2. What do my students need? Deep - Momentum.pdf

WORD COUNT	6364	TIME SUBMITTED	22-JUL-2024 08:26AM
		PAPER ID	110586999

Momentum: Physics Education Journal
8 (2), 2024, 217-229
Available at: ejournal.unikama.ac.id/index.php/momentum
ISSN 2548-9127(print) | 2548-9135 (online)

What do my students need? Deep analysis of student's individual cognitive ability using person diagnostic map

Moh. Irma Sukarelawan[1], Toni Kus Indratno[1]*, Widodo[1], Pratiwi Dwijananti[2], Fitri Nur Hikmah[3], Nurul Syafiqah Yap Abdullah[4]

[a]Pendidikan Fisika, Universitas Ahmad Dahlan, Yogyakarta, Indonesia
[b]Pendidikan IPA, Universitas Negeri Semarang, Indonesia
[c]Pendidikan Fisika, Universitas Islam Negeri Antasari, Indonesia
[d]Jabatan Fizik, Universiti Pendidikan Sultan Idris, Malaysia
e-mail: tonikus@staff.uad.ac.id
* Corresponding Author.

Received: 25 February 2024; Revised: 27 March 2024; Accepted: 28 March 2024

Abstract: This research aims to evaluate students' conceptual understanding in the field of physics, focusing on the concepts of heat and temperature, using the Person Diagnostic Map (PKMAPs) approach. This method allows individual assessment of students' conceptual understanding, going beyond the limitations of conventional analysis methods that focus on groups. This research used a survey involving eight students from a private university in Yogyakarta, Indonesia. Data was collected through a multiple-choice test of 20 items, processed using Ms. Excel and Winsteps 4.6.1. The research results show that PKMAPs are effective in identifying individual student understanding, including detecting "correct" response patterns resulting from guessing or cheating, as well as "incorrect" response patterns caused by incompetence or inaccuracy. This information allows educators to determine appropriate teaching methods, including remediation, re-teaching, or enrichment, according to each student's individual needs. This research concludes that using the Person Diagnostic Map in the context of physics education provides a more personal and effective approach to analyzing students' conceptual understanding. This method provides deeper insight into students' individual strengths and weaknesses, facilitating more focused and effective learning planning.
Keywords: personal learning; person diagnostic map; conceptual understanding; heat and temperature

How to Cite: Sukarelawan, M. I., Indratno, T. K., Widodo, W., Dwijananti, P., Hikmah, F. N., & Abdullah, N. S. Y. (2024). What do my students need? Deep analysis of student's individual cognitive ability using person diagnostic map. *Momentum: Physics Education Journal*, *8*(2), 217-229. https://doi.org/10.21067/mpej.v8i2.9900

Introduction

Students' conceptual understanding is one of the classic problems that has been researched in the field of education, including the field of physics, until today (Istiyono et al., 2022; Özmen, 2024; Sukarelawan et al., 2019; Zhao et al., 2023; Wahyuni et al., 2024). Conceptual understanding involves the ability to identify the patterns, relationships, and principles underlying those concepts. This allows students to view concepts in a broader framework and understand how these concepts are related and interact (Atmaja, 2021). Conceptual understanding also involves the ability to apply these concepts in solving real problems and situations (Putri et al., 2023). Several factors that influence conceptual understanding include previous background knowledge, experience, and learning context. Individuals who have broader knowledge and experience tend to have better conceptual understanding. A relevant and meaningful learning context can also help strengthen conceptual understanding.

Various methods of analyzing students' conceptual understanding have been widely used. For example, interview methods (Fuchs & Czarnocha, 2016; Jankvist & Niss, 2018), multiple-choice (Dulger, 2017; Kusairi et al., 2022), two-level multiple choice (Atchia et al., 2022; Onder-Celikkanli & Tan, 2022; Wang et al., 2022), three-level multiple choice (Prodjosantoso et al., 2019; Yeo et al., 2022), and four-level multiple choice (Astuti et al., 2023; Atmaca Aksoy & Erten, 2022; Jumadi et al., 2023; Taban & Kiray, 2022). The approach to analyzing conceptual understanding is oriented to classical test theory (CTT). The CTT can only provide information at the group level and cannot provide an overview of students' understanding of concepts at the individual level.

One of the main problems is the difficulty of distinguishing between correct answers due to a good understanding of the concept and correct answers due to guessing or cheating, as well as incorrect answers due to true incompetence or just carelessness. This becomes a dilemma in determining the right learning approach for each student. Rasch modeling emerged as an alternative approach that allows educators to understand students' conceptual understanding at the individual level so educators can more effectively determine remediation, re-teaching, or enrichment strategies that suit the needs of each student.

Several approaches have been used to describe students' conceptual understanding. In classical test theory, the descriptive approach is more widely used and preferred because of its simplicity (Özmen, 2024; Sukarelawan et al., 2019; Tene et al., 2024). This approach provides an overview of students' general conceptual understanding at the group level (Soeharto et al., 2024; Zabidi et al., 2022) but cannot provide an individual-level overview. On the other hand, the use of the Wright map, as part of modern test theory, is currently experiencing increasing use to describe the state of students' conceptual understanding (Puspitasari et al., 2022; Sukarelawan et al., 2022). This approach offers more detailed information than the descriptive approach. The Wright map can display the level of conceptual understanding down to the individual level. However, the Wright map cannot explain and estimate each individual's response patterns and answers. One approach that can describe the conceptual understanding level by estimating each individual's response pattern is person-diagnostic maps (PKMAPs). PKMAPs has several features. Soeharto and Csapó (2022) use PKMAPs to scale data to detect outliers. Therefore, there is limited information using PKMAPs to describe students' conceptual understanding in detail.

The PKMAPs diagnostic map is a means of displaying student responses to items (Linacre, 2021a). PKMAPs can estimate the response pattern/answers of each student. A student's "correct" response pattern can be detected, whether it is due to the student's ability or due to guessing or cheating. Likewise, the pattern of "wrong" responses from students, whether purely due to their incompetence or because they are not careful (careful). So, by using this map, an educator/instructor can easily determine which parts need remedial teaching, re-teaching, or enrichment. Educators can also use this information as a report on student academic progress to parents because it can accurately explain the strengths and weaknesses of each individual student.

Person Diagnostic maps the difficulty level of items from easiest to most difficult for each student. The location of the question shows the level of difficulty of the question compared to the student's abilities. The higher you go, the higher the difficulty of the questions, and vice versa (Soeharto & Csapó, 2022).

