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Unravelling Misconceptions: Analysing Primary School Pupils' Understanding on the Greenhouse Effect through the RASCH Model

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Abstract: The purpose of this study was to examine common misconceptions among elementary school students regarding the greenhouse effect. The method used was descriptive research, using 52 student samples selected by purposive sampling technique, and the Rasch model was used to analyze the data. The results showed that the Rasch Model confirmed the validity of the tool, highlighting the challenges in understanding the concept of the greenhouse effect among bright students. Students had a misconception rate of 63% when analyzing the relationship between the ozone layer and the greenhouse effect, 62% when distinguishing between the greenhouse effect and global warming, 60% when examining the relationship between the greenhouse effect and cow dung waste, and 56% when determining the relationship between the greenhouse effect and acid rain. Effective teaching strategies are essential for correcting misconceptions, and future research should explore media or learning models to address these issues. It is imperative for educators to design targeted interventions that specifically target these prevalent misconceptions to improve science education outcomes among elementary school students in Indonesia.

Keywords: Elementary school; Greenhouse effect; Misconception; RASCH model

Introduction

The greenhouse effect is a challenging scientific concept that can be hard for some pupils in primary school to fully grasp (Sukardi et al., 2018; Bhattacharya et al., 2020; Lehnert et al., 2019). As a result, when pupils try to comprehend this concept, misconceptions in some cases arise. A misconception is a false understanding or belief about a certain subject. Due to the intricacy of the theory and the challenges of comprehending abstract scientific concepts, pupils can create misconceptions in the context of the greenhouse effect.

A common misperception about the greenhouse effect among pupils in primary school is that it exclusively results from the physical features of a greenhouse, such as its glass walls and roof (Sagala et al., 2019). They might not realize that the phrase "greenhouse effect" refers to the way in which particular gases trap heat in the earth's atmosphere as a metaphor (Lehnert et al., 2019). Beside, pupils could see the greenhouse effect negatively and be unaware of how crucial the impact is to preserving the earth's temperature (Satriadi et al., 2019). It's vital to remember that the greenhouse effect causes global warming, despite the fact that some pupils might incorrectly use the two terms interchangeably. To address these misconceptions, teachers and educators play a pivotal. It is essential for them to utilize age-appropriate explanations, visual aids, and real-life examples to facilitate pupils in developing a more accurate understanding of the greenhouse effect (Kurup, 2021). Encouraging hands-on activities, conducting experiments, and fostering discussions can further enrich pupils' comprehension of this significant scientific concept role (Jin et al., 2019).

Studying misconceptions about the greenhouse effect among elementary school pupils holds significant value for various compelling reasons. First and foremost, it plays a pivotal role in enhancing scientific literacy from a young age. By recognizing and

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addressing these misconceptions early on, educators can establish a robust foundation in climate science for pupils. This foundation becomes increasingly critical in a world grappling with pressing environmental challenges, where informed decisions and actions are paramount.

Misconceptions, particularly those related to complex scientific concepts like the greenhouse effect, act as significant barriers to a comprehensive understanding of these subjects. Conducting research in this area offers a unique opportunity to not only identify these misconceptions but also gain valuable insights into their underlying causes. Such knowledge serves as a stepping stone for the development of targeted educational interventions designed to rectify these misconceptions and promote accurate understanding among students.

Furthermore, delving into these misconceptions goes beyond mere correction; it fosters the development of critical thinking skills among pupils. By analyzing and challenging these misconceptions, students are encouraged to delve deeper into complex scientific ideas, ultimately cultivating a more profound grasp of these concepts. This analytical approach also empowers them to engage in reasoning and decision-making based on empirical evidence, a vital skill in navigating the complexities of our ever-changing world. It provides educators with the tools to build a strong educational foundation, equips students with the critical thinking skills needed for informed decision-making, and contributes to a broader understanding of effective science education strategies.

