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DEVELOPMENT OF A GOOGLE FORM-BASED THREE TIER DIAGNOSTIC TEST INSTRUMENT TO IDENTIFY MISCONCEPTIONS OF GRADE VII STUDENTS ON THE THEME OF HEAT AROUND US

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Abstract: Understanding a concept is very important for students to understand, but in the process misconceptions often occur. To minimize misconceptions, an instrument is needed that can diagnose student misconceptions through diagnostic test assessments. The purpose of this study is to assess the level of validity and ensure the use of a Google form-based three-tier diagnostic test. This instrument can identify the misconceptions of seventh grade junior high school students on the theme of heat around us. This development research refers to the three steps of the Thiagarajan model: defining, designing, and developing. Expert validators and samples, namely 2 lecturers as assessment experts participated in this study, 1 lecturer as a media expert, and 3 practitioners, as well as 30 seventh grade junior high school students. Interview sheets, validation, limited trials and teacher response questionnaires were used in data collection. The percentage calculation results obtained a score of 89.9% with a very valid category. The results of the limited trial showed that 83.4% of students had misconceptions, 12.3% knew the concept, and 4.3% did not know the concept. While the results of the teacher response questionnaire showed that 84.6% of the test were in the very high category.

Keywords: Google Form-based Three-tier Diagnostic Test Instrument, Misconceptions, Heat Around Us Theme.

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INTRODUCTION

Concept is something that needs to be understood by students so that the understanding they get is in accordance with the theory and the truth. Conception is the process of understanding and interpreting concepts. In the mind, conceptions are interconnected to produce an abstraction mindset. When concepts are interpreted into conceptions and then applied to facts, misconceptions can arise. Student misconceptions are misconceptions by students that are different from scientists' conceptions (Wiyono et al., 2016; Wulandari et al., 2022).

In higher education, misconceptions will continue and become increasingly difficult to eliminate if not recognized early. It is important for educators to be aware of and recognize children's misconceptions from an early age so that these misconceptions do not continue and affect later concepts. (Kamilah et al., 2019). The use of diagnostic test instruments given to students after learning is completed is one method to identify misconceptions. (Mubarak, 2016). Diagnostic tests are used to evaluate how well students conceptually understand important ideas in a particular subject, especially those that are often misunderstood (Abbas, 2018).

In essence, integrated science learning is a teaching method that allows students to recognize material both individually and in groups by actively investigating, clarifying, validating, and presenting their findings. (Lukum., 2015; Asiani et al., 2022). *Webbed* type is one of the possible integration paradigms for junior high school integrated science learning (Devi et al., 2023). This approach was chosen because the ideas in KD Science are different and related to each other but do not overlap. Therefore, in order for these ideas to become a fully formed competency, it is necessary to connect them with certain topics. Where this is in accordance with the characteristics of the *webbed* integration model, namely teaching a number of KDs that are connected using themes (Heru et al., 2014).

Based on the results of preliminary interviews conducted in two schools Carenang junior high school 1 and Ciruas junior high school 2, it was found that teachers never evaluate their assessments to find out themiscon ceptions experienced by students. teachers only use essay and multiple choice questions, both of which have advantages and disadvantages including more subjective questions, in making questions takes a long time but can cover the material more widely. In a short time, multiple choice tests can identify many students (Arum,etal., 2022). However, students' concepts or understanding can only be the result of chance or conjecture because they are not fully expressed. As for the essay form, students have more time to reflect and record their understanding in detail in their writing, but the process of interpreting and analyzing the findings of the essay exam is time-consuming for the researcher. (Kamilah et al, 2019).

In *webbed* integrated science learning, which uses a theme to teach several KDs, the suitable theme used is "Heat around us". The problem found based on the interviews conducted is that there are still many students who experience misconceptions, so the purpose of this study is to determine the level of validity of test instruments and to find out that through Google Form-based three-tier diagnostic test instruments based on limited trial results can identify student misconceptions. The development of a *three-tier* diagnostic test instrument is important to do so that student misconceptions can be identified as quickly as possible (Septiani, et al., 2022). Based on the above problems, to help identify any misconceptions that students may have. "Development of a *google form-based three-tier diagnostic* test instrument to identify misconceptions of seventh grade students on the theme of heat around us" is an interesting topic to be explored and further developed by researchers.

