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Development of Progressive Integrated Testing to Identify Science Concept Understanding and Misconceptions of Grade VII Junior High School Students

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Abstract: This study aims to produce an integrated, valid, and practical step-by-step test that is valid, reliable, and practical to identify students' understanding of science concepts and misconceptions. The study was conducted based on the Plomp & Nieveen model and test development steps by Oriondo & Dallo-Antonio. The subject of this study is an integrated gradual test. The object of this research includes the characteristics, validity, reliability, practicality, and profile of students' understanding of concepts and misconceptions in science learning. Data was collected through interviews, document studies, questionnaires and tests. The data was analyzed qualitatively and quantitatively. The results of the study obtained the characteristics of an integrated phased test including a four-level diagnostic test. Integrated phased tests with valid, reliable and practical categories. The results of the measurement of the students' science concept understanding profile on temperature, heat and expansion materials obtained an average understanding of concepts with a low category. The average misconception of students in the material Temperature, Heat and Expansion was obtained at 63% with a high category. The causes of misconceptions in students include their own thoughts, workbook books, and learning resources available on the internet. The integrated gradual test is able to reveal the profile of students' concept understanding and misconceptions so that science learning outcomes are of higher quality.

Keywords: Conceptual understanding; Misconceptions; Science; Progressive integrated testing

Introduction

Science subjects have many concepts that must be understood by students so that students can understand science material and its application correctly. Concept understanding plays a major role in the quality of learning outcomes because concept understanding is the basis for achieving quality learning outcomes (Aen & Kuswendi, 2020; Ulfa et al., 2023). If students' understanding of concepts is not in line with scientific concepts, then students will experience misconceptions (Mukhlisa, 2021; Rohmah et al., 2023). It is important to identify misconceptions that occur in students as early as possible to minimize the increase in concepts that have not been understood by students so that later students will be able to achieve the expected learning goals (Cahaya et al., 2024; Mukhlisa, 2021; Sari et al., 2024). If misconceptions are ignored, they can damage the formation of scientific ideas and cause learning disabilities in students, resulting in low learning outcomes (Mardana & Yasa, 2021; Nuraina & Rohantizani, 2023; Rahmawati et al., 2024). This shows that students' understanding of concepts and misconceptions need to be identified so that students can achieve maximum learning outcomes.

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In ideal circumstances, teachers should be able to find out that students' understanding of science concepts is correct or has misconceptions. However, the idea that the importance of knowing misconceptions in students is still not emphasized by teachers in science learning. This is evidenced by the low number of teachers who measure the misconceptions that occur in students (Fajriyanti & Sayekti, 2022; Haerunnisa et al., 2022; Salamah et al., 2020). This problem is relevant to the problems that researchers found in SMP Negeri 1 Mengwi, SMP Negeri 3 Mengwi and SMP Negeri 1 Kuta found that most science teachers only focus on identifying concept understanding without measuring students' misconceptions. This is because the assessments used are multiple-choice questions and essays. The assessment includes conventional assessment methods that only focus on measuring overall learning outcomes without detecting students' conceptual understanding and misconceptions (Pratiwi et al., 2023). In addition, the characteristics of the application of multiple-choice tests provide an opportunity for learners to guess the correct answers and there is no further analysis of the answers. This makes it difficult to know the level of understanding of concepts and misconceptions of students as a whole.

Measuring conceptual understanding and misconceptions requires valid, reliable, and practical assessments and can be used on a large scale. For this reason, the development of conceptual understanding and misconception assessments is very important. Currently, there are a number of instruments developed in science learning, including two tier, three tier and four tier (Istiyono et al., 2023; Pasaribu & Irfandi, 2023; Ningroom et al., 2025). However, the diagnostic test still has limitations so that it is not able to identify students' understanding of concepts and misconceptions effectively.

Diagnostics two-tier has limitations, namely not always appropriate in distinguishing students who understand concepts, misconceptions, and do not understand concepts, especially in Indonesian students who have low confidence in answering questions (Mahardika et al., 2020). It was also found that most of the three and four tier diagnostic tests that have been developed use a multiple choice format that still facilitates students to guess the correct answer (Damayanti et al., 2023; Erwinsyah et al., 2020; Maryam et al., 2024; Pasaribu & Irfandi, 2023; Rawh et al., 2020; Wahyudi et al., 2021). Standardized diagnostic tests that have been developed previously focus only on identifying misconceptions, but not identifying the causes of student misconceptions (Nurfadila et al., 2020).

