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ASSESSING INVENTIVE THINKING USING RASCH MODEL

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ABSTRACT

This study uses Rasch modeling to examine the inventive thinking of Sriwijaya University students enrolled in the chemistry education program. This research employs a cross-sectional study design and is quantitative. This study was conducted at FKIP Sriwijaya University's Chemistry Education Study Program. The subjects of this study consisted of 159 students from 3 active student classes of the chemistry education study program in 2024. The results of the study were analyzed using the RASCH Model with the help of the WINSTEP application, namely 1) Validity analysis (Person and item fit) shows that the Person/item fit Mean Square (MNSQ) for the inventive thinking instrument is in the range of 0.5-1.5 so that it is included in the category of "productive to use," while the reliability analysis (Person and item reliability) shows the results that r> 0.91 so that it is reliable; 2) Inventive thinking analysis (Person measure analysis) shows the results that there are 135 participants who fit/meet the Rasch modeling criteria; 3) Analysis of data bias between student generations (DIF analysis) shows that DIF only occurs in item KV3, where the probability is <0.05. This indicates that item KV3 is detrimental or beneficial to a particular generation; 4) Analysis of the science-related attitude and inventive thinking categories (Logit value of person) shows that 4.06% are in the high category, 94.3% are in the medium category, and 1.64% are in the low category; 5) Analysis of differences in inventive thinking between generations (Independent t-test) shows that the calculated t is smaller than the t table value, so there is no significant difference. The results of this study can conclude that there is no significant difference in inventive thinking ability between student levels, and most students are in the medium category.

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1. INTRODUCTION

The main shift of the twenty-first century is the appearance of a new set of economic and social indicators, which in turn change technical advancement, labor market rivalry, and structural transformation (Osman et al., 2010). Employees in today's workplace must be able to locate, process, and arrange information, solve problems, and have teamwork skills. These abilities are expected of workers and students since they are considered essential to workplace performance (van Laar et al., 2018). All students are increasingly expected to possess 21st-century abilities in expectations of 21st-century jobs. The knowledge-based economy necessitates a large workforce with 21st-century capabilities (Carayanis, 2020). The enGauge 21st century skills framework identifies four essential 21st century abilities: high productivity, innovative thinking, digital age literacy, and effective communication (Abdullaha & Osman, 2010).

One of the key elements of 21st century abilities is the ability to inventive thinking. In order to prepare students for success in the twenty-first century, education must change from merely assessing discrete knowledge to assessing students' critical thinking, problem-solving, information-gathering, communication, teamwork, creativity, and innovation skills (Abdullah & Osman, 2010). This demonstrates the value of thinking skills in creating a generation that can solve complicated problems, thinks creatively, critically, and innovatively, has a sharp mind, and thinks creatively and unconventionally (Sahak et al., 2012).

In addition to academic success, kids who possess 21st-century skills—such as inventive thinking—are better equipped to handle issues on a global scale (Samad et al., 2023). It is a cognitive process that uses creative and critical thinking during problem-solving to generate innovative or custom-designed solutions. It comprises six sub-constructs, namely flexibility, self-regulation, curiosity, creativity, risk-taking, and higher-order thinking, to handle erratic and challenging circumstances in their work and personal lives in this international digital era (Turiman et al., 2020). Flexibility is students may adapt their thoughts, attitudes, and behaviors when faced with a task that has limited time and resources during the learning process; Self-regulation enables students to independently define objectives, make plans for achieving them, manage their time, and evaluate the caliber of their education; Curiosity is a key element of lifelong learning and describes students' enthusiasm in learning new things and their questions while doing so; creativity, which enables pupils to freely evaluate themselves, produce original ideas and authentic goods, and form strong, imaginative, generative, and ecologically conscious opinions about proposed ideas; risk taking is the willingness of students to make mistakes, take on challenging assignments, communicate with others, and get feedback from their peers; High-order thinking abilities are pupils are able to analyze and resolve assignment issues, draw conclusions and interpretations, compare analyses, and use these abilities in real-world situations, Furthermore inventive thinking abilities that will be crucial in the workforce of the future (Lemke, 2002). So, it needs to be measured with precise and accurate measurements.

The RASCH Model is an analytical model that uses probability estimates that concentrate on the caliber of the result measurements to assess the measurement qualities of rating scales. This analysis is predicated on the idea that the likelihood of someone passing a test question is related to the statement about someone's ability and the level of difficulty of the question whose empirical data is tested (Stolt et al., 2022). Tests that offer trustworthy proof of student aptitude are developed using Rasch analysis as a guide. Regardless of how test results are applied, this is crucial. The accuracy of assessment findings influences decisions on which students fulfill passing requirements or who may be eligible (Farlie et al., 2021). Based on the aforementioned, the researcher believes it is critical to use appropriate and precise modeling, specifically Rasch analysis modeling, to analyze the inventive thinking skills of students enrolled in Sriwijaya University's chemical education study program.

2. METHOD

2.1 Types of research

This study uses a cross-sectional study design and is quantitative. Utilizing a snapshot of participants' attitudes, actions, or other characteristics in a study population (such as a group of people or an organization) at a particular moment in time, a cross-sectional study—also referred to as prevalence or transversal research (Maier et al., 2023). This study begins by determining the formulation of the problem, objectives, participants, and instruments to be used. Continued with data collection using the cross-sectional survey method. The data obtained were then analyzed using the Rasch Model, which consists of person and item fit and person and item reliability, DIF analysis, person measure analysis, and independent t-test. The results of the analysis are interpreted and made into conclusions.