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METHODS

This research is a type of research and development (R&D). The model often referred to as the (four-D) model is the basis of this development research. includes four phases: definition, design, development, and dissemination (Thiagarajan, 1974). The 4D development model was modified into 3D, only up to the develop stage. Here are the details of the stages:

Define Stage

At this stage the activities carried out are front end analysis, concept analysis, task analysis and goal formulation.

1. Front end analysis
   Front-end analysis is the initial stage carried out to identify problems in schools that will later have a way to solve them. The types of questions used by teachers in conducting evaluations are usually general types such as multiple choice (PG) and ordinary descriptions so that they cannot diagnose whether students experience misconceptions or not. Information was collected based on the findings of interviews with science teachers in junior high schools, which in evaluating student learning outcomes, teachers have never compiled and applied *three-tier* test instruments.
2. Concept analysis
   The purpose of concept analysis is to find concepts and materials that will be applied in preparing the grids of question instruments. Based on the interview, it is also known that KD learning which often occurs misconceptions is in Physics learning. Based on the concept analysis that has been carried out, researchers make models and test instruments of the *webbed* integration model with the theme "Heat around us". KD analysis that will be used is KD 3.4 heat, KD 3.5 energy, KD 3.11 solar system, and KD 3.8 material particles.
3. Task analysis
   The purpose of task analysis is to formulate solutions based on the problems that arise in the front end analysis. The next stage is to determine the KD which will later make indicators of competency achievement (IPK) and objectives in the preparation of test instruments related to the theme of Heat around us. Consisting of 4 KD, 3 KD are from class VII and 1 KD is from class IX which consists of the fields of physics, chemistry and IPBA.
4. Formulation of objectives
   Based on the results of the three previous stages, the next step is to formulate objectives. The formulation of these objectives is to determine the indicators of competency achievement (IPK) based on material and curriculum analysis. After the formulation of GPA, then the learning objectives are formulated. The goal is for researchers to know the subject matter and achievements that will be included in the test instrument.

Design Stage (Planning)

Test development criteria are the activities at this stage that consist of: media selection, format and the first *design* that begins once the test is set.

1. Media selection
   In the preparation of this assessment instrument, the media used is Google Form. The selection of Google Form as the media to be used is expected to be a solution in solving problems that have occurred in learning evaluation activities. This Google Form supports learning evaluation activities, namely the *three-tier test*. In addition, Google Form can be accessed by anyone and anywhere, as long as it has a link to the questions made by the researcher.

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2. Format selection
   The test instrument technique used in this study is a three-tier test with 30 questions. The sources for researchers to make questions are from BSE science books grade VII, articles, journals, and the internet.
3. Initial design
   The first step taken at this stage is to develop an initial product format grid. The steps taken are preparing and creating a grid format and the material that will be used as a source for making questions. Determining basic competencies (KD) followed by GPA. KD and indicators are formulated in KKO according to *Krathwohl*, 2002 which is the basis for preparing questions.

Develop Stage

To produce a draft question instrument that has been updated based on the experts' suggestions is the goal of this stage which includes:

1. Instrument validation
   At this stage, validation is carried out to measure the validity level of the developed product. After obtaining suggestions from the validator, the product will be revised. The results of the revision will be carried out a limited trial on seventh grade junior high school students in one school to find out whether the developed test instrument can diagnose misconceptions experienced by seventh grade students on the theme of heat around us
2. Data analysis
   After the validation sheet is filled in and a score is obtained, data analysis is carried out to determine the validity level of the question using the formula:

$$P = \frac{f}{N} \times 100\% \quad \text{..... (1)}$$

Description:
P= Percentage of assessment (%)
f= Number of scores obtained
N= maximum number of scores

Next, determine the validation criteria which can be seen in the following table:

Table 1. Achievement Level

Achievement Level	Description
81,2-100 %	Very valid
62,5-81,2 %	Valid
43,7-62,5 %	Fairly valid
25-43,7 %	Invalid

(Source: Sudijono, 2012)

Next, we analyzed the teacher response questionnaire data by finding out the score, if they answered each question in the questionnaire accurately. Using the percentage technique described by Riduwan (2012), the data was examined using the following formula:

$$\text{Percentage} = \frac{\textit{The sum of each item's answer scores}}{\textit{The item's ideal score number}} \times 100\% \quad \text{..... (2)}$$

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The following standards are applied when interpreting the results:

Table 2. Guidelines for Interpreting Teacher Response Scores

Percentage Range	Criteria
0-20	Very low
21-40	Low
41-60	Medium
61-80	High
81-100	Very high

(Sumber : Riduwan, 2012).