As previously stated, the accuracy of information on students' conceptual understanding is the main basis for determining the type of learning or treatment educators can plan to optimize students' conceptual understanding. Mistreatment will be malpractice for students, resulting in lower student conceptual understanding. Therefore, it is essential to analyze students' conceptual understanding so that educators can determine the appropriate type of treatment for each student. This research aims to evaluate students' level of conceptual understanding using the Person Diagnostic Map (PKMAPs) method so that they can provide appropriate recommendations regarding students' conceptual understanding.

Method

This type of survey was conducted at a private university in Yogyakarta, Indonesia. The survey involved eight students (four men and four women) from physics classes. The respondents in the survey were the population in the physics class who would take the heat and temperature course. Data on students' conceptual understanding was collected via Google Forms. Data collection was carried out before regular learning activities began. The average time required by students to complete one set of items is around 40 minutes.

The instrument used in this research was 20 multiple-choice items on heat and temperature material developed by Sukarelawan et al. (Jumadi et al., 2023). Twenty items are spread into four concept groups, namely: (1) temperature (6 items), (2) expansion (4 items), (3) the effect of heat on temperature changes and changes in form (4 items), and (4) heat and heat transfer (6 items). Instrument details are shown in Table 1.

Table 1. Description of multiple-choice items on heat and temperature

No. item	Code	Item description
1	T1	Temperature depends on the size/mass of the object
2	T2	Temperature depends on the material of the object
3	T3	The temperature of a substance can be transferred
4	T4	Two different temperatures can be added together
5	T5	There is no lowest temperature limit
6	T6	The division of a substance results in the temperatures of the two parts being different
7	E1	Expansion only occurs in one linear dimension
8	E2	The mass of an expanding object increases.
9	E3	Expansion occurs due to an increase in the number and size of particles
10	E4	Expanding substances have a constant density.
11	EoH1	The high specific heat of a substance will speed up the substance's absorption of heat.
12	EoH2	Materials such as wool can warm the body
13	EoH3	Changes in temperature and shape occur simultaneously
14	EoH4	Heating always increases the temperature
15	H&T1	There are two types of heat, namely cold heat and hot heat. There are two types of temperature, namely cold temperature and hot temperature.
16	H&T2	Cold objects do not contain heat.
17	H&T3	Heat depends on the size of the object/mass
18	H&T4	Heat depends on the material of the object
19	H&T5	Heat can flow due to different types of substances
20	H&T6	The color of the clothes does not affect how quickly they dry

Code T = Temperature, E = Expansion, EoH = Effect of heat on temperature and phase of matter, H&T = Heat and heat transfer

Student concept understanding data is processed using Ms. software. Excel and Winstep 4.6.1 (Linacre, 2021b). Ms. Excel was used to prepare data, and Winstep was used to analyze students' understanding of concepts. Analysis of student learning needs begins by photographing students' overall conceptual understanding through the Wright map. Then, identify patterns of suitability of student responses to the model. After the identification process, we skimmed any indications of carelessness, cheating, or guessing answer patterns using the Guttman scalogram. The final stage is to analyze each student's learning type through a personal diagnostic map.

Results and Discussion

Result

Distribution of student abilities

In general, the level of students' conceptual understanding of heat and temperature material is visualized in Figure 1. Figure 1 visualizes the students' conceptual understanding level in the form of a Wright map. Wright maps are used to provide an overview of student's conceptual understanding of each sub-material in the topic of heat and temperature.

