P-ISSN: 1693-1246
E-ISSN: 2355-3812
June 2025

Jurnal Pendidikan Fisika Indonesia 21 (1) (2025) 54-68
DOI: 10.15294/jpfi.v21i1.15023

http://journal.unnes.ac.id/journals/jpfi

Rasch Model Application: Identification of Students' Conceptual Understanding of Static Fluid

Khusaini*[1], Nur Azizah[2], Purbo Suwasono[3], Chusnana Insjaf Yogihati[4], Aries Dewi Andriani[5]

[1,2,3,4]Department of Physics Education,
Universitas Negeri Malang, Indonesia
khusaini.fmipa@um.ac.id

[5]SMAN 5 Malang,
Malang, Indonesia

Received: 15 February 2025. Accepted: 16 May 2025. Published: 12 June 2025

Abstract

This research aimed to determine the level of student conceptual understanding of Static Fluid material using the Rasch Model. The study used a cross-sectional survey with a quantitative descriptive approach. The sample was invited using simple random sampling of as many as 50 students of class XI Science in Malang Regency. The research used 15 multiple-choice questions on the conceptual understanding of static fluids. Research data analysis used the Rasch Model, assisted by Ministep software version 4.8.2.0. Based on the results of data analysis, it was concluded that the average distribution of the ability to understand static fluid concepts was above the standard average difficulty of the questions. This is indicated by 34 out of 50 students falling into the high and medium ability categories, meaning that students' conceptual understanding of static fluid material is quite good. The results of this research also found that students' conceptual understanding in the sub-chapter of Archimedes' principle was relatively low, as evidenced by 13 students answering correctly the question of conceptual understanding in this sub-chapter. Meanwhile, students' conceptual understanding of the hydrostatic pressure sub-chapter is relatively high, as indicated by 47 students answering correctly the question of conceptual understanding in this sub-chapter. This research is beneficial in providing a clear picture of students' conceptual understanding of static fluid material, highlighting areas where students still face difficulties. Teachers can use this information to design appropriate teaching strategies. Additionally, applying the Rasch model in evaluating conceptual understanding can enrich the literature in physics education.

Keywords: Conceptual understanding, Rasch models, static fluid

INTRODUCTION

Physics is closely related to mathematical concepts and equations, so students must deeply understand the concepts (Abriani & Nursalam, 2016). A deep understanding of concepts can develop students' abilities in learning physics. Understanding concepts is considered a reflection of educational competence and ability, and is the basis for students to fully apply the concepts they understand (Atmaja, 2021). Students must be able to enrich their thinking abilities, memorize learning material, and understand the concepts being taught (Charli, Amin, & Agustina, 2018).

Static Fluids is a physics topic that requires a good and correct understanding of the concept (Mubarokah, 2019). Understanding concepts is important for students to reveal what they observe (Abriani & Nursalam, 2016; Ningrum & Linuwih, 2015). The static fluid chapter material is important because the results of research by Mason and Singh (2016) state that static fluid is a concept often applied in everyday life. Hence, students need a good understanding of the concept. Students who master concepts can explain events in everyday life and identify problems (Arista, Suma, & Suastra, 2022; Atmaja, 2021).

However, many students still do not understand the concept of static fluid material. This is proven based on the research results of Adisna, Wahyuni, and Suyudi (2020), students' understanding of concepts in static fluid material obtained an average of 25% and is classified as low in the topic of hydrostatic pressure, Pascal's law and Archimedes' principle c Results that were not much different were also shown by the research results of Puri and Perdana (2023) which stated that understanding of physics concepts on the topic of static fluids reached an average value of around 47.7 and was in the poor category (Puri & Perdana, 2023). Additionally, Latifah (2016) argued that hydrostatic pressure is one of the complex topics in static fluid mechanics. This proves that students get less stable answer results, such as different answers to the same concept. Based on the answers obtained, 35% of students answered incorrectly due to students' lack of understanding of hydrostatic pressure, which assumes the same thing as pressure and density. Students also cannot understand the meaning of the questions, so there are still answers that do not match the questions. Apart from that, students are still unable to differentiate between pressure and weight of objects, as evidenced by the percentage of incorrect answers, reaching 56.7%. This often happens to students who assume that pressure is the same as the weight of the material. Apart from hydrostatic pressure, there is Archimedes' principle material which has low conceptual understanding as shown by research by Prastiwi, Parno, & Wisodo (2018) which states that students still have difficulty solving problems and essay questions tested on Archimedes' principle material as evidenced by the percentage obtained of 2.2%, which is in the low category.