Product revision

Product revision was conducted after the acquisition of expert judgment. Any suggestions, criticisms, recommendations, and input from the professionals were noted and used to refine the product design.

RESULTS AND DISCUSSION

This research is a type of development research that uses the 3D method, which consists of 3 stages only to the development stage, so that a research product is produced in the form of a three-tier diagnostic test instrument based on Google Form to identify misconceptions of grade VII students on hot themes around us. The test instrument product is composed of 30 questions which are then carried out in the expert validation test stage consisting of assessment experts, media experts, and expert practitioners. The development of a Google Form-based *three-tier* test instrument was examined to establish the level of validity and whether it could diagnose the misconceptions of grade VII students on the theme of heat around us. The validation sheets of *assessment* experts, media and practitioners were used in the calculation of scores. And to find out whether it can diagnose students' misconceptions, it is calculated using the teacher response questionnaire and the results of the limited trial.

Presentation of Validation Data.

The analysis of the results of the validation assessment by experts is carried out through several aspects, namely, aspects of material, construction and language, the explanation is as follows:

Assessment Expert Validation Results

Validation by *assessment* experts has the aim of detailing the material, construction and language scores, shown from several sub-aspects on the learning material tested on the Google Form-based *three-tier* diagnostic test instrument. The results of the *assessment in the assessment* aspect obtained a percentage of 91.89% which is included in the Very Valid category. Obtained from 2 *assessment* expert validators in three aspects assessed. The following results are obtained:

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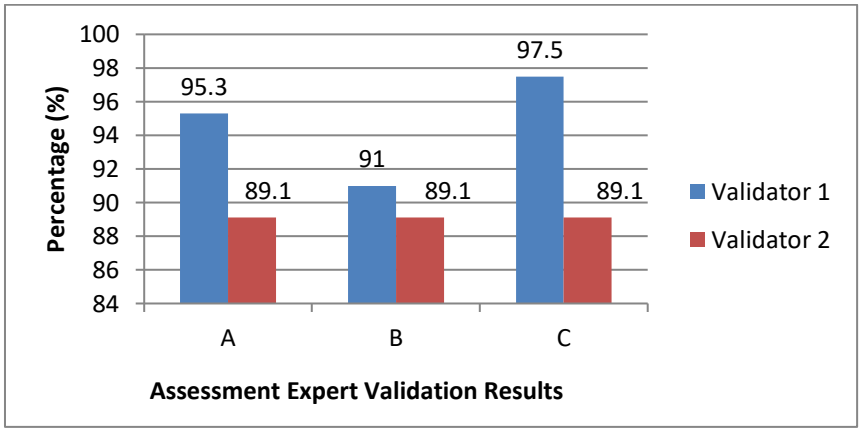

Figure 1. Assessment expert validation percentage graph (Description A: material aspect, B: construction aspect, C: language aspect)

Assessment of material aspects (A) is carried out to evaluate the scope of suitability of KD, indicators, themes, cognitive domains, and the use of *webbed* models that must be completed by students. It can be seen through Figure 1 shows the percentage of acquisition from both validators in the material aspect of 95.3% and 89.1% categorized as very valid. The very valid category in this aspect proves that the overall results show a very valid state so that the questions that have been made are in accordance with the KD, indicators, themes, cognitive domain and the use of the *webbed* model.

The test product was then evaluated based on construction aspects (B) including the subject matter is formulated briefly, clearly and firmly, does not provide an answer key, does not include double negative statements, is in accordance with the misconceptions to be detected, and the questions do not cause new misconceptions. The assessment of the construction aspect obtained a percentage from both validators of 91% and 89.1%, categorized as very valid. The very valid category in this aspect proves that the overall results show a very valid condition so that the questions that have been made are in accordance with all indicators in the construction aspect.

The assessment of language aspects (C) includes language that is in accordance with the KBBI, communicative, and the font size on the questions is suitable and comfortable. The language aspect assessment obtained a percentage from both validators of 97.5% and 89.1%, categorized as very valid. The very valid category in this aspect proves that the overall results show a very valid condition so that the questions that have been made are in accordance with the KBBI and all indicators in the language aspect.

