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Analysis of Students' Differentiating, Organizing, and Attributing Skills in Solving High School Chemistry Problems: Rasch Modeling

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Abstract

The low analytical ability of students in chemistry remains a major concern, particularly in understanding complex materials at the C4 level of Bloom's taxonomy. This study aims to measure the analyzing ability of 12th-grade students in solving chemistry problems using Rasch Modeling in several high schools in Gorontalo Province. The study employed a quantitative, non-experimental (survey) design. Data were collected using a diagnostic multiple-choice test, and the sample consisted of 544 science students from nine high schools, selected through convenience sampling. The results showed a variation in students' analyzing abilities across schools. The highest mean score was recorded at SMA Negeri 1 Tapa (0.94), while the lowest was at SMA Negeri 1 Telaga Biru (-0.96), with other schools ranging from -0.73 to 0.18. The hypothesis test led to the rejection of the null hypothesis (Ho), indicating significant differences in students' analyzing abilities in chemistry, based on three indicators: differentiating, organizing, and attributing. These findings highlight the need for targeted instructional strategies to improve students' higher-order thinking skills across schools.

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1. INTRODUCTION

Analyzing ability is one of the Higher Order Thinking Skills (HOTS) that is very important in learning chemistry at the Senior High School (SMA) level. Based on Bloom's revised taxonomy by Anderson and Krathwohl, the ability to analyze is classified at level C4 and consists of three main indicators, namely differentiating, organizing, and attributing. These three indicators reflect the skills to break down information into components, organize them into meaningful structures, and relate the information to appropriate concepts. In the context of chemistry learning, these skills are essential for understanding chemical reactions, relationships between concepts, and applications in problem solving (Khokhar, 2025).

The Indonesian national curriculum emphasizes the importance of HOTS-oriented learning, aiming to equip students with advanced cognitive abilities such as analytical thinking. However, there remains a considerable gap between these curriculum goals and the actual performance of students, particularly in their ability to answer chemistry questions at the C4 (analyzing) level. Although the national curriculum has encouraged HOTS-based learning, the reality in the field shows that students still have difficulty in solving analytical questions that test C4 skills. Based on assessment results in various regions, many students tend to rely on memorization and have difficulty linking information conceptually, especially in dealing with questions that contain contextual or multiple stimuli (Purwa Kusuma et al., 2021). This discrepancy suggests that despite the intended outcomes of he curriculum, the implementation and actual mastery among students remain limited. As a result of this gap, students' conceptual understanding is limited and has an

impact on the overall low achievement of chemistry learning. In this case, analytical questions are often an obstacle because they demand more complex information processing than just memorization (Hu, 2019). This is also reinforced by the findings of (Parimata et al., 2023), which state that students only excel at distinguishing indicators, but are weak in organizing and attributing complex information. The inconsistency between students' expected and actual performance in analytical skills reflects a critical need to reevaluate both instruction and assessment methods.

To obtain an accurate picture of students' analytical skills, valid and reliable assessment instruments are needed. Conventional assessment methods are often unable to describe students' abilities objectively and in depth, especially in terms of the match between the difficulty level of the questions and students' abilities. Therefore, the utilization of the Item Response Theory (IRT) approach, especially Rasch Modeling, becomes very relevant. The Rasch model is able to measure the level of individual ability and item characteristics simultaneously on one logit scale, as well as identify items that are inappropriate or biased towards certain groups (Ramli & Muslimahayati, 2021).

Previous studies have shown the effectiveness of Rasch modeling in evaluating HOTS questions. In addition to improving instrument validity, this model helps in the preparation of fair questions and accurate learning diagnostics (Rahmawati et al., 2022). According to (Karim et al., 2022), students' critical thinking skills in chemistry can be effectively measured using diagnostic tests designed in line with higher-order thinking indicators. Furthermore, the use of multiple-choice diagnostic tests aligned with higher-order thinking indicators has been shown to provide accurate insights into students' conceptual understanding and analytical abilities in chemistry learning (Rumape et al., 2024).

This research is motivated by the importance of measuring students' analytical skills in a more in-depth and empirical evidence-based manner. Based on the results of initial exploration in nine high schools in Gorontalo Province, it was found that there were variations in students' analytical abilities in solving C4 level chemistry questions. The mismatch between the level of difficulty of the questions and the level of student ability reinforces the urgency of applying Rasch modeling in learning evaluation. Therefore, this study aims to analyze the ability of grade XII high school students in solving C4 level chemistry problems based on three indicators (Differentiating, Organizing, and Attributing Ability Analysis) using the Rasch modeling approach. These findings reinforce the urgency of applying Rasch modeling as a data-based evaluation tool in the context of chemistry learning..

