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Investigation of students' conceptual understanding of fluids in Kupang City and Sabu Raijua District

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Abstract
This study analyzes students' concept understanding ability on fluid material in Kupang City and Sabu Raijua Regency. Using the descriptive quantitative method, this study involved 332 high school students in grades XI and XII of science specialization in the age range of 14-18 years, with research samples in Kupang City including 91 male students and 160 female students, while samples in Sabu Raijua Regency included 33 male students and 48 female students. The instrument, in the form of 12 multiple-choice questions based on cognitive indicators of understanding (C2), was declared reliable, with Cronbach's Alpha 0.82 in the outstanding category. The results showed that students in Kupang City had a concept understanding level of 39.54% (less understanding category), lower than students in Sabu Raijua Regency with a percentage of 45.47% (sufficient understanding category). Gender analysis revealed that female students were superior to male students in all indicators, especially in the comparing indicator. However, weaknesses were seen in the summarising and explaining indicators in both regions. Rasch modeling analysis with the help of WINSTEPS showed variations in students' abilities between the low to sufficient categories. The findings are expected to be a reference for teachers to design contextual, problem-based, and collaborative learning and utilize learning media to improve students' concept understanding in Physics.

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1. Introduction

The current challenges of the 21st century require the education sector to be able to equip individuals with various abilities. As emphasized in the Assessment and Teaching of 21st Century Skills (ATC21S), which categorizes 21st-century skills into 4 categories, namely ways of thinking (focusing on cognitive abilities), ways of working (related to communication and collaboration), tools for working (involving the ability to use ICT) and skills for living in the world (abilities related to social, cultural and globalization needs (Griffin et al., 2012). One of the categories, namely, way of thinking, includes creativity, innovation, critical thinking, problem-solving, and decision-making. These high-level abilities certainly require more understanding to be able to apply these abilities in everyday life in all fields of science including in the field of Physics.

Physics is a field of science with complex insights that students need to understand well. Because of its complexity, the ability to understand Physics in depth is essential for students to be able to solve various problems they face. The ability to understand concepts is the ability of students to understand concepts correctly, both theoretically and in their application to solving various problems (Du et al., 2023). With a good understanding of Physics concepts, it can help students actively engage in physics learning, master knowledge, and improve their abilities in everyday life (Xu & Ma, 2024).

The ability to understand concepts is an essential ability at the C2 cognitive level, which is important for students to master before mastering higher-level abilities, such as cognitive aspects C3 to C6 in Bloom's Taxonomy (Indahsari et al., 2018; Widiawati et al., 2022). Students who understand Physics concepts and principles optimally will be more skilled in understanding various concepts from simple to more complex. A deep understanding allows students to apply their knowledge in the

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context of a given problem, thus improving their ability to solve various problems effectively (Sari et al., 2023; Darwish et al., 2018). If students have a strong understanding of basic concepts, they are better able to relate the concepts in real-life contexts. They are able to affiliate them into a more complete understanding (Yeadon & Hardy, 2024). Conversely, weak concept understanding can hinder students' ability to develop strategies and systematic steps for the formation of their cognitive understanding (Aprilia et al., 2024). Therefore, it is essential to train students' ability to understand basic concepts as well as more complex concepts, so that students are more accustomed and able to understand the overall concepts learned (Baert, 2019).

However, in the current practice of learning Physics, especially in Indonesia, it is still often found that students cannot understand concepts in learning Physics. This finding is evident in student learning outcomes that are less than optimal and have not been well-stimulated (Sari et al., 2020; Yanto et al., 2021). Based on several previous studies, it is known that many students cannot explain the principles used in solving problems, have difficulty understanding Physics material during the learning process, are unable to answer simple questions correctly, and many concept misunderstandings indicate low concept understanding ability (Cindikia et al., 2020; Fadillah et al., 2023; Hidayat et al., 2020; Martawijaya et al., 2023; Resbiantoro et al., 2022; Haryono et al., 2021).

In learning Physics, there are a number of concepts that students have not fully understood. Based on the literature review, some Physics materials that are often the focus of research to measure students' ability to understand concepts while showing a low level of understanding include fluids (31.52%), sound and light waves (16.3%), electricity (11.96%), elasticity and Hooke's law (17.39%), and kinematics (22.83%). This data shows that students' understanding of fluid concepts is still relatively low compared to other materials.

Specifically, several previous studies have shown that students' ability to understand concepts in fluid material has not been optimal, with an average percentage of ability to understand below 50% (Sularso et al., 2017; Setiawan & Faoziyah, 2020; Annisa, 2023; Sumardiana & Rasyidi, 2021). Fluid material is considered quite complex and abstract because it involves various concepts related to everyday life and requires in-depth metacognitive knowledge. This complexity often makes it difficult for students to understand fluid concepts and connect them with phenomena that occur in real life (Suhaili et al., 2022; Mufit et al., 2023; Purwanto et al., 2020; Putri & Yuliati, 2020).

In East Nusa Tenggara (NTT) Province, especially around Kupang City and Sabu Raijua Regency, research on understanding Physics concepts is still limited. Given the different geographical conditions and educational resources in NTT, it is important to evaluate the extent to which high school students in the area understand Physics concepts well. As well as several studies outside NTT also conducted the same investigation regarding the profile of student understanding (Salam et al., n.d.; Cicyn Riantoni et al., 2023; Maulani et al., 2020; Affriyenni et al., 2020; Jamaludin & Batlolona, 2021; Alkalah, 2016).

This study is in the latest position in exploring the ability to understand students' concepts in physics material, especially fluid topics in the NTT region. Previous research shows that fluid is one of the materials with a relatively low level of student understanding (Sularso et al., 2017; Setiawan & Faoziyah, 2020; Annisa, 2023; Sumardiana & Rasyidi, 2021). Utilizing the Rasch modeling method is a crucial step to map the profile of students' understanding ability in Kupang City and Sabu Raijua Regency, as an approach that is rarely applied in these areas. The gap revealed is the lack of in-depth studies related to students' understanding of Physics concepts in NTT, which has unique characteristics in terms of geography and educational resources. The novelty of this study lies in its geographical focus and gender-based analysis that provides new insights into the variations and challenges of understanding physics concepts in the region.

This research was conducted in NTT because the region still faces challenges in the quality of education, such as limited access to learning resources, technology, and competent teaching staff (Forster, 2018). In addition, the social and economic background of the community, the majority of whom work in the agricultural and marine sectors, also affects students' understanding of Physics concepts (Habibillah & Hadjri, 2024). This study aims to map students' abilities in understanding Physics concepts and solving problems as a first step to formulating more effective and contextualized educational interventions. Furthermore, investigating empirical data in NTT, this research is expected to provide concrete recommendations for teachers, schools, and policymakers to improve students' 21st-century skills, as well as contribute to efforts to equalize the quality of education in Indonesia and develop innovative learning models that are appropriate to local conditions.