Referring to the limitations of these tests, the solution that can be done is to develop a multi-level diagnostic test that can identify the understanding of concepts, misconceptions, and causes of misconceptions among students. The test in question is an integrated gradual test. The integrated phased test is a diagnostic test consisting of four levels of questions. Integrated phased tests are different from the four-tier diagnostic tests that have been developed by previous research. The frequently developed four-tier diagnostic test consists of two questions and two confidence levels in a multiple-choice format. Meanwhile, the integrated gradual test has a "progressive" characteristic which means that the questions are developed in stages including the first level of multiple-choice questions, the second level of description questions, the third level of beliefs and the fourth level of open-ended questions about the source of knowledge. This aims for students to take the test systematically starting from the basic level to the complex level. The next difference is that the integrated phased test has the characteristic of "integrated" which means that it identifies two abilities of students, including measuring concept understanding and misconception at the same time. This aims to produce effective and efficient assessments for science students and teachers. Meanwhile, diagnostic tests that are widely developed only focus on identifying misconceptions, without identifying further understanding of concepts.

Furthermore, an integrated gradual test was developed on the science material of the Independent Learning Curriculum class VII odd semester, namely temperature, heat and expansion. The material is important to understand by students because it is the foundation of science learning in phase D. However, it was found that there is still a lack of development of instruments for measuring the understanding of concepts and misconceptions of temperature, heat and expansion materials in science learning for junior high school students. Previous research has only developed an instrument to measure the understanding of concepts and misconceptions of temperature, heat and expansion materials for high school students in Physics learning (Appiah-Twumasi et al., 2021; Sofianto et al., 2020; Yuliana et al., 2023).

Based on the description above, the importance of developing instruments to identify understanding concepts and misconceptions and limitations in the development of instruments in previous research, shows the need to develop test instruments to identify understanding concepts and misconceptions in temperature, heat and expansion materials for junior high school students. For this reason, an integrated gradual test was developed to identify students'

understanding of science concepts and misconceptions. The purpose of this study is to: find out the characteristics of integrated gradual tests; know the validity, reliability, and practicality of integrated phased tests; and to know the profile of students' concept understanding and misconceptions on temperature, heat and expansion materials. With the development of this integrated gradual test, it is hoped that it will be able to identify students' understanding of concepts as a whole so that they can map students who already understand concepts, do not understand concepts, and misconceptions. In addition, it is hoped that an integrated gradual test will be able to detect the cause of misconceptions in students so that teachers can take appropriate steps to remediate misconceptions.

Method

This research includes research and development that develops products in the form of integrated phased tests. The development of integrated phased tests follows the development model by Plomp et al. (2013) which consists of three stages including preliminary research, development or prototyping phase and assessment phase, presented in Figure 1.