2. METHOD

2.1 Research design and location

This study used a quantitative approach with a non-experimental survey design. The research was conducted in the even semester of the 2024/2025 academic year, precisely from February to March 2025, in nine senior high schools (SMA) in Gorontalo Province, each of which was disguised as SMAN A, SMAN B, SMAN C, SMAN D, SMAN E, SMAN F, SMAN G, SMAN H, and SMAN I.

2.2 Object and subject of research

The subjects in this study were even semester chemistry specialization program XII grade students from the nine schools. The sampling technique used was convenience sampling, namely selection based on ease of access and school willingness. The total respondents in this study were 544 students, consisting of 180 male students and 364 female students. The number of respondents from each school is shown in Table 1.

Table 1. Demographic profile of respondents (n=544)

Demographics	Code	Total	
		n	%
School Name			
SMAN 1 A	A	31	5,7
SMAN 1 B	B	93	17,1
SMAN 4 C	C	80	14,7
SMAN 2 D	D	24	4,4
SMAN 1 E	E	77	14,1
SMAN 1 F	F	143	26,2
SMAN 2 G	G	23	4,2
SMAN 1 H	H	44	8,1
SMAN 3 I	I	29	5,3
Gender			
Male	M	180	33,1
Famale	F	364	66,9

2.3 Instruments and data collection techniques

The main instrument in this study was a diagnostic test of analyzing ability in the form of multiple choice questions with indicators measuring analyzing ability (C4) based on Bloom's revised taxonomy. The

questions were developed based on three cognitive indicators, namely differentiating, organizing, and attributing, with the content of class XII chemistry material. Each question consists of one stimulus, one question statement, and four answer choices. Data collection was conducted face-to-face in each school. Test processing time was limited to 60 minutes, with direct supervision by researchers and subject teachers in each school.

2.4 Data analysis technique

Data analysis was conducted using the Rasch Model approach with the help of Winsteps version 3.73 software. Rasch modeling was chosen because it is able to provide linear measurements based on item response theory and provide simultaneous information about item quality and student ability.

The stages of analysis include:

a. Instrument validity and reliability, using summary statistics, person-item map, and Cronbach's alpha.
b. Item fit based on Mean Square (MNSQ), Z-Standard (ZSTD), and Point Measure Correlation (Pt Mean Corr) values.
c. Unidimensionality through analysis of variance explained by measure.
d. Item bias (Differential Item Functioning/DIF) by gender and school.
e. Student ability distribution through Wright Map.

The selection of the Rasch model in this study is based on the argument that this approach is more objective and able to identify interactions between respondents and items in depth (Sumintono & Widhiarso, 2015). In addition, this modeling allows for a fairer analysis and is free from the influence of data distribution, as well as being able to evaluate the suitability of the items to the indicators being measured simultaneously.

3. RESULT AND DISCUSSION

3.1. Result

Validity of Instrument Test Questions Differentiating, Organizing, and Attributing Ability of Class XII Chemistry Material Students

Analysis of the validity of the item fit order instrument using the Rasch model with the help of winstep 3.73 software, the output used for validity analysis is item fit order and wright map.

a) Item Fit Order

Based on Table 2. the Item Statistic test was carried out: fit test and misfit order (valid and invalid items) on Winstep 3.73 for Windows to get the validity of the items on the diagnostic test instrument for analyzing skills. In Table 3. it can be seen from all the items that the Outfit Mean Square value has met the criteria for item suitability. Item question 1 has a ZSTD value of -2.02 outside the specified value criteria interval, but for its MNSQ value of 0.73 and Pt Mean Corr of 0.42 it is still within the allowed limits. item question 4 has a ZSTD value of 3.8 outside the specified value criteria interval, but for its MNSQ value of 1.25 and Pt Mean Corr of 0.40 it is still within the allowed limits.

Item numbers 1 and 4 have ZSTD values outside the specified interval limits, but have MNSQ and Pt Mean Corr values that are still within the allowed limits. In this instrument there are also no items that have a negative value for the Pt Mean Corr criterion. Although there are some items that do not meet the criteria, it does not reduce the quality of the items. So the two question numbers are still said to be valid because there are no items that do not meet the three criteria so that the two items can still be used, so there is no misinterpretation in reading the questions.

Table 2. Item fit order

Item	Outfit		PT-Measure Cor	Compliant Status	Interpretation
	MNSQ	ZSTD			
1	1.07	0.9	0.42	2 Criteria	As per
2	1.09	1.5	0.41	3 Criteria	As per
3	1.07	1.1	0.41	3 Criteria	As per
I 4	1.25	3.8	0.40	2 Criteria	As per
5	1.02	0.4	0.42	3 Criteria	As per
6	1.02	-0.3	0.42	3 Criteria	As per
7	1.02	0.4	0.42	3 Criteria	As per
8	1.01	0.1	0.45	3 Criteria	As per
9	0.97	-0.5	0.45	3 Criteria	As per
10	1.01	0.2	0.45	3 Criteria	As per
11	0.96	-0.7	0.48	3 Criteria	As per
12	0.98	-0.3	0.50	3 Criteria	As per
13	0.96	-0.7	0.48	3 Criteria	As per
14	0.93	-1.1	0.48	3 Criteria	As per
15	1.07	0.9	0.42	3 Criteria	As per
16	1.02	0.3	0.42	3 Criteria	As per
17	1.02	0.4	0.42	3 Criteria	As per
18	1.04	0.6	0.42	3 Criteria	As per

b) Wright Map

The results of the wright map analysis can be seen in Figure 1. Based on Figure 1. wright map analysis, the right part shows the distribution of item difficulty

