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A Shift in the Conceptual Understanding of Physics Students Through the Wright Map

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Abstrak

Ada keterbatasan literatur yang melaporkan penggunaan model Rasch dalam menganalisis pemahaman konseptual suhu siswa di Indonesia. Terdapat 58% mahasiswa S1 Pendidikan Fisika mengalami miskonsepsi pada topik suhu. Oleh karena itu penelitian ini bertujuan untuk menganalisis pemahaman konseptual siswa dengan menggunakan instrumen diagnostik dua tingkat. Pemahaman konseptual siswa diberikan melalui metode survei menggunakan instrumen diagnostik miskonsepsi dua tingkat. Survei dilakukan pada 26 siswa (31% laki-laki dan 69% perempuan) usia berkisar antara 16 tahun sampai 19 tahun di sekolah menengah umum. Pemahaman konseptual siswa tentang materi suhu diberikan menggunakan enam item diagnostik dan dianalisis menggunakan peta Wright. Pengumpulan data dilakukan secara online menggunakan Google form yang didistribusikan melalui grup WhatsApp kelas. Analisis data dilakukan dalam dua tahap yaitu, pengkodean jawaban siswa, dan analisis pemahaman konseptual siswa. Hasil analisis menunjukkan adanya pergeseran tingkat pemahaman konsep 50% siswa. Jadi, peta Wright memberikan visualisasi pergeseran tingkat pemahaman konseptual siswa tentang topik suhu.

Kata kunci: Kesalahpahaman, Model Rasch, Konsep Suhu, Tes Diagnostik Dua Tingkat, Peta Wright

Abstract

There is limited literature reporting on the use of the Rasch model in analyzing the conceptual understanding of student temperature in Indonesia. There are 58% of Physics Education undergraduate students experience misconceptions on the topic of temperature. Therefore, this study aims to analyze students' conceptual understanding using a two-level diagnostic instrument. Students' conceptual understanding was administered through a survey method using a two-level misconception diagnostic instrument. The survey was conducted on 26 students (31% boys and 69% girls) ages ranging from 16 years to 19 years at a public high school. Students' conceptual understanding of the temperature material was administered using six diagnostic items and analyzed using the Wright map. Data collection has been done online using a Google form distributed through the class WhatsApp group. Data analysis has been carried out in two stages namely, coding students' answers, and analyzing students' conceptual understanding. The analysis results showed a shift in the level of conceptual understanding of 50% of students. So, the Wright map provides a visualization of shifts in the level of students' conceptual understanding of the topic of temperature.

Keywords: Misconception, Rasch Model, Temperature Concept, Two-tier Diagnostic Test, Wright Map

1. INTRODUCTION

Various reports on students' difficulties in studying physics, especially misconceptions or alternative conceptions on the topic of heat and temperature, have become one of the characteristics of physics education research (PER) over the last five decades (Lemmer et al., 2020; Sukarelawan et al., 2019). Misconceptions on the topic of heat and temperature occur in almost various countries (Aykutlu et al., 2017; Chu et al., 2012; Fenditasari et al., 2020; Madu & Orji, 2015; Saricayir et al., 2016; Wong et al., 2016). In Indonesia, misconceptions about heat and temperature are experienced by students at several

levels of education. For example, junior high school students, high school students, undergraduate students, teacher candidates, and postgraduate students (Fenditasari et al., 2020; Sukarelawan et al., 2019; Taqwa et al., 2019; Winarti & Budiarti, 2020). This misconception will have a negative impact on understanding the next more complex concept. Therefore, this situation needs serious attention and must be addressed or corrected, because it is not easily changed (Berek et al., 2016; Taqwa et al., 2020).

Misconceptions of heat and temperature occur on various topics, namely: temperature, expansion, the effect of heat on changes in temperature and object shape, and heat and its transfer (Fitriah, 2017; Lestari et al., 2017; Rahayu et al., 2019; Zayyinah et al., 2018). There are 58% of Physics Education undergraduate students experience misconceptions on the topic of thermal equilibrium (Taqwa et al., 2020). Another researcher also found that students in grades XI and XII experienced misconceptions of 84% and 90% on the topic of thermal equilibrium (Fenditasari et al., 2020). The previous researcher identified at least 47% of high school students in Bulukumba, Indonesia, experience misconceptions on the topic of the phase change (Handayani, 2020).