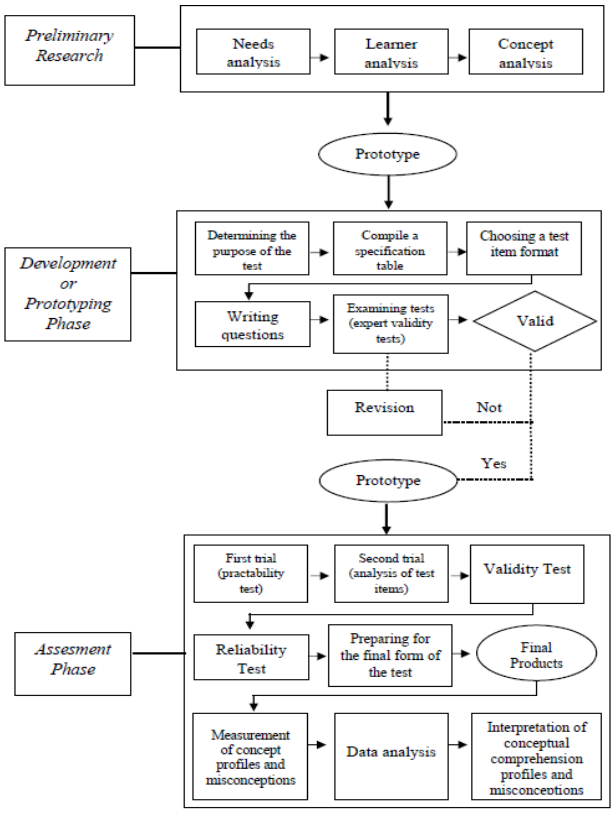

Figure 1. Stages of development research

Referring to Figure 1, preliminary research including several activities were carried out, namely needs analysis, concept analysis and student analysis. Development or prototyping phase follow the test planning steps by Oriondo & Dallo-Antonio (2005) which consists of determining the purpose of the test, compiling a grid table, choosing a test format, and writing questions. Furthermore, a validity test is carried out by an expert (theoretical validity). Assessment phase is the trial stage was carried out, namely the practicality test and the effectiveness test (empirical validity). In addition, several additional trials were carried out following the test trial steps by Oriondo et al. (2005) is trying reliability testing and interpreting the test score.

The types of data in this study include: qualitative data in the form of the results of descriptions of needs, needs, and concepts and results of theoretical validity in the form of input from experts; quantitative data in the form of test results (validity, reliability, differential power index, difficulty level, item sensitivity index) and the results of measuring the profile of students' concept understanding and misconception. The collection of research data consisted of: data on the need analysis of science teachers collected through the interview method; data analysis of test needs and concept analysis were collected through the document study method; student analysis data through the questionnaire method; Data on the level of validity, practicality and profile of students' understanding of concepts and misconceptions through the test method.

1.1 One of the Scout activities is camping. When carrying out the camp, there is an activity of lighting a bonfire to provide a sense of warmth at night. Lighting a campfire is an example of heat transfer....
   a. Radiation
   b. Conduction
   c. Convection
   d. Induction
1.2 My scientific reason for answering question 1.1 is.....
1.3 My level of confidence in the answers and reasons....
   1. Confident
   2. Not sure
1.4 The answers and reasons for questions 1.1 and 1.2 I obtained from....(Answers can be selected from more than one).
   1. Thinking for yourself
   2. Science teacher
   3. Textbook
      3.1 Erlangga Student Science Books
      3.2 Science LKS
      3.3 Other books:.....
   4. Internet
      4.1 *Youtube*
      4.2 *Website*
   5. Others:.....

Figure 2. Integrated phased test form

The research data was analyzed qualitatively and quantitatively. Qualitative data analysis is carried out descriptively, i.e. data is described and described according to discoveries in the field. Quantitative data analysis uses the Gregory index to calculate the results of the validity of the content expert, the calculation of the average score to calculate the results of the language validity and the practicality test. The analysis of the test requirements used is polyatomic test

analysis, including analysis of differential power index, difficulty level, sensitivity index, empirical analysis of the validity of question items using Pearson Product Moment correlation, and reliability analysis of question items using Alpha Cronbach. Quantitative data were analyzed using Microsoft Excel and IBM SPSS Statistic 23 software.

The form of the integrated phased test is presented in Figure 2. Based on Figure 2, for the measurement of the profile of concept understanding and misconception, refer to the integrated phased test rubric presented in Table 1.

Table 1. Unified Phased Test Rubric

Answer Combinations			Category Profile	Score
Multiple Choice	Reason	Confidence Level		
True	True	Believe	Complete understanding	5
True	True	Not Sure	Guess/Lack of confidence	4
True	Wrong	Not Sure	Lack of understanding	3
Wrong	True	Not Sure	Lack of understanding	3
True	Wrong	Believe	Positive misconceptions	2
Wrong	True	Believe	Negative misconceptions	2
Wrong	Wrong	Not Sure	Don't understand	1
Wrong	Wrong	Believe	A complete misconception	0