The causes of students' lack of conceptual understanding are grouped into three, namely: the first cause is that students only focus on the mathematical equations used in solving problems without knowing the basic concepts of physics material (Amin, Azis, & Swandi, 2019). This is proven based on research by Kulsum and Nugroho (2014), which states that the cause of low understanding of concepts is that students are only able to memorize without understanding physics concepts, as evidenced by the score obtained being less than the 72 minimum credit obtained (KKM) mark set at SMAN 8 Semarang. The second cause of low understanding of physics concepts is that teachers in delivering material do not pay close attention to comparing material and systematic delivery, and do not emphasize basic concepts, so students find it difficult. Physics is a science that has objects in the form of real objects. If it is delivered only using the lecture method, the material students receive will only be understood as formulas or abstract concepts (Elisa & Mardiyah, 2018). This is in line with research by Siahaan, Maison, Agus Kurniawan, & Deswalman (2021), which stated that based on the results of an interview from one of the physics teachers at SMAN 10 Jambi City, several students had not reached the minimum score of 70 in physics as determined by the school. Students with less than minimum learning completeness (KKM) are still classified as having low ability to understand physics concepts due to a lack of basic concepts and learning methods. Other difficulties can be caused by a lack of media to support learning (Parahna, Wahid, & Bellia, 2022). Lack of media use will make students feel monotonous regarding the delivery of learning material, which requires supportive learning media. One way of delivering learning material is using teaching aids as a form of activity to convey the material so that the learning process tends to be more student-centered (Prihatiningtyas & Haryono, 2019).

Various efforts were made to overcome difficulties in understanding students' concepts in static fluid material. Based on research conducted by Puri and Perdana (2023), efforts to determine the level of understanding of concepts in fluid material were carried out by applying the Visualization Auditory Kinesthetic (VAK) learning model. The research results show that although this learning model can be used as an alternative, students' conceptual understanding of static fluid material is still in the poor category (Puri & Perdana, 2023). Another effort made to overcome difficulties in understanding concepts according to research (Azarine, 2021) is to use an integrated STEM Project-Based Learning (PBL) learning model. This research shows students can answer type C5 and C6 questions on static fluid material. However, in general, the learning process implemented by teachers tends to be teacher-centered with monotonous methods. It does not activate student participation in discovering a concept during the learning process (Salay, 2019). This learning approach causes students to gain less understanding of the process of static fluid concepts. Therefore, the learning process must be changed from teacher-centered to student-centered (Abriani & Nursalam, 2016). Another effort to develop students' knowledge and understanding can be using learning media (Parahna et al., 2022). One of the learning media that can support the learning process is teaching aids. Teaching aids are an instructional process that aims to convey material to make the teaching process more focused on students. One example of a tool that can make it easier for students to understand concepts is the use of U-pipes in material about hydrostatic pressure. The Integrated Instrument Component (KIT) includes the U pipe trainer. The KIT itself is one of the teaching materials in the form of teaching aids that can make it easier for a teacher and students during the learning process, so that in learning carried out with the help of KIT media to help understand students' difficulties in understanding concepts (Saadah, Ahied, Rosidi, & Wulandari, 2022).

An assessment of the ability to understand concepts is needed to test the extent of understanding of concepts, providing information regarding aspects and components of learning that need improvement (Barnawi, Himawan, Sauri, & Berlian, 2022). Assessment is important in the measurement process, especially in determining the sample's performance based on the measured characteristics. Therefore, research instruments that are compatible with the ability to understand concepts are needed. Present Rasch Model modeling as a solution to the limitations of classical statistical models (Medriati, Risdianto, Purwanto, & Kusen, 2022).

The Rasch Model is a probabilistic model that describes people's interactions with test or survey items and is governed by two parameters: item difficulty and a person's ability (Planinic, Boone, Susac, & Ivanjek, 2019). This research comprehensively and effectively creates an accurate and linear measurement scale. Apart from that, it can provide comprehensive information regarding the analysis of students' ability to understand concepts, which is individual-centered. This is supported by the objective Rasch model, which excludes subjective results, which means that the analysis results are unrelated to the research sample, as in classical modeling (Novinda, Silitonga, & Hamdani, 2019). In Rasch modeling, the Rasch Model can identify interactions between test items and students simultaneously because both can be represented on a linear scale and at the same interval (Risdianto & Sumartono, 2022). The Rasch model also explains that statistical analysis does not rely on raw scores, but on logit unit values, which describe the probability that students will answer a question item correctly (Wibisono, 2018). The development of the Rasch Model in physics learning can be seen in the research that Ayub, Istiyono, Munadi, Permadi, Pattiserlihun, and Sudjito (2020) stated that the magnetism material in the Fun Frame in Physics (FFP) media can be used to measure students' abilities, ranging from low ability to high ability. This is proven by the distribution of the difficulty levels of the questions: 25% very easy, 37.5% easy, 12.5% difficult, and 25% tough (Ayub et al., 2020). Results that were not much different were also shown by research results (Nurani, 2023), which stated that students' learning abilities in working on wave and optics questions were below average, namely 80.0%. This is because the percentage category of easy questions is straightforward: 14.3%, easy 57.1%, difficult 14.3%, and very difficult 14.3%. Apart from that, based on research results (Palimbong, Mujasam, & Allo, 2019), analysis of the questions in the final semester measurement exam concluded that the measurement was declared valid and reliable, and the difficulty level of the questions was excellent. Several studies show that the measurement instruments used can determine the relationship between student abilities and the difficulty of the test items.

