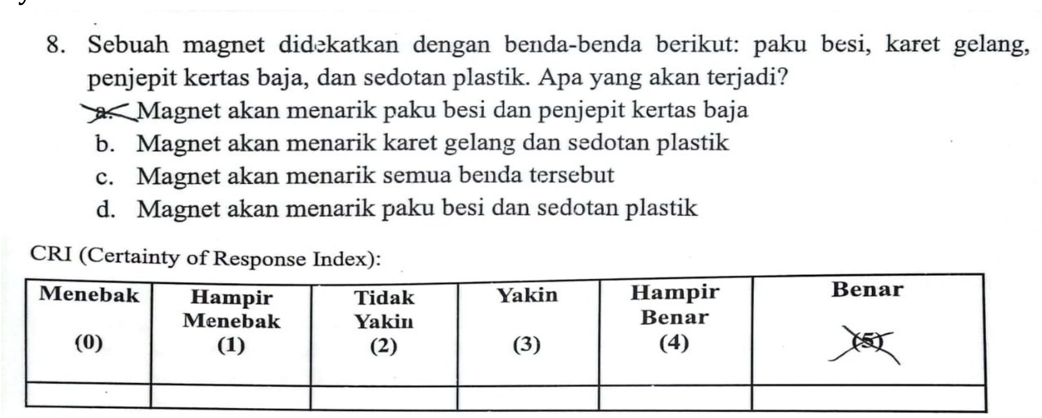
a. 1 dan 2
b. 2 dan 5
c. 1 dan 3
d. 2 dan 4

CRI (Certainty of Response Index):

Menebak (0)	Hampir Menebak (1)	Tidak Yakin (2)	Yakin (3)	Hampir Benar (4)	Benar (5)
			X		

Fig. 8. Example of answer to question number 7

The next question is to analyze the interaction of magnets with various materials as in Figure 9. This question tests students' understanding of ferromagnetic properties by presenting a story problem. Students are asked to analyze the possibilities that occur when a magnet is brought close to a variety of different objects. Although questions number 7 and 8 discuss ferromagnetics, the test results between the two questions are very different. based on the results of table 3, student understanding dropped to 55.17% and the number of students who guessed the answer increased. This indicates that students do not fully understand ferromagnetic material. Students are still hesitant to determine answers to questions that rely heavily on literacy skills, therefore, students need to improve their literacy skills.



8. Sebuah magnet didekatkan dengan benda-benda berikut: paku besi, karet gelang, penjepit kertas baja, dan sedotan plastik. Apa yang akan terjadi?

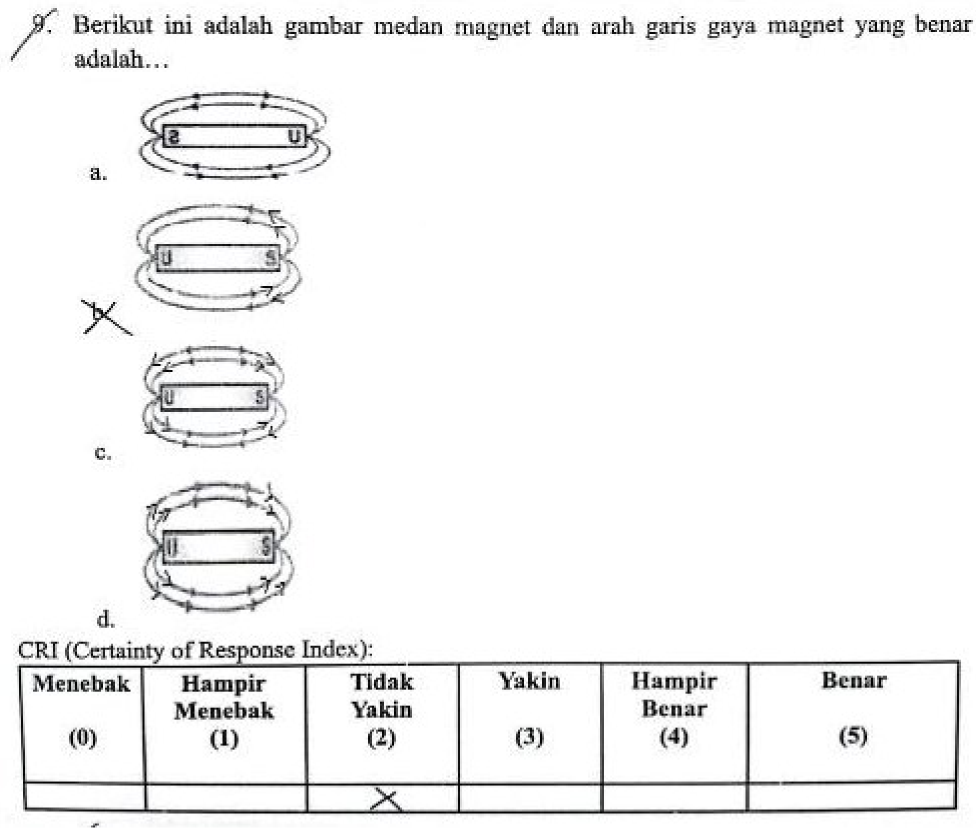
a. Magnet akan menarik paku besi dan penjepit kertas baja
b. Magnet akan menarik karet gelang dan sedotan plastik
c. Magnet akan menarik semua benda tersebut
d. Magnet akan menarik paku besi dan sedotan plastik