Results and Discussion

Research Result

The preliminary research stage consists of needs analysis activities carried out through interviews with science teachers. The results of the interviews showed that science teachers only focused on identifying the understanding of science concepts and did not measure misconceptions, when the evaluation activities of students did not understand the purpose of the questions, and the students were less serious about answering the questions given by the teacher. Furthermore, the results of the test analysis used by science teachers are still using conventional test methods to identify students' understanding of concepts and misconceptions, namely multiple-choice questions and descriptions. The use of this test method has not been able to provide comprehensive measurement results regarding the profile of students' concept understanding and misconception. The next stage is the analysis of students which is carried out through the distribution of questionnaires. The results of the analysis obtained that 56% of students felt afraid when doing the test, 52% of students did not understand the purpose of the questions well and 72% of students had difficulties when doing the test. In addition, the results of the analysis were obtained that students considered that the test was better done by utilizing technology, such as smartphones. After getting an overview of science learning needs and student needs, an integrated gradual test product was developed to help science teachers identify the profile of students' concept understanding and misconceptions. An integrated gradual test was developed referring to the indicators of understanding the concept of cognitive level two (C2) Revised Bloom Taxonomy. Furthermore, a concept analysis was carried out to obtain the learning outcomes of science phase D in the Decree of the Head of the Education Standards, Curriculum, and Assessment Agency Number 032/H/KR/2024 which contains Learning Outcomes in Early Childhood Education, Basic Education, and Secondary Education Levels in the Independent Curriculum.

The development or prototyping phase consists of test objective development activities. An integrated phased test is a diagnostic test aimed at finding out the strengths and weaknesses of students when learning a certain concept. After that, a specification table was prepared that contained the grid of the integrated phased test. The content of the specification table includes concept understanding indicators, question indicators and question numbers. The preparation of the specification table guided by the hierarchy of science material for odd semester class VII includes; The Essence of Science and Scientific Methods is Chapter I; Substance and Its Changes are Chapter 2; Temperature, Heat and Expansion are Chapter 3; and Motion and Style is Chapter 4. Each chapter is developed with 20 questions, so that the total number of questions is 80 questions. The results of the selection of an integrated step-by-step test format are a four-tier diagnostic test consisting of four levels, of which the first level is a multiple-choice question, the second level is a description question; the third level is a question of confidence level and the fourth level is an open-ended question about the source of knowledge. Question writing is done on a google form to produce a technology-based test which then produces an integrated gradual test draft.An integrated phased test

draft was then carried out to test theoretical validity consisting of content experts and linguists. The results of the validity test of content experts are presented in Table 2 and the validity of linguists are presented in Table 3.

Table 2. Results of Content Expert Validity Testing

Yes	Aspects	Average CV Score	Category Validity
1	Material	1	Very High
2	Construct	0.96	Very High
Average		0.98	Very High

Table 3. Results of linguist validity test

Material	Average CV Score	Category Validity
The Essence of Science and the Scientific Method	95.83	Very High
Substances and Their Changes	100	Very High
Temperature Heat and Expansion	100	Very High
Motion and Style	97.92	Very High
Average	98.43	Very High

Based on Tables 3 and 4, it can be stated that the integrated phased test has a high validity category in terms of content and language.

Phase assessment phase the trial stage and measurement of the profile of concept understanding and misconception were carried out on one material topic, namely Temperature, Heat and Expansion as many as 20 questions. This is because the material is difficult to understand and often causes misconceptions for students. The first phase of the trial was carried out to test the practicality by science teachers and students. The results of the practicality test are presented in Table 4.

Table 4. Practicality Test Results

No.	Assessment Aspects	Average Teacher Assessment Results	Average Student Assessment Results
1.	Grammar	92.22	82.47
2.	Ease of Operation	94.81	81.75
Average Value of Practicality		93.52	82.11
Practicality Qualifications		Very practical	Very Practical

Based on Table 4, it can be stated that the integrated phased test has a very practical category reviewed in terms of grammar and ease of workmanship. Furthermore, an integrated gradual test was carried out in the second stage, namely the differentiation index, difficulty level, and question sensitivity index. The results of the test were then analyzed quantitatively using the guidelines for the polyatomic test questions. The results of the second phase of the trial are presented in Table 5.