In general, most research question instruments apply classical test theory. However, classical test theory still has several weaknesses, namely, the test measurement results depend on the characteristics of the test applied. In contrast, the item parameters depend on the test taker's ability (Ibnu, Indriyani, Inayatullah, & Guntara, 2019). Then the Rasch Model theory emerged, which has advantages including missing data that can predict the score, able to identify student error responses, student ability does not solely depend on the accuracy of the answer, but also the ability to recognize responses that are just mere guesses (Sumintono, 2016). Therefore, using the Rasch Model is more effective than analyzing classical test theory.

From the several explanations so far, research that uses the Rasch Model mainly analyzes test items using classical test theory and the Rasch Model. This is proven by research by Jumini, Madnasri, Cahyono, & Parmin (2023), who analyzed the quality of the items measuring scientific literacy and found that the quality of the items measuring literacy using classical test theory had medium category reliability, while the Rasch Model was in the outstanding category (Jumini et al., 2023). Research also analyzes the quality of the questions on the ability to differentiate between series and parallel circuits using classical test theory and the Rasch Model. The results show that the quality of the items on distinguishing series and parallel circuits using classical test theory has poor reliability. In contrast, the reliability for the Rasch Model is sufficient (Erfan, Maulyda, Hidayati, Astria, & Ratu, 2020). Different research was conducted by Tutuala, Widyaningsih, Yenusi, & Yusuf (2021) who used the Rasch Model to analyze the level of saturation in studying physics in the online period (Tutuala et al., 2021), the results showed that the level of saturation was divided into several criteria, namely very saturated

10%, saturated 60%, quite saturated 27% and not saturated 3 %. Another study by Maisyaroh (2023) analyzes the ability to understand static fluid concepts. This research shows that the ability to understand fluid concepts is categorized as quite good; however, it has not been realized whether learning media is used in learning (Maisyaroh, 2023).

By explaining the various reasons, the researcher felt it was necessary to identify students' understanding of concepts in static fluid material, so research was conducted with the title "Application of the Rasch Model: Identifying Students' Understanding of Concepts in Static Fluid Material". The purpose of this research is to determine the level of students' understanding of using the Rasch Model in Static Fluid material.

METHOD

This quantitative research aims to obtain data from numbers or values representing student test results (Purwasih, Kasli, & Susanna, 2022). This quantitative research uses a survey type (non-experimental). The type of survey in this research applies a cross-sectional survey in the form of data collection carried out only once (Sugiyono, 2022). Data collection using the survey method is used to analyze students' conceptual understanding, which describes the ability to understand the concept of static fluid material in the existing population. The population taken was class XI IPA students, with a sampling technique using simple random sampling. This technique was chosen because all class results show that the quality of the items on distinguishing series and parallel circuits using classical test theory has poor reliability. In contrast, the reliability for the Rasch Model is sufficient (Erfan, Maulyda, Hidayati, Astria, & Ratu, 2020). Different research was conducted by Tutuala et al., (2021) who used the Rasch Model to analyze the level of saturation in studying physics in the online period (Tutuala et al., 2021). The results are shown in Table 1.

Table 1. Research Sample

School	Female Student	Male Student
A	12	14
B	17	7
Total	29	21

The sample was taken from 50 students, consisting of 21 men and 29 women. The sample size used in Rasch modeling meets feasibility. This is proven by explanations (Linacre, 1994; Sumintono & Widhiarso, 2014) that targeting a sample size of 50 people is sufficient to obtain stable estimation results on a scale of ± 1 logit with a confidence level of 99%.

The research instrument is 15 multiple-choice questions on understanding the concept of static fluid material. Questions adapted from Setiawan (2020). In this study, I used multiple-choice or one-tier questions. Multiple choice questions cover levels C1 to C3 according to Bloom (2001) (Gunawan & Paluti, 2017). The knowledge dimension used is conceptual knowledge, which refers to understanding concepts and relationships between elements. The questions refer to the thesis entitled Development of a Diagnostic Assessment for Fluid Misconceptions in a Five-Tier Format to Reveal Students' Concept Understanding Profiles. Semarang State University. The grid instrument includes indicators and details of the sub-material division. The subtopics include hydrostatic pressure, buoyant force, Archimedes' principle, and Pascal's law. The hydrostatic pressure sub-material uses KIT learning media to deliver the material. In contrast, for the Buoyancy Force, Archimedes' Principle, and Pascal's Law, the sub-material only used explanations from the teacher using the lecture method. The research instrument must go through a validity and reliability process (Zamista & Kaniawati, 2015). The validation results by lecturers were 93% included in the very suitable category for use with revisions. Meanwhile, the results of teacher validation were 96% included in the category, which is very suitable for use with revision. An empirical test was also carried out by testing it on 42 class XI Science students who had studied Static Fluid material to see the results of its validity and reliability. The validation results obtained 14 valid questions, and the Cronbach alpha reliability value using Microsoft Excel was 0.82. The values obtained show that the research instruments used are in the very high category, indicating that the questions used are consistent for carrying out repeated measurements (Janna, 2021).