Findings of misconceptions about the greenhouse effect still occur in prospective teachers and secondary schools (Chang & Pascua, 2015; Varela et al., 2018). Based on previous studies on the greenhouse effect and global warming, the researcher concludes that there is still a lack of research that specializes in greenhouse effect misconceptions at the elementary school level. This article, therefore, highlights the novelty of a research study focusing on primary school children, a group that has received little attention in greenhouse effect investigations in Indonesia. Using a three-tier diagnostic test instrument with a Rasch model for data analysis, this study provides a comprehensive assessment of children's understanding and perceptions. Findings from this study contribute to a broader understanding of environmental education, helping to shape effective strategies to raise awareness about the greenhouse effect among elementary school children in Indonesia and beyond.

Studying and correcting these misconceptions not only improves scientific literacy but also fosters students' critical thinking skills to deal with environmental changes due to the greenhouse effect in the present and future (Yilmaz & Can, 2019). Addressing misconceptions about the greenhouse effect teachers play an important role in this process. By using age-appropriate explanations, visual aids, and real-life examples, educators can foster a more accurate understanding of the concept among students (Petersen et al., 2020).

Method

This study is a type of descriptive research, which tries to describe something without making any changes or interventions. A test instrument is used in the procedure, which is a survey method. The test is meant to measure students' comprehension of or knowledge of the phenomena under study—the greenhouse effect. The test's results are then included in the data collected in this descriptive study to reveal information about the respondents' level of comprehension of the subject under investigation.

This study used a three-tier diagnostic test instrument that offers a comprehensive assessment across multiple levels of proficiency. The Certainty of Response Index (CRI) is applied at Levels 1-5, to ensure the inclusion of complex cognitive processes in the items. The test instrument is designed to measure the level of proficiency in a specific domain. The three-level diagnostic test instrument administered to pupils consisted of 18 questions on the greenhouse effect, each with three levels. The initial level of each question necessitated a simple yes or no response, followed by a request for the rationale behind the chosen answer at the second level. For the third level, the CRI (Certainty of Response Index) was used to score responses on a scale of 1 to 5. The strong internal consistency of the assessment tool utilized in this study indicates the questions were well-designed and successfully captured the intended level of understanding. Besides, the questions' level of difficulty allowed for the obvious disparity between the abilities of participants, demonstrating the validity and sensitivity of the instrument.

Using the purposive sampling technique, the sample used in this study was 52 elementary school pupils in the fourth grade, consisting of 29 female pupils and 23 male pupils. Considering that the sample used was adequate, this implies that the researcher believed that the group of pupils selected for this study accurately reflected the abilities and characteristics of elementary school pupils as a whole. Besides, considering that the greenhouse effect material had been taught previously in the first semester of the fourth grade, it suggests that the pupils already had knowledge or exposure to the subject matter. This prior teaching may have an impact on pupils' understanding and performance during the assessment: This study aims to answer the questions are the common instrument validity of CRI that always be used by teachers and the common primary pupils' misconception on greenhouse effect.

The Rasch model, a well-known psychometric method, was used in this study's data processing to process the data and enable thorough analysis of participant responses (Hizqiyah et al., 2023). The Rasch model enables the conversion of raw scores into estimates of individual ability and item difficulty, allowing for a more accurate evaluation of participant ability levels. The Rasch model provides insights into the validity and reliability of test instruments.

Certain criteria are required in order to evaluate misconceptions in the responses to the questions that researchers offer to the pupils. These are the scoring criteria.