In particular, this research has high urgency due to the gap in the quality of education in NTT, especially in Kupang City as the center of education and Sabu Raijua as a developing area. Limited learning facilities, educators, and physics laboratories hinder students' understanding of physics concepts as well as their ability to understand concepts and solve problems (Abdulbasit & Mekuria, 2021). In addition, geographical, social, and economic conditions, such as the dominance of the agriculture and fisheries sectors in Sabu Raijua, also affect students' perceptions of the relevance of physics in everyday life (Tan, 2024).

This research is important to map students' learning challenges, provide contextual solutions such as improving teacher competence and learning facilities, and encourage equitable distribution of education quality. By practising problem-solving and critical thinking skills, this research contributes to human resource development in NTT. It forms the basis for formulating effective education policies for Kupang City and Sabu Raijua.

This study emphasizes the importance of knowing the ability profile of students in educationally deprived areas such as NTT to develop more relevant learning strategies. The findings have a practical impact in the form of recommendations for teachers to implement problem-based, collaborative learning, as well as the utilization of technology in the application of learning media. However, there are some limitations, such as the uneven distribution of samples between urban and rural areas and the focus on only one Physics topic, namely fluid, so the results of this study do not fully represent other Physics materials. Therefore, a broader follow-up study is needed to enrich the understanding of students' ability to understand Physics concepts.

2. Method

This study uses quantitative research methods with descriptive research types. The descriptive quantitative research method was used in this study to investigate students' concept understanding and problem-solving skills in learning Physics in Kupang City and Sabu Raijua Regency. This method systematically describes and analyzes data based on measuring students' abilities using effective and measurable instruments (Loeb et al., 2017). This method allows researchers to identify patterns or gaps in students' ability to understand Physics material, such as basic concepts and applications in problem-solving. The results can be used to develop more specific and objective recommendations, such as improving educational interventions.

This study determines the sample size because the student population in NTT is quite large. Based on data from BPS (2023), the total number of high school students, both public and private, in NTT Province reached 207.039 students. To determine a representative sample size, a calculation according to Slovin (1960) was used, which is formulated as follows:

$$n = \frac{N}{1+Ne^2} \quad (1)$$

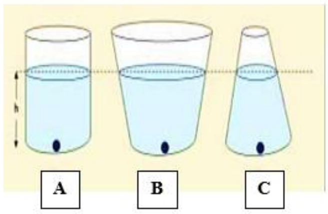
This study is quite significant in scale, so the margin of error used ranges from 5% to 7% (Lu et al., 2018). By setting a margin of error of 6%, the sample size calculated using the Slovin formula resulted in a minimum of 278 participants used in this study.

The population in this study included high school students in grades XI and XII of science specialization in East Nusa Tenggara. The research sample was selected through a random sampling technique, where sampling was done randomly without regard to factors in the population (Adisna et al., 2020). Participants came from high school students in Kupang City, totaling 251 participants with a male sample of 91 students and a female sample of 160 students with an age range of 14-18 years, while the sample from Sabu Raijua Regency consisted of 81 participants with 33 male students and 48 female students in the age range of 15-18 years. The difference in the number of samples from the two locations is significant because, based on the Ministry of Education and Culture’s Data Portal (2023), the population of high school students in Kupang City is around 16,076 people compared to

Sabu Raijua Regency, with around 5,448 high school students. Therefore, the number of high school samples from Kupang City is more dominant than the samples from Sabu Raijua Regency.

The instrument used in the study tested the ability to understand concepts around fluid material consisting of 12 multiple-choice questions adopted from research by Rizky (2021). The concept understanding ability questions tested in this study can be shown in the following figure:

Here is an image of several containers filled with the same type of liquid.



Hydrostatic pressure occurs on objects located in the container....

a. A
b. B
c. C
d. A and B
e. A, B, and C

Figure 1. An Example of a Question on the Ability to Understand Concepts in Fluid Material

The indicators in the questions are adjusted to the cognitive indicators at the C2 level, namely understanding, according to Anderson and Krathwohl (Afifah, 2019), as shown in Table 1 below:

Table 1. Cognitive Process Aspects of Understanding C2 on Taxonomy

No	Cognitive Profile	Interpretation
1	Interpret	Change from one form to another
2	Exemplify	Find a specific example or illustration of a concept or principle
3	Classify	Specifies something that belongs to a category
4	Generalize	Abstracting common themes or main point
5	Inference	Drawing logical conclusions from the information presented
6	Compare	Looking for connections between two ideas, objects, or similar things
7	Explain	Construct a causal model of a system

The concept understanding ability test data was analyzed quantitatively with two types of analysis, namely the profile analysis of the ability to understand the concept of high school students in Kupang City and Sabu Raijua Regency and the analysis of the ability level of each student using Rasch modeling assisted by WINSTEPS version 3.7.3. Rasch modeling, according to Sumintono & Widhiarso (2015) in (Zaidi et al., 2024), is a statistical method used to analyze student abilities, so in this study, Rasch modeling analysis was carried out to determine the level of ability to understand the concept of each high school student in both Kupang City and Sabu Raijua Regency.

The profile analysis of the ability to understand concepts in each region was conducted in general by finding the percentage profile of the ability to understand concepts in each area and, more specifically, by looking at the ability profile of each gender in both Kupang City and Sabu Raijua Regency. Specific analysis based on gender was carried out to identify differences in understanding concepts between men and women (Alamanda et al., 2023). The profile analysis obtained is then categorized based on the categorization of the level of ability to understand the idea shown in Table 2.