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levels, while the left part shows the distribution of respondents' abilities. In addition, the left side of the wright map shows the position of the respondent which is symbolized by the "#" and "." signs. The respondent's position is between logit -2 to logit +3. This shows that the ability to analyze students has a score that varies from the lowest to the highest.

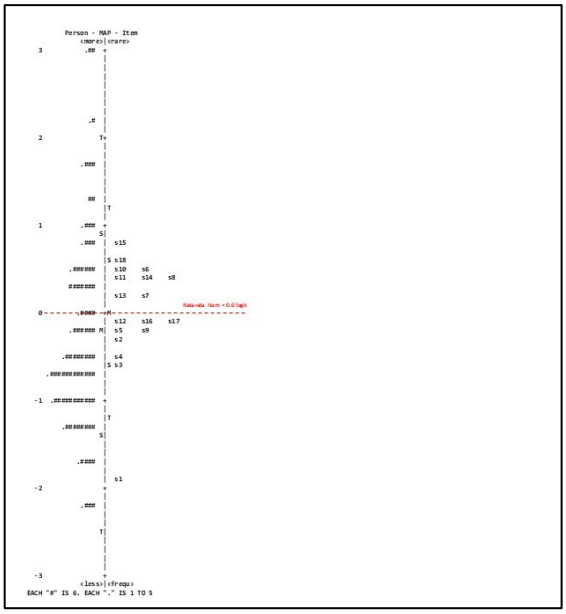

Figure 1. Wright map

Based on Figure 1. above, it can be seen that the item that has a high level of difficulty to be approved by respondents is item number 15 with code S15, then for items that have a low level (easy) to be approved by respondents is item number 1 with code S1.

Reliability of the Differentiating, Organizing, and Attributing Ability Test Instrument of Class XII Chemistry Students

Instrument reliability is done to see if the instrument used is reliable. Testing the reliability of instruments using Rasch analysis can be seen from the quality of student response patterns, instruments and interactions between persons and items. To see the reliability of the instrument to be tested, the Summary Statistic and item undimensionality are used.

a) Summary Statistic

Summary statistics to display the value of reliability measurements, both measurements from the respondent's side (person reliability) or from the review of question items (item reliability) as well as the interaction between respondents and items. Reliability can be seen in Table 3.

Table 3. Summary of fit statistic

	Responden (N-544)	Item (N-18)
Mean	-0.25	0.00
Realibility	0.72	0.97
Separtion Index (Realibility)	1.60	5.92
Croonbach Alpha (KR-20) = 75		
Chi -Square : 10873.58 with 9231		
Dfp : 0.0000		

Based on Table 3. Summary Statistic of the Rasch Model analysis results on the reliability test shows that the person reliability value is 0.72 and the item reliability value is 0.97. this shows that the learning outcomes diagnostic test instrument has sufficient person reliability and has excellent item reliability because it is above 0.95, namely 0.97. As for the Cronbach Alpha value, it shows the interaction between respondents and the item as a whole. Based on Table 2. shows the Alpha Cronbach value of 0.75, meaning that the reliability of the interaction between person and item is at a very good level because it is in the range of 0.70-0.80.

The separation person value of 1.60 is included in the "Poor" category, but the value of 1.60 is included in the qualification of the person separation index value even though it is in the "Poor" category and the separation item value of 5.92 is included in the excellent category. The greater the Separation value, the better the quality of the instrument in terms of overall respondents and items, because it can identify groups of respondents and groups of items (Laliyo et al., 2022).

b) Undimensionality

Undimensionality is a measure to evaluate whether the instrument that has been made is able to measure what should be measured in this case measuring the ability to analyze (Level C4) students. Measurement of unidimensionality can be seen in the raw variance value explained by measure and the inexplained variance value. The measurement analysis results can be seen in Figure 2.