Table 1. Criteria for Answer Combination Patterns and Pupils Scoring

Answer combinations				Scoring
Tier 1	Tier 2	Tier 3	Criteria of pupils' answer	
Correct	Correct	Sure	Understand the concept	5
Correct	Correct	Not sure	Lucky	4
Correct	False	Not sure	Lack of concept understanding	3
False	Correct	Not sure	Lack of concept understanding	3
False	False	Not sure	Does not understand the concept	1
False	Correct	Sure	Misconception	2
Correct	False	Sure	Misconception	2
False	False	Sure	Misconception	0

The following is the flow conducted in this research:

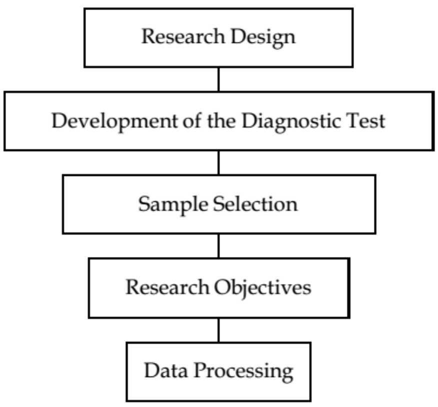


Figure 1. The research flow

Result and Discussion

The Validity of CRI Instrument through RASCH Model

Validity in instrument-making refers to the extent to which the instrument accurately measures the intended concept or ability (Abdul et al., 2022), ensuring that the questions and tasks asked are relevant and appropriate to the objectives and indicators being tested. In the RASCH model, the validity and reliability of an instrument can be seen. Validity refers to the extent to which a measurement instrument measures what it is supposed to measure (Chan et al., 2021), while reliability relates to the consistency and accuracy of the instrument in producing similar results if repeated at different times and situations (Quansah, 2022). In other words, validity is concerned with whether the instrument measures correctly, while reliability focuses on how consistently the instrument measures. The reliability of the participants and items being evaluated is the most important indicator to determine how effective a measurement tool is. The purpose is to find out further about how consistently the measurement provides hidden features or distinctive dimensions of the variable being measured. The RASCH model's summary statistics are used to present the results of the analysis (Table2).

Table 2. Summary of Measured Person and Item

Parameter	Measure	Infit		Outfit		Separation	Reliability	KR-20
		MNSQ	ZSTD	MNSQ	ZSTD			
Person (52)	.14	1.00	.17	1.00	.19	4.16	.95	.96
Items (18)	.00	.96	.35	1.00	.13	4.65	.96	

High-number reliability is an indication of good reliability. It shows a good correlation between pupils' responses to the context, indicating that knowledge among pupils is typically not dispersed and can be quantified. The information in the Table 1 demonstrates that an individual separation index of 4.16 corresponds to a person reliability of 0.95. This shows that the test-taking behaviour of pupils was deemed to be consistent.

Besides, the Cronbach's Alpha Coefficient (KR-20) score of 0.96 shows positive pupils-test interaction. For researchers and educators, this information is crucial for designing follow-up strategies and pupils' skill development (Gordon et al., 2021). A reasonably high item separation index value of 4.65, which is equivalent to item reliability of 0.96, was additionally a part of the study's results. This shows that the products have through a thorough review procedure and have demonstrated their ability to produce accurate and trustworthy results. These items are reliable as efficient measurement tools in the context of decision-making or research due to their acceptable consistency.

Besides, infit and outfit findings that meet expectations show that the multiple-choice test's items have been properly designed and are capable of effectively describing the construct being measured (Thacker & Sinatra, 2019). Users may feel confident in relying on the results thanks to the test's accuracy and dependability. It's vital to keep in mind that only a small percentage of items may deviate from the predicted range when interpreting these infit and outfit results (Sulsilah et al., 2023). The fact that the products are often of good quality is unaffected by this, though. It is more reasonable to assess test performance overall by concentrating on the majority of items that correspond to the standard. Reliability guarantees that the measurement instrument provides consistent and stable results when repeated in various situations or at various times, so it can be relied upon to accurately measure the same concept or ability.