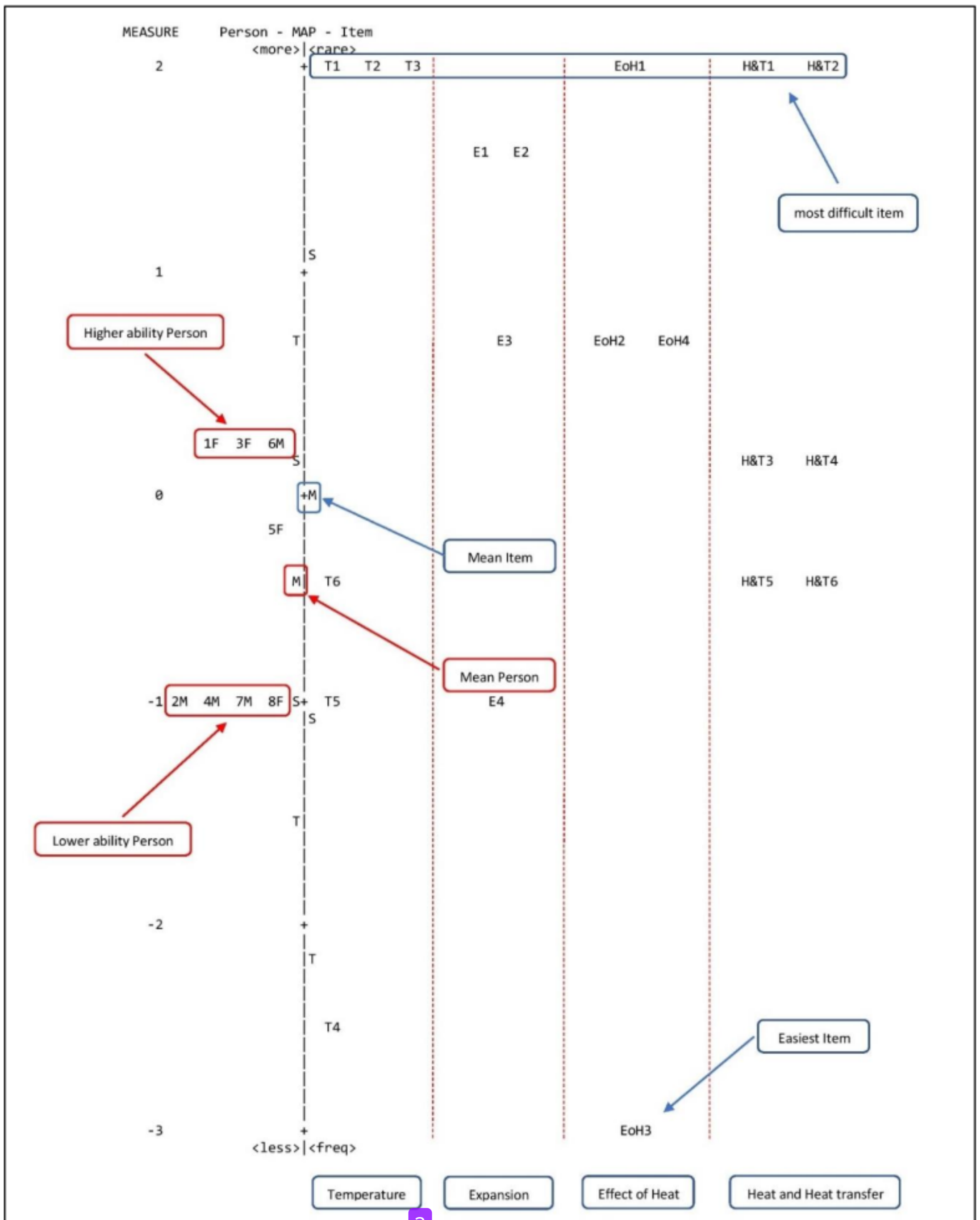


Figure 1. Distribution of students' conceptual understanding

Based on Figure 1, the average item difficulty level is higher than the average student's ability. Three students have the highest abilities: two females (1F and 3F) and one male (6M). Meanwhile, in the low-ability group, there were three males (2M, 4M, and 7M) and one female (8F). From an item perspective, six items have the highest level of difficulty, spread across the concept of temperature (T1, T2, and T3), the influence of heat (EoH1), and the concept of heat and its transfer (HD1 and HD2). Meanwhile, the easiest item is in the concept of heat influence (EoH3). Of the 20 items tested, 11 of the 20 items (55%) were above the abilities of all students. In the opposite situation, the two items with the easiest difficulty level were below all students' locations.

Suitability of student response patterns

Table 2. summarizes the suitability of student response patterns based on the Rasch model.

Table 2. Suitability of student response patterns

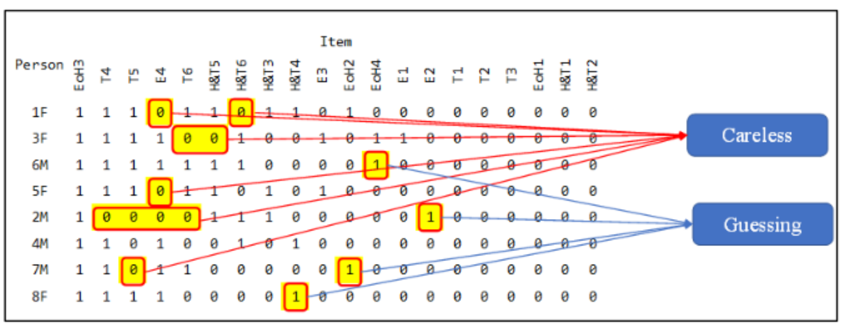
Person	Measure	Model S.E.	Outfit		PT. Mea Corr.
			MnSq	Zstd	
1F	0.21	0.62	0.91	-0.14	0.68
3F	0.21	0.62	1.19	0.62	0.59
6M	0.21	0.62	0.60	-1.15	0.77
5F	-0.17	0.62	0.87	-0.26	0.67
2M	-0.98	0.67	2.15	1.94	0.39
4M	-0.98	0.67	0.70	-0.52	0.67
7M	-0.98	0.67	0.91	-0.02	0.63
8F	-0.98	0.67	0.61	-0.76	0.70

Based on Table 2, the student ability level ranges from -0.98 to 0.21 logit. The model's standard error (S.E) is in the range of 0.62 to 0.67 logit. Outfit MnSq values are in the range 0.60 to 2.15. The Zstd value is in the range of -1.15 to 1.94. Meanwhile, the value of Pt. Mea Corr. It is in the range of 0.39 to 0.77.

Screening student response patterns

The results of the analysis of student response patterns are displayed in Table 3.

Table 3. Student response patterns based on the Guttman Scalogram

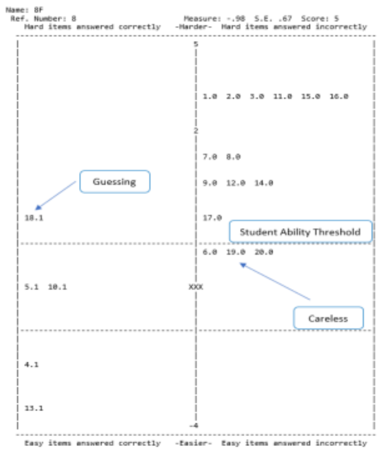


Person	EoH3	T4	T5	E4	T6	H&T5	H&T6	H&T3	H&T4	E3	EoH2	EoH4	E1	E2	T1	T2	T3	EoH1	H&T1	H&T2
1F	1	1	1	0	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0
3F	1	1	1	1	0	0	1	0	0	1	0	1	1	0	0	0	0	0	0	0
6M	1	1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0
5F	1	1	1	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0
2M	1	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0
4M	1	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
7M	1	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
8F	1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0

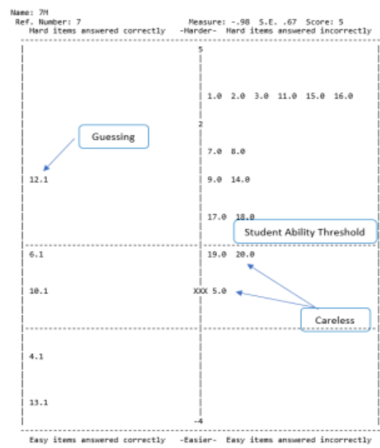
Table 3 shows indications of Careless and Guessing patterns from student responses. Initial identification results show that 5F Careless students answered item E4. Meanwhile, student 1F, apart from Careless answering item E4, Careless also answered item H&T6. In line with 1F, 3F students indicated Careless answering two items, T6 and H&T5. Apart from Careless, students 2M and 7M indicated that they answered guessing. 2M Careless students answered four items (T4, T5, E4, and T6) and guessing answered one item (E2). Meanwhile, 7M Careless students answered item T5 and guessed item EoH2. In other conditions, students 6M and 8F only indicated guessing on items H&T4 and EoH4.

Person diagnostic

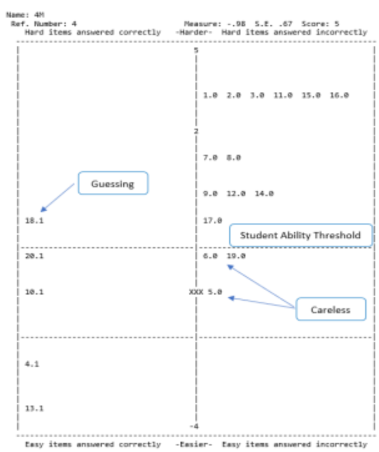
Analysis of the types of errors made by students is shown in Figure 2.