Table of STANDARDIZED RESIDUAL variance (in Eigenvalue units)

	-- Empirical --		Modeled
Total raw variance in observations =	23.7	100.0%	100.0%
Raw variance explained by measures =	5.7	24.1%	23.9%
Raw variance explained by persons =	2.5	10.7%	10.6%
Raw Variance explained by items =	3.2	13.3%	13.2%
Raw unexplained variance (total) =	18.0	75.9% 100.0%	76.1%
Unexplned variance in 1st contrast =	1.7	7.0% 9.2%	
Unexplned variance in 2nd contrast =	1.5	6.2% 8.1%	
Unexplned variance in 3rd contrast =	1.4	6.0% 7.8%	
Unexplned variance in 4th contrast =	1.4	5.8% 7.6%	
Unexplned variance in 5th contrast =	1.2	5.2% 6.8%	

Figure 2. Standardized residual variance

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Based on Figure 2. obtained a raw variance explained by measure value of 24.1% which is in a bad classification. However, the value of the raw variance explained by measure of 24.1% has met the expected value of 23.9%. This shows that the undimensionality requirement has been met. Where it is based on the raw variance by measure proposed by Principal Component Analysis (PCA). PCA explains that the acceptable value for raw variance by measure must be> 20%, more if> 40% and very good if> 60% (Sungkim et al., 2021). As for the acquisition of the unexplained variance value by the instrument, ideally none of them exceeds 15% and all are below 8%. This shows that the level of independence of items in the instrument is good.

The Ability of Class XII Students in General in Solving Differentiating, Organizing, and Attributing Ability Test Questions of Class XII Chemistry Material Students

In the data on the results of the distribution of diagnostic test instruments for learning outcomes, there are three indicators that were analyzed with the help of Winstep 3.73 software. The instrument consisting of 18 items was given to 544 respondents (students) in class XII IPA in nine senior high schools namely SMAN A, SMAN B, SMA Negeri 4 Gorontalo, SMA Negeri 2 Gorontalo, SMAN F, SMAN E, SMAN D, SMAN H, and SMAN I. The results of the general description related to the students' answers in class XII chemistry material were analyzed. The results of the general description related to student answers on chemistry class XI material can be seen by looking at the average value (mean) in each indicator presented in the graph.

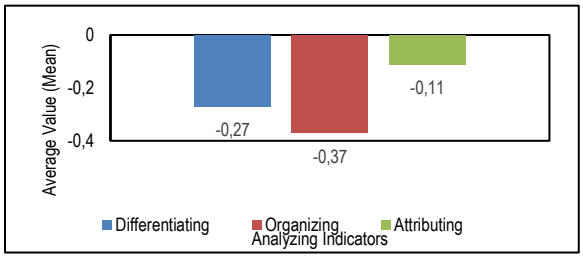

Figure 3. Graph of average (mean) values in each indikator

Based on the graph, it shows that the average value (mean) of each indicator is different, where the indicator with the highest average value (mean) is owned by the attributing indicator of -0.11. This means that the attributing indicator has a high level of difficulty to be answered by respondents (students), meaning that students in three high schools find it difficult to answer questions in the form of attributing in chemistry material. Then for the indicator with the lowest mean value is owned by the Organizing indicator of -0.37. This means that the Inferring indicator has a low level of difficulty to be answered by respondents (students), meaning that students in nine senior high schools easily answer questions in the form of organizing in hydrocarbon material, chemical bonds and reaction rates.

Problem Indicator Differentiating

In this indicator there are 6 items from 3 materials analyzed with the help of Winstep 3.73 software. Questions that include differentiating indicators are numbers S1, S2, S7, S8, S13 and S14. In general, the differentiating indicator items are below logit +1. The average ability to analyze students successively in item S1 is 79.41%, S2 is 50.18%, S7 is 39.34%, S8 is 35.85%, S13 is 40.99%, and S14 is 36.58%.

Problem of Organizing Indicator

In this indicator there are 6 items from 3 materials analyzed with the help of Winstep 3.73 software. Questions that include organizing indicators are number S3. S4, S9, S10, S15 and S16. In general, the organizing indicator items are below logit +1. The average ability to analyze students in S3 was 56.62%, S4 was 53.31%, S9 was 47.79%, S10 was 34.56%, S15 was 29, 96%, and S16 was 47.06%

Attributing Indicator Questions

In this indicator there are 6 items from 3 materials analyzed with the help of Winstep 3.73 software. Questions that include attributing indicators are number S5. S6, S11, S12, S17 and S18. In general, the attributing indicator items are below logit +1. The average ability to analyze students successively in item S5 was 47.98%, S6 was 35.92%, S11 was 35.85%, S12 was 45.77%, S17 was 46.14%, and S18 was 32.35%.

Based on the explanation of each indicator above, it can be concluded that the level of ability to analyze class XII students with an overall percentage reached 44.3%. In the analysis based on indicators, Differentiating ability reached 47.06% (sufficient category), while Organizing ability was at 44.88% (sufficient category), and Attributing ability also reached 40.56% (sufficient category). The average score of students' overall ability in solving C4 level questions is 44.17. This finding shows that students' ability to analyze

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is still in the sufficient category. However, this result indicates that there are variations in students' analytical aspects, where some areas, still need more attention to be improved.