It is also crucial to note that appropriate infit and outfit results may also suggest that the construct being measured by the test is unidimensional, in addition to showing that the items meet the unidimensionality criterion (Rodríguez-Mora et al., 2022). In this situation, researchers or test participants can proceed with more certainty when inferring conclusions or making decisions from the results. Besides, successful infit and outfit findings can offer suggestions for future improvements in test design or item improvement (Muslihin et al., 2022). To ensure enhanced test fit and validity, more efficient development may be carried out by knowing which items perform well and which require function. Standardized infit and outfit outcomes in the context of multiple-choice testing also represent the standard of the data processing and statistical analysis conducted (Wind & Gale, 2015). More certainty in the test result's overall reliability can be gained from good statistical validity and consistency.

The measurement data on pupils' ability level, which falls within the range from -3.0 logits to +3.0 logits, shows an adequate level of power. This means that the instrument is effective in measuring pupils' ability. It is assumed that the measurement findings acquired are an appropriate representation of the pupils' abilities when there is strong evidence in this range (Van Zile-Tamsen, 2017). Having a measurement tool that can generate precise statistics for a pupils' proficiency level is crucial. As a result, it is possible to assess pupils more objectively and utilize that information to guide decisions in both educational and research contexts.

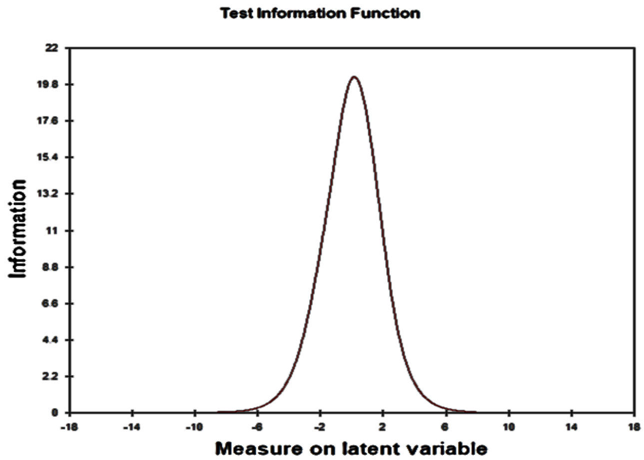


Figure 2. Measurement reliability

In order to test pupils' ability, the measurement tool depicted in Figure 1 provides essential accuracy and dependability. The information obtained from these tools may be relied upon to be an accurate reflection of pupils' abilities within this range, serving as an adequate basis for the objective assessment of decisions or the tracking of pupils' development. It should be mentioned that the measurement instrument's validity can be significantly increased by the amount of measurement precision depicted in the graph. The confidence in the measurement results and the validity of the measurement as a whole can be increased by having an instrument that can provide precise data on pupils' level of thinking ability (Perera et al., 2018).

Valid questions are questions that already contain indicators of CRI development. The next step is to assess the validity of the items more thoroughly after determining whether the items fit the previously mentioned criteria. Mean square (MNSQ), which should be in the range of $0.50<y<1.50$, is one of the evaluation criteria used. This range indicates a high level of Rasch model fit for the test items. Standardized ZSTD was also used as one of the evaluation criteria. According to Laliyo et al. (2020), the acceptable range is $-2.0<Z<+2.0$ (Novita et al., 2022). ZSTD clothing identifies the level of correspondence between item scores and Rasch model predictions. The item is regarded as fitting the Rasch model if the ZSTD value is within this range. Besides, PTMEA Corr also known as the correlation between item scores and specific measures is a crucial factor to take into consideration when assessing item validity. The PTMEA Corr correlation should typically be greater than zero and not very near to it (Mufida et al., 2022). The acceptable range of values is $0.4<x<0.8$. A sufficient amount of correlation between item scores and specific metrics is indicated by this range. According to the table, valid and invalid questions can be analysed based on the three criteria above. According to the MNSQ criteria, invalid questions are numbers 5 and 12, while according to the ZSTD criteria, invalid questions are numbers 5, 9, 11, and 12. Therefore, these four numbers still require further analysis and improvement.