Media Expert Validation Results

Validation by media experts has the aim of detailing the presentation, grammar and grammar scores, shown from several sub-aspects on the learning material tested on the Google Form-based *three-tier* diagnostic test instrument. The results of the assessment in the media aspect obtained a percentage of 89.83% in the Very Valid category obtained from the media expert validator in the three aspects assessed. The following results are obtained:

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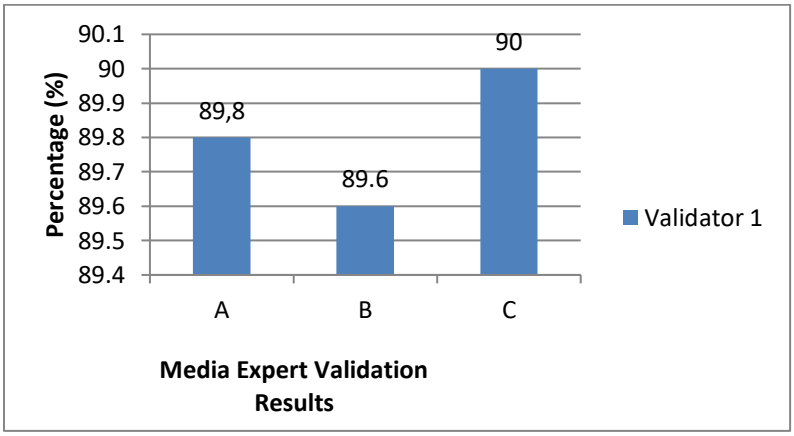

Figure 2. Percentage chart of Media expert validation (Description A: aspect presentation, B: graphical aspects, C: grammatical aspects)

The assessment of the presentation aspect (A) is carried out to evaluate the scope of the conciseness of the concepts presented, the clarity of the writing, the ease of display of Google Form as media, the stimulus of the presentation of images and graphics and the suitability of the duration of the problem. As can be seen from Figure 2, the percentage of media validators in the presentation aspect is 89.8%, categorized as very valid. The very valid category in this aspect proves that the overall results show a very valid state so that the questions that have been made are in accordance with the scope of the indicators in the presentation aspect.

The test products were then evaluated based on the grammatical aspects (B) including the suitability of the content material, the color of the layout elements, not using too many letter combinations, not excessive letter variations, the size of images, proportional tables or graphs, and image quality. The percentage of media validators in the graphic aspect is 89.6%, categorized as very valid. The very valid category in this aspect proves that the overall results show a very valid condition so that the questions that have been made are in accordance with all the indicators in the graphical aspect.

The assessment of grammatical aspects (C) includes language that is in accordance with the KBBI, communicative, does not use taboo language, answer choices do not repeat words and spaces, types, and font sizes on questions are suitable and comfortable. The assessment of the grammar aspect obtained a percentage from the media validator of 90%, categorized as very valid. The very valid category in this aspect proves that the overall results show a very valid condition so that the questions that have been made are in accordance with the KBBI and all indicators in the grammar aspect.

Practitioner Expert Validation Results

Validation by expert practitioners has the aim of detailing the eligibility scores of content, language and appearance, shown from several sub-aspects on the learning material tested on the Google Form-based *three-tier* diagnostic test instrument. The results of the practitioner aspect assessment are calculated and get a percentage of 88.11% which is included in the Very Valid category. Obtained from practitioner expert validators in three aspects assessed. The following results are obtained:

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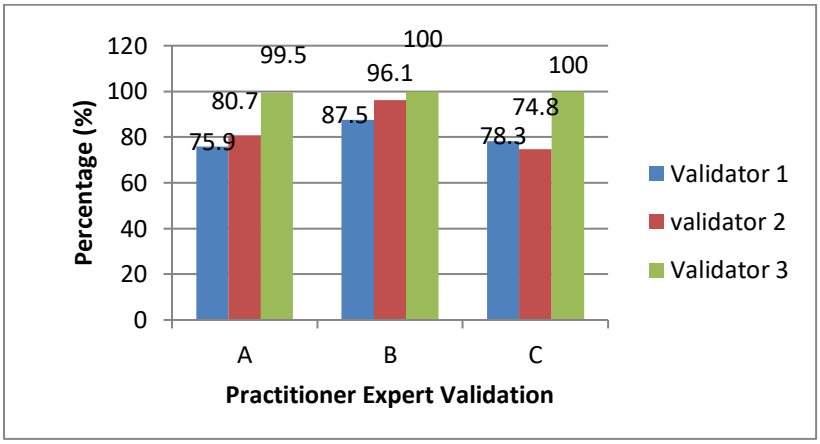