CRI (Certainty of Response Index):

Menebak (0)	Hampir Menebak (1)	Tidak Yakin (2)	Yakin (3)	Hampir Benar (4)	Benar (5)

Fig. 9. Example of answer to question number 8

Problem number 9 discusses the magnetic field and magnetic lines of force presented in Figure 10. The type of problem presented is a question with a picture answer. Students are asked to choose the correct magnetic image according to the direction of the magnetic lines of force. This type of question trains students' accuracy in seeing the direction of magnetic lines of force and magnetic poles. Although the magnetic field and magnetic lines of force are in the textbook, many students are still confused about the magnetic lines of force. The abstract nature of magnetic lines of force makes it difficult for students to realize how the basic concept of magnetic lines of force. This can be seen from the low level of student understanding of the concept. To explain abstract material, teachers can use animated image media as well as research that has previously been applied to Kudus University students. Animated picture media proved to be effective in reducing misconceptions (Zuliana, 2017).



9. Berikut ini adalah gambar medan magnet dan arah garis gaya magnet yang benar adalah…

a.

b.

c.

d.

CRI (Certainty of Response Index):

Menebak (0)	Hampir Menebak (1)	Tidak Yakin (2)	Yakin (3)	Hampir Benar (4)	Benar (5)
		X			

Fig. 10. Example of answer to question number 9

Problem number 10 discusses how a magnetic field is formed around a magnet as shown in Figure 11. This problem relates to the north and south poles of a magnet. A magnet is able to create a magnetic field because it has a north pole and a south pole. The test results showed that many students guessed their answers because their knowledge was limited to magnets having north and south poles. The teacher has not explained in depth about the origin of the magnetic field to the students. The percentage of misconceptions and incomprehension of the concept is the same at 24.13%. Meanwhile, concept understanding is only 13.79%. This shows that the magnetic field material has not been conveyed well to students.

10. Bagaimana cara medan magnet terbentuk di sekitar sebuah magnet batang?
  a. Oleh karena adanya gaya gravitasi magnetik yang menarik benda-benda logam
  b. Oleh karena adanya medan listrik yang dihasilkan oleh magnet
  c. Oleh karena adanya arus listrik yang mengalir di sepanjang batang magnet
  d. Oleh karena adanya kutub utara dan kutub selatan yang menghasilkan medan magnet

CRI (Certainty of Response Index):

Menebak (0)	Hampir Menebak (1)	Tidak Yakin (2)	Yakin (3)	Hampir Benar (4)	Benar (5)

Fig. 11. Example of answer to question number 10

Problem number 11 with the percentage of misconceptions reached 55.17% and student understanding was 2 students or 6.89%. When compared to other questions with misconceptions, question number 11 has the highest percentage. Based on Figure 12, the question presented asks for students' understanding of the effect of magnetic fields on surrounding objects. In the basic concept of magnetic field, if the magnet is kept away from objects that can be attracted by magnets, the magnetic field will be weaker so that metal objects will be weaker to be attracted by magnets. Students experience misconceptions because they are not careful in understanding the reading sentence. Thus, this misconception can be reduced by deepening students' understanding of the magnetic field.