Table 3. Item Analysis

Question number	Score outfit MNSQ	Score outfit ZSTD	Ptmeasure correlation	Description
1	1.31	1.40	0.68	Valid
2	1.26	1.09	0.71	Valid
3	0.65	-1.80	0.83	Valid
4	0.74	-1.32	0.82	Valid
5	1.52	2.11	0.67	Invalid
6	1.39	1.55	0.72	Valid
7	1.09	0.49	0.74	Valid
8	1.43	1.88	0.65	Valid
9	0.60	-2.22	0.86	Invalid
10	0.99	0.04	0.80	Valid
11	0.52	-2.41	0.85	Invalid
12	0.45	-3.24	0.90	Invalid
13	0.80	-0.81	0.82	Valid
14	1.11	0.57	0.78	Valid
15	1.36	1.62	0.65	Valid
16	0.55	-1.90	0.81	Valid
17	0.80	-0.88	0.79	Valid
18	1.36	1.46	0.48	Valid

If any of the three evaluation criteria are not met, then the item is considered inadequate and needs further analysis. This analysis aims to evaluate the trends and characteristics that may affect the item's inaccuracy in measuring the desired variable. Further analysis may examine item content, language structure, or other factors that may affect item quality (Adams & Wieman, 2011). Analysing and correcting inadequate items can improve the validity of the measurement instrument as a whole. These evaluation steps are important to ensure that the measurement instruments used meet the standards of reliability and validity in measuring the desired variables. By having items that meet these evaluation criteria, it can be guaranteed that the measurement results obtained will be more accurate and reliable in analysing and understanding the variables being measured (Varela et al., 2018).

The consistency of the item difficulty levels and the pupils' ability assessments created in Table 2 were evaluated in the third step. The corresponding pupils' ability level is higher based on how difficult the item is to accomplish. The previous Wright map demonstrates that practically all of the pupils' talents are covered by every instrument component. This map produces variation between pupils with very high ability (>3.0 logits) and pupils with very low ability (-2.0 logits). In further analysis of item validity, it is worth noting the differences that occur in the logit ranges of -3.0 to -0.5 and +1.0 to +3.8. It can be seen that the data generated in these ranges is quite sparse, so efforts need to be made to expand the amount of data available in these intervals (Laliyo et al., 2020). This is important to ensure that the measurement instrument can provide accurate and representative data across a wider range of ability levels. The range of item difficulty is concentrated between -1.2 logits and +1.6 logits despite these variations. Comparable degrees of difficulty between objects are represented by this range. The difficulty of the items varied, with item P18 having the highest difficulty (logit: +1.6) and item P16 having a relatively lower difficulty (logit: -1.2).