Table 2. Categorization of Level of Understanding Concepts

Level of Understanding (%)	Interpretation
81-100	Very good
61-80	Good
41-60	Simply

Level of Understanding (%)	Interpretation
21-40	Less
0-20	Very less

Rasch analysis was conducted by finding the logit value of each student to interpret the level of student ability further. In addition, Rasch modeling is used to evaluate the reliability of the research instrument, namely the test instrument's reliability level, which measures students' ability to understand fluid material. The person or Item Reliability determines reliability in Rasch modeling in the *Summary Statistics table output.* Test instrument reliability criteria in Rasch modeling according to Sumintono & Widhiarso (Sumintono et al., 2015), shown in Table 3 below:

Table 3. Interpretation of Reliability Value

Reliability Value (Person/Item)	Interpretation
> 0.94	Special
0.91 – 0.94	Very good
0.81 – 0.90	Good
0.67 – 0.80	Simply
< 0.67	Weak

Rasch modeling is also used to test the instrument's validity by looking at *Cronbach's Alpha* value, which indicates overall reliability and reflects the relationship between students and given question items (Fiskawarni et al., 2024). Reliability is important because it shows the extent to which the measurement instrument (in this case, the question item) can provide consistent and accurate results when used by various students and ensures that the results obtained from the test truly reflect the understanding and skills possessed by students. *Criteria* for interpreting the *Cronbach's Alpha* value in Rasch modeling (Sumintono et al., 2015) can be seen in Table 4 below:

Table 4. Interpretation of Cronbach's Alpha Value

Cronbach's Alpha Value	Interpretation
$\alpha \geq 0.80$	Very good
$0.71 \leq \alpha < 0.80$	Good
$0.61 \leq \alpha < 0.70$	Simply
$0.50 \leq \alpha < 0.60$	Bad
$\alpha < 0.50$	Very bad

Other analyses needed in this study include Wright Map, Person Measure, Person Fit (outfit Mean Square (MNSQ), outfit Z-standard (ZSTD), point measure correlations (Pt Measure Corr.), standard deviation, and scalograms to see the level of ability based on the highest to lowest order of students on the ability to understand concepts between students in Kupang City and Sabu Raijua Regency. The Wright Map describes the distribution of test takers' skills and the difficulty level of items on the same scale (Asriadi & Hadi, 2021). Person fit is used to identify response patterns that do not fit the ideal model (Handayani et al., 2023). Person Measure is used to assess students' ability to answer the given fluid questions. Scalograms are used to identify patterns of student answers that do not fit the ideal model.

In the Person fit analysis, it is necessary to check the person using the criteria according to Boone in (Sumintono et al., 2015) to check the suitability of items and the ability of students who do not fit (outliers or misfits) by observing the following conditions:

a. The accepted Outfit MNSQ (Mean Square) values are: 0.5 < Outfit - MNSQ < 1.5

b. Accepted ZSTD (Z - Standard) Outfit values are: -2.0 < ZSTD < +2.0

c. Pt Measure Corr (Point Measure Correlation) value: 0.4 < Point Measure Corr < 0.85

3. Results and Discussion

3.1. Results

This study's analysis consists of two parts: an overview of students' ability to understand concepts in Kupang City and Sabu Raijua Regency and an analysis of each student's ability level using Rasch modeling.

3.1.1. Profile of Concept Understanding Ability of High School Students in Kupang City and Sabu Raijua Regency

Based on the results of the analysis, the ability to understand the concept of high school students in the two regions shows differences in the level of understanding of the concept and the category achieved. The ability to understand the idea of high school students in Kupang City is in the category of not understanding the concept, with a percentage of 39.54%. In contrast, the ability of high school students in Sabu Raijua Regency is higher, with a percentage of 45.47% in the category of understanding the concept sufficiently.

The profiles of concept understanding ability in the two regions were further broken down by gender. The identity of each gender for each region is FK for "Kupang female," MK for "Kupang male," FS for "Sabu female," and MS for "Sabu male." The profile of the ability to understand concepts based on gender is presented in Figure 2 below:

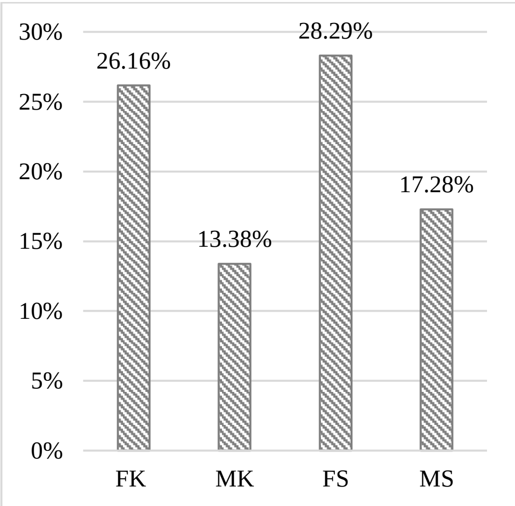


Figure 2. Profiles of Concept Understanding Ability Based on Gender

The ability to understand concepts is also analyzed by looking at the student's ability level in each aspect of C2 in Bloom's Taxonomy, namely the cognitive process of understanding. The profile of students' ability to understand concepts is shown below:

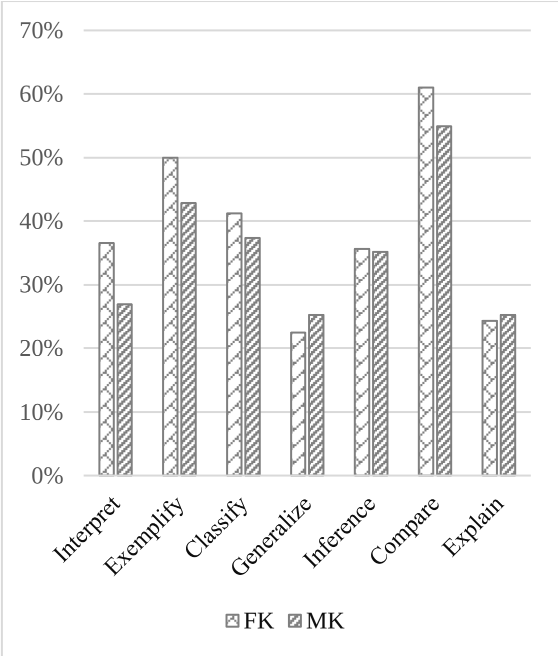


Figure 3. The Ability of Kupang City High School Students Based on Gender in Each Indicator of Concept Understanding

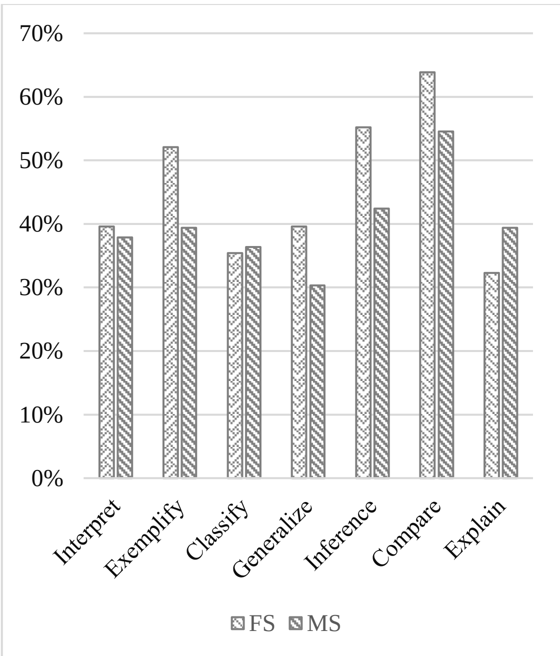


Figure 4. The Ability of High School Students in Sabu Raijua Regency Based on Gender on Each Indicator of Understanding Concepts