One type of instrument that can reveal students' misconceptions is a two-tier diagnostic model instrument (Kanli, 2015; Mutlu & Sesen, 2015; Potvin et al., 2015). This type of instrument is a refinement of the conventional multiple-choice type. The two-tier diagnostic consists of conventional multiple-choice (first tier) and reasons (second tier) (Kaltakci-Gurel et al., 2015; Soeharto et al., 2019). Various studies have used a two-tier instrument to diagnose heat and temperature misconceptions in students (Maunah & Wasis, 2014; Ni'mah et al., 2019; Sanyto et al., 2016; Saricayir et al., 2016; Winarti & Budiarti, 2020). This instrument has been widely used in science as an effective method for evaluating sophisticated student understanding (Xiao et al., 2018). This instrument is not only able to assess conceptual understanding but can also diagnose students' misconceptions (Laliyo et al., 2019).

Analysis techniques based on classical test theory (CTT) and item response theory (IRT) have been used to analyze the pattern of students' answers in the form of multiple choices. Currently, there are limitations to the use of IRT in diagnosing students' misconceptions. Various articles use classical test theory-based analysis (CTT) to analyze and describe students' misconceptions on the topic of temperature. The CTT technique is based on a non-linear total score. In contrast, IRT is based on the equivalence between individual ability and item difficulty on a linear scale in a single frame of reference. Personal ability and item difficulty are not interdependent (Wind & Gale, 2015). Therefore, IRT is an alternative to evaluating students' conceptual understanding (Blanc & Rojas, 2018). As part of IRT, the Rasch model can integrate the diagnostic evaluation approach of misconceptions and summative evaluation (Liu, 2012). Through the Wright map, the Rasch model can see the interaction between items and persons at the individual level (Sumintono & Widhiarso, 2014). The Wright map places people and items hierarchically according to the person's abilities and item difficulty level (Blanc & Rojas, 2018). Based on the potential possessed by the Rasch model, this study aims to analyze students' conceptual understanding of the topic of temperature using a rating scale through the Wright map.

2. METHODS

This research is a type of survey research. The research was conducted in one of the public high schools in the Tidore Islands, Indonesia. Respondents involved in this study came from physics class students who had taken heat and temperature subjects. Respondents consisted of 26 students (31% male and 69% female). Respondents of Male is symbolized by

"L" and female is represented by "P." Respondents' age ranged from 16 years to 19 years (mean age = 17.31 years, SD = 0.68 years).

Students' conceptual understanding was diagnosed using a two-tier diagnostic instrument on the topic of temperature. Figure 1 represents one of the two-tier diagnostic questions. The diagnostic instrument on the topic of temperature consists of 6 items and is described in Table 1. The diagnostic questions used have been tested for compatibility with the Rasch model. The value of item fit against the model was evaluated through the MNSQ Outfit value, Outfit Z-standard, and Point Measure Correlation (we reported in another study).

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1.	1. Doni mengambil dua potong es batu dari dalam kulkas (satu berukuran besar dan yang lainnya berukuran kecil). Doni merasakan bahwa es batu yang lebih besar lebih dingin. Apakah anda setuju terhadap pernyataan Doni? a. Tidak setuju. Semakin besar ukuran es batu maka semakin tinggi suhunya. b. Tidak setuju. Suhu kedua es batu tidak ada perbedaannya c. Setuju. Semakin besar ukuran es batu maka semakin rendah suhunya. 2. Apa alasan yang melatarbelakangi pilihan anda? a. Suhu tidak bergantung pada ukuran benda b. Suhu sebanding dengan ukuran benda c. Suhu berbanding terbalik dengan ukuran benda

Figure 1. Example of a two-tier Diagnostic Misconception on the Topic of Temperature

Table 1. Description of Instrument Items for Diagnosing Temperature Topic Misconceptions

No. Item	Description
Item 1 (Q1)	The temperature depends on the size/mass of the object
Item 2 (Q2)	The temperature depends on the material/material of the object
Item 3 (Q3)	The temperature of a substance can be transferred
Item 4 (Q4)	Two different temperatures can be added
Item 5 (Q5)	No lowest temperature limit
Item 6 (Q6)	The division of a substance causes the temperature of the two parts to be different

Sources: (Abbas, 2016; Chu et al., 2012; Eryilmaz, 2010)

Data collection has been done online using a Google form distributed through the class WhatsApp group. We ensure the anonymity of respondents in this study. Excel and Winsteps 4.6.1 were used to process the collected data. To tabulate and code student responses, Excel is used. Through the Wright map, Winsteps is used to assess students' conceptual understanding.