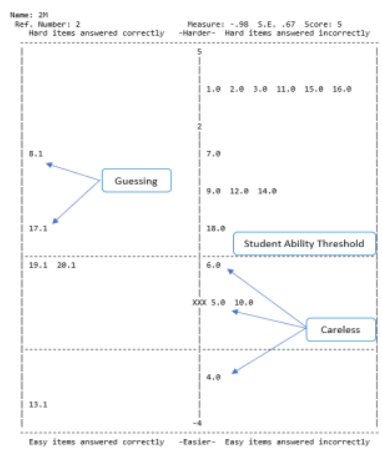
(a)



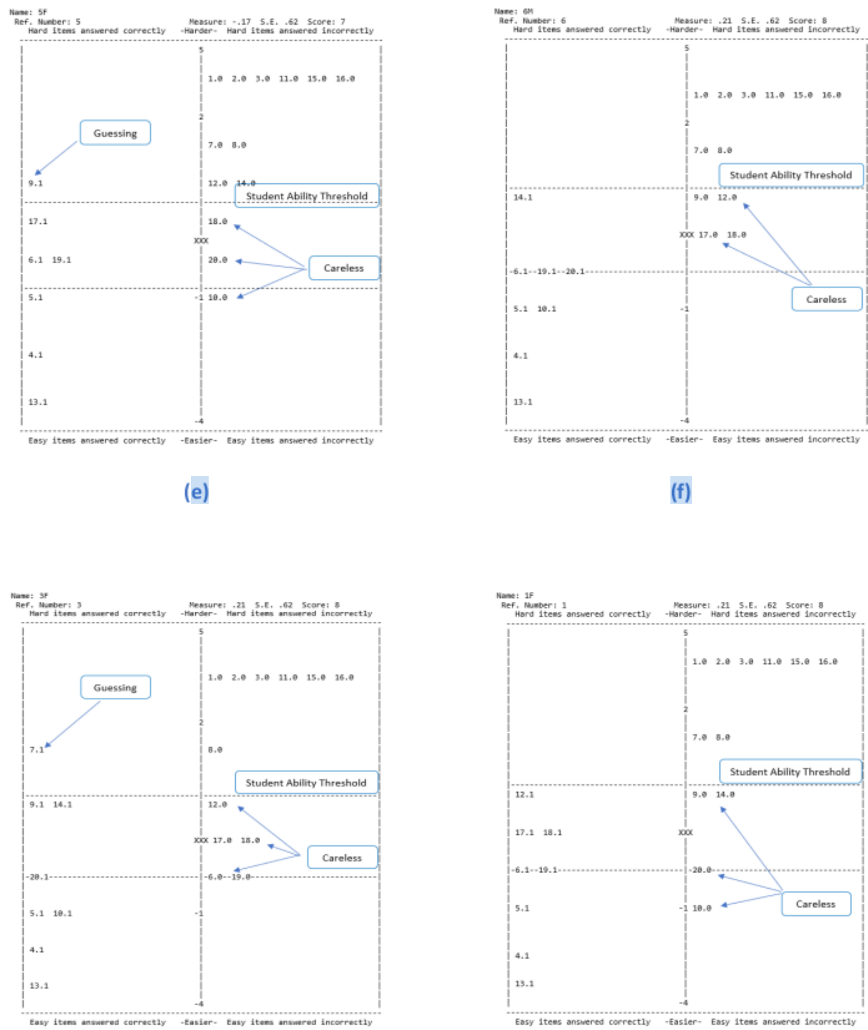
(b)



(c)



(d)



(e) (f)

(g) (h)

Figure 2. Person diagnostic

Figure 2(a), 2(b), 2(c), and 2(d) include students who are in the slow learner group. These four students have an ability range of -0.98 ± 0.67 logit. The analysis results show that the four students had Guessing and careless responses. Students 8F, 7M, 4M, and 2M guessed on items H&T4, EoH2, E2, and H&T3. Meanwhile, careless responses were on items T4, T5, T6, E4, H&T5, and H&T6. Figure 2(e), student 5F, is included in the medium ability category and has an ability limit range of -0.17 ± 0.62 logit. Based on the ability threshold value, it was found that there were answers in the form of careless (items E4, H&T4, and H&T6) and guessing in item E3.

Figures 2(f), 2(g), and 2(h) depict three students who have high abilities. The three figures show the range of students' abilities (1F, 3F, and 6M) each of 0.21 ± 0.62 logit. Based on the 1F student ability threshold, four items (items E3, E4, EoH4, and H&T6) were identified, which were responded to carelessly. The same thing happened to 6M students, who were careless on items E3, EoH2, H&T3, and

H&T4. Meanwhile, student 3F, apart from having a careless response to five items (items T6, EoH2, H&T3, H&T4, and H&T5) also had a Guessing response pattern to one item (Item E1).

Discussion

This research aims to analyze the learning needs of students in depth. This needs to be done so that students receive treatment according to their needs. The data collection stage (test) was carried out in the first hour of the physics lecture schedule on heat and temperature. The analysis begins by taking a picture of the overall relationship between student abilities and the items' difficulty level using a Wright Map. Then, analyze the suitability of student response patterns through the response pattern match table. This table is used for the initial identification of response patterns that match the Rasch model. Next, screen students' response patterns using the Guttman scalogram. This table can illustrate patterns of right and wrong answers caused by cheating, guessing, or carelessness. Then, determine student learning needs using a personal diagnostic chart.

Figure 1 maps hierarchically between student abilities and item difficulty levels (Ayu et al., 2023; Thohir et al., 2021). The map is divided into two parts, namely, the left part depicts the person's condition, and the right part describes the item's condition (Sukarelawan et al., 2021). The person's location determines the level of the student's ability, and the item's location determines the item's difficulty level. The person in the bottom location shows the student with the lowest ability (slow learner), and the person in the top location shows the student with the highest ability. Identical to the person's condition, the item with the highest location is the item with the highest level of difficulty, and the item with the lowest location is the item with the lowest level of difficulty.

The Wright map maps the location of people and items hierarchically in 1 logit ruler that stretches from -3 to 2 logits. The average item logit value is higher than the person logit average value. This indicates that the items' overall difficulty level is higher than the students' abilities. Therefore, the Wright map shows that students have not mastered 55% of the items. Therefore, 55% of the items representing various concepts need attention from the instructor. These findings need to be confirmed in Figure 2 in detail to map the needs for the right type of learning for students.