3.1.2. Analysis of the Level of Understanding Ability of Each Student with Rasch Modeling

3.1.2.1 Test Instrument Analysis

Analysis of the student concept understanding test instrument using Rasch modeling obtained the *Statistic Summary* table output as follows:

SUMMARY OF 322 MEASURED (NON-EXTREME) Person

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	4.7	12.0	-.55	.76	1.00	.1	1.01	.1
S.D.	3.1	.0	1.48	.11	.22	.6	.58	.8
MAX.	11.0	12.0	2.71	1.08	1.72	2.0	4.10	2.6
MIN.	1.0	12.0	-2.71	.63	.54	-2.2	.31	-1.9

REAL RMSE .80 TRUE SD 1.24 SEPARATION 1.54 Person RELIABILITY .70
MODEL RMSE .77 TRUE SD 1.26 SEPARATION 1.63 Person RELIABILITY .73
S.E. OF Person MEAN = .08

Person RAW SCORE-TO-MEASURE CORRELATION = .99
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .82

SUMMARY OF 12 MEASURED (NON-EXTREME) Item

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	136.2	332.0	.00	.15	1.00	-.3	1.01	-.2
S.D.	43.8	.0	.89	.01	.23	2.6	.33	2.3
MAX.	214.0	332.0	1.66	.18	1.37	4.1	1.69	3.7
MIN.	65.0	332.0	-1.47	.13	.61	-4.8	.45	-4.3

REAL RMSE .15 TRUE SD .88 SEPARATION 5.72 Item RELIABILITY .97
MODEL RMSE .15 TRUE SD .88 SEPARATION 6.02 Item RELIABILITY .97
S.E. OF Item MEAN = .27

Figure 5. Reliability of Concept Understanding Ability Test Instrument

The reliability results show that the research instrument has reliable quality. *Cronbach's Alpha* value of 0.82 indicates that the instrument's internal consistency is in the very good category, so this instrument is quite stable for measuring students' concept understanding ability. *Person reliability of* 0.70 indicates that student response data has a fairly good level of reliability. The *item reliability* obtained was very high, at 0.97, indicating that the items in the instrument were very well designed, able to measure the ability to understand the concept of students in both regions consistently, and could be applied to a broader sample without reducing the quality of the measurement results (Sumintono et al., 2015).

3.1.2.2 Distribution of Students' Comprehension Levels and Problem Difficulty Levels

The student ability level can be analyzed by looking at the visual displayed by the WINSTEPS application in the *output table 1 Variable Maps.* The output provided is called the *Wright Map*, which illustrates the distribution of student abilities and the difficulty level of questions ranging from high to low categories*. Wright Map* can help analyze the distribution of students' ability to understand concepts based on a logit scale (Bohori & Liliawati, 2019). The *Wright Map of* the two groups of students can be shown in Figure 6.

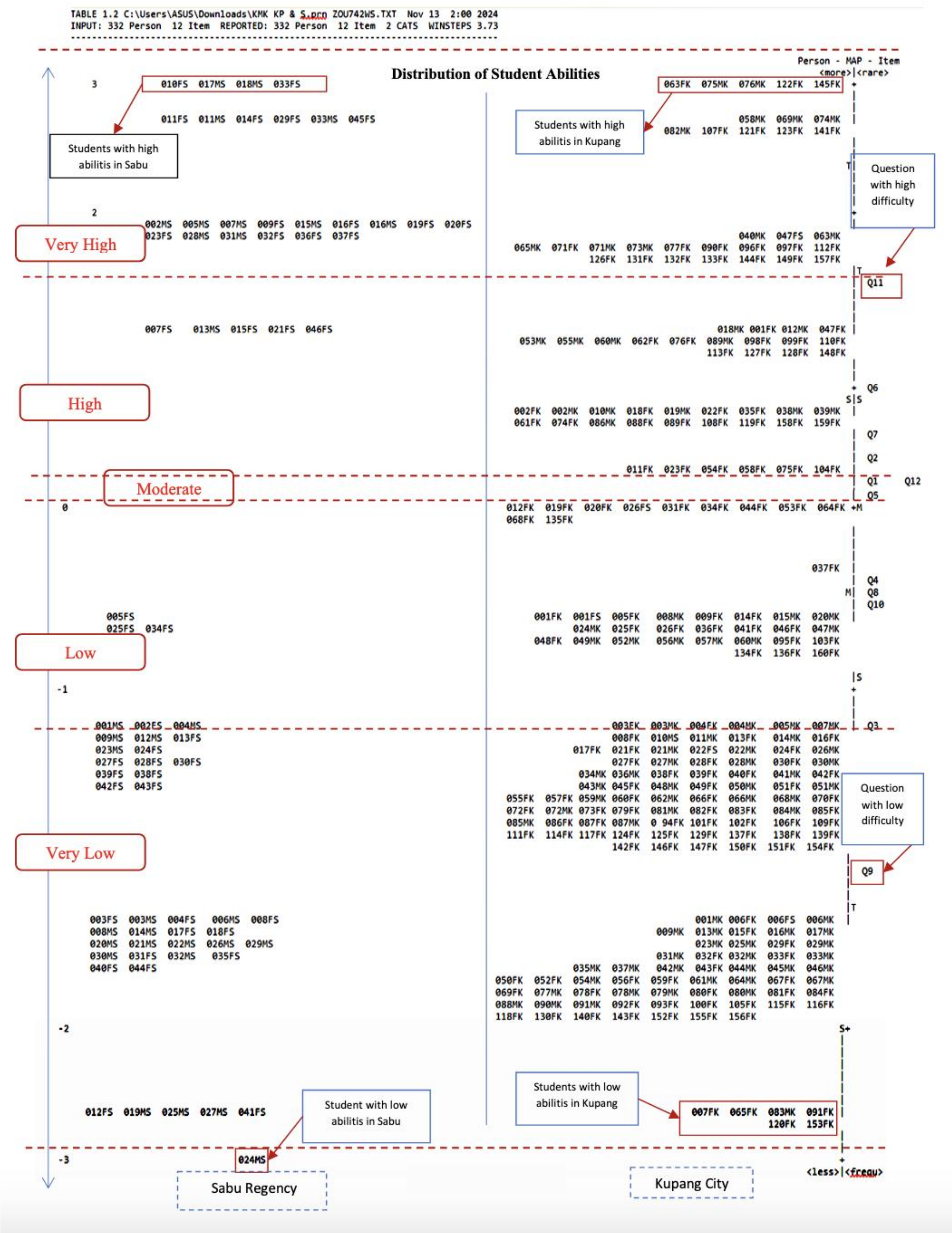


Figure 6. Wright Map

Based on Figure 6, *Wright's* map on the left of part I illustrates students' abilities in the Sabu Raijua district. Four students with codes 010FS, 017MS, 018MS, and 0.33MS have abilities in the very high ability category. The student group's logit value is +3 logit. The lowest student in region I is student 24MS, with a logit value of -3, which indicates shallow ability.