To verify the suitability of fit and unfit (misfit) items to determine the quality of the items in the Rasch Model using criteria from (Linacre, 2002) and (Sumintono & Widhiarso, 2015). Question items are said to be valid if they can meet at least two criteria and are corrected if they only meet one of the criteria above, and discarded if none of them meet the criteria (Sumintono & Widhiarso, 2015; Jumini et al., 2023). Table 2 shows the criteria in the Rasch Model.

Table 2. Rasch Model Validity Criteria1.5>-0.2

MNSQ Infit Outfit Value	ZSTD Infit Outift Value	PT Measure Corr value	Information
>1.5	>+2.0	>0.85	misfit
0.5-1.5	(-2.0) – (+2.0)	0.4-0.85	fit
<0.5	<-2.0	<0.40	misfit

Meanwhile, the difficulty level of the items in the Rasch Model is categorized based on the logit measure and the standard deviation (SD) value of the logit items, which are then divided into four criteria as seen in Table 3.

Table 3. Question Item Difficulty Level Criteria

Measure Value (*logit*)	Interpretation of Question Item Difficulty
measure logit>SD logit	very difficult
0≤measure logit≤SD logit	difficult
- SD logit≤ measure logit≤0	currently
measure logit< - SD logit	easy

In the Rasch Model, grouping students' ability levels can be seen through the standard deviation values of person logit and measure logit, which are then divided into the following three criteria (Table 4). Item and Person Reliability will be determined based on the criteria in Table 5.

Table 4. Criteria for Student Ability

Measure Value (*logit)*	Interpretation of Student Abilities
measure logit > SD logit	high
0 ≤ measure logit ≤ SD logit	currently
measure logit < - SD logit	low

Table 5. Reliability Criteria in the Rasch Model

Reability Value (*Person/Item)*	Interpretation
>0.94	special
0.91-0.94	very good
0.81-0.90	good
0.67-0.80	enough
<0.67	weak

The results of the Rasch modeling analysis on 14 items on the instrument about the ability to understand static fluid concepts produced nine items that functioned normally to test the ability to understand static fluid concepts and had good value depictions for a measurement. Data analysis was performed using Rasch Model analysis assisted by Ministep software version 4.8.2.0 (limited version of Winstep software) (Linacre, 2012). Table 6 indicates the material distribution regarding understanding the concept of static fluids used in research

Table 6. Distribution of Material

Sub Material	Items
hydrostatic pressure	**S1,S3,S10**,S11,S12,S13,S14
buoyancy	**S2,S4,S5,S6,S9**
archimedes' principle	**S7**
Pascal's law	**S8**

RESULT AND DISCUSSION

The level of suitability of the question items can be known through the results of the Rasch Model analysis in the item fit table. The results of the level of suitability of the question items indicate the level of validity of a question instrument being tested. The following item fits in Table 7, showing everyday research question items.

Table 7. Level of Suitability of Question Items

Item	Measure	INFIT		OUTFIT		PT MEASURE
		MNSQ	ZSTD	MNSQ	ZSTD	CORE
Item 1	-5.87	Minimum Measure				0.00
Item 2	-5.87	Minimum Measure				0.00
Item 3	-4.20	1.32	0.91	2.63	1.28	0.24
Item 4	-5.87	Minimum Measure				0.00
Item 5	-1.65	-1.65	0.44	-2.02	0.18	-1.54
Item 6	-2.30	-2.30	1.98	3.17	6.80	3.13
Item 7	0.15	0.15	0.58	-1.85	0.41	-1.83
Item 8	-1.78	-1.78	0.64	-1.20	0.30	-1.22
Item 9	0.58	0.58	1.37	1.89	1.55	1.19
Item 10	0.16	0.16	0.83	-0.70	0.74	-0.59
Item 11	-0.50	-0.50	0.87	-0.37	0.88	-0.19
Item 12	2.17	2.17	0.89	-0.77	0.69	-0.04
Item 13	2.17	2.17	0.97	-0.17	1.06	0.38
Item 14	1.56	1.56	1.14	1.24	1.91	1.25

Table 7 shows that out of 14 tested questions, nine were declared valid and five were declared invalid. Invalid questions were deleted because none met the item validity criteria. Valid questions were then grouped based on the difficulty level obtained from the item fit table. Table 8 shows the questions' difficulty level distribution using the Rasch Model.