Comparison of the Ability of Class XII Students in Completing Differentiating, Organizing, and Attributing Ability Test Questions on Chemistry in Class XII of Each High School in Gorontalo Province

Data from students' answers from 18 question items with 544 respondents in class XII IPA in nine high schools (SMA) in Gorontalo Province were analyzed using the Rasch Model with the help of Winstep 3.73 Software. As for seeing the ability to analyze students in each high school, it can be seen in the person measure test presented in the following chart.

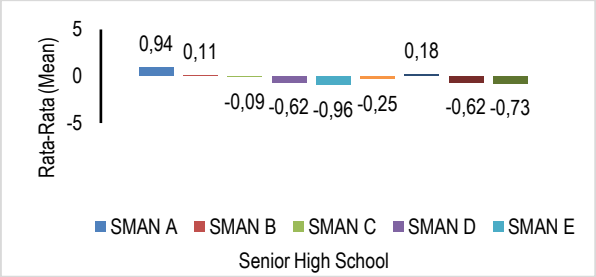

Figure 4. Average (mean) analyzing ability of students in each school

Based on the data in the graph of the ability to analyze students on chemistry in class XII IPA in high schools in Gorontalo province, it is known that the highest average (mean) is owned by SMAN A which is 0.94. This shows that the ability to analyze students on chemistry at SMAN A is quite good because respondents are able to answer the questions on the instrument used. This shows that the ability to analyze students on chemistry at SMAN A is quite good because the respondents were able to answer the questions on the instrument used. The lowest mean is owned by SMAN E which is -0.96. This shows that the ability to analyze students on chemistry material at SMAN E is said to be less good, because respondents are less able to answer the questions of the instrument used in this study. The mean value (mean) which is greater than logit indicates that the respondent's ability is greater than the difficulty level of the question item or the respondent is able to respond to the question items in the instrument (Muntazhimah et al., 2020).

Based on the graph in Figure 4. it can be explained that the higher the graph obtained, the item on the indicator is difficult for respondents to answer. Conversely, if the graph obtained is lower, the indicator is easy for respondents to answer. So, schools with high mean scores show a tendency for student ability to be greater than the difficulty level of the questions.

As for seeing the ability to analyze students on chemistry material in class XII IPA based on three indicators in each high school in Gorontalo Province, it can be seen in the item measure test presented in the following table and graph.

Table 4. Average (mean) ability to analyze students on chemistry material in class xii ipa in each school

Average (Mean)	Indicator		
	Differentiating	Organizing	Attributing
A	-1,15	0,56	0,59
B	-0,54	0,36	-0,06
C	-0,11	-0,14	0,25
D	-0,07	0,29	-0,06
E	-0,37	0,17	0,10
F	-0,17	-0,20	0,18
F	-0,46	0,07	0,40
G	-0,07	-0,14	0,27
H	0,29	-0,31	-0,15

DIF Plot Analysis of Differentiating, Organizing, and Attributing Ability of Class XII Students in Solving High School Chemistry Problems Against Gender Differences

DIF Plot Analysis of Differentiating, Organizing, and Attributing Ability of Students in Solving High School Chemistry Problems Against Gender Differences is presented in Figure 5.

Based on Figure 5, the DIF plot based on the ability of Class XII students in solving Chemistry Level C4 (Analyzing) questions based on the three indicators is explained as follows: There are extreme graphs on several question items, namely question items 1, 5 and 10 which have a much different difference than other question items. Item question 1 men have the ability to analyze chemistry questions at level C4 (analyzing) higher than women. Item question 5 men have the ability to analyze chemistry questions at level C4 (analyze) higher than women. Item question 20 men have the ability to analyze C4 level chemistry questions (analyzing) higher than women. This shows that the ability to analyze C4 level chemistry questions (analyzing) of male and female students has a difference in explaining chemical material based on the item level and item dif value and its logit value.

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The results of the logit value obtained by the average ability of students in explaining chemical material, especially in chemistry questions at level C4 (analyzing) between male and female students are presented in Table 5.

Table 5. Ability to analyze chemistry problems level C4 (analyzing) of male and female learners

School	Female Measure Results	Male Measure Results
SMAN A	0.698	0.459
SMAN B	0.292	-0.087
SMAN C	0.111	-0.540
SMAN D	-0.477	-0.799
SMAN E	-0.614	-1.186
SMAN F	-0.182	-0.501
SMAN G	0.165	0.117
SMAN H	-0.467	-1.006
SMAN I	-0.430	-1.067
Average Number	-0.904	-4.610

Based on Table 5. shows that female students have a higher average ability, namely with a measure value = -0.904 than male abilities, namely with a measure value = -4.610.