Table 5. Results of the Second Trial

Number Questions	Differentiation Index	Difficulty Level	Sensitivity Index
1	Enough	Keep	Sensitive
2	Enough	Keep	Sensitive
3	Weak	Difficult	Insensitive
4	Good	Keep	Sensitive
5	Good	Keep	Sensitive
6	Good	Keep	Sensitive
7	Good	Keep	Sensitive
8	Good	Keep	Sensitive
9	Weak	Difficult	Insensitive
10	Enough	Keep	Sensitive
11	Enough	Difficult	Sensitive
12	Good	Keep	Sensitive
13	Good	Keep	Sensitive
14	Enough	Difficult	Insensitive
15	Enough	Difficult	Sensitive
16	Good	Keep	Sensitive
17	Enough	Keep	Sensitive
18	Enough	Criticism	Sensitive
19	Weak	Criticism	Sensitive
20	Enough	Criticism	Sensitive

In the second stage of the test, an analysis of empirical validity (question items) and reliability of question items was also carried out. The results of the reliability test obtained a value of r11, which is 0.796 with a high reliability category. The results of the analysis of the validity of the question items are presented in Table 6.

Table 6. Results of the Validity Test of the Question Item

Number Questions	Calculated r-value	Table r values	Category
1	0.42	0.14	Valid
2	0.38	0.14	Valid
3	0.14	0.14	Invalid
4	0.62	0.14	Valid
5	0.56	0.14	Valid
6	0.57	0.14	Valid
7	0.54	0.14	Valid

Number Questions	Calculated r-value	Table r values	Category
8	0.53	0.14	Valid
9	0.27	0.14	Valid
10	0.40	0.14	Valid
11	0.42	0.14	Valid
12	0.54	0.14	Valid
13	0.58	0.14	Valid
14	0.33	0.14	Valid
15	0.32	0.14	Valid
16	0.56	0.14	Valid
17	0.44	0.14	Valid
18	0.46	0.14	Valid
19	0.23	0.14	Valid
20	0.45	0.14	Valid

Based on the results of the second phase of the trial in Tables 5 and 6, 16 questions were obtained that were feasible and met the test requirements to be used in measuring the profile of students' concept understanding and misconceptions on Temperature, Heat and Expansion material.

Furthermore, the preparation of the final form of the integrated gradual test on Temperature, Heat and Expansion material was carried out through google form. An integrated gradual test is then applied in the science learning process to determine the profile of students' concept understanding and misconception. The results of the measurement of the concept understanding profile in each concept understanding indicator (C2) are presented in Table 7 and the measurement of misconceptions is presented in Table 8.

The average profile of students' concept understanding in each category is presented in Figure 3. Based on Figure 3, the profile of students' concept understanding in temperature, heat and expansion material is mostly in the low category.

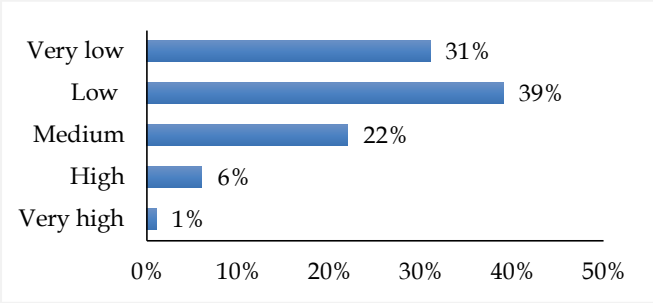

Figure 3. Average concept understanding profile in each category

Table 7. Profile of Students' Concept Understanding

Concept Understanding Indicator (C2)	Question Number	Whole Understanding	Understanding Lack of Confidence	Lack of understanding	Don't Understand
Interpreting	1, 2	16%	3%	8%	9%
Exemplifies	3, 4, 5	14%	1%	3%	11%
Classify	6, 7	19%	3%	26%	20%
Summarize	8, 9, 10	17%	2%	8%	13%
Conclude	11, 12	17%	4%	11%	14%
Differentiate	13, 14	24%	2%	7%	9%
Explain	15, 16	7%	0%	6%	17%

Table 8. Profile of Student Concept Misconceptions

Concept Understanding Indicator (C2)	Question Number	Positive Misconceptions	Negative Misconceptions	A Whole Misconception
Interpreting	1, 2	25%	1%	39%
Exemplifies	3, 4, 5	30%	1%	39%
Classify	6, 7	40%	0%	25%
Summarize	8, 9, 10	20%	1%	38%
Conclude	11, 12	24%	1%	28%
Differentiate	13, 14	34%	0%	24%
Explain	15, 16	24%	1%	44%
Average		28%	1%	34%
Misconception Profile				63%

Based on Table 8, the average student misconception profile is 63% with a high category.