Based on Table 2. Suitability of student response patterns, it was found that the Outfit MnSq and Zstd values for 2M students were outside the response suitability range, 0.5 – 1.5 (Siew & Abd Rahman, 2019). This indicates an inconsistent response pattern. However, the value of PT. Mea Corr. shows a response orientation in the same direction as the model (Yuhanna et al., 2021). Based on the logit values, it is indicated that five students (5F, 2M, 4M, 7M, and 8F) require some special learning because the logit values are negative.

Instructors can prepare several types of special learning: re-teaching, remedial, and enrichment. Remedial teaching aims to help students with difficulty understanding certain material or concepts. The main focus is improving students' understanding of difficult material, whether due to misconceptions, lack of understanding, or difficulty learning a topic. This involves additional strategies such as tutoring sessions, re-teaching material individually or in small groups, and more intensive approaches to understanding difficult concepts. Meanwhile, re-teaching is more holistic in its approach. The goal is to ensure that students thoroughly understand all the material taught previously. Re-teaching can involve repeating material over a certain period, a complete revision of all material studied, or using different learning methods to help students understand the material in depth.

On the other hand, enrichment learning aims to present material or learning experiences that are more complex, challenging, or advanced for students who have mastered basic material. The focus is on providing higher challenges and going beyond the standard curriculum further to develop students' interests, curiosity, and potential. This may include a research project, exploration of a more complex topic, or a more in-depth learning experience in a particular field.

To support the information on student response patterns in Table 2, Table 3. Student response patterns based on the Guttman Scalogram (Guttman Scalogram) simultaneously ranks the item difficulty level and student ability level. Table 3. Student response patterns based on the Guttman Scalogram can provide an initial picture of guessing, carelessness, or cheating based on student response patterns. Cheating can be identified by comparing one student's answer pattern to another (Laliyo et al., 2022). Carelessness can be expected to occur if an item with a low level of difficulty is answered incorrectly. In contrast, two or more items with a higher level of difficulty can be answered consistently correctly. Meanwhile, an answer is indicated as guessing if two or more items with a low difficulty level are consistently wrong. Still, you can correctly answer an item with a higher difficulty level. After conducting an initial investigation, no identical response patterns were found between students. Table 3. Student response patterns based on the Guttman Scalogram only indicates the existence of careless and guessing. However, the pattern of answers with scores 1 and score 0, which were initially identified as careless or guessing answers, needs to be confirmed again using the person diagnostic map (Figure 2. Person diagnostic).

Determining students' individual learning needs can be evaluated comprehensively through a person diagnostic map. However, this map cannot show cheating patterns accurately. So, person diagnostics are more appropriate for identifying carelessness or guessing. Therefore, the visualization combination between the Guttman scalogram and the person diagnostic map will complement each other and provide more accurate and comprehensive information.

Generally, the person diagnostic map is divided into two parts, the left and right. The left part of the map shows items answered "correctly" (coded with the number 1), and the right part shows items answered "wrong" by students (coded with the number 0). The symbol "xxx" shows the mean logit of individual student abilities. Meanwhile, the top horizontal dotted line is the student's ability threshold, obtained from the student's logit score plus the standard deviation. Items positioned above the student's ability threshold have a <50% probability of being answered "correctly." Meanwhile, items below the threshold line have a > 50% chance of being answered "correctly."

More specifically, the map can be divided into four parts. The top-right (quadrant 1) is an item with a higher difficulty level than the student's ability and is answered: "wrong." The top-left (quadrant 2) items have a higher difficulty level than the student's ability and are answered "correctly." The bottom left (quadrant 3) are items with a lower difficulty level than the student's ability and are answered "correctly." Meanwhile, the bottom-right items have a low difficulty level and are answered: "wrong."

Based on the results of the initial investigation carried out using the Guttman Scalogram on 8F students, the answer to item H&T4 was indicated as guessing because there was a consistent pattern of wrong answers on the previous four items, and this was proven after being confirmed on the person diagnostic map. Items T6, H&T5, H&T6, and H&T3 are indicated as items beyond their capabilities. However, in reality, items T6, H&T5, and H&T6 were answered incorrectly because they were careless, and only item 17 was answered incorrectly because it was beyond their capabilities. So, 8F students only need remedial learning on T6, H&T5, and H&T6 concepts. Based on Figure 2(a), 12 items are beyond the ability of 8F students, and only four items are below the logit of their ability. Therefore, 8F students need re-teaching on items that are guessed and beyond their abilities and receive enrichment learning on items that are below the logit of their abilities.

In the results of the initial investigation on 7M students, item 12 was identified as a guessing answer and was proven after being confirmed by the diagnostic person. More in-depth analysis of five items (H&T5, H&T6, H&T3, H&T4, and E3) which were identified as items that 7M students were unable to answer. After confirming the person diagnostic map, not all items are difficult for students. Two items (Items H&T5 and H&T6) are errors because they are careless, and the other three are because they are beyond their capabilities. So, 7M students only need remedial learning on concepts according to items T5, H&T5, and H&T6 (see Figure 2(b)). Apart from needing remedial learning, 7M students need re-teaching on items with a logit value above the logit of 7M and items answered by guessing. Because 7M students can complete four items (items T4, T6, E4, and EoH3) well, 7M students need to be given enrichment learning of these concepts.

The results of skimming the response patterns of 4M students in Table 3 do not show any indication of guessing or carelessness. However, after a more detailed look at the diagnostic person, one item (H&T4) was guessing and three items (T5, T6, and H&T5) were careless. Meanwhile, four items (T4, E4, EoH3, and H&T6) could be done well, and the other items were above the abilities of 4M students. Therefore, 4M students need three types of learning: re-teaching on items that are guessed and have a logit value above the ability threshold, remedial learning on items answered carelessly, and enrichment on items that have been mastered.

The answer pattern given by student 2M shows indications of guessing at E2 because of the consistent pattern of wrong answers in the previous five items (lower level of difficulty than E2). However, after conducting an in-depth analysis using a diagnostic person, E2 and H&T3 were answered correctly because of the guess results. Student 2M also did not master 11 items (see Figure 2(d)). So, 2M students need re-learning on items that are guessed and beyond their abilities. Apart from guessing, 2M students were careless in answering four items (Items T4, T5, T6, and E4). The results of this initial investigation have been supported visually by the diagnostic person. Therefore, 2M students also need remedial learning. Apart from requiring re-learning and remedial learning, 2M students need enrichment learning to strengthen the concepts that they have mastered in items EoH3, H&T5, and H&T6.