Table 8. Difficulty Level of Questions

Total Score	Total Count	Jmle Measure	Item
13	50	2.17	S7
13	50	2.17	S8
18	50	1.56	S9
26	50	0.58	S4
29	50	0.16	S5
31	50	-0.15	S2
33	50	-0.50	S6
39	50	-1.78	S3
47	50	-4.20	S1
Mean		0,00	
P.SD		1,92	

Table 8 shows the most considerable logit value (+2.17), question S7 sub-chapter Archimedes Principle, and the smallest logit value (-4.20), question S1 sub-chapter Hydrostatic Pressure. A high logit value indicates that the question's difficulty level is also high. This difficulty level is related to the total score column, which provides information about students who can answer the question correctly. Other information related to the difficulty of the item we obtained on question item S5 with a value of (+0.16 logit) and question item S4 with a value of (+0.58 logit), we can say that question item S4 is almost four times more difficult than question item S5.

The comparison of question items S4 (+0.58 logit) answered correctly by 26 students and question items S9 (+1.56 logit) answered correctly by 18 students will be different from question items S3 (-1.78 logit) answered correctly by 39 students and question items S1 (-4.20 logit) answered correctly by 47 students. Questions S4 and S9 are (+0.98 logit), while S3 and S1 are (- -2.42 logit). However, the difference between the two comparisons is eight scores. However, it is not simply that both have the same logit distance. Rasch modeling uses the odds ratio probability based on the score obtained by each question. The algorithm results from the odd ratio probability produce a logit value (the logarithm of the odd ratio). This logit value is the reference for Rasch Modeling in determining the difference in the difficulty level between question numbers. This makes calculations using Rasch Modeling more precise and accurate.

The item measure table in the Rasch Model contains information on fit items, which are then grouped based on the Rasch Modeling difficulty level criteria, divided into four criteria: challenging, complex, moderate, and easy. The item measure table also provides information on the standard deviation value of 1.92 as a reference in grouping the questions' difficulty level. Table 9 is a table of analysis of the difficulty criteria for the questions.

Table 9. Results of Analysis of Question Item Difficulty Level Criteria

Criteria	Item	Measure Value *(logit)*	Material
very difficult	S7	2.17	archimedes' principle
	S8	2.17	Pascal's law
difficult	S9	1.56	buoyancy
	S4	0.58	buoyancy
	S5	0.16	buoyancy
currently	S2	-0.15	buoyancy
	S6	-0.50	buoyancy
	S3	-1.78	hydrostatic pressure
easy	S1	-4.20	hydrostatic pressure
P.SD	1.92		

In addition, the results of the Rasch Model analysis in the person measure table provide information related to students' ability to answer questions. The students' abilities are then grouped based on the Rasch Modeling criteria to determine the level of students' conceptual understanding of the questions being worked on. The reference for grouping students' abilities is seen from the standard deviation value, which is then categorized into high, medium, and low-level abilities. This can be seen in Table 10.

Table 10. *Person Measure*

Student Code	*Measure (logit)*	Total Score	Criteria *(logit)*	Category
02P,13P	3.01	8	>2.01	high
03P, 05P, 10P,22P, 26P, 30L, 31P, 37L, 39P, 41L, 42L, 44P, 47P,48P	2.00	7		
08P, 14P, 27L, 28P, 29P, 32P, 34L, 35L, 36P, 38L, 40P, 43L, 45P, 46P, 49P, 50P	1.24	6		
11P, 25P,	0,55	5	<2,01	currently
33P	-0,14	4		
01L, 17L, 23L	-0,90	3		
09L, 12L, 15L, 24P	-1.87	2		

Student Code	*Measure (logit)*	Total Score	Criteria *(logit)*	Category
04L, 06L, 07L, 16L, 18L, 19L, 20L, 21L	-3.40	1	<0.00	low
mean	0.35			
P.SD	2.01			

Table 10 shows that the distribution of student abilities is mainly in the medium category, with 32 students. On the other hand, two students in the high category got a score (+3.01 logit) and eight in the low category got a score (-3.40 logit). Other information that we can know is that students 11P and 25P have a logit person of +055 and students 03P, 05P, 10P, 22P, 26P, 30L, 31P, 37L, 39P, 41L have a logit person of +2.00, which means that the ability of students with a logit of +2.00 is approximately four times that of students with a logit of +0.55. Students who have the same logit value indicate that their ability to get the number of correct answers is also the same.