2.2 Participant

The students (159) from Sriwijaya University's chemical education study program participated in this study. The study was divided into the following three classes:

Table 1. Research Participants

Year of the Generation	Number of Students
2023	69
2022	58
2021	60

2.3 Instrument

Inventive thinking measurement instrument used in this study is an adaptationof the instrument developed by Turimen et al (2020), consists of 33 questions with 6 aspects of inventive thinking measured: 1) Flexibility, 2) Self-regulation, 3) Curiosity, 4) Creativity, 5) Risk taking, and 6) Higher order thinking.

2.4 Data analysis

2.4.1 Validity and Reliability of Instruments

The validity of the RASCH Model parameters can be seen based on person and item fit. Generally, the range value between 0.5 and 1.5 indicates the suitability of the data that fits the model. A complete interpretation of the mean-square (MNSQ) fit statistics based on several simulation studies is presented in Table 2 (Boonee et al., 2013).

Table 2. Interpretation of Mean-Square (MNSQ) statistical parameters

Mark	Information
>2.0	Distorted or removed from the measurement system
1.5-2.0	Not productive for measurement construction, but does not need to be spent
0.5-1.5	Productive for measurement
<0.5	Less productive for measurement, but not necessary to remove. Can produce good reliability and separation but can also be misleading

Reliability in the Rasch Model measurement has two types of reliability indexes, namely, person reliability and item reliability, whose values range from 0 to 1. The standard values for person reliability and item reliability are presented in Table 3 (Maslahul et al., 2022).

Table 3. Standard values for reliability

Mark	Information
>0.94	Special
0.91-0.94	Excellent
0.80-0.90	Good
0.67-0.80	Enough
<0.67	weak

2.4.2 Inventive thinking analysis (Person Measure analysis)

The average value of each student's work on the questions is displayed by the person measure. The values of the Outfit Mean Square (MNSQ 0.5-1.5), Outfit ZStandard (ZSTD between -2 and 2), and Point Measure Correlation (Pt Mean Corr 0.4-0.85) must now be taken into account for analysis. The individual is considered suitable based on the three criteria (Erfan et al., 2020).

2.4.3 Data bias analysis (DIF Analysis)

DIF analysis can identify measurement bias. A probability value <0.05 indicates DIF. Items with a meaningful effect size and statistically significant DIF are indicated by DIF contrast >0.64 (moderate to large DIF is indicated by DIF contrast >0.64) (Boonee et al., 2013).

2.4.4 Analysis of differences between student groups (Independent t-test)

An independent t-test was conducted using WINSTEPS to see whether there is a significant difference between the values (Soeharto & Csapó, 2022). The measurement results are said to have significant differences between two groups if the t-count is greater than the table.

2.4.5 Inventive thinking ability category analysis (LVP Analysis)

One method for determining the levelization of study variable features is to use the person's logit value (LVP). Levelization is accomplished by combining the standard deviation (SD) with the average logit of individuals or units (Juandi et al., 2023). LVP analysis criteria are presented in Table 4 (Maslahul et al., 2022).

3. RESULTS AND DISCUSSION

An online platform was used to distribute instruments to 159 students of the chemistry education study program at Sriwijaya University and analyze the inventive thinking of chemistry education students.

3.1 Validity and reliability analysis

The validity of the Rasch parameters is seen from the person and item fit presented in Table 5.

Table 5. Validity of Rasch Parameters

Aspect	Mark
Number of Questions	34
MNSQ outfit items	1.01
MNSQ infit items	0.96
MNSQ Person Outfit	1.01
Person infit MNSQ	1.05
Item separation	7.57
Person separation	3.19

The table shows that the Person fit Mean Square (MNSQ) for the inventive thinking instrument is 0.5-1.5, and the item fit Mean Square (MNSQ), which is also in the range of 0.5-1.5. This shows that seen from the participants (Person) and also the instruments (items) used are included in the category "Productive to use" in research, or in other words, it is appropriate in measuring what should be measured. After the instruments are declared valid, fit, or in accordance with the Rasch parameters, the instrument reliability analysis is carried out. The results of the reliability analysis are shown in Table 6.

Table 6. Reliability results

Aspect	Mark
Item Reliability	0.98
Person Reliability	0.91

From the Table 6, it can be seen that the inventive thinking instrument's item reliability is in the category >0.94 (special), so it can be concluded that the instrument has carried out measurements very well, or in other words, it is consistent in assessing what it assesses.

In the Excellent category, person reliability for inventive thinking is 0.91. The measurement's ability to reach people with varying skill levels indicates that it has been effective. Item reliability demonstrates the consistency of the questions that can yield trustworthy findings when used for measurements, while personal reliability reflects the consistency of respondents' responses (Ngadi & Author, 2023). The higher the validity and reliability values of the instrument, the more accurate the data obtained (Fitri, 2017).

3.2.Participant Match Analysis (Person Measure analysis)

An individual (person) is said to be suitable for the model because it has met at least two of the three existing criteria (Sari & Mahmudi, 2024). The following is a summary of the results of the suitability of person measures with the three criteria presented in Table 7.

Table 7. Summary of person measure suitability with 3 criteria

Criteria	Suitable	Not suitable
0.5<MNSQ<1.5-2<ZSTD<2 0.4< Pt Measure Corr< 0.85	135 (85%)	24 (15%)

In the Table 7, only 135 participants out of 159 met the criteria or fit. So for the next analysis, only 135 participants who were suitable/fit with Rasch modeling were performed.

3.3 Data bias analysis (DIF Analysis)

To determine whether there are biased or DIF items by looking at the DIF analysis table produced. If the Probability value (prob) <0.05, then the instrument item is biased or DIF and can be detrimental to specific groups; in this case, this study harms the generation group. The DIF results on inventive thinking data are presented in Figure 1.