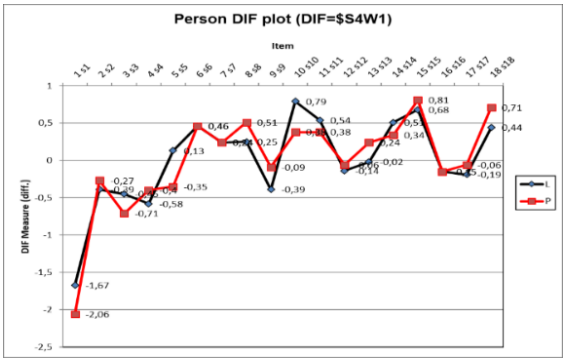

Figure 5. Person dif plot based on analysis of students' differentiating, organizing, and attributing ability in solving high school chemistry problems against gender differences l = male students, p = female students

Ability of Class XII Students in Solving Differentiating, Organizing, and Attributing Ability Test Questions on Chemistry Materials for Class XII Students Against School Differences

The DIF Plot of Differentiating, Organizing, and Attributing Ability Analysis of Students in Solving High School Chemistry Problems Against School Differences is presented in Figure 6.

This analysis focused on schools that were classified as having extreme differences or showing indications of DIF (Differential Item Functioning) based on the graphs and logit values displayed. Schools such as SMAN B, SMAN C, SMAN D, SMAN F, SMAN G, and SMAN H were eliminated from further discussion because the logit values between these schools did not show significant or extreme differences. The difference in measure values between these schools tended to be small and did not show a prominent pattern of impropriety or inequality. Therefore, the analysis only focused on schools that were classified as having extreme differences (DIF), namely SMAN A, SMAN I, and SMAN E.

Based on Figure 6, showing the DIF plot based on the Ability of Class XII Students in Solving Chemistry Problems at Level C4 (Analyzing) against school differences is explained as follows: There are extreme graphs on several question items, namely question items 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 16, and 18, which show significantly different differences compared to other question items. The further analysis of the three schools classified as having extreme differences (DIF) namely SMAN A, SMAN I, and SMAN E is explained as follows:

Item question 1 at SMAN A shows the ability to analyze chemistry questions at the C4 level is lower than other schools. However, in question items 5 and 11, SMAN A actually has a higher ability than other schools. In addition, in question items 8, 12, and 13, students from SMAN A again showed lower ability. This shows that there is an inconsistency in the ability to analyze at SMAN A which is quite significant, so it is included in the extreme DIF category. This is also reinforced by the highest logit value of 0.575, which shows a striking difference compared to other schools.

Question item 18 at SMAN E shows that students have higher analyzing ability than other schools. The measure value at SMAN E of -0.852 indicates that although overall it is in the lowest position, there are items that show extreme superiority, which indicates the unnatural distribution of students' abilities. Therefore, SMAN E also belongs to the extreme DIF category.

SMAN I has a logit value of -0.693 which is quite low. Although not explicitly mentioned in each extreme item, the far logit position compared to the average and the tendency of low performance patterns make this school belong to extreme DIF. It is important to follow up

on this to find out the factors that cause the low performance of analyzing students in this school.

Thus, the three schools (SMAN A, SMAN E, and SMAN I) show extreme patterns of Differentiating, Organizing, and Attributing Ability Analysis of Students compared to other schools, both in strengths and weaknesses, and therefore fall into the DIF category.

The results of the logit values obtained for the average ability of students in explaining chemistry material, especially in chemistry questions at the C4 (analyzing) level based on school differences are presented in Table 6.

Table 6. Ability to analyze chemistry problems level c4 (analyzing) based on school differences

School	Measure Result
SMAN A	0.575
SMAN B	0.105
SMAN C	-0.076
SMAN D	-0.584
SMAN E	-0.852
SMAN F	-0.251
SMAN G	0.158
SMAN H	-0.578
SMAN I	-0.693
Average Number	-2.197

Based on Table 6 shows that students who are in SMAN A have a higher average ability which is with a measure value = 0.575 > the ability of SMAN G which is with a measure value = 0.158 > the ability of SMAN B which is with a measure value = 0.105 > the ability of SMAN C which is with a measure value = -0.076 > the ability of SMAN F which is with a measure value = -0.251 > the ability of SMAN H which is with a measure value = -0.578 > the ability of SMAN D which is with a measure value = -0.584 > the ability of SMAN I which is with a measure value = -0.693 > the ability of SMAN E which is with a measure value = -0.852.

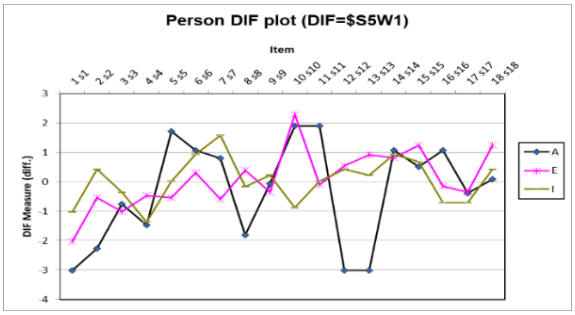

Figure 6. Person dif plot based on analysis of students' differentiating, organizing, and attributing ability in solving high school chemistry problems against school differences

Hypothesis Testing

Hypothesis testing serves to determine whether or not there is a difference in the ability to analyze students on chemistry material at SMAN A, SMAN B, SMA Negeri 4 Gorontalo, SMAN D, SMAN E, SMAN F, SMAN G, SMAN H, and SMAN I in terms of 3 indicators using diagnostic tests about the ability to analyze. Hypothesis testing in this study was calculated statistically using the SPSS application one-way ANOVA test.