The results of the Rasch Model illustrate the comparison of item and person measures in the Wright map. In Figure 1, the Wright map on the right is a map of the distribution of the difficulty level of the questions, and on the left is the distribution of students' conceptual understanding abilities. The specialty of this map illustrates the distribution of students' abilities and the distribution of students' difficulty levels on the same scale. This map also provides information that the higher the logit value owned by students, the higher the possibility of the student answering the question item. This Wright map also presents information that the average value of the logit distribution at the student's ability level obtained a value of 0.35 logit (information in Table 10) and for the average logit level of item difficulty 0.00 logit which we can conclude that the majority of students have a level of conceptual understanding ability above the level of question difficulty—proven by the majority of 34 out of 50 students being above the logit value of the question item. Therefore, students' conceptual understanding of static fluid material is good. The map also shows that students 02P and 13P can do almost all the questions correctly. This is because the students' abilities have a value (+3.01 logit) higher than the difficulty level of question S7, Archimedes' principle, and question S8, Pascal's law, which have a logit value of +2.17 logit. The logit value of the students' abilities is higher than the logit value of the question items; this means the probability of correctly doing questions with lower logits is more than 50%. Students 02P and 13P will not find it difficult when working on question S4 about Buoyancy, which has a logit value of +0.58, because the difficulty level of the question is below the logit value of their abilities.

In addition, see the map image there is one student, namely 33P with a value of (-0.14 logit) has a value that is almost the same as the S2 question item with a value of (-0.15 logit), the probability of this student being able to work on the S2 question item correctly is 50%. However, student 33P can work on question S6 with a value of (-0.50 logit) correctly because the level of difficulty or the logit value of the question item is lower than the ability of student 33P, in contrast when student 33P cannot work correctly on question S4 with a value of (+0.58 logit) because the logit value is above the logit ability of student 33P (Figure 1).

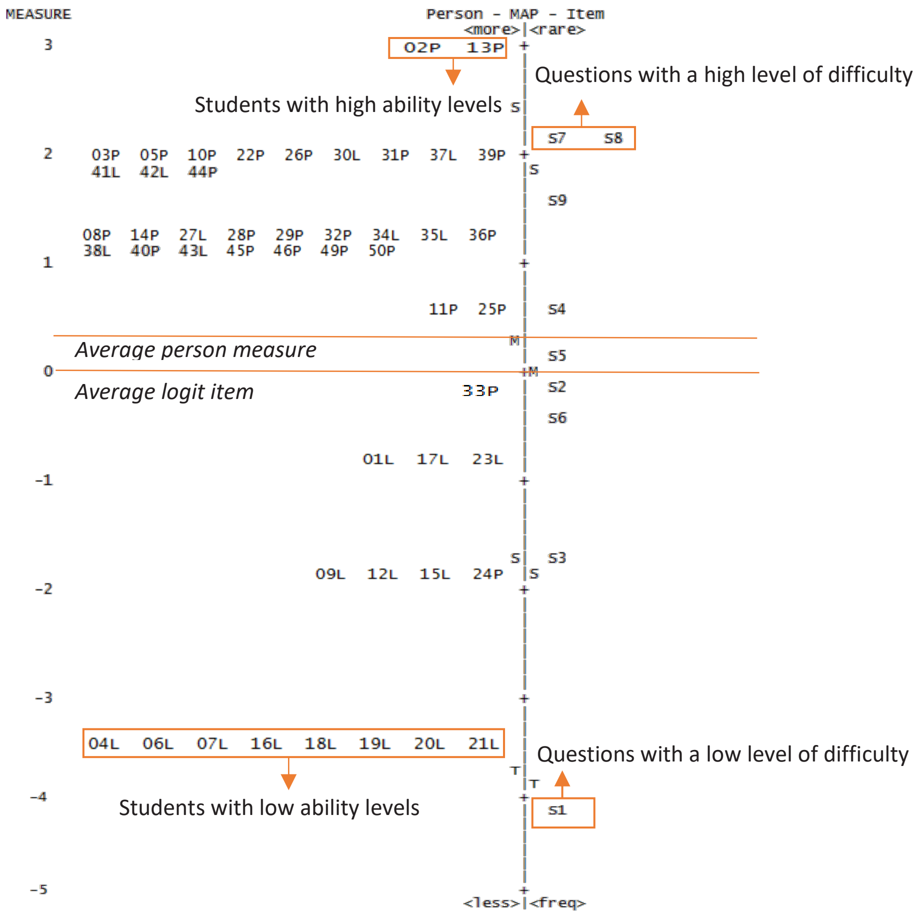

Figure 1. Wright Map

In the Rasch Model analysis research, detailed information on instrument reliability is also provided. The analysis results with the Rasch Model obtained a real item reliability value of 0.94. We get the instrument results in the outstanding category from the real item reliability analysis results. This shows that the question instrument used contains varying levels of difficulty. Question item S7, sub-chapter Archimedes' principle, is the most challenging category of questions because only 13 out of 50 students could answer it. Figure 2 describes the Archimedes principle question, where students must be able to show each condition, namely floating, hovering, and sinking. In this question, the calculation is done only by equating all unit conversions and comparing it with the formula ρb < ρf, floating if ρb = ρf, and sinking if ρb > ρf.