Discussion

The characteristics of the integrated phased test were developed in the learning of science in odd semesters for students in grade VII of junior high school. Integrated phased tests are a type of diagnostic test that aims to identify the strengths and weaknesses of students after learning science concepts. Diagnostic tests help educators in determining students' understanding of science concepts and are able to distinguish between students who have understood science concepts in accordance with scientific concepts

or who have misunderstood concepts (misconceptions) (Ningroom et al., 2025). The diagnostic test type of integrated step-by-step test is a multi-stage diagnostic test. A multi-level diagnostic test is an alternative to identifying conceptual understanding and misconceptions is more valid and reliable than multiple-choice tests because it is able to distinguish students with misconceptions and lack of knowledge (Çelikkan & Kızılcık, 2022). An integrated phased test is a four-level diagnostic test. Diagnostic tests four tier It is a diagnostic test consisting of four questions on one question. The question stage in the integrated gradual test, namely the first level in the form of multiple-choice questions, aims to test students' basic understanding of science concepts that have been learned. The second level in the form of description questions aims to facilitate students to show the ability to explain concepts, processes and others in their own words. In addition, through this description question, educators can uncover areas that may require further confirmation and guidance. Students who are able to write correct answers mean that students already have a deep understanding of the science concepts that have been studied. The third level is in the form of confidence level aimed at assessing the level of confidence in the answers to multiple-choice questions and descriptions. This helps educators to identify how confident the learner is with his or her understanding. The fourth level in the form of open-ended questions aims to write down the source of knowledge that students obtain, so that educators can find out the causes of misconceptions that occur. Thus, later educators can provide the right solutions to remediate misconceptions experienced by students.

The results of the theoretical validity test of the integrated phased test were obtained with a very high validity category in the content aspect, namely the material and the construct. The test that was declared materially valid showed that the content of the integrated gradual test had represented the entire science material of the odd semester class VII. Tests that are declared constructively valid show that the integrated phased test consists of question items that have a proper structure and framework (Putri et al., 2023). Thus, an integrated gradual test is feasible to identify the profile of concept understanding and misconception of students in grade VII of junior high school in odd semesters. Meanwhile, the results of the theoretical validity test from the language apparatus obtained a very high validity category. This shows that the integrated phased test is declared feasible from the structure and grammar of Indonesian and in accordance with the language development of junior high school students.Referring to the level of questions in the integrated phased test which consists of four levels of questions, the integrated phased test includes polyatomic questions. Thus, an integrated phased test is tested and analyzed based on the conditions of the polyatomic test. The results of the trial were obtained 16 questions that had different power and a good level of sensitivity. A total of 16 questions were then continued for empirical validity tests and reliability tests.

The results of empirical validity were obtained that the question items were classified as valid categories. An empirically valid test means that the test already has the accuracy and suitability between the test as a measuring tool and the object to be measured (Ali & Khaeruddin, 2012). Thus, the integrated gradual test developed already has accuracy and suitability in identifying the profile of concept understanding and misconception of grade VII students in science learning.

The results of the reliability test obtained a value of r_{11} which is 0.796 with a high reliability category. The high reliability category indicates that the test has high consistency. A reliable test is a test that has accuracy and consistency in assessing the object being assessed (Ramadhan et al., 2024). Integrated phased tests have high reliability that can be used repeatedly on the same subject, anytime, and anywhere. This is because the reliable test will show the same results (steady/stable).

The practicality of the integrated phased test was reviewed by science teachers and students. Practicality is reviewed from the writing and ease of the test. The results of the practicality of the integrated phased test) including the practicality test by the science teacher obtained a score of 93.52 with the very practical category and the practicality test by the student obtained a score of 82.11 with the very practical category. Thus, the integrated phased test is stated to be very practical to be used to identify students' understanding of concepts and misconceptions.

The results of the measurement of the understanding profile of science concepts refer to Table 7, The results of the measurement of the science concept understanding profile of students have the highest complete understanding of the distinguishing indicator as much as 24%, students have the highest understanding of non-confidence, namely in the inference indicator as much as 4% and students show lack of understanding and do not understand the highest, namely in the classification indicator as much as 26% and 20%.

The differentiation indicator of getting the highest percentage of complete understanding shows that 24% of learners are able to find the difference between two or more objects, events, ideas, problems or situations (Anderson & Krathwohl, 2001). In science teaching,

differentiation is an important ability to see the differences in science concepts because science has many interrelated concepts. In the Temperature, Heat and Expansion material, students are able to distinguish the properties of objects when absorbing and releasing heat.