The left part of the map in region II shows students' ability in Kupang City. Five students coded 063FK, 075MK, 076MK, 122FK, and 145FK are in the very high ability category. Their logit value is +3 logits. The lowest group of students in region II are students 007FK, 065FK, 063MK, 091FK, 120FK, and 153FK, with a logit value of less than -3, which indicates shallow ability.

High school students in Kota Kupang and Kabupaten Sabu Raijua with very high ability levels could answer all questions correctly, even questions coded Q11 in the highest difficulty category. Likewise, students at a very low ability level could not answer all questions, even questions coded Q9 in the lowest difficulty category. These results inform us that both groups of students in Kupang City and Sabu Raijua Regency are still distributed among students with different abilities to understand physics concepts ranging from high to low levels. However, it can be seen that students in Kupang City have a smaller distribution of low levels compared to Sabu Raijua district. According to Tanti et al. (2020), this difference is due to the difference in location, which allows the quality of learning or other factors to affect the level of students' understanding ability, which is different between cities and districts.

Data processing related to the distribution of student ability levels and the difficulty level of questions between students in Kupang City and Sabu Raijua Regency was analyzed using the table *output in* the WINSTEPS application, namely Table 17. *Person Measure*. The *Person Measure* table is a table that details each individual's logit information (Sumintono et al., 2015). The results of the *Person Measure* output of the two regional groups can be seen in Figure 7.

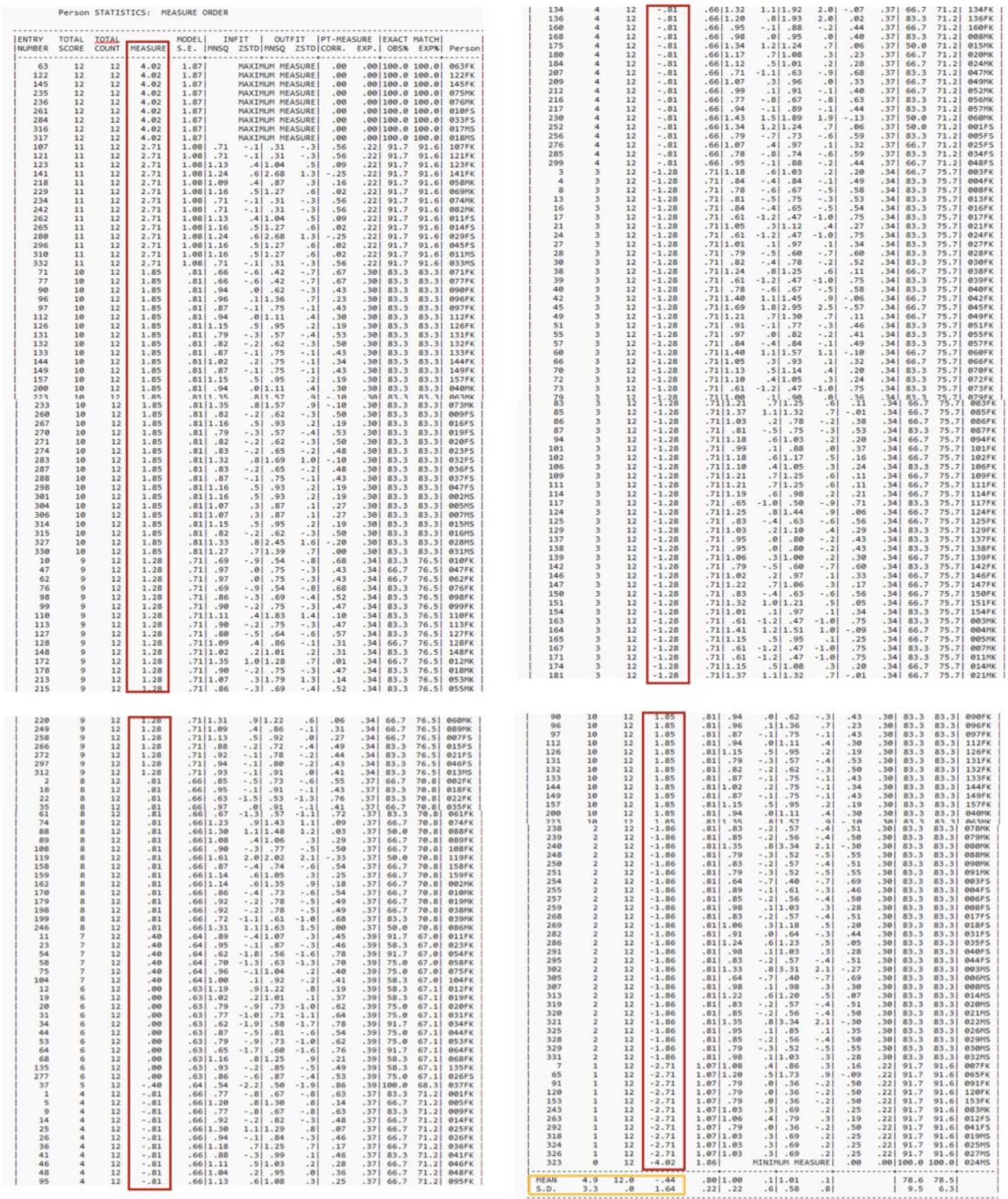


Figure 7. Person Measure of Students in Kupang City and Sabu Raijua Regency

The Person Measure table in Figure 7 shows the mean logit value (MEAN) is -0.44 with a standard deviation of 1.64. The mean and standard deviation values can be used as a reference for grouping student abilities (Widia Linta Nurjanah et al., 2024). The ability to understand students in Kupang City, in the high category, is obtained by students with codes 063FK, 122FK, 145FK, 075MK, and 076 MK at logit *person* +4.02. In contrast, in the low category, there are students 083MK with logit *person* -2.71. Judging from their abilities, students at high ability levels have almost three times the abilities of 083MK students.

Based on Figure 7, the ability to understand students in Sabu Raijua District is high. Students 010FS, 033FS, 017MS, and 018MS have logit person +4.02, while in the low category, students 024MS, 027MS, and 025MS have logit person -4.02. From these results, it appears that the group of students in Sabu Raijua in the high ability category has twice the ability of students with low ability.