Liquid substances K, L and M have density of 1 g/cm^3, 900 kg/m^3 and 800 kg/m^3 respectively and fill a container of equal volume. If an object with a density of 0.9 g/ml is put into the three liquids in turn, then...

a. Object sinks at K, L and M.
b. Object sinks at K and floats at L and M.
c. Objects floating on K and sinking on L and M.
d. The object floats in all three liquids.
e. The object floats in K, floats in L and sinks in M.

Figure 2. Question Item S7

In the response, many students answered incorrectly. There were 26% of students who answered correctly, namely option E, while the rest chose the wrong answer. The following is the distribution of student answers to question item S7 in Table 11.

Table 11. Distribution of Answer Options for Item S7

Option	Percentage (%)
A	12
B	18
C	34
D	10
E	26
Total	100

Based on the data in Table 11, we can see that the distribution of the most answers is in answer choice C, which is 34%. Students who choose this answer probably do not understand the concept of sinking and floating, and only understand the concept of floating. The reason why students might answer C is because of the wrong conversion factor. They use easier unit conversions to improve the question items so students understand them better.

Then, for the S1 question item, the hydrostatic pressure sub-chapter is the question with the easiest category because 47 out of 50 students were able to answer it. Figure 3 describes the hydrostatic pressure question, where students can compare the amount of pressure at a certain depth. This question does not use calculations because it is enough to understand the relationship between the formulas for hydrostatic pressure (Figure 3).

The pressure felt by a diver when diving under different circumstances at sea and in a freshwater lake, if he dives at the same depth. ($\rho_{water} = 1000\,\frac{kg}{m^3}$ dan $\rho_{sea\,water} = 1030\,\frac{kg}{m^3}$) then….

a. Pressure in seawater = pressure of freshwater lake
b. Sea water pressure is greater because it is salty
c. Greater freshwater lake pressure
d. Greater sea water pressure
e. Sea water pressure is greater because it is very wide

Figure 3. Question Item S1

Many students answered correctly in the response. 94% of students answered option D correctly, while the rest chose the wrong answer. The following is the distribution of student answers to the S1 question items in Table 12.

Table 12. Distribution of Answer Options for Item S1

Option	Percentage (%)
A	0
B	6
C	0
D	94
E	0
Total	100

Based on the data in Table 12, we can see that the distribution of the most answers is in answer choice D, which is 94%. Students who choose this answer will likely understand the concept after being explained the learning media used to explain the hydrostatic pressure material.

Based on the entire series of analyses presented previously, the level of students' conceptual understanding assisted by KIT learning media, analyzed using the Rasch Model on static fluid material, is in the good category. This is because to determine students' conceptual understanding, it is necessary to analyze fit questions according to Rasch Modeling. Of the 14 questions, nine fit questions were obtained because they were within the MNSQ infit range between 0.5 <MNSQ <1.5. According to the research of Gyasi-Gyamerah, Quansah, Amissah, and Gyasi-Gyamerah (2024), for fit questions using the MNSQ infit value range between 0.5 <MNSQ <1.5, two items were obtained that were not fit. The nine questions that were declared fit were then grouped according to the level of difficulty of the questions to determine each student's conceptual understanding ability in answering each question. Question item S7, with a value of (+2.17 logit) in the difficult category, was answered by only 13 out of 50 students, while the easy question item S1, with a value of (-4.20 logit), was answered by 47 out of 50 students. This aligns with research conducted by Kurniawan & Andriyani (2018), who found that difficult S3 questions with a value of (+2.03 logit) were only answered by 2 out of 10 students. However, easy S1 questions with a value of (-2.15 logit) were answered by 9 out of 10 students (Kurniawan & Andriyani, 2018). Another study conducted by Azizah and Wahyuningsih (2018) found that difficult S18 questions with a value of (+2.06 logit) were answered by 18 out of 40 students, while easy S14 questions with a value of (-1.49 logit) were answered by 37 out of 40 students (Azizah & Wahyuningsih, 2020). These results can provide information on the difficulty level of the questions corresponding to the total score of each item.

Based on Table 10, 34 out of 50 students have an average understanding of the concept of students in the medium and high categories. This study is also by Maisyaroh (2023), who stated that the results of data analysis showed that 34 out of 54 students' ability to understand the concept of static fluids was categorized as quite reasonable, and dominated by students with a high to medium ability level. In addition, Maisyaroh’s study provided information that students had difficulty answering questions about Pascal's law because they did not understand the concept. The question items on Pascal's law were difficult because students could compare the significant pressure forces between the pistons using Pascal's law. However, they found it challenging to implement the calculations in natural phenomena. This contrasts with the questions in the sub-chapter on applying Archimedes' Principle, which are classified as easy questions. This finding is related to a total of 46 students who were able to answer correctly. Many students answered correctly because "if a submarine is going to change to a floating position, the density of the ship must be smaller than the density of sea water" (Maisyaroh, 2023). Another study by Wicaksono, Bukifan, & Kusairi (2019) stated that the average ability of students' conceptual understanding of static fluid material reached 63.47% and was classified as good (Wicaksono et al., 2019). The results of this study indicate that students have difficulty with the buoyancy force material, which can only identify the buoyancy force experienced by objects, but have difficulty identifying the gravity acting on objects. In contrast to the study (Putri, Parno, & Supriana, 2017), the test analysis results showed that students' conceptual understanding was still relatively low, with an average test score of 3.15 and a standard deviation of 1.72 from a maximum score of 10. The lack of conceptual understanding of students mainly argues that the shape of the container influences hydrostatic pressure, and the object's mass influences Archimedes' force. From the explanation above, we can conclude that a good study can identify students' difficulties in a subject matter and the reasons given.