The indicator concluded that it obtained the highest percentage in the category of understanding unconfidence as much as 4%. The ability to infer means that the participant is able to abstract a concept/principle to explain a set of examples by looking at the relationships between the examples (Anderson & Krathwohl, 2001). In science learning, inference is the ability to connect separate science concepts to form a broader understanding. In the material on Temperature, Heat and Expansion, students lack confidence when abstracting and looking at the relationship of a set of examples of expansion phenomena that occur in life.

The classification indicator obtained the highest percentage in the category of lack of understanding and not understanding the concept of 26% and 20%. The ability to classify means that students are able to find general categories of concepts or principles from examples (Anderson & Krathwohl, 2001). Science encompasses many diverse objects, living things and phenomena. Having the ability to classify in science learning aims to enable students to group information or examples into a more systematic way so that they are easy to learn and understand. In the material on Temperature, Heat and Expansion, students have not been able to classify the types of heat transfer including conduction, convection and radiation.

The summary indicator obtained a percentage of 17% which showed that 17% of learners were able to make a single statement that represented some of the information they were sharing (Anderson & Krathwohl, 2001). Through the ability to summarize, learners can analyze information, choose revealing information and eliminate irrelevant points. Students in the Temperature, Heat and Expansion material have been able to summarize the concept of heat from several examples of science phenomena.

The interpreting indicator obtained a percentage of 16% which showed that 16% of students were able to change information from one representation to another (Anderson & Krathwohl, 2001). Interpretive skills are relevant to science learning because the results of science experiments and data processing often use various visualizations such as tables, graphs, diagrams and images. By having the ability to interpret, students are able to understand the meaning of an experiment result and the results of data processing presented in tables, graphs, diagrams and figures. Students in the Temperature, Heat and Expansion material were able to interpret the results of the experiment in the form of a table regarding the concept of heat and expansion.

The indicator for example obtained a percentage of 14% in the category of complete understanding which means that students are able to provide examples of general concepts or principles (Anderson & Krathwohl, 2001). Science concepts are concepts that can be applied in real life. Having the ability to exemplify means that students are able to demonstrate the application of science concepts in real life. One of the concepts of science in Temperature, Heat and Expansion materials that are often found in daily life is heat transfer. Students have been able to provide examples of heat transfer in daily life.

The indicator explains that obtaining the lowest percentage of complete understanding is only 7% which means that only a small percentage of students are able to construct and use the causal model of a system (Anderson & Krathwohl, 2001). The ability to explain in science learning allows students to show the extent of their understanding of the concepts and phenomena of science that have been studied. In the material on Temperature, Heat and Expansion, a small number of students have been able to explain the cause and effect of the concept of applying heat and expansion.

The average understanding of students' concepts in the material of Temperature, Heat and Expansion is 1.76 which is relatively low. This is in line with previous research that students' understanding of concepts in science learning is still below 50% (Fajri & Wulandari, 2022; Rizkita & Mufit, 2022). The understanding of concepts that is still not optimal is due to the fact that students are more focused on memorizing formulas without understanding the concept of science in the formula. In addition, there is a lack of activities to discover science concepts during learning so that learning becomes less meaningful for students (Fajri & Wulandari, 2022; Rizkita & Mufit, 2022).

The highest misconception is in the category of complete misconception. This happens because most learners choose the wrong answer at the first level and write the wrong reason at the second level. However, students are confident in the answers and reasons. This phenomenon occurs because students have wrong intuition. Intuition is wrong means that students give and conclude their own concepts due to low understanding of a science concept (Nuraina & Rohantizani, 2023). The second highest misconception is the positive misconception category. This happens because some students choose the correct answer at the first level, but cannot write down the correct reason at

the second level and are confident in the answer and reason. This phenomenon occurs because students do not understand the concept of science that has been studied. Positive misconceptions can make teachers suspect that students have a good understanding. However, when the material is deepened in the second level question, students show misunderstanding or misconception (Kobi, 2022).