Based on the mean and SD values obtained, the student ability level can be classified into three categories: high ability if measure > SD, medium ability if mean < measure < SD, and low ability if measure < mean. Based on these criteria, the level of ability to understand the concept of students in Kupang City and Sabu Raijua Regency on fluid material can be seen in Table 5 below:

Table 5. Distribution of Students' Concept Understanding Ability Level in Kupang and Sabu Raijua City

Location	Student Ability Level	Person	Person (%)
Kupang City	High	31	12.35
	Medium	54	31.51
	Low	166	66.14
Sabu Raijua	High	23	28.4
	Medium	4	4.94
	Low	54	66.66

The results of the ability to understand concepts presented in Table 5 quantitatively show the distribution of student ability levels in both regions. The percentage at each ability level shows that students in Sabu Raijua district excel at the high ability level, especially in understanding the topic of fluids. However, students in Kupang City tend to dominate at the medium level of ability, while the low level of ability shows almost the same percentage between the two regions.

3.1.2.3 Person Fit Level

Person fit analysis was obtained using WINSTEPS *output table* no.6, "Item Fit Statistic". The *Person Fit Order* serves to identify individuals with mismatched response patterns, indicating a mismatch between the answers given and the student's ability compared to the ideal model. This table can also be used to evaluate the consistency of students' thinking or detect any cheating they may do (Sumintono et al., 2015). The student's *Person Fit Order* table is shown in Figure 8.

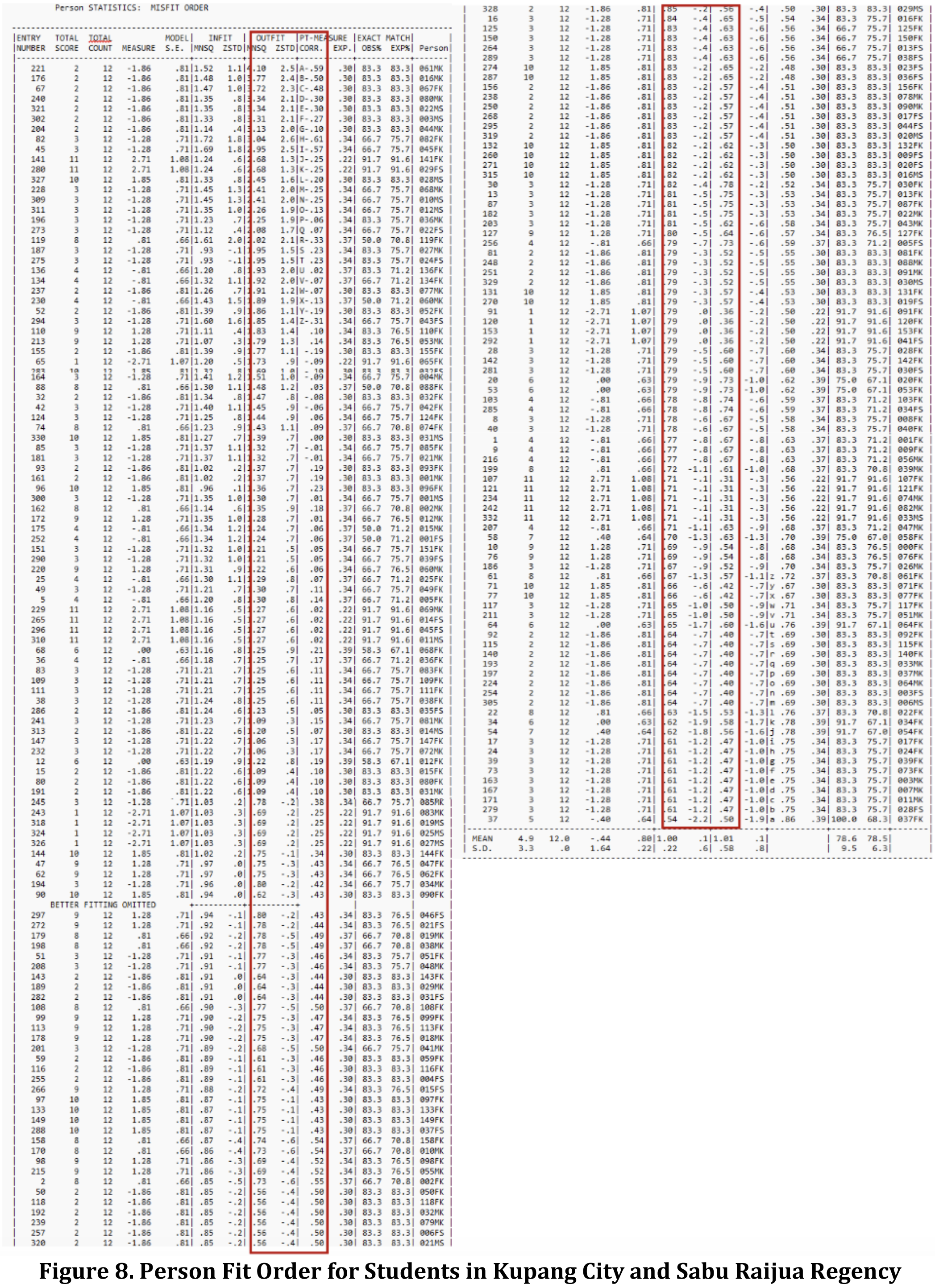


Figure 8. Person Fit Order for Students in Kupang City and Sabu Raijua Regency

Based on the analysis, the level of individual suitability is based on the requirements of student ability suitability (Sumintono et al., 2015). The grouping of students in the *misfit* category is presented in Table 6 below:

Table 6. Distribution of Students with Misfits

Location	Student Ability Level	Person	%
Kupang City	Does not fulfil 2 categories (MNSQ & ZSTD)	047FK, 090FK, 115FK, 037FK, 077FK, 064MK, 039FK, 093FK, 073FK, 003MK, 007MK, 011MK,	4,78
	Does not fulfil 2 categories (MNSQ & PT Corr.)	0,68MK, 0,36MK. 136FK, 134 FK, 077MK, 060MK, 052MK, 110FK, 053MK, 155FK, 0,86MK, 063MK, 065MK, 073MK, 060FK, 004MK, 081MK, 147FK, 072MK, 015 FK, 080FK, 031MK	8,76

Location	Student Ability Level	Person	%
	Does not fulfill 3 categories	061MK, 016MK, 067FK, 080MK, 141FK, 119FK, 027FK,	2,78
Sabu Raijua	Does not fulfil 2 categories (MNSQ & ZSTD)	003FS, 006MS, 028FS	3,7
	Does not fulfll 2 categories (MNSQ & PT Corr.)	029FS, 028MS, 0,10MS, 012MS, 0,22FS, 024FS, 043FS, 032FS, 012FS	11,11
	Does not fulfil 3 categories	022MS, 033MS	2,46

The results show that some students in Kupang City and Sabu Raijua District have a distribution of understanding skills that are still misfits. The proportion of students with this misfit is quite large, suggesting a pattern of answers that is not as expected. Students with logit results that did not meet two or three categories were said to be misfits, indicating that these students may not have fully understood the question and, therefore, answered in a pattern that did not fit the measurement model.