11. Apa yang terjadi jika Anda memindahkan sebuah magnet lebih jauh dari benda logam yang sebelumnya ditarik oleh magnet?
  a. Medan magnet akan menjadi lebih kuat dan menarik benda logam lebih kuat
  b. Medan magnet akan tetap sama, tetapi benda logam tidak akan tertarik lagi jika terlalu jauh
  c. Medan magnet akan menjadi lebih lemah dan benda logam akan tertarik lebih lemah
  d. Medan magnet akan menghilang sepenuhnya dan tidak mempengaruhi benda logam

CRI (Certainty of Response Index):

Menebak (0)	Hampir Menebak (1)	Tidak Yakin (2)	Yakin (3)	Hampir Benar (4)	Benar (5)
			X		

Fig. 12. Example of answer to question number 11

Figure 13 discusses the relationship between electrical energy and magnetism. As we know that the energy produced by the movement of magnets can produce electrical energy that can be used for daily activities. Many students answered correctly. But because many had doubts about their own answers, most answers were categorized as guessing answers. The misconceptions in number 12 are also still relatively low. Nevertheless, teachers need to increase students' understanding by involving students directly. For example, such as showing students how electromagnetic performance on objects in everyday life.

12. Apa hubungan antara gaya magnet dan energi listrik?

a. Gaya magnet dapat menghasilkan energi listrik melalui pergerakan medan magnet.
b. Energi listrik dapat dihasilkan dengan memanaskan magnet.
c. Gaya magnet tidak memiliki hubungan dengan energi listrik.
d. Energi listrik hanya dapat dihasilkan oleh sumber energi lain seperti bahan bakar fosil.

CRI (Certainty of Response Index):

Menebak (0)	Hampir Menebak (1)	Tidak Yakin (2)	Yakin (3)	Hampir Benar (4)	Benar (5)

Fig. 13. Example of answer to question number 12

The third misconception occurred in question number 13 with a percentage of 34.48% and students who understood the concept were 2 people or 6.89%. This question discusses the identification of making magnets in various ways such as rubbing, induction, and using electric current. Figure 14 shows an example of students' answers to question number 13. Based on the results of the analysis and interviews with the 5th grade teacher, students have already made magnets using equipment provided by the school. However, the results of the CRI test on how to make a magnet still have misconceptions. This can occur because the sentences contained in the textbook and the sentences used in the questions have different sentence arrangements. So that students experience misconceptions in understanding the sentences presented in the questions. To overcome this, schools can optimize the literacy program for 15 minutes before learning begins.

13. Seorang siswa melakukan percobaan untuk membuat magnet dengan menggunakan berbagai metode berikut:

No	Cara membuat magnet
1.	Menggosokkan sebatang baja dengan magnet tetap beberapa kali searah.
2.	Menggantungkan sepotong besi pada magnet kuat selama beberapa hari.
3.	Memanaskan sepotong baja hingga merah, kemudian mendinginkannya di medan magnet kuat.

Berdasarkan metode yang dilakukan siswa tersebut, manakah di antara cara-cara tersebut yang benar untuk membuat magnet?

a. Hanya cara 1 yang benar
b. Hanya cara 2 yang benar
c. Cara 1 dan 2 benar
d. Semuanya benar

Fig. 14. Example of answer to question number 13

The last misconception is found in question number 14 with a percentage of 37.93% and no students who understand the concept. Figure 15 still discusses how to make a magnet by conduction. Magnets can be made by attaching iron to a magnet for a long enough period of time so that if the iron is only attached for a few minutes, the magnetic properties will not transfer to the iron. Multiple choice options in question number 14 are made with the aim of testing students' understanding of the concept of making conduction magnets. Misconceptions can occur because students are less able to understand similar sentences so that many students are fooled. To overcome this, schools can maximize literacy programs by providing reading materials derived from Permendiknas so that students' insights related to magnetic material can increase.

14. Manakah dari pernyataan berikut yang benar tentang cara membuat benda menjadi magnet?

a. Besi bisa menjadi magnet jika ditempelkan pada magnet selama beberapa menit.
b. Besi bisa menjadi magnet jika dipanaskan hingga merah dan didekatkan ke magnet.
c. Besi bisa menjadi magnet hanya jika dipukul dengan palu sambil ditempelkan pada magnet.
d. Besi bisa menjadi magnet jika berada dalam medan magnet selama waktu yang cukup lama.