Furthermore, the analysis results of the difficulty of the questions and students' abilities can be described through a Wright map that can describe the distribution of the difficulty level of the questions and the level of students' abilities. Based on Figure 1, the average ability of students' conceptual understanding was obtained (+0.35 logit) and the average difficulty of the questions was obtained (0.00 logit), proving that students' conceptual understanding ability is higher than the difficulty of the questions (Sumintono & Widhiarso, 2015).. In line with this, previous research by Apriani, Islamiati, Putri, Susilawati, Muharram, & Nur'aeni (2023) stated that the average value of the person logit (+0.90 logit) with the average item logit (0.00 logit) indicated that the average student ability was above the average difficulty of the questions. Different results were shown by (Nurani, 2023), which obtained an average value of student ability of (-1.11 logit), and the average value of the difficulty of the questions was obtained (0.00 logit), indicating that the level of student ability was below the level of difficulty of the questions. Thus, students' abilities and test items can be compared using the average logit value of Rasch Modeling.

In addition, this study found that students had difficulty with Archimedes' principle questions. Most students answered the questions incorrectly, and only 13 out of 50 could answer correctly. This is also supported by the explanation in the literature review of Utami, Djudin, & Arsyid (2014), who stated that students' errors in the concept of Archimedes' principle were 58%, namely, assuming that Archimedes' force was only influenced by the density of the object. Not much different results were also shown by the results of Kurniawan (2023), showing that students did not understand the material on Archimedes' Principle (with 51.4%), thinking that the volume of fluid affected the magnitude of the lifting force experienced by the object. This shows that in this study, the understanding of the concept of Archimedes' principle was relatively low.

According to students, the results of this study on hydrostatic pressure questions are considered easy because 47 out of 50 students could answer them, indicating that, in this study, the understanding of the concept of hydrostatic pressure questions is relatively high. The results of research by Niksoni and Yuliati (2017) showed the same thing on hydrostatic pressure questions; students' conceptual understanding ability was 70% because students were able to understand the concepts and factors that influence the sub-chapter of hydrostatic pressure (Niksoni & Yuliati, 2017). This is in contrast to the presentation in the literature review, according to research by Rizkiyati, Supriadi, and Maryani (2018), showing that students' understanding of the concept of static fluids on the topic of hydrostatic pressure is still low. This is because students are still influenced by the volume of water and the vessel's shape when answering questions about hydrostatic pressure. In this study, behind the high understanding of the concept of hydrostatic law material, because KIT learning media assisted it during learning, the use of this media was considered a good solution, so that the material was interesting, and it was effective to apply in learning (Agyofannyngrum & Widodo, 2017). This media explains the relationship between the formulas in hydrostatic pressure material, where hydrostatic pressure is directly proportional to its depth (h) and the density of the liquid (ρ). Also, if we apply pressure to the liquid through a funnel at a certain height, the liquid in the U-tube will change, and the change in the liquid's height is called the liquid's surface height. The same law was produced from the experiments as the theory, where the greater the pressure given to the liquid, the greater the changes produced. From this explanation, students are considered able to know the relationship between the formulas of hydrostatic pressure. The possibility of students answering correctly is 94% because they understand the concept after explaining the learning media used. Hydrostatic pressure is directly related to events around us, including the pressure caused by the force on the liquid against a pressure area at a certain depth (Nisa', Munawaroh, Yasir, & Wulandari, 2022).

CONCLUSION

The results of the Rasch Model obtained an average of students' conceptual understanding ability (+0.35 logit) and an average of the difficulty of the test items obtained (0.00 logit), proving that students' conceptual understanding ability is higher than the difficulty of the test items. This is evidenced by 34 out of 50 students falling into the high and medium ability category, which means that students' conceptual understanding of static fluid material is in the pretty good category. This study also found that students' conceptual understanding of Archimedes' principle questions was relatively low, evidenced by 13 students correctly answering the conceptual understanding questions in the sub-chapter. Meanwhile, students' conceptual understanding of hydrostatic pressure questions was relatively high, evidenced by 47 students correctly answering the conceptual understanding questions in the sub-chapter, because KIT learning media assisted them in delivering the material.

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