Data analysis has been carried out in two stages. The first stage is coding students' answers to categorize conceptual understanding. The categorization of students' conceptual understanding and coding rating scale refers in Table 2. The coding results are then analyzed using the percentage technique. The second stage is to analyze students' conceptual understanding based on the rating scale through the Wright map. Grouping students' conceptual understanding based on LVP (Logit Value of Person) concerning the average logit (M) and standard deviation (SD) (Adams et al., 2019, 202 5 The level of students' conceptual understanding is grouped into 4, namely Low (LVP < M-SD), Moderate (M-SD ≤ LVP < M), High (M ≤ LVP < M+SD), dan Very High (LVP ≥ M+SD). At this stage, each

score of conceptual understanding based on one-tier and two-tier has been compared. Before the analysis, the data were first grouped based on the rating scale.

Table 2. Decisions on Conceptual Understanding Two-tier Diagnostic Test Instrument

1st Tier	2nd Tier	Conceptual Understanding	Rating Scale
True	True	Scientific Knowledge (SK)	3
True	False	False Positive (FP)	2
False	True	False Negative (FN)	1
False	False	Misconception (Misc)	0

Source: Kaltakçi (2012)

3. RESULTS AND DISCUSSION

Result

Overview of Students' Conceptual Understanding

Based on the results of coding students' conceptual understanding that has been done, referring to Table 2, students' conceptual understanding is visualized in Figure 2.

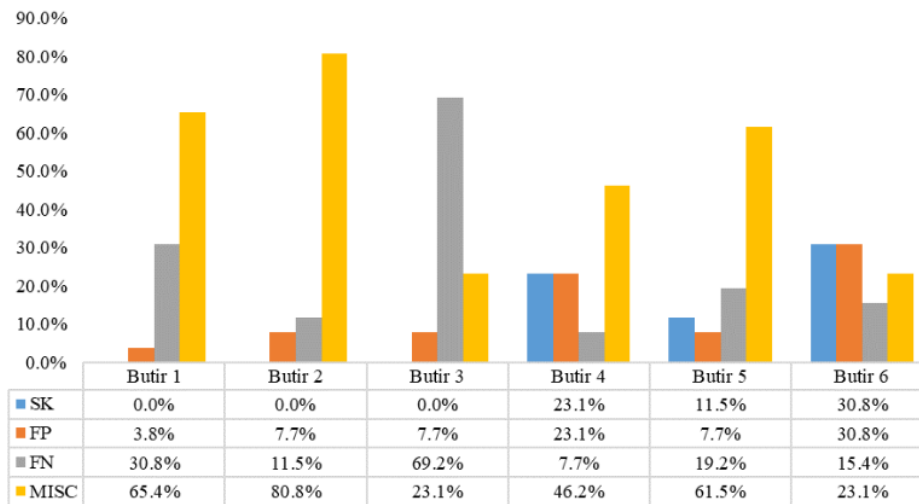|	Butir 1	Butir 2	Butir 3	Butir 4	Butir 5	Butir 6
SK	0.0%	0.0%	0.0%	23.1%	11.5%	30.8%
FP	3.8%	7.7%	7.7%	23.1%	7.7%	30.8%
FN	30.8%	11.5%	69.2%	7.7%	19.2%	15.4%
MISC	65.4%	80.8%	23.1%	46.2%	61.5%	23.1%

Figure 2. Percentage of Students' Conceptual Understanding Categories

Based on Figure 2, it is identified that there are gradations in students' conceptual understanding levels. Students with the highest scientific knowledge on item 6 (Q6) are 30.8%, and the lowest is in Q1, Q2, and Q3, each at 0%. Most of the students had misconceptions about the six items tested. Misconceptions can occur due to conditions of False Positive (FP), False Negative (FN), or pure misconceptions (MISC). Most of the misconceptions (MISC+FP+FN) occurred in Q1, Q2, and Q3, 100%. Students understand that the temperature of objects depends on the size and type of material that makes up objects, and the temperature can be transferred from one object to another. Meanwhile, the minor misconceptions (MISC+FP+FN) occurred in item 6 (Q6) at 69.2%. Some students understand that when an object is divided into two parts, the temperature of the two halves will be different. In particular, the number of students who experienced False Negative was more dominant than students who experienced False Positive. The highest False Negative occurred in Q3 items (69.2%), and the highest False Positive was in Q6 (30.8%). Meanwhile,

more than 50% of students experienced misconceptions (MISC) in Q1, Q2, and Q5. The highest misconception occurred in Q2 (80.8%). In contrast, the lowest misconceptions appeared in Q3 and Q6, respectively 23.1%.