3.2. Discussion

Reliability of the Differentiating, Organizing, and Attributing Ability Test Instrument of Class XII Chemistry Students

In this study, the reliability test of the research instrument based on Table 2. has an Alpha Cronbach value of 0.75 which is included in the excellent category which shows that student interaction with the test is special. The instrument reliability test shows that the Summary Statistics and undimensionality values have met the predetermined criteria. So that the data obtained is in accordance with Rasch modeling. So the learning outcomes diagnostic test instrument to measure students' ability to analyze chemistry material in class XII is said to be a reliable instrument and can be used for research.

The validity of the Differentiating, Organizing, and Attributing Ability Test Instrument of Class XII Chemistry Students

As for the validity test of a question item can be said to be valid or appropriate and it can be ascertained that the quality of the item is good and can be used if there is one criterion that still meets the three criteria MNSQ, ZSTD and PT Mean CORR. Based on Table 3 that the learning outcomes diagnostic test instrument as many as 18 items are included in the valid category in terms of measurement. This shows that this instrument is said to be valid and can be used in research.

The Ability of Class XII Students in General in Completing the Differentiating, Organizing, and Attributing Ability Test of Class XII Chemistry Materials

In general, the data from the analysis of the ability to analyze students in class XII in chemistry materials in high schools in Gorontalo Province in the 2024/2025 academic year obtained varying average values. As for the results of the analysis of students' ability to analyze (level C4) in terms of 3 indicators, it can be

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seen in the table of average values (mean) in each of the following indicators.

Table 7. Average value in each indicator of analyzing ability

Indicator	Average Value (Mean)
Differentiating	-0,27
Organizing	-0,37
Attributing	-0,11

In table 7. shows the results of the average value (mean) in each indicator from highest to lowest starting from the differentiating indicator has a value of -0.27, the organizing indicator has a value of -0.37, the attributing indicator has a value of -0.11, So, the results obtained obtained that the three indicators, namely the differentiating indicator, the organizing indicator, and the attributing indicator are negative.

The indicators that have negative values and are easy for students to answer, in other words, in nine high schools in Gorontalo Province in the differentiating indicator, it is suspected that students are able to distinguish, focus and select relevant/important parts from irrelevant/unimportant parts. In the organizing indicator, it is suspected that students are able to organize, find, combine and arrange how an element fits into its structure. Then, in the Attributing indicator, it is suspected that students are able to deconstruct and connect things in determining the point of view (the intention behind the question material).

Comparison of the Ability of Class XII Students in Completing the Differentiating, Organizing, and Attributing Ability Test of Class XII Chemistry Students in Each High School in Gorontalo Province

Based on table 4, the average (mean) value of students' ability to analyze in nine schools obtained the average (mean) value from the highest to the lowest consecutively starting from SMAN A by 0.94, SMAN B by 0.11, SMAN C by -0.09, SMAN D by -0.62, SMAN E by -0.96, SMAN F by -0.25, SMAN G by 0.18, SMAN H by -0. 62, SMAN I by -0.73. so it can be interpreted that the average value of school A > G > B > C > F > H > D > I > E.

The analysis conducted on the ability to analyze students in nine high schools in Gorontalo Province shows that the ability to analyze students on chemistry material in SMAN A is better than the other eight high schools and SMAN E is less than the other eight high schools. This happens because if the average value (mean) is smaller than the logit value of 0.0 then it shows the tendency of students' abilities or students' abilities are lower than the difficulty level of the question. On the other hand, if the mean value is greater than the logit value of 0.0 then it shows the tendency of students' abilities or students' abilities higher than the level of difficulty of the questions, so the students at SMAN A were quite easy in answering the questions in the instrument in this study while the students of the other eight SMAN tended to find it difficult to answer the questions in the instrument in this study.

The Ability of Class XII Students in Completing the Differentiating, Organizing, and Attributing Ability Test of Class XII Chemistry Material Students Against Gender Differences

Person DIF Analysis of Students' Differentiating, Organizing, and Attributing Ability in Solving High School Chemistry Problems on gender differences in chemistry material specifically on C4 (analyzing) level chemistry questions can be seen in Figure 5. which shows the existence of data that has a biased graph contained in question items 1, 5 and 10. For this biased data, the results of men have a higher ability to solve C4 (Analyzing) level chemistry questions than women. This indicates that there are items that are biased towards gender because this person diff aims to find out an instrument or item that is biased if it is found that one individual with certain characteristics is more advantaged than individuals with other characteristics. So it can be seen that the three numbers are more easily answered by male students than female students, which indicates the existence of gender-biased items.