There is no indication of guessing answers from the Guttman scalogram skimming results in student answer patterns 5F, but there is an indication of careless answers in item E4. After conducting an in-depth analysis of the person's diagnostic map, it was found that there was guessing on item E3 and carelessness on items H&T6, E4, and H&T4. Based on his ability threshold, there are six items that he can answer and ten items that are beyond his ability. Therefore, 5F students need remedial, enrichment, and re-teaching types of learning so that mastery of concepts in heat and temperature material can be more optimal.

There are indications of guessing on the EoH4 concept by 6M students because visually, there is a consistent pattern of wrong answers on the previous four concepts (H&T3, H&T4, E3, and EoH2). The results of investigations through diagnostic personnel did not prove that there was guessing in the EoH4 concept. Another fact revealed through personal diagnostics is that the consistent errors visualized in Table 3. Student response patterns based on the Guttman Scalogram are due to carelessness, not to the incompetence of 6M students. This is because the logit values of the concepts H&T3, H&T4, E3, and EoH2 are below the threshold of their ability.

There is no indication of guessing in student 3F's answer pattern. However, there are indications of carelessness on five items (T6, H&T5, H&T3, H&T4 and EoH2). Based on the results of in-depth investigations on diagnostic personnel, it was confirmed that 1 item (EoH4) was answered by guessing and five careless items (T6, H&T5, H&T3, H&T4, and EoH2). Seven items are above the 3F student's ability limit, and seven are below the ability limit. Therefore, 3F students need to receive remedial learning and re-learning to correct misconceptions and receive enrichment learning to strengthen the concepts they have mastered.

The final student with the highest level of ability is 1F. The Guttman scalogram indicates no guessing pattern and only a careless pattern on items E4 and H&T6. Further analysis and investigation of diagnostic personnel shows carelessness not only on items E4 and H&T6 but also on items E3 and EoH4. Visually, the 1F student's ability limit is at a difficulty level equivalent to the EoH2 item. However, the diagnostic person indicated that the EoH4 item, which had a higher difficulty, was still within his limits. So empirically, 1F students have mastered eight items but have not yet mastered eight (see Figure 2(h)). Therefore, 1F students need three types of learning like other students.

Based on Figure 1, it is identified that items T6, H&T5, and H&T6 are items that were answered carelessly by more than 50% of students, and 13 items (T1, T2, T3, E1, E2, E3, EoH1, EoH2, EoH4, H&T1, H&T2, H&T3, and H&T4). Therefore, instructors need to prepare or design remedial learning, which is predominantly answered carelessly, and design re-learning for guessed items beyond the student's abilities.

Conclusion

Analysis of individual learning needs has been carried out through a series of investigative processes, starting from taking a general picture of the relationship between student abilities and item difficulty levels using a Wright Map, followed by an initial investigation of cheating, careless and guessing patterns using the Guttman scalogram and ending with a deep analysis of learning needs. Individual students use the person diagnostic maps technique. From the analysis of student response patterns using the Guttman scalogram, it can be concluded that there were no indications of cheating by students. The person diagnostic maps technique can accurately describe students' abilities so that instructors can develop or prepare learning types of remedial learning, relearning, and enrichment oriented towards individual needs. Meeting the learning needs of individual students will have an impact on increasing their academic performance.

The method of analyzing individual student learning needs using diagnostic person maps is based on modern test theory that can estimate at the individual level quickly and accurately. This method will help instructors understand the weaknesses and strengths of students' concepts. Instructors can also use this method to make students' final academic reports. However, this research still needs to develop teaching materials that can accommodate the types of learning students need. Therefore, we recommend that in future research, we can develop types of personal learning-oriented learning based on the results of investigations into diagnostic person maps. Future researchers can even develop a learning system or platform that starts by carrying out tests, then produces information on individual student weaknesses and strengths, and then integrates with types of learning that are oriented to the needs of each student. This will lead to a personalized learning model.

Acknowledgment

We want to send our greatest gratitude to the Institute for Research and Community Service, Universitas Ahmad Dahlan, for granting research funds number: PD-152/SP3/LPPM-UAD/VIII/2023 in the Penelitian Dasar (PD) scheme.

References

Astuti, I. A. D., Bhakti, Y. B., Prasetya, R., & Rahmawati, Y. (2023). Four Tier-Relativity Diagnostic Test (4T-RDT) to Identify Student Misconception. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *8*(1), 75–84. https://doi.org/10.26737/jipf.v8i1.3668

Atchia, S. M. C., Chummun, D., & Luckho, S. (2022). Use of design thinking as a strategy to identify and clear students' misconceptions in photosynthesis: a case study. *Journal of Biological Education*, 1–18. https://doi.org/10.1080/00219266.2022.2100452

Atmaca Aksoy, A. C., & Erten, S. (2022). A Four-Tier Diagnostic Test to Determine Pre-Service Science Teachers' Misconception about Global Warming. *Journal of Baltic Science Education*, *21*(5), 747–761. https://doi.org/10.33225/jbse/22.21.747

Atmaja, I. M. D. (2021). Koneksi Indikator Pemahaman Konsep Matematika dan Keterampilan Metakognisi. *NUSANTARA : Jurnal Ilmu Pengetahuan Sosial*, *8*(7), 2048–2056. https://doi.org/10.31604/jips.v8i7.2021.2048-2056

Ayu, S. M., Gustina, E., Sofiana, L., Wardani, Y., & Sukarelawan, Moh. I. (2023). Physical and psychological violence victimization scale in adolescents dating: Confirmatory factor analysis and Rasch model. *International Journal of Evaluation and Research in Education*, *12*(1), 96–105. https://doi.org/10.11591/ijere.v12i1.22250

Dulger, M. H. (2017). Assessing the Validity of Multiple-choice Questions in Measuring Fourth Graders' Ability to Interpret Graphs about Motion and Temperature. *International Journal of Environmental and Science Education*, *12*(2), 177–193.