Specific Description of Students' Conceptual Understanding

The various types of students' conceptual understandings that were not correctly diagnosed using a two-tier instrument were tabulated in Table 3.

Table 3. The Combination of Students' Conceptual Understanding Errors is Based on the two-tier Diagnostic Test

Conceptual Understanding	Item					
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**
Misconception	1.1c,1.2c; 1.1a,1.2b; 1.1c,1.2b.	1.1d,1.2d; 1.1b,1.2a; 1.1a,1.2a; 1.1a,1.2b.	1.1a,1.2a; 1.1a,1.2c; 1.1c,1.2a; 1.1c,1.2c.	1.1c,1.2b; 1.1c,1.2c; 1.1d,1.2a; 1.1d,1.2c.	1.1a,1.2a; 1.1b,1.2d; 1.1b,1.1a.	1.1a,1.2a; 1.1c,1.2a; 1.1c,1.2c.
False Negative	1.1a,1.2a; 1.1c,1.2a.	1.1d,1.2c; 1.1b,1.2c.	1.1a,1.2b; 1.1c,1.2b.	1.1d,1.2d.	1.1b,1.2b; 1.1a,1.2b.	1.1a,1.2b; 1.1e,1.2b.
False Positive	1.1b,1.2b.	1.1c,1.2a.	1.1d,1.2d.	1.1a,1.2a; 1.1a,1.2b; 1.1a,1.2c.	1.1c,1.2d.	1.1b,1.2a; 1.1b,1.2c.

Table 3, shows the various combinations of student responses based on the two-level diagnostic test. The concept in Item 1 (Q1) relates to temperature dependence on the size/mass of objects. Some students still think that large ice cubes have a higher temperature because the temperature is proportional to the size/mass of the object. Some other students understand that large ice cubes have a lower temperature because the temperature depends on the object's size. Some of the other students incorrectly understand that large ice cubes have a higher or lower temperature because the temperature does not depend on the object's size. This situation is included in the level of understanding of the concept of False Negative. On the other hand, students understand that large and small ice cubes do not have a temperature difference because the temperature is proportional to the object's size. Understanding this concept is included in the type of False Positive.

The concept in Item 2 (Q2) is related to temperature dependence on the material that makes up the object. Most students think that aluminium tables have a lower temperature than plastic tables in the same room because the temperature depends on the material. Some substances feel colder than others. A few students understand that a plastic table has a lower temperature than an aluminium table because the temperature does not depend on the object's material. Some other students cannot compare the temperatures of the two tables because the temperature does not depend on the object's size. This type of conceptual understanding is included in the False Negative type. The type of False Positive conceptual understanding experienced by students is that students understand that the temperature of the two tables is the same because the temperature depends on the material.

The concept in Item 3 (Q3) is regarding the process of temperature transfer between objects. A small number of students have misconceptions. Students understand that when a spoon is used to stir hot vegetables, the temperature of the two does not change. Some students reasoned that the temperature flows from the spoon to the vegetables. Another student reasoned because the temperature moved from the vegetables to the spoon. At the same time, other students understand that the temperature of the vegetables is increasing. They reasoned that the increase in vegetables' temperature occurs because of the temperature

transfer from the spoon to the vegetables. However, other students reasoned because the temperature moved from the vegetable to the spoon. In item 3, most of the students understood that the temperature of the vegetables and spoons did not change when the vegetables were stirred using a spoon. Some of the other students understand that the temperature of vegetables increases when stirred using a spoon. Students reasoned because of the transfer of energy from vegetables to spoons. The combination of conceptual understanding and reasoning is included in the False Negative category. In other combinations of answers, it was identified that students understood the addition of a spoon's temperature when used to stir vegetables. They reasoned because of the addition of the temperature of the spoon. This type of understanding is included in the False Positive category.