CRI (Certainty of Response Index):

Menebak (0)	Hampir Menebak (1)	Tidak Yakin (2)	Yakin (3)	Hampir Benar (4)	Benar (5)
			X		

Fig. 15. Example of answer to question number 14

Problem number 15 discusses the use of magnets in everyday life. The question in Figure 16 is closely related to the use of magnetic energy to generate electricity. One of the objects that use electromagnetics is the refrigerator door. The way the refrigerator door works is to use electromagnetic energy to keep the door closed so that the temperature remains stable. Based on the analysis, most students have understood the use of electromagnetics in everyday life. This can be seen from the low value of misconceptions and incomprehension only occurs in 2 students. This shows that the application of electromagnetics has been used on a wide scale, making it easier for teachers to provide understanding to students related to examples of electromagnetic objects in everyday life.

15. Apa fungsi magnet pada pintu lemari es?

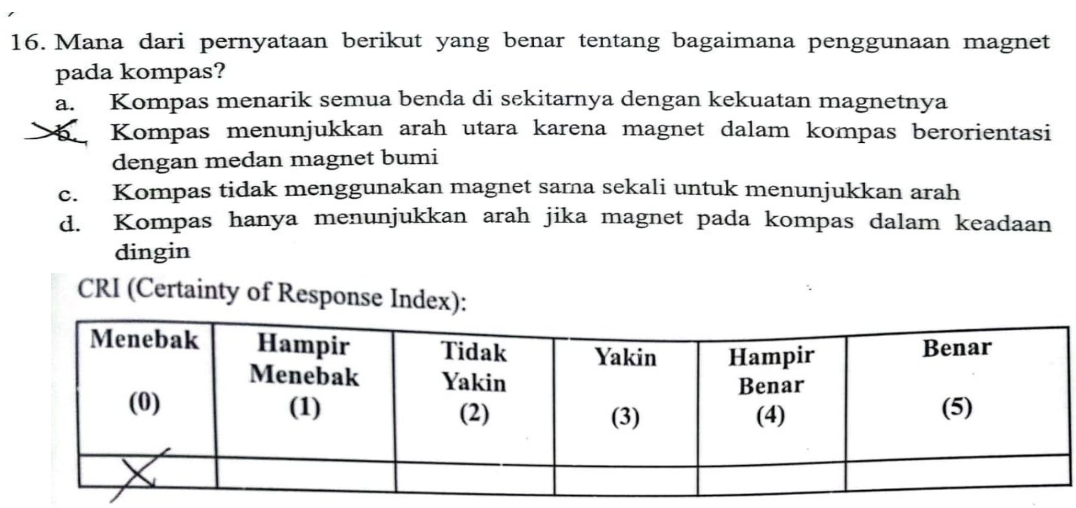
a. Magnet pada pintu lemari es membantu pintu tetap tertutup rapat
b. Magnet pada pintu lemari es menjaga makanan tetap dingin
c. Magnet pada pintu lemari es menarik semua benda di dalam lemari es
d. Magnet pada pintu lemari es membuat lampu di dalam lemari es menyala

CRI (Certainty of Response Index):

Menebak (0)	Hampir Menebak (1)	Tidak Yakin (2)	Yakin (3)	Hampir Benar (4)	Benar (5)

Fig. 16. Example of answer to question number 15

The last question number explains about the benefits in technology and industry found in Figure 17. The question tests students' understanding of the use of magnetic compasses in everyday life. Although questions number 15 and 16 are similar, the test results show different results. Many students had never seen a compass in person so they answered the questions with a feeling of doubt. As a result, the number of guessing and conceptualizing answers was almost the same. Meanwhile, misconceptions only occurred in 3 students.