Fuchs, E., & Czarnocha, B. (2016). Teaching Research Interviews. In *The Creative Enterprise of Mathematics Teaching Research* (pp. 179–197). SensePublishers. https://doi.org/10.1007/978-94-6300-549-4_16

Istiyono, E., Shanti, M. R. S., Saepuzaman, D., Dwandaru, W. S. B., & Zakwandi, R. (2022). A Four Tier Web Based Assessment with Eight Categories Diagnostic. *2022 8th International Conference on Education and Technology (ICET)*, 190–196. https://doi.org/10.1109/ICET56879.2022.9990847

Jankvist, U., & Niss, M. (2018). Counteracting Destructive Student Misconceptions of Mathematics. *Education Sciences*, *8*(2), 53. https://doi.org/10.3390/educsci8020053

Jumadi, J., Sukarelawan, Moh. I., & Kuswanto, H. (2023). An Investigation of Item Bias in the Four-Tier Diagnostic Test Using Rasch Model. *International Journal of Evaluation and Research in Education (IJERE)*, *12*(2), 622–629. https://doi.org/10.11591/ijere.v12i2.22845

Kusairi, S., Sutopo, .., & Suryadi, A. (2022). Utilizing Isomorphic Multiple-Choice Items to Diagnose Students' Misconceptions in Force and Motion. *New Physics: Sae Mulli*, *72*(4), 311–318. https://doi.org/10.3938/NPSM.72.311

Laliyo, L. A. R., Sumintono, B., & Panigoro, C. (2022). Measuring changes in hydrolysis concept of students taught by inquiry model: stacking and racking analysis techniques in Rasch model. *Heliyon*, *8*(3), e09126. https://doi.org/10.1016/j.heliyon.2022.e09126

Linacre, J. M. (2021a). *A User's Guide to WINSTEPS® MINISTEP Rash-model computer programs. Program Manual 4.8.0.*

Linacre, J. M. (2021b). *Winsteps® (Version 4.6.1) [Computer Software].*

Onder-Celikkanli, N., & Tan, M. (2022). Determining Turkish high school students' misconceptions about electric charge imbalance by using a four-tier misconception test. *Physics Education*, *57*(5), 055010. https://doi.org/10.1088/1361-6552/ac68c1

Özmen, K. (2024). Health Science Students' Conceptual Understanding of Electricity: Misconception or Lack of Knowledge? *Research in Science Education*, *54*(2), 225–243. https://doi.org/10.1007/s11165-023-10136-3

Prodjosantoso, A. K., Hertina, A. M., & Irwanto, I. (2019). The Misconception Diagnosis on Ionic and Covalent Bonds Concepts with Three Tier Diagnostic Test. *International Journal of Instruction*, *12*(1), 1477–1488. https://doi.org/10.29333/iji.2019.12194a

Puspitasari, A. D., Sukarelawan, Moh. I., Damayanti, E. N., Syifa, A., & Fitri, F. (2022). Model pembelajaran predict observe explain dalam edmodo untuk meningkatkan pemahaman konsep fisika di SMP: Analisis stacking. *Berkala Fisika Indonesia : Jurnal Ilmiah Fisika, Pembelajaran Dan Aplikasinya*, *13*(1), 31–40. https://doi.org/10.12928/bfi-jifpa.v13i1.23204

Putri, N. L. S., Susanti, R. H., & Purnama, M. D. (2023). Improvement of elementary science learning outcomes using guided experimentation method. *Journal of Environment and Sustainability Education*, *1*(2), 72–79. https://doi.org/10.62672/joease.v1i2.19

Siew, N. M., & Abd Rahman, M. S. (2019). Assessing the Validity and Reliability of the Future Thinking Test using Rasch Measurement Model. *International Journal of Environmental and Science Education*, *14*(4), 139–149.

Soeharto, S., & Csapó, B. (2022). Exploring Indonesian Student Misconceptions in Science Concepts. *Heliyon*, *8*(9), e10720. https://doi.org/10.1016/j.heliyon.2022.e10720

Soeharto, S., Martono, M., Hairida, H., Akhmetova, A., Arifiyanti, F., Benő, C., & Charalambos, C. (2024). The metacognitive awareness of reading strategy among pre-service primary teachers and the possibility of rating improvement using Rasch analysis. *Studies in Educational Evaluation*, *80*, 101319. https://doi.org/10.1016/j.stueduc.2023.101319

Sukarelawan, Moh. I., Jumadi, J., & Rahman, N. A. (2019). An Analysis of Graduate Students' Conceptual Understanding in Heat and Temperature (H&T) Using Three-Tier Diagnostic Test. *Indonesian Review of Physics*, *2*(1), 9–14. https://doi.org/10.12928/irip.v2i1.910

Sukarelawan, Moh. I., Jumadi, Kuswanto, H., Nurjannah, T., Hikmah, F. N., & Ramadhan, M. F. (2021). Implementation of Rasch Model for Mapping Students' Metacognitive Awareness. *Jurnal Pendidikan Fisika Indonesia*, *17*(2), 86–93. https://doi.org/10.15294/jpfi.v17i2.27172

Sukarelawan, Moh. I., Puspitasari, A. D., Sulisworo, D., Kuswanto, H., & Jumadi. (2022). A shift in the conceptual understanding of physics students through the wright map. *Jurnal Pendidikan Dan Pengajaran*, *55*(1), 127–141. https://doi.org/10.23887/jpp.v55i1.37155

Taban, T., & Kiray, S. A. (2022). Determination of Science Teacher Candidates' Misconceptions on Liquid Pressure with Four-Tier Diagnostic Test. *International Journal of Science and Mathematics Education*, *20*(8), 1791–1811. https://doi.org/10.1007/s10763-021-10224-8

Tene, T., Bodero-Poveda, E., Vique López, D., Vacacela Gomez, C., & Bellucci, S. (2024). Assessing the State of Modern Physics Education: Pre-test Findings and Influencing Factors. *Emerging Science Journal*, *8*, 1–19. https://doi.org/10.28991/ESJ-2024-SIED1-01

Thohir, M. A., Sukarelawan, Moh. I., Jumadi, J., Warsono, W., & Citrasukmawati, A. (2021). The effects of instructional design based web course on pre-service teachers' competencies. *International Journal of Evaluation and Research in Education (IJERE)*, *10*(1), 230–236. https://doi.org/10.11591/ijere.v10i1.20475

Wahyuni, B., Zainuddin, Z., Misbah, M., & Murshed, M. B. (2024). Character-based physics learning module through generative learning model: Student conceptual understanding. *Journal of Environment and Sustainability Education*, *2*(1), 31–39. https://doi.org/10.62672/joease.v2i1.15

Wang, X.-M., Wang, S.-M., Wang, J.-N., Hwang, G.-J., & Xu, S. (2022). Effects of a Two-Tier Test Strategy on Students' Digital Game-Based Learning Performances and Flow Experience in Environmental Education. *Journal of Educational Computing Research*, 073563312210951. https://doi.org/10.1177/07356331221095162