The concept in item 4 (Q4) is about the final temperature of two mixed objects (summation of temperatures). Students assume that when hot coffee is mixed with water at a lower temperature, it causes an increase in the temperature of the coffee. They think that the temperature of coffee and water can be added to ordinary algebra. Another student assumed that the temperature of the water was insignificant because it was significantly lower than the temperature of the coffee. At the same time, some students think that when two objects are mixed, the final temperature is obtained from the sum of the temperatures of water and coffee. But at the level of reasoning, the reasoning is because the high temperature will decrease and the low temperature will increase. This understanding condition is included in the False Negative category.

Item 5 (Q5) concept is regarding the lowest temperature that a cooled object can reach. Based on the recapitulation of students' answers, some students experienced misconceptions. When water is continuously cooled, its temperature will continue to decrease and can reach infinity because the heat possessed by water continues to decrease endlessly. Some students understand that when water is continuously cooled, the temperature will remain at -10oC. There is a reason for the process of dissipating heat that occurs without stopping, and there is also a reason that the temperature of the ice cubes is only able to reach -10oC. Another type of understanding that students have is that the temperature of the cooled water only reaches -10oC because the temperature of the object has a limit. In this conceptual understanding, students understand that when water is continuously cooled, it will cause an infinite decrease in temperature. The reason is that the temperature has the lowest limit. The type of understanding that this student has is in the False Negative category.

The concept in item 6 (Q6) relates to dividing a substance so that the temperature of the two parts is different. The diagnostic results show that there are various combinations of answers from students. It was identified that some students had misconceptions. Students hold the understanding, that if one substance is divided by two, then the temperature of the two parts is different. They reasoned that the emergence of temperature differences is due to temperature dependence on the size and mass of the substance. In the same case, other students understand that if a substance is divided into two, the smaller pieces have a lower temperature because the temperature of each part depends on the size and mass of the substance.

On the other hand, students consider the trim pieces to have a lower temperature because the temperatures of the two halves are proportional to the ratio of size or mass. In the type of False Negative conceptual understanding, two types of understanding are identified. Some students think that the two parts have different temperatures because the magnitude of the temperature does not depend on the size and mass of the substance. Some say that the temperature of the two parts cannot be distinguished because the temperature is not affected by the size/mass of the substance. Another type of conceptual understanding is False Positive. In this type of concept understanding, there are two combinations of student answers

identified. Because the temperature of each part is dependent on the size and mass of the substance, some students believe that the temperature of the two sections is the same. Some think that the temperature of the two parts is the same because the object's temperature is proportional to its size and mass.

Students' Conceptual Understanding Scores

Students' conceptual understanding scores based on the combination of answers to the two-level diagnostic test are shown in Figure 3.
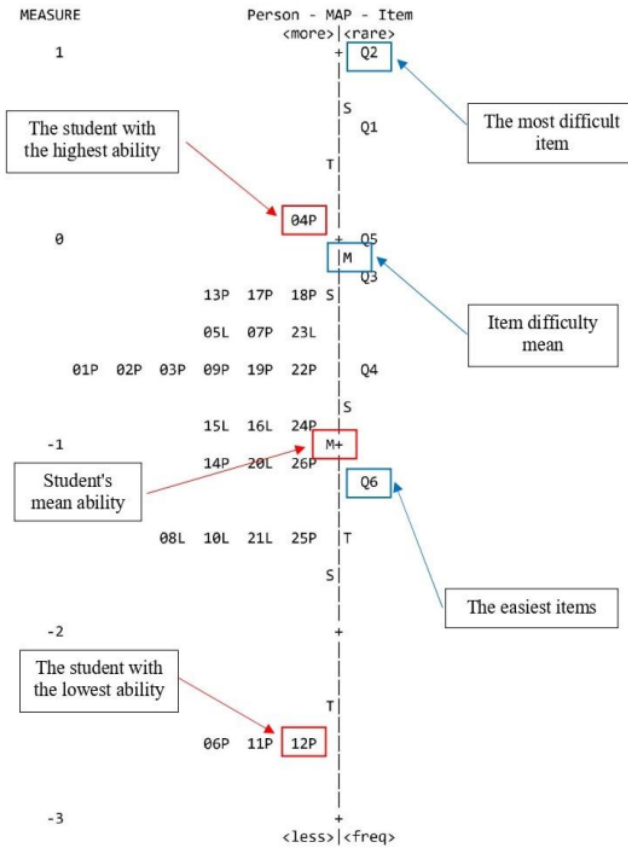

Figure 3. Conception score based on two-tier

Figure 3, shows that the students' average ability (M_{person} = -0.93) is lower than the average difficulty level (M_{item} = 0.00). Sixteen students (61.5%) have a conceptual understanding score above the average person's ability. But only one student (3.8%) has ability above the average item difficulty level. 04P students had the highest conceptual knowledge score, and 12P students had the lowest conceptual knowledge. On the other hand, the three most difficult items were Q2 (1.05 logit), Q1 (0.70 logits), and Q5 (0.10 logit). While the easiest item to have is Q6 (-1.12 logit).