Another Rasch modeling analysis that can be done to identify students' ability to understand concepts is through Scalograms. Scalogram or Guttman scale is a measurement technique used to assess the consistency of respondents' answers to a series of statements or items with a certain order of difficulty or intensity (Sumintono et al., 2015). The following table shows the Scalogram of high school students in Kupang City and Sabu Raijua as shown in the following figure:

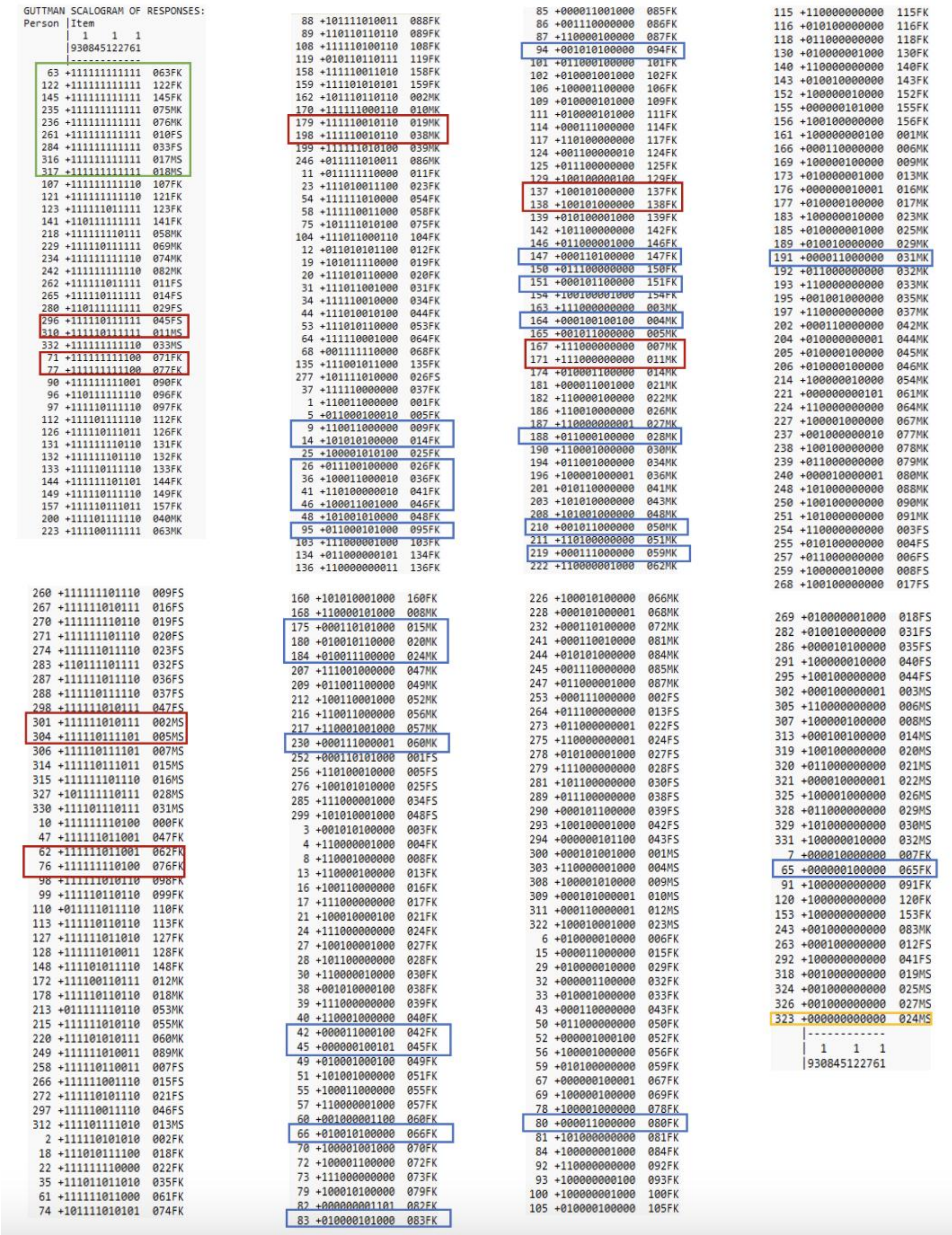


Figure 9. ***Scalograms***

The virtue of the Scalogram is that it can detect cheating, i.e. students cheating on each other (Sumintono et al., 2015). Based on Figure 9, the scalogram provides some information, among others, there are groups of students with a very high level of concept understanding (green line), students with a very low level of concept understanding (yellow line), students who are indicated to cheat (red line), and groups of *misfit* students or experiencing a mismatch between individual abilities and the difficulty level of the question (blue box). Students marked with a red line are considered cheating such as cheating because they have the same answer pattern as other students. The *Person* marked with a blue line is considered a *misfit* because they can answer questions at the highest difficulty level, such as questions Q6, Q7, and Q11, but cannot answer questions at lower levels, such as Q3 and Q9.

3.2. Discussion

The ability to understand Physics concepts among students in the classroom certainly varies, mainly if the comparison of the ability to understand concepts is carried out by investigating a wider area. This study takes an in-depth look at the ability to understand students in two locations, namely in Kupang City and Sabu Raijua Regency. Similar research was conducted by Zuhdi & Makhrus (2020), which shows that it is essential to know the differences in the ability level to understand Physics concepts in different areas to understand variations in students' understanding of the same material in different contexts.

Based on the analysis, it appears that the ability to understand the concepts of high school students in Sabu Raijua Regency is superior to those in Kupang City. The case found in this study is quite different from most studies that generally indicate that students in urban areas are superior to students in rural areas in understanding concepts optimally (Khan et al., 2021; Ringo et al., 2021). However, such cases may occur, as Sagatbek et al. (2024) found that the comprehension skills of rural students can be superior to urban students because the limited resources in rural schools often create a more focused learning environment. In addition, smaller class sizes allow for more intensive interaction and collaboration among students. A similar opinion comes from the findings of Astalini et al. (2020), that students in rural areas can show superior concept understanding ability compared to urban students because rural students grow up with a cultural background that can encourage a strong sense of community and lead to better understanding ability. Hence, students are more optimally involved in learning. In addition, the learning environment in rural areas is less influenced by external distractions commonly found in urban environments, such as using *gadgets* for playing rather than learning, which leads rural students to focus more on improving their ability to understand scientific concepts (Kelly, 2013; Batlolona et al., 2019; Assem et al., 2023).