16. Mana dari pernyataan berikut yang benar tentang bagaimana penggunaan magnet pada kompas?
a. Kompas menarik semua benda di sekitarnya dengan kekuatan magnetnya
b. Kompas menunjukkan arah utara karena magnet dalam kompas berorientasi dengan medan magnet bumi
c. Kompas tidak menggunakan magnet sama sekali untuk menunjukkan arah
d. Kompas hanya menunjukkan arah jika magnet pada kompas dalam keadaan dingin

CRI (Certainty of Response Index):

Menebak (0)	Hampir Menebak (1)	Tidak Yakin (2)	Yakin (3)	Hampir Benar (4)	Benar (5)
X					

Fig. 17. Example of answer to question number 16

Based on the results of the analysis, the CRI technique proved to be able to measure the misconceptions experienced by students in private elementary schools in Purworejo Regency on magnetic material. Misconceptions occurred in question number 3 by 34.48%, question number 11 by 55.17%, question number 13 by 34.48%, and question number 14 by 37.93%. While the average percentage of student understanding in question number 3 was 20.68%, question number 11 was 6.89%, question number 13 was 6.89%, and question number 14 was 0%. The data shows that the high level of misconception is inversely proportional to the low level of student understanding. this is in line with the misconception research by Tahir and Marniati. Students with low concept understanding experience high misconceptions (Tahir & Marniati, 2021).

Misconception factors in magnetic material are caused by preconceptions and imperfect understanding. Based on the results of analyzing each item, misconceptions in number 3 occur due to preconceptions. Misconceptions in numbers 11, 13, and 14 occur due to imperfect understanding. This finding aligns with research conducted by Zulkarnaen (2020), which found that students' conceptions could not solve problems. Preconceptions that students bring before learning need to be straightened out to minimize misconceptions at the next level of education. This proves that misconceptions need to be reduced because they can hinder the learning process. On the other hand, misconceptions encourage teachers to better understand students and develop better learning innovations. Although the pros and cons of the impact of misconceptions are contradictory, they are all interconnected so they can be justified. Therefore, students need to deepen their understanding of the concepts taught by the teacher.

Deepening the basic concepts in magnetic material can minimize misconceptions in students in elementary school. Proper understanding of concepts can be started by applying learning strategies that are appropriate to the problem at hand. appropriate learning. Based on the misconceptions experienced by 5th grade students of Purworejo Regency Private Elementary School, the appropriate learning strategy to reduce misconceptions is by applying a conceptual change learning model combined with interactive learning media. This is in line with previous research by Risma Ulinnuha Rohman and Wirawan Fadly. The conceptual change model aims to reduce misconceptions in students based on the STEM approach (Rohmah & Fadly, 2021). The conceptual change learning model allows students to understand the relationship between concepts with the help of columns and sign instructions as a visualization of concept mapping. In addition, learning media innovations to make it easier for students to understand the material also need to be improved (Saifudin & Suharso, 2021). This allows students to understand the concept as a whole and helps correct misconceptions of previous concepts. Students are expected to be able to learn anytime and anywhere to improve their abilities (Ngurahrai et al., 2019). Teachers need to provide interactive, innovative, and creative media to minimize misconceptions so that they are in accordance with the students' cognitive development stage (Maryani & Atmojo, 2024). This solution is in line with research on improving student understanding by using magic board props (Trengganis et al., 2024).

Although this study was able to identify misconceptions in students, there are still shortcomings in this study. One of them is that the sensitivity of calculations using the CRI technique is still lacking so that it affects the assessment. One example occurs with students in the guessing category. Many students answered the questions correctly, but felt less confident to show their level of confidence. This affected the percentage of concept understanding in the study. Therefore, it is better to combine the CRI technique with other techniques to get more accurate misconception results. One of the studies conducted by Chen and Andersson. Although the CRI approach ignores response and index measurement errors on each item, this can be overcome by using a mixed model that combines latent class models and measurement models (Chen & Andersson, 2023).

CONCLUSION

Based on the research results and discussion, the CRI (Certainty of Response Index) technique can detect misconceptions accurately. Based on the results of the analysis, moderate category misconceptions found in question number 3 amounted to 34.48%, number 11 amounted to 55.17%, number 13 amounted to 34.48%, and number 14 amounted to 37.93%. The factors that cause misconceptions are influenced by the initial concepts that students bring and imperfect understanding. Therefore, misconceptions in students should be utilized by teachers to deepen students' understanding by applying conceptual learning models combined with interactive learning media. So that it can reduce misconceptions in science subjects, especially magnetic material. As a suggestion, the use of the CRI technique can be combined with other techniques so that the level of sensitivity of the assessment can be higher.

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