Shifts in Students' Conceptual Understanding Scores

Based on the results of student response analysis, we compared the level of students' conceptual understanding based on one-tier and two-tier multiple-choice types. The comparison results show a shift in students' conceptual understanding scores as shown in Figure 4.
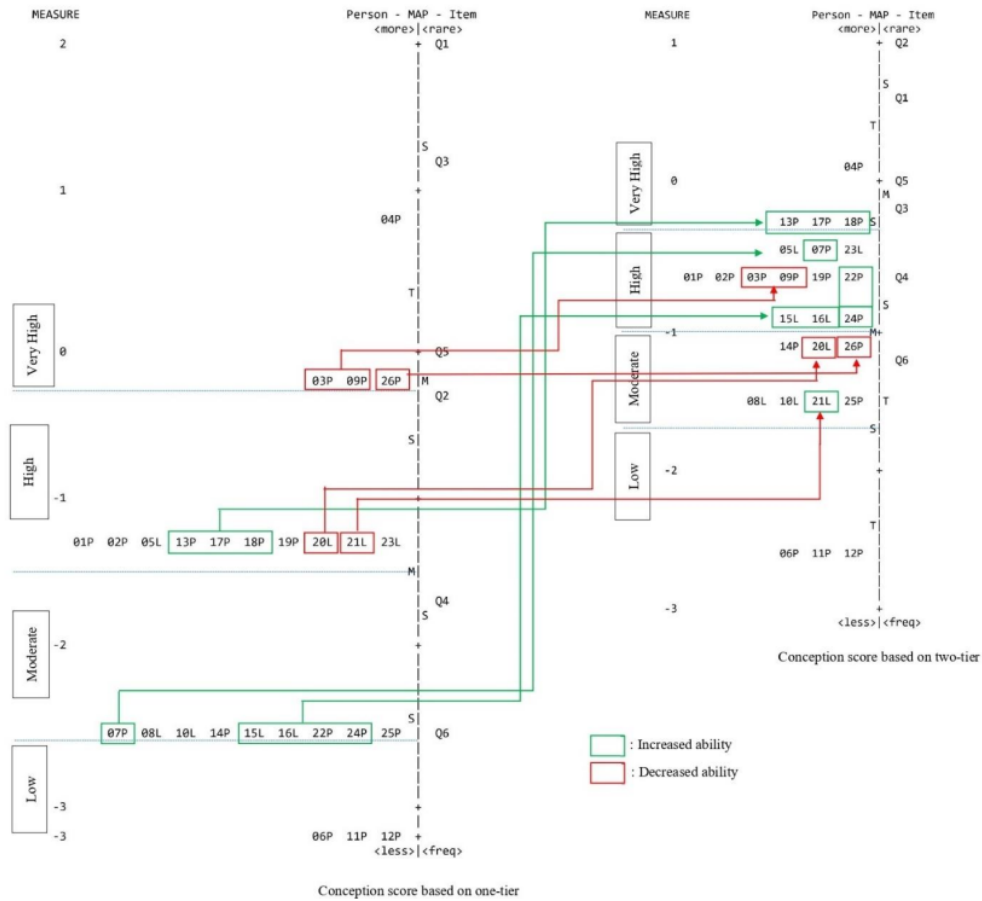

Figure 4. Shifts in Students' Conceptual Understanding Scores Based on One-tier and Two-tier Multiple Choices

Figure 4, shows the grouping of student abilities based on LVP (Logit Value of Person). The average logit of students' conceptual understanding shifted from -1.59 logit (based on one-tier type) to -0.93 logit (based on two-tier type) or increased by 0.66 logits. At the same time, the standard deviation of students' abilities and item difficulty levels also shifted. The standard deviation of students' conceptual understanding shifted from 1.20 logit (one-tier type) to 0.71 logits (two-tier type). The standard deviation of the item difficulty level shifted from 1.54 logit to 0.73 logits. Based on one-tier and two-tier, students 04P (highest ability) and 12P (lowest ability) did not experience a shift in the level of conceptual understanding. However, if viewed from the LVP, 04P students experienced a decrease in

score from 1.04 logit to 0.22 logit. Meanwhile, 12P students experienced an increase in their score from -3.83 logit to -2.50 logit.