Based on the average of the logit measure value of the Analysis of Students' Differentiating, Organizing, and Attributing Ability in Solving High School Chemistry Problems on gender differences, the results can be seen in Table 5. which shows that female students have a higher average ability, namely with a measure value = -0.904 than male abilities, namely with a measure value = -4.610. This is in accordance with the findings by oleh (Utami & Yonanda, 2020) that women have a higher average ability to solve chemistry problems. This is also supported by research by (Fatima et al., 2021) which states that female students tend to be more careful, diligent, and have good metacognitive abilities in understanding abstract chemical concepts. In addition, according to (Irwan et al., 2024), women show more

reflective and organized learning strategies that affect their effectiveness in solving chemistry problems, especially on topics that require in-depth concept understanding.

Ability of Class XII Students in Solving Differentiating, Organizing, and Attributing Ability Test Questions on Chemistry Materials for Class XII Students Against School Differences

Person DIF Analysis of Students' Differentiating, Organizing, and Attributing Skills in Solving High School Chemistry Problems against schools on chemistry material, especially on chemistry questions at level C4 (analyzing) can be seen in Figure 6. which shows the existence of data that has a biased graph contained in question items 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 16, and 18. Based on this biased data, the results show that schools A, C, B, E, and G show higher Differentiating, Organizing, and Attributing Ability Analysis than other education levels on certain items, while schools A, C, and D also show lower abilities on some items, which indicates the existence of biased items against school differences because this person dif aims to find out an instrument or item that is biased if it is found that one individual with certain characteristics is more advantaged than individuals with other characteristics.

Based on the average value of the logit measure analysis of students' differentiating, organizing, and attributing abilities in solving high school chemistry problems to different levels of education, the results can be seen in Table 6. which shows that students who are at education level A have a higher average ability, namely with a measure value = 0.575. The ability of students in school G is with a measure value = 0.105. The ability of learners in school B is with a measure value = 0.105. The ability of learners in school C is with a measure value = -0.076. The ability of learners in school F is with a measure value = -0.251. The ability of learners in school H is with a measure value = -0.578. The ability of learners in school D is with a measure value = -0.584. The ability of learners in school I is with a measure value = -0.693. The ability of learners in school E is with a measure value = -0.852. It can be seen that students in school A have a higher average ability than other schools and school E has a lower average ability. This is because based on the facts found in the field that students in school A more often learn independently because of the minimal number of educators. This is in line with the findings of (Purba et al., 2022) which show that learning independence has a positive and significant effect on achievement.

Hypothesis Testing

Based on the results of the hypothesis test analysis using the One Way ANOVA test with the help of the SPSS application, a p-value smaller than 0.050 was obtained. This shows that H_0 is rejected and H_1 is accepted, which means that there is a significant difference in the Analysis of Distinguishing, Organizing, and Attributing Ability of students in solving chemistry problems in nine public high schools in Gorontalo Province. This finding is reinforced by the measurement results using the Rasch model, which provides a more in-depth picture of the distribution of students' analytical skills based on the logit measure. Significant differences between indicators indicate that students have varying ability tendencies in distinguishing important information from questions (differentiating), organizing concept structures (organizing), and attributing reasons or causes (attributing) to their answers.

The implications of these findings are very important for teaching, learning and assessment. Teachers need to design learning strategies that emphasize the development of analytical skills as a whole, by providing contextual problem exercises that demand all three indicators. In the assessment process, the utilization of the Rasch model allows a more objective and diagnostic analysis of student abilities, so that it can be used to design targeted interventions in improving higher order thinking skills, especially in chemistry subjects.

4. CONCLUSION

This study shows that the Analysis of Students' Differentiating, Organizing, and Attributing Ability in Solving High School Chemistry Problems can be measured effectively using Rasch modeling. The instrument used proved to be valid and reliable, with very high item reliability values and a fairly diverse distribution of student abilities. In addition, undimensionality and item fit analysis confirmed that all items were statistically feasible to use.

The results also showed differences in ability between schools, reflecting the importance of strengthening analytical learning strategies in various educational units. The dominance of students in the differentiating indicator compared to the other two

indicators shows that students find it easier to distinguish information than to organize and connect it conceptually.

Therefore, chemistry learning at the high school level needs to be directed at developing high-level thinking skills as a whole through the use of context-based analytical questions and exploratory learning strategies and based on concept understanding, not just memorization. For this reason, educators are advised to design lessons that encourage students to analyze, evaluate, and reflect deeply on the chemical concepts learned. In addition, policy makers in the field of education are expected to support this effort through the provision of professional training for teachers, curriculum preparation that emphasizes higher order thinking skills, and the development of assessment instruments that are able to measure students' analytical abilities more authentically and holistically.

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