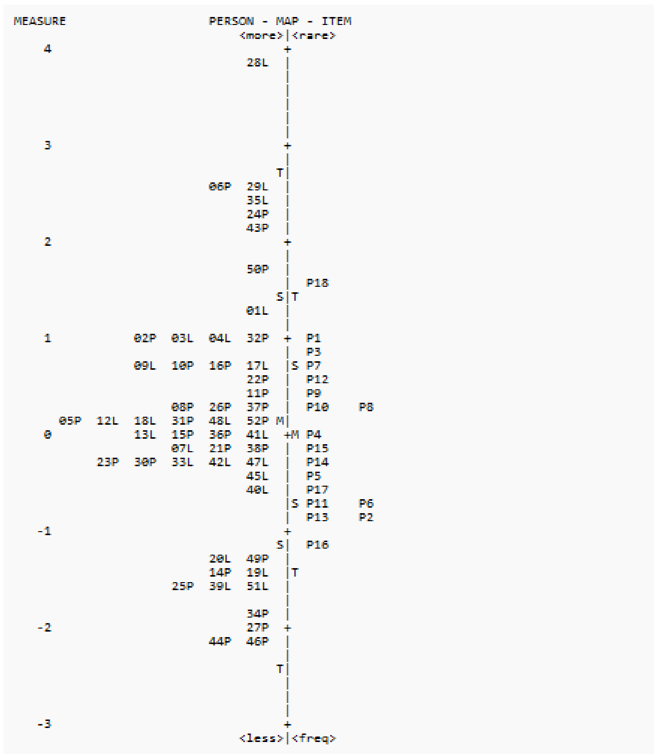


Figure 3. Wright map person and item

Important information about the relative difficulty of each test item is provided by this analysis. Instrument users can develop acceptable strategies for testing pupils' abilities at a more appropriate level by knowing the level of item difficulty (Laliyo et al., 2020). Besides, categorizing and contrasting pupils abilities within a specific range can be done by understanding the amount of item difficulty. The identification of items with various degrees of difficulty might also offer insightful information for creating future measurement tools. The instrument design can be changed or improved to reach the required level of difficulty in accordance with the measurement objectives by knowing whether items are comparatively difficult or easy.

The Misconception in Greenhouse Effect Material

When someone has an incorrect or warped grasp of specific ideas, rules, or phenomena, misconceptions were resulted. This may be brought about by a number of things, including insufficient knowledge, incorrect interpretation, or misunderstandings of the topics being taught. When there is a disconnect between pupils' instinctive knowledge and scientifically taught concepts, misconceptions can result. In a learning environment, misconceptions can prevent pupils from comprehending a topic or subject matter (Yilmaz & Can, 2019). Pupils might develop difficult-to-remove misconceptions and erroneous understandings. Unresolved misconceptions could interfere with pupils' learning and make it harder for them to comprehend real topics.

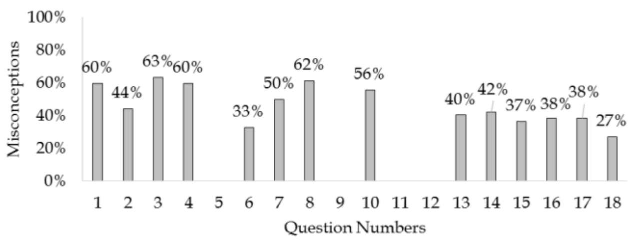
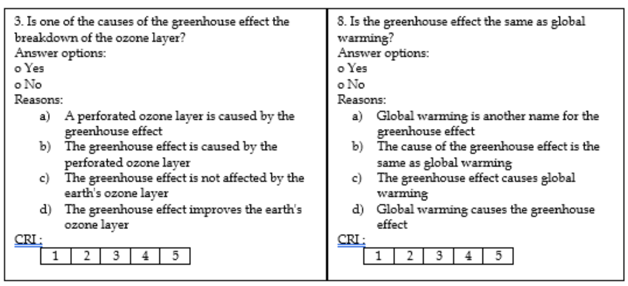


Figure 4. Greenhouse effect test result

Misconceptions can result from a variety of causes. First, false beliefs might arise from commonplace events. Although they may bring knowledge from their daily activities to class, pupils' understanding may not always correspond to what is being covered there. Second, false assumptions may also result in misunderstandings. Pupils sometimes assume things about the topics being taught that are incorrect or inadequate (Perera et al., 2018). Misunderstandings may result from this and interfere with accurate comprehension. Third, misconceptions can also arise due to conflict with prior knowledge. When pupils are taught new concepts that conflict with what pupils previously thought, misconceptions can occur. This is because pupils have difficulty changing their existing understanding and accepting the new concept (Jane I. & Sunday, 2018). In addition, misconceptions can also lead to deeper misunderstandings. If misconceptions are not addressed, pupils may develop a network of incorrect concepts that are difficult to correct. Pupils may find it difficult to understand the concept associated with the misconception and build correct knowledge.