Students' abilities are grouped into four levels: Low, Moderate, High, and Very High. Based on one tier, the highest distribution is in the High (38.5%) and Moderate (34.6%). Meanwhile, the distribution of students in the Low and Very High groups was 11.5% and 15.4%, respectively. The same thing happened to the distribution of students' conceptual understanding based on two-tier. The highest distribution was found in the High (46.2%) and Medium (26.9%). The distribution of students' conceptual understanding in the Very High and Low groups was 15.4% and 11.5%, respectively.

Figure 4, shows that 30.8% of students experienced an increase in conceptual understanding. In contrast, the other 19.2% experienced a decrease in the level of conceptual understanding. A total of 11.5% of students experienced a shift in conceptual understanding from the Very High group to High (7.7%) and Moderate (3.8%). There was a shift in conceptual understanding of 19.2% of students from the High to Very High and Moderate groups. The shift in students' conceptual understanding also occurred in the Moderate group. A total of 19.2% of students in this group shifted up to the High group.

Discussion

Misconceptions or alternative conceptions are two terms used to describe an understanding of a phenomenon that is not linear with the consensus of scientists and usually contradicts the agreed principles (Türkmen, 2015). Misconceptions can come from various sources (Kaltakci-Gurel et al., 2016). For example, daily experience, formal and informal teaching, socializing, and reading. Although it is seen as a classic problem since seven decades ago, there is an increasing awareness to evaluate students' conceptual understanding of the physical phenomena that occur (Sukarelawan et al., 2021). Misconceptions have also become one of the most studied areas in physics education (Docktor & Mestre, 2014). The misconception is a serious "distraction" experienced by students due to incomplete knowledge construction. Prolonged misconceptions will have an impact on the process of restructuring knowledge (Taslidere, 2016).

Misconceptions on the topic of temperature have become a global problem (Chu et al., 2009; Fenditasari et al., 2020; Kartal et al., 2011; Wong et al., 2016). There are at least six misconceptions that we have identified from the results of the literature review. First, students view that the temperature of an object depends on its size/mass (Eryilmaz, 2010; Gurcay & Gulbas, 2015). Second, the temperature of an object depends on its constituent materials (Eryilmaz, 2010; Turgut & Gurbuz, 2012). Third, the temperature of a substance can flow from one object to another (Chu et al., 2012; Fenditasari et al., 2020; Turgut & Gurbuz, 2012). Fourth, when two objects are mixed, the mixture's temperature is the algebraic sum of the temperatures of the two (Chu et al., 2012). Fifth, continuously cooled objects will experience an infinite decrease in temperature (Alwan, 2011; Chu et al., 2012). Sixth, if the object is divided into two, then the temperature of each part will be different (Abbas, 2016).

Based on the findings that have been presented previously, it is in line with the previous researcher who conducting an identification of misconceptions by giving 10 two-tier questions. The result showed that students experienced misconceptions in all sub-topics, namely, thermal equilibrium, the effect of heat on temperature changes, the effect of heat on changes in the state of matter, heat transfer, expansion, and Black's Principle (Taqwa et al., 2020). Then this study is supported by other previous research which identifies misconceptions among physics education students in Yogyakarta on the heat and temperature topic of physics education. Based on the results, the percentage of physical education students' misconceptions in Yogyakarta varies on each subtopic misconception. This shows

that the student's misconception is in a high category and needs special attention for educators to carry remediation out. Moreover, the biggest misconception subtopic is needed more detailed explanations (Fenditasari et al., 2020).

Students' misconceptions can come from False Negative (FN), False Positive (FP) conditions, or come from pure misconceptions (MISC). False Positive describes students who answered correctly at first but incorrectly at second (reasoning). Conversely, False Negative is a type of conceptual understanding students have when they are wrong at the first level and right at the second level. That is, students, do not understand physical concepts but understand the reasons why these concepts apply.