The average misconception experienced by students is 63% which is relatively high. The results of the study are in line with previous research, namely that the misconception of students in science learning is still relatively high with a percentage of 66 to 92% (Mariyadi et al., 2023; Pulu & Amahoru, 2023). High misconceptions are due to students not understanding the concepts of science that have been studied (Shidik & Tae, 2022). In addition, students do not want to ask questions when they do not understand the concept, causing the concept of science that is embedded in students to be an inappropriate science concept (Mariyadi et al., 2023).

Based on the results of the research, the causes of misconceptions that occur in students mostly come from their own thoughts. These findings are consistent with previous research, namely that students have different meanings or words (understanding) between teachers and students (Abdila & Khairuna, 2022; Felita et al., 2023; Nuraina & Rohantizani, 2023). This is found in the reasons written by students in the second level questions such as: "students think that melted butter is exposed to heat, meaning that heat can produce new substances". In fact, the correct scientific concept is that "butter placed on hot Teflon will melt because heat can change the shape of the substance.". In addition, students' wrong thinking is caused by students having the wrong preconception. Students already have an initial concept before participating in the learning process at school (Suparno, 2013). This was found in the reason that students in the second level questions such as: "students perceive dark-colored shirts to have thinner fabrics than light-colored shirts so that they dry easily". In fact, the corresponding scientific concept is that "dark-colored shirts absorb more heat energy from sunlight. On the other hand, light-colored T-shirts (green, yellow, red) tend to reflect more sunlight."

The second cause of misconception comes from the LKS book. Students revealed that the science concept errors they had were sourced from the Science LKS book used in the learning process published by Catur Wangsa Mandiri. After further analysis, the LKS book does not contain misconceptions of science concepts. However, the presentation of the material in the LKS book is still made into one, such as the concept of melting and melting. Melting and melting are different science concepts, while in the LKS book they are explained at the same time. This triggers a misconception in the concept of melting, namely students think that melted ice cubes are a process of releasing heat. In fact, the correct concept is that melting is the process of absorbing heat. In addition, the explanation of science concepts in the LKS book is relatively concise so that it is not understood by students. As a result, students partially grasp or do not understand at all about the concepts they are learning (Suparno, 2013). For example, the relationship between the expansion coefficient of length and the increase in the length of an object is not explained in detail. This results in misconceptions such as students thinking that bimetals will curve towards metals that have a greater coefficient of expansion of length. The finding is in line with previous research that the LKS book which contains a concise explanation causes students to not be able to understand the relationship between concepts and contains many difficult terms that are understood by students (Izza et al., 2021).

The third cause of misconception comes from learning resources spread across the internet that is website and youtube. After the analysis, there are several webisite which contains a misconception about Temperature, Heat and Expansion. The misconceptions found are such as "melting is caused by heating with temperature" and "thick clothing can withstand cold weather so that the body feels warm. In addition to the webisite, misconceptions are also found in youtube i.e. "heat can conduct heat". Previous research has also found that inaccurate and complete teaching materials on the internet can cause misconceptions in students (Nurcahyono & Suprapto, 2023).

The implications of measuring profiles, understanding concepts and misconceptions in science learning can make it easier for teachers to follow up on learning and improve student outcomes. This is in line with the findings Khasana et al. (2024) that it is important to carry out measures of concept understanding and misconception because it can affect the quality of student learning outcomes. Students who already understand the concept (C2) mean that students already have a foundation to solve problems at a higher level of cognition, namely applying (C3), analyzing (C4), evaluating (C5) and creating (C6). Students who experience misconceptions can be remediated according to the cause of their respective misconceptions so that all students gain scientific knowledge and students can apply science concepts appropriately in real life. For this reason, it is important to conduct training for science teachers on the preparation of integrated gradual tests so that the implementation of science learning is effective.

Conclusion

Integrated phased tests have the characteristics of a four-level diagnostic test. The results of the integrated phased test were obtained to be valid, reliable, and practical. The results of the measurement of the students' science concept understanding profile on temperature, heat and expansion materials obtained an average understanding of concepts with a low category. The average misconception of students in the material Temperature, Heat and Expansion was obtained at 63% with a high category. The causes of misconceptions in students include their own thoughts, workbook books, and learning resources available on the internet. The implications of measuring the profile of understanding science concepts and misconceptions can make it easier for teachers to follow up on learning and improve student outcomes.

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The authors declare no conflict of interest.

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