Figure 3. Practitioner expert validation percentage chart (Description A: aspect content eligibility, B: linguistic aspects, C: appearance aspects)

The assessment of the content feasibility aspect (A) is carried out to assess the scope of the suitability of the material with the KD, the breadth and depth of the material, the accuracy of the material, the subject matter is relevant in everyday life, the subject matter increases students' curiosity, the correctness of the answer key, and the formulation of questions in accordance with the level, type of school, and class. As can be seen from Figure 3, the percentage obtained from the three validators in the content feasibility aspect is 75.9%, 80.7% and 99.5%, categorized as valid and very valid. The very valid category given by validator 3 in this aspect of content feasibility proves that the overall results show a very valid state so that the questions that have been made are in accordance with all indicators in the content feasibility aspect. However, the other two validators gave valid scores because there were some questions that were not in accordance with the content feasibility aspect so they needed to be corrected.

The test product was then evaluated based on linguistic aspects (B) including language that is in accordance with the KBBI, communicative, does not use language that is considered taboo, has options to answer without repeating words and spaces, the type and size of the letters on the questions are suitable and comfortable, does not contain language that offends SARA, and the language used is adjusted to the level of student development. The assessment of the language aspect obtained a percentage from the three validators on the language aspect of 87.5%, 96.1% and 100%, categorized as very valid. The very valid category in this aspect proves that the overall results show a very valid state so that the questions that have been made are in accordance with all indicators in the linguistic aspect.

The assessment of the display aspect (C) includes the ease of reading text/writing, images, or graphics, the appearance presented is not boring, the ability of the media to increase student motivation, the ability of the media to increase knowledge, and media support for student learning independence. The assessment of the display aspect obtained a percentage from the three validators of 78.3%, 74.8% and 100% in the valid and very valid categories. The very valid category in this aspect proves that the overall results show a very valid state so that the questions that have been made are in accordance with all indicators in the display aspect. However, the other two validators gave valid scores because there were some questions that were not in accordance with the display aspect so they needed to be corrected. Table 3 below displays the average assessment obtained from the validation received from the experts:

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Table 3. Results of Overall Validation of Test Instruments

No	Validator	Percentage	Category
1.	Assessment / *material expert*	91,89 %	Very Valid
2.	Media Expert	89,83 %	Very Valid
3.	Expert Practitioner	88,11 %	Very Valid
	Overall	89,94 %	Very Valid

The results of expert validation resulted in an average percentage in the "very valid" category of 89.9%. This finding indicates the high validity of the test and its suitability for use by students in grade VII. Although the test product is very valid, it still has to be improved in accordance with the recommendations and input from the validators to make it more suitable for use as a student learning outcomes test instrument, especially on the theme of heat around us.

Product Revision

After the results of product validity are known, the next stage is product revision. The Google Form-based *three-tier* diagnostic test instrument after being validated by expert validators, the next step is to make improvements according to the suggestions and input from expert validators. one of the *assessment* expert validators gave advice in the form of questions that have pictures that are attempted to be taken by themselves, and if using images from the internet, don't forget to include the source. While other validators provide advice on each item. For example, item number 9, measuring instrument ℃ to 100 ℃ so that the numbers are changed. Then for question number 15, the reason should explain the structure of each material. In question number 16, the reason is related to the concept of physics. In question number 19, the reason should be adjusted to the nature of the substance, for example solid substances have solid properties and so on.

Furthermore, there are suggestions for improvement from media validators, providing suggestions in the form of writing must be checked again and the question indicators must use the ABCD format because most of the questions do not have *degrees*. In addition, adjustments were made in response to recommendations from practitioner validators, including one of the practitioner validators giving advice on question number 2 to be enlarged and clarified again. In question number 5, only one picture should be used, so that there is no misconception. Another validator gave advice on question number 1 because the question was asked to sort, so the data in the question was randomized. In question number 8, the word "sort" in the question sentence is not needed. Problem number 9 should be the type of metal and specific heat presented as part of the problem. problem number 12 the question sentence "shown by numbers 1-9" should not be used. Problem number 13 should be replaced with "which describes the molecules of the compound". Problem number 14 should add the word "method".