Analyses of the data and classifications of conceptual comprehension and misconceptions based on question indicators. From the table above, it is found that the misconceptions obtained from the five most numbers are in order from number 3, 8, 1, 4, and 10. In question no. 3, the question indicator is that pupils are able to analyze the link between the ozone layer with holes and the greenhouse effect and the percentage of misconceptions obtained is 63%. In question number 8, the question indicator is that pupils can distinguish the greenhouse effect and global warming, the misconception obtained is quite high, and the percentage is 62%. The next misconception percentage of 60% was occupied by numbers 1 and 4 with indicators such as analysing the relationship between the greenhouse effect and cow dung waste and analysing the relationship between air conditioning as a cause of the greenhouse effect. In the last place is number 10 with an indicator in the form of determining the relationship between the greenhouse effect and acid rain. Some common misconceptions about the greenhouse effect were discovered from the five questions, including the fact that pupils were still unable to connect the links between the ozone layer, cow dung, air conditioning, and acid rain and that they continued to misunderstand the greenhouse effect for global warming.


3. Is one of the causes of the greenhouse effect the breakdown of the ozone layer?
Answer options:
o Yes
o No
Reasons:
a) A perforated ozone layer is caused by the greenhouse effect
b) The greenhouse effect is caused by the perforated ozone layer
c) The greenhouse effect is not affected by the earth's ozone layer
d) The greenhouse effect improves the earth's ozone layer
CRI:

1	2	3	4	5

8. Is the greenhouse effect the same as global warming?
Answer options:
o Yes
o No
Reasons:
a) Global warming is another name for the greenhouse effect
b) The cause of the greenhouse effect is the same as global warming
c) The greenhouse effect causes global warming
d) Global warming causes the greenhouse effect
CRI:

1	2	3	4	5

Figure 5. Sample of pupils answers

The figure above is one of the pupils' answers to number 3 which discusses the link between the ozone hole and the greenhouse effect and number 8 about the difference between the greenhouse effect and global warming. It can be seen that pupils are still mistaken in determining the cause of the greenhouse effect. Pupils answer that the hole in the ozone layer is caused by the greenhouse effect while the fact that the greenhouse effect occurs one of the causes is the hole in the ozone layer, concept reversal and high confidence in answering questions seen from the CRI which causes pupils to experience misconceptions. Next, when viewed from question number 8, pupils answered that the greenhouse effect is the same as global warming in terms of its causes, while the fact is that the two phrases cannot be equated because the greenhouse effect is different from global warming in terms of its causes, namely if the greenhouse effect is caused by excess solar radiation entering the earth and global warming is caused by pollutant gases. The wrong answer coupled with the high CRI of the pupils' answer indicates that the pupils believe the wrong concept (misconception). The reason for this is that some complex concepts are often simplified to facilitate understanding. However, oversimplification can lead to misconceptions. Often ignoring important aspects or complexities in a concept and narrowing their understanding into false generalizations.

The outcomes that showed in Table 1 proved that the instrument had effectiveness, met the requirements of person and item reliability, and demonstrated good construct validity. It was discovered that nearly all high-ability pupils had trouble comprehending the concepts of the causes and effects of the greenhouse effect, the distinction between the greenhouse effect and global warming, and the connection between the greenhouse effect and acid rain. The Rasch model technique, which merges diagnostic and summative instrument development processes, produced detailed, accurate, and quantifiable results in the series of verifications that were undertaken (Manik et al., 2022).

The method utilized in this study is a useful tool for helping teachers assess pupils' learning progress and the learning process. This is because qualitative item production processes and quantitative data analysis have been integrated, giving teachers the opportunity to thoroughly examine pupils' knowledge, concepts that pupils grasp or do not understand, and misconceptions. It is possible to identify the transition from pupils' misconceptions to overall conceptual knowledge by combining Rasch model analysis with probability curves. Due to the interconnection of people and things, it is rather challenging to complete such a task using conventional methods. However, the Rasch model can overcome this interdependence because test items and their degrees of difficulty remain constant regardless of which sample is used for the initial validation (Karoror & Jalmo, 2022). This shows that the unidimensionality and local independence conditions for the instrument pieces have been met. Overall, this study offers empirical support for the assertion that pupils' assumptions alter in response to their learning process.