False Negatives are considered not problematic because they are caused by conditions of lack of information or student carelessness (Istiyani et al., 2018; Kaltakci-Gurel et al., 2015). At the same time, pure misconception (MISC) is a condition of students' conceptual understanding that is not right at the first and second tiers. If referring to the student responses in Table 4, it was found that there was an illogical combination of answers at the first and second tiers. For example, the combination of student responses in Q1 (temperature dependence on the size/mass of objects).

The Wright map maps the states of persons and items on the same logit scale. The left part of the map shows students' abilities, namely the level of students' conceptual understanding, and the right shows item difficulty (Sukarelawan & Gustina, 2021). Students with high conceptual understanding score occupy the top-left position, and those with low scores occupy the bottom-left positions. Items with a high difficulty level are displayed on the top right, while items with a low difficulty level are displayed on the bottom right. The symbol "M" shows the mean of the logit person and item. The mean items are standardized on a logit scale of 0.00, and the mean person can have a chance of being higher (positive score) or lower (negative score) than the item mean. The mean person is positive, meaning that the average student's ability is higher than the average item's difficulty level. On the other hand, the mean person has a negative value, which means that the average difficulty level of the item is higher than the average student's ability. The symbols "S" and "T" respectively indicate the value of 1 time the standard deviation and two times the standard deviation of the student's logit ability and item difficulty level.

Although student 04P had the highest conceptual knowledge score, the probability of correctly answering Q2 and Q1 was less than 50%. This means that 04P students have a great chance of experiencing misconceptions in the form of False Positive (FP), False Negative (FN), and pure misconceptions (MISC) on the concepts of Q2 (Temperature depends on the material/material) and Q1 (Temperature depends on size/mass object). If you look at the 12P student's logit value against the logit item, then the 12P student has a less than 50% chance of correctly answering all the items. This happens because the logit ability of 12P students is lower than the difficulty level of Q6 (lowest logit).

Different assessment instruments are used to cause a shift in the number of students at a certain level of understanding. The one-tier or conventional multiple-choice diagnostic test is difficult to identify guesses from students so they overestimate students' scores and contribute to error variance (Kaltakci-Gurel et al., 2015, 2017; Soeharto et al., 2019). The determination of misconceptions is important, but the elimination of these misconceptions is even more important (Aslan & Demircioğlu, 2014). Students' conceptual understanding of the condition of False Positive and pure misconceptions is very resistant to change. Differentiating students who lack knowledge from misconceptions is important because remediation activities from different situations require different learning methods (Peşman & Eryılmaz, 2010). Remediation cannot be done only by using conventional learning. Effective specific learning models are needed to improve this situation.

The conceptual change model has been proposed as a framework for reducing misconceptions. This model views the reduction process as suppressing misconceptions and being replaced with scientific understanding. This model shows that learning new concepts will impact the destruction of old memories (Wenning, 2008). The conceptual change model is an effective teaching strategy to overcome/reduce misconceptions because of its practicality. This approach developed by Posner and his colleagues represents a perspective based on the views of Piaget and Zeitgeist. If it meets four conditions, conceptual change can occur (1) Dissatisfaction; students must be dissatisfied with the initial concept and realize that their concept is inadequate, (2) Intelligibility; students must easily understand the new concept offered, (3) Plausibility; the new concept must be logical and can be imagined in mind, (4) Fruitfulness; new concepts must be efficient, meaning they can solve similar problems that cannot be solved by students' initial concepts (Soysal, 2020).

This research is limited to being applied to temperature and groups of students from eastern Indonesia. The combination of student answers at the first level (concept) and second level (reasoning) has not been explored further. However, this research has made a significant contribution in utilizing the Wright map to map students' conceptual knowledge. So that schools, teachers or instructors, and even parents can optimize their various roles in facilitating student learning through the selection of teaching strategies as an effort to improve students' conceptual understanding. Therefore, we see that there is still a lot of potential for further research that can be developed. They can develop media and innovative learning models that are oriented toward reducing the misconceptions that occur. In addition, researchers can elaborate further on why there is an illogical combination of answers at the first and second tiers.

4. CONCLUSION

The level of students' conceptual knowledge experienced a shift when analyzed using different diagnostic tests. The average logit and standard deviation also experienced a shift, causing differences in the classification of students' conceptual understanding levels. This finding has implications for using two-tier diagnostic instruments that are more accurate than the one-tier type in describing the condition of students' conceptual understanding. Therefore, we recommend the use of a two-tier model instrument to diagnose students' misconceptions.

5. ACKNOWLEDGMENTS

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