Data Analysis of Students' Misconceptions Based on Limited Trial

The calculation of the score of the 3TMC (three-level multiple choice) test instrument is obtained by giving the correct answer (worth 1), choosing the reason correctly (worth 1), and indicating the level of confidence in the answer (if sure it is worth 1, if not sure it is worth 0).Data regarding the number of correct answers obtained from the limited test results that have been carried out. To obtain data on student misconceptions, after that the calculations were carried out manually using Microsoft Excel. It can be seen that of the 30 items developed, most students experience misconceptions on each item. With a total of 100% of the limited trial results to 30 students, who knew the concept as much as 12.3%, did not know the concept as much as 4.3% and who experienced misconceptions as much as 83.4%. Based on the results of the limited trial, most

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students experienced misconceptions. According to Ma'rifah et al. (2016) students face difficulties in the form of problems displayed in the form of graphs and images, problems in understanding ideas, and challenges in calculating or applying formulas. Most students are mistaken about the terms they often hear. In addition, another thing that can affect the low understanding of concepts is because students have difficulty in creating their own concepts, when they have a poor understanding of the concepts they learn. (Hidayat et al, 2020).

There are several things that cause most students to experience high misconceptions. The high level of misconceptions among students can be caused by their own way of thinking. Constructivist philosophy argues that during the learning process, students create their own conceptual framework for the material they learn. Students will understand a concept more fully if their understanding is in line with the vision of experts, Misconceptions arise when students' understanding deviates from this alignment. (Hidayat et al., 2020). Students who understand concepts are usually students who have prior knowledge. A higher level of prior knowledge makes it easier for students to absorb and understand the teachings. Conversely, learners who have little prior knowledge usually view new material as lessons that need to be remembered, making it difficult for them to accept and pay attention to the material being taught. (Putra *et a*l, 2020). Figure 4 shows the distribution of students' overall conceptual understanding

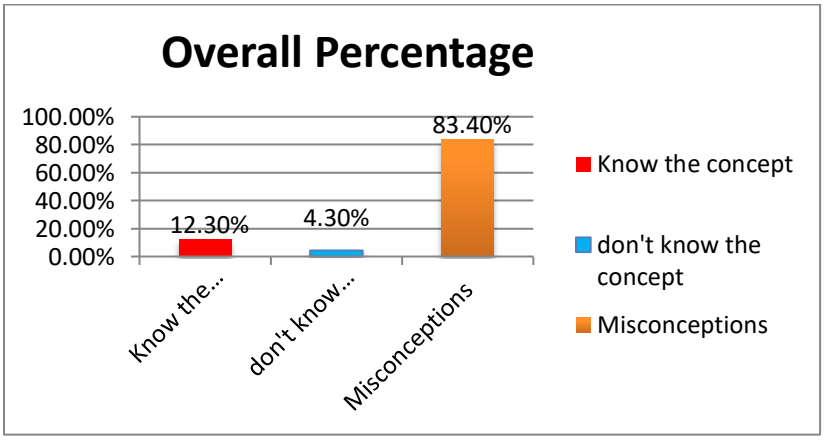

Figure 4. Overall Percentage

Teacher Response Questionnaire Results

The results of the teacher response questionnaire were assessed by validators who were 3 Science teachers in three junior high schools in Serang Regency. Analyzed through the aspects assessed, namely aspects of knowledge construction, material and language with the following details:

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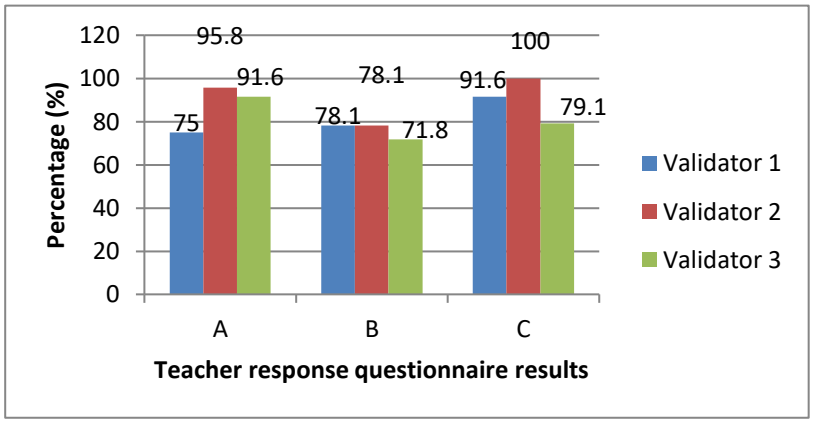