When a person's conception of a material differs from the conception established by scientists or specialists in their field, misconceptions are created. Pupils' misconceptions might begin with themselves, as when they perceive personal experiences as conditions events encountered in their lives. Pupils may also pick up misunderstandings from teachers as a result of learning from them. If a teacher's instruction is less focused than it should be, pupils may interpret ideas incorrectly, or perhaps the instructor himself misunderstands the idea in question, making his explanation of it incorrect as well. The analysis of misconceptions that occur in fourth-grade pupils on greenhouse effect material is due to pupils' misunderstanding of the concepts of global warming, the greenhouse effect, ozone layer depletion, and acid rain as shown in Figure 3. Pupils mistakenly believe that the greenhouse effect causes the perforated ozone layer, despite the fact that one of the effects it causes is the perforation of the ozone layer. This misconception is further exacerbated by pupils' high levels of confidence in their ability to respond to CRI questions. One of the reasons for this misconception may be that pupils still do not fully comprehend the ozone layer and its value, the lack of information provided, and the lack of supporting visuals to show the connection between the ozone layer and the greenhouse effect for pupils whose thinking is still abstract (Jarrett & Takacs, 2019). Next, pupils believe that the greenhouse effect is the same as global warming in terms of its cause, while the fact is that the two phrases cannot be equated because the greenhouse effect is different from global warming in terms of its cause, namely if the greenhouse effect is caused by excess solar radiation entering the earth and global warming is caused by pollutant gases (Leichenko & Brien, 2020).

This is due to the fact that some complicated ideas are frequently simplified for explanation. Oversimplification, however, might result in misunderstandings frequently discarding crucial details or subtle distinctions in a subject and condensing it into false generalizations. To remove pupils' false assumptions and foster scientifically accurate conceptual knowledge, effective and purposeful teaching strategies are required (Scotti Di Uccio et al., 2020). Teachers are required to collect specific data regarding the nature and traits of pupils' assumptions, because improving pupils learning outcomes on content related to the greenhouse effect goes beyond the teacher's primary responsibility (Seroussi et al., 2019). The following is an infographic about misconceptions that often occur in elementary school students.

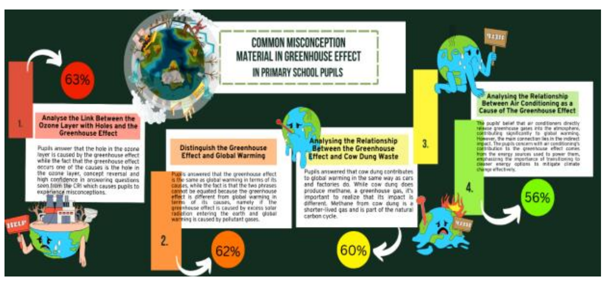


Figure 6. The infographic of common misconception in greenhouse effect material

Conclusion

In this study, the RASCH model was employed to assess the utility of the tool, validate its compliance with individual and item reliability standards, and establish construct validity. Notably, the research uncovered challenges among highly intelligent students regarding their understanding of the greenhouse effect, including its causes, effects, distinctions from global warming, and connections to acid rain. Misconceptions were prevalent, with 63% of students misunderstanding the link between the ozone layer and the greenhouse effect, 62% struggling to differentiate between the greenhouse effect and global warming, 60% misinterpreting the relationship between the greenhouse effect and cow dung waste, and 56% misconceiving the connection between the greenhouse effect and acid rain. For educators and researchers in Indonesia, developing diagnostic instruments using the Rasch model is seen as a critical literacy-building process. The study emphasizes the need for further analysis integrating conceptual comprehension levels and item creation to assess students' alternative concepts and learning progress. Effective teaching strategies are essential to dispel misconceptions and cultivate scientifically accurate conceptual understanding. Future research should explore media or learning models to address these persistent misconceptions among students.

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Conflicts of Interest
The authors declare no conflict of interest.

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