Yeo, J.-H., Yang, H.-H., & Cho, I.-H. (2022). Using A Three-Tier Multiple-Choice Diagnostic Instrument Toward Alternative Conceptions Among Lower-Secondary School Students in Taiwan: Taking Ecosystems Unit as An Example. *Journal of Baltic Science Education*, *21*(1), 69–83. https://doi.org/10.33225/jbse/22.21.69

Yuhanna, W. L., Al Muhdhar, M. H. I., Gofur, A., & Hassan, Z. (2021). Self-reflection assessment in vertebrate zoology (Sravz) using rasch analysis. *Jurnal Pendidikan IPA Indonesia*, *10*(1), 35–47. https://doi.org/10.15294/jpii.v10i1.25603

Zabidi, Z. M., Sumintono, B., & Abdullah, Z. (2022). Enhancing analytic rigor in qualitative analysis: developing and testing code scheme using Many Facet Rasch Model. *Quality & Quantity*, *56*(2), 713–727. https://doi.org/10.1007/s11135-021-01152-4

Zhao, C., Zhang, S., Cui, H., Hu, W., & Dai, G. (2023). Middle school students' alternative conceptions about the human blood circulatory system using four-tier multiple-choice tests. *Journal of Biological Education*, *57*(1), 51–67. https://doi.org/10.1080/00219266.2021.1877777

2. What do my students need? Deep - Momentum.pdf

ORIGINALITY REPORT

8%
SIMILARITY INDEX

PRIMARY SOURCES

1	ijere.iaescore.com Internet	37 words — 1%
2	Ety Dwiastuti, Moh. Irma Sukarelawan, Sriyanto Sriyanto. "Learning Management System Acceptance Rate Among Vocational School Physics' Student", JIPFRI (Jurnal Inovasi Pendidikan Fisika dan Riset Ilmiah), 2022 Crossref	33 words — 1%
3	Jumadi Jumadi, Moh Irma Sukarelawan, Heru Kuswanto. "An investigation of item bias in the four-tier diagnostic test using Rasch model", International Journal of Evaluation and Research in Education (IJERE), 2023 Crossref	32 words — 1%
4	ppjp.ulm.ac.id Internet	30 words — 1%
5	Hiroyuki Miyasaka, Izumi Kondo, Chihiro Yamamura, Naoko Fujita, Abbas Orand, Shigeru Sonoda. "The quantification of task-difficulty of upper limb motor function skill based on Rasch analysis", Topics in Stroke Rehabilitation, 2019 Crossref	22 words — < 1%
6	eprints.uad.ac.id Internet	19 words — < 1%

7. J M Rosha, A Hidayat. "Analysis of Creative Thinking Skill Instrument Test (CreaTSIT) on renewable energy topic for senior high school student using Rasch model", Journal of Physics: Conference Series, 2023 — 18 words — < 1%
Crossref

8. Mursyidah, Anwar, M Subianto. "Students' worksheet on circular cylinder topic using GeoGebra software through Discovery Learning model", Journal of Physics: Conference Series, 2020 — 16 words — < 1%
Crossref

9. Stella H. Kim, Adriana M. Strutt, Laiene Olabarrieta-Landa, Anthony H. Lequerica et al. "Item analysis of the Spanish version of the Boston Naming Test with a Spanish speaking adult population from Colombia", The Clinical Neuropsychologist, 2018 — 16 words — < 1%
Crossref

10. Moh. Irma Sukarelawan, Sriyanto Sriyanto, Ariati Dina Puspitasari, Dwi Sulisworo, Ulfiana Nurul Hikmah. "Four-Tier Heat and Temperature Diagnostic Test (4T-HTDT) to Identify Student Misconceptions", JIPFRI (Jurnal Inovasi Pendidikan Fisika dan Riset Ilmiah), 2021 — 14 words — < 1%
Crossref

11. Suci Musvita Ayu, Erni Gustina, Liena Sofiana, Yuniar Wardani, Moh Irma Sukarelawan. "Physical and psychological violence victimization scale in adolescents dating: Confirmatory factor analysis and Rasch model", International Journal of Evaluation and Research in Education (IJERE), 2023 — 14 words — < 1%
Crossref

12. Peijie Song, Xiaojuan Li, Jianjun Cui, Kai Chen, Yandong Chu. "The Impact of the Damping — 12 words — < 1%

Coefficient on the Dynamic Stability of the TM-AFM Microcantilever Beam System", Applied Sciences, 2024
Crossref

13 www.mdpi.com — 12 words — < 1%
Internet

14 patents.justia.com — 11 words — < 1%
Internet

15 Mona Isa, Mazlan Abu Bakar, Mohamad Sufian Hasim, Mohd Khairul Anuar, Ibrahim Sipan, Mohd Zali Mohd Nor. "Data quality control for survey instrument of office investors in rationalising green office building investment in Kuala Lumpur by the application of Rasch analysis", Facilities, 2017 — 10 words — < 1%
Crossref

16 Kaixin Guo, Xin Yu. "Long-Term Forecasting Using MAMTF: A Matrix Attention Model Based on the Time and Frequency Domains", Applied Sciences, 2024 — 9 words — < 1%
Crossref

17 Trika Nurul Iftiah, Insar Damopolii, Silvia Hanna Kusuma Sirait. "Analysis of rural students' critical thinking skills about the human circulatory system during pandemic", AIP Publishing, 2023 — 9 words — < 1%
Crossref

18 oaji.net — 9 words — < 1%
Internet

19 www.coursehero.com — 9 words — < 1%
Internet

20 doktori.bibl.u-szeged.hu — 8 words — < 1%
Internet

21	eprints.unm.ac.id Internet	8 words — < 1%
22	joease.id Internet	8 words — < 1%
23	repository.iainkediri.ac.id Internet	8 words — < 1%
24	repository.uhamka.ac.id Internet	8 words — < 1%
25	tused.org Internet	8 words — < 1%
26	journal2.uad.ac.id Internet	7 words — < 1%
27	Derya Kaltakci-Gurel. "Exploring Pre-Service Teachers' Conceptual Understanding and Confidence in Geometrical Optics: A Focus on Gender and Prior Course Achievement", Education Sciences, 2023 Crossref	6 words — < 1%
28	journal.unismuh.ac.id Internet	6 words — < 1%

EXCLUDE QUOTES	OFF	EXCLUDE SOURCES	OFF
EXCLUDE BIBLIOGRAPHY	ON	EXCLUDE MATCHES	OFF