Figure 5. Graph of the percentage of teacher response questionnaire results (Description A: knowledge construction aspect, B: material aspect, C: language aspect)

Assessment of the knowledge construction aspect (A) is carried out to evaluate the scope of making it easier for teachers to carry out the *assessment* process, making it easier for teachers to construct knowledge, helping in diagnosing misconceptions experienced by students, helping teachers in measuring student abilities, helping teachers in diagnosing student learning difficulties, helping teachers in determining the level of achievement of each student. As can be seen from Figure 5, the percentage obtained from the three validators in the knowledge construction aspect is 75%, 95.8% and 91.6% in the high and very high categories. The very high category given by validators 2 and 3 in the knowledge construction aspect proves that the overall results show a very high state so that the questions developed are in accordance with all indicators in the knowledge construction aspect. However, one of the validators gave a score in the high category because there were several questions that were not in accordance with the aspects of knowledge construction so that improvements needed to be made.

The test product is then evaluated based on the material aspect (B) which consists of conformity with the indicators, homogeneous and logical answer choices, there is only one answer key, the questions are in accordance with the semester level of the students, the questions asked help in detecting students' misconceptions, the questions are not related to everyday life, the questions asked are easy for the students' level, and the questions asked describe the breadth and depth of the material. the indicators used consist of 1 negative statement and the rest are positive statements. The material aspect assessment obtained a percentage from the three validators on the material aspect of 78.1%, 78.1% and 71.8% in the high category. All validators gave scores in the high category in the material aspect because the material analysis of the kd used most of the minimum indicators are analyzing (C4) so that all the question levels are high. In addition, there is also one KD that is in grade IX, so the Science Teacher as Practitioner Validator considers the questions developed are not easy for the level of students.

The assessment of language aspects (C) includes language that is in accordance with the KBBI, communicative, the terms used are not in accordance with the KBBI, the terms used are not in accordance with the theme "heat around us", the formulation of test instruments does not contain offensive words or sentences and does not use words that contain multiple interpretations. The indicators used consisted of 2 negative statements and the rest were positive statements. The assessment of the language aspect obtained a percentage from the three validators of 91.6%, 100% and 79.1% in the very high and high categories. The very high category in this aspect proves that the overall results show a very high state so that the questions that have been made are in accordance with the KBBI and all indicators in the language aspect. However,

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one of the validators gave a high score because there were some questions that were not in accordance with the language aspect so they needed to be corrected.

Relationship between Limited Trial Results and Teacher Response Questionnaire Results

Based on the description above, it can be seen that through the results of limited trial data analysis to 30 seventh grade students in one of the junior high schools in Serang Regency, the overall percentage of students' misconception level was 83.4% misconceptions, 12.3% students knew the concept, and 4.3% students did not know the concept. Furthermore, the results of the teacher response questionnaire, getting the average results of three validators obtained an overall percentage of 84.6% in the very high category. In this case, it is certain that through the results of limited trials the Google Form-based three-level diagnostic test instrument can identify The misconceptions of seventh graders about the hot themes around us.

CONCLUSION

Based on the results of research and development of Google Form-based *three-tier* diagnostic test instruments to identify the misconceptions of seventh grade students on the theme around us, it can be concluded that the results of expert validation show that the average percentage of 89.9% is categorized as very valid, with the results of *assessment* expert validation obtaining a percentage of 91.8% which is included in the very valid category, media expert validation obtaining a percentage of 89.8% which is included in the very valid category, and practitioner validation obtaining a percentage of 88.1% which is included in the very valid category.

After the revision was made, a limited trial was carried out which had a result of 83.4% of students experiencing misconceptions, 12.3% of students knew the concept, and 4.3% of students did not know the concept. This is reinforced by the results of the teacher's response which is categorized as very high with an average percentage value obtained of 84.6%, with overall results in the knowledge construction aspect obtaining a percentage of 87.5% which is categorized as very high, the material aspect obtaining a percentage of 76% which is categorized as high, and the language aspect obtaining a percentage of 90.2% which is categorized as very high, so it can be ascertained that the Google Form-based *three-tier* diagnostic test instrument to identify the misconceptions of seventh grade students on the theme of heat around us has had very high teacher response results.

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