The level of ability based on gender from the analysis results shows that female students in both Kupang City and Sabu Raijua Regency are better able to understand concepts than male students. This difference can be explained through several factors that may affect female students' ability to understand concepts. Female students often show a more organized and consistent learning pattern, as seen from the answer pattern shown by the scolagram in Figure 9. Consistent female students' answers help them absorb and process information better. The same thing was expressed by Khan et al. (2021), that female students tend to have consistency in understanding concepts, which allows them to explore various concepts in depth and specifically, resulting in better understanding than male students.

The static fluid subtopics tested in this study included hydrostatic pressure, Pascal's law, Archimedes' law, and buoyancy force. The results show that students in Kupang City excel in discussing Archimedes' law but have the lowest understanding of buoyancy force. Regarding gender, both female and male students in Kupang City showed a high understanding of Archimedes' law but a low understanding of the concept of buoyancy force. Many students had difficulty understanding that buoyant force is equal to the weight of the displaced fluid. According to Loverude et al. (2003), although students have been taught this principle, they still need to apply it correctly in various situations, indicating a lack of understanding of the basic concept of buoyancy.

In contrast to Kupang City, students in Sabu Raijua District appeared to excel in the discussion of Pascal's law and had the lowest understanding of buoyancy force. Based on gender, female students in Sabu Raijua have the highest knowledge of Archimedes' law, while male students excel at hydrostatic pressure. However, female students had the lowest knowledge of buoyancy force, while male students had difficulty understanding Archimedes' law.

Another factor that causes differences in concept understanding ability based on gender is perseverance in learning. Female students' approach to academic tasks tends to be more focused and diligent, so they can develop a deeper understanding. This aligns with research by Ringo et al. (2021), which showed that female students tend to adopt more effective study habits and persevere in working on the problems given. Such habits can improve female students' understanding of more complex topics than male students.

Analysis of students' level of understanding ability on each indicator of the cognitive process of understanding (C2 in Bloom's Taxonomy) shown in Figures 2 and 3 shows that female students in both Kupang City and Sabu Raijua District were superior to male students. In general, female and male students had the highest ability on the comparing indicator, with more than 50% of students answering correctly. The comparing indicator is often considered a basic skill that is easier for students to understand and apply. According to Kristiningtyas & Woro (2017), comparing involves recognizing and analyzing differences and similarities between two or more objects, concepts, or ideas. This is the first step in critical thinking, making this indicator superior to other indicators. In Kupang City, the lowest-achieving indicator for female students was summarizing, while male students showed weakness in the explaining indicator. In contrast, in Sabu Raijua district, female students had the lowest achievement on the explaining indicator, while male students showed weakness on the summarizing indicator. There may be differences in the teaching methods used in Kupang City and Sabu Raijua District. According to Ulfah & Arifudin (Ulfah & Opan Arifudin, 2021), if teaching focuses more on summarizing information, students may be more familiar with this type of task but less trained in explaining. Conversely, according to Rahmawati et al. (2018), students may not get enough practice in summarizing if learning emphasizes discussion and explanation. Female students may be better at distilling and presenting information concisely, while male students may better construct arguments and explain concepts.

Based on the analysis using Rasch modeling, it appears that the ability to understand the concept of Physics among students in both Kupang City and Sabu Raijua Regency has variations in the ability to understand the concept. The analysis results show that the ability to understand Physics learning concepts for Kupang City and Sabu Raijua Regency students is still relatively low. Therefore, special measures are needed to improve the ability to understand Physics concepts in these two regions, especially for students with very low ability categories. One approach that can be applied is contextual and problem-based learning (Sumardiana & Rasyidi, 2021; Arifah et al., 2023; Prastiwi et al., 2018). Physics concepts are presented in a local context relevant to the daily lives of Kupang and Sabu Raijua students, making the material more meaningful and easy to understand. In addition, the analysis results show that some students still have difficulty answering questions with a basic level of understanding. Hence, there needs to be reinforcement on these basic questions before students continue to solve problems with a higher difficulty level. A collaborative learning approach is also recommended to enable students to exchange understanding in learning groups, as in the research of Prayogi et al. (2024), which showed that collaborative learning can help students in the low category improve their abilities through discussion and cooperation. Furthermore, monitoring students who experience misfits or errors in answering questions with low difficulty levels must also be done to provide more effective and targeted learning interventions (Sumintono et al., 2015). Monitoring students' errors in answering helps teachers organize learning strategies and appropriate assessments in learning Physics.

Another approach that can build students' concept understanding ability is by using learning media. The learning media used must be able to present learning that is more dynamic and able to explain abstract concepts such as dynamic fluids, electricity and magnetism, waves and vibrations, kinematics, and thermodynamics in high school physics material, which is often found to have low student ability to understand concepts in the material. (Jufriadi & Andinisari, 2020). One of the learning media that has the advantages described earlier is digital-based learning media. (Masrifah & Amiroh, 2023). Then, based on information from the Central Statistics Agency (2023) regarding the use of *gadgets,* in the province of NTT, it is known that around 61.48% of the people have used *gadgets* in their daily lives, including high school students with an age range of 14-19 years. Therefore, digital-based media can be used in learning to help improve the ability of high school students to understand the concepts of both Kupang City and Sabu Raijua Regency.

By applying these approaches, students' understanding of Physics concepts in both Kupang City and Sabu Raijua Regency is expected to improve so that students have a strong foundation in this subject and can continue their understanding to higher cognitive levels.

4. Conclusion

This study shows that the ability to understand Physics concepts of students in Kupang City and Sabu Raijua Regency varies, with the majority being in the low to moderate understanding category. Students in Kupang City have a lower ability to understand concepts, with a percentage of 39.45%, compared to students in Sabu Raijua Regency, with a percentage of 45.47%, which is in the sufficient understanding category. Based on gender analysis, female students in both regions showed better concept understanding than male students, influenced by learning consistency and persistence. The research instrument proved reliable, although only a tiny proportion of students reached the very high category, with the majority in the good to fair category. Variations in achievement on cognitive process indicators of understanding, such as comparing, summarizing, and explaining, indicate the influence of teaching methods applied in each region. To improve awareness of physics concepts, contextual, problem-based, collaborative learning strategies are needed, as well as the use of media that support the learning process and can improve the ability to understand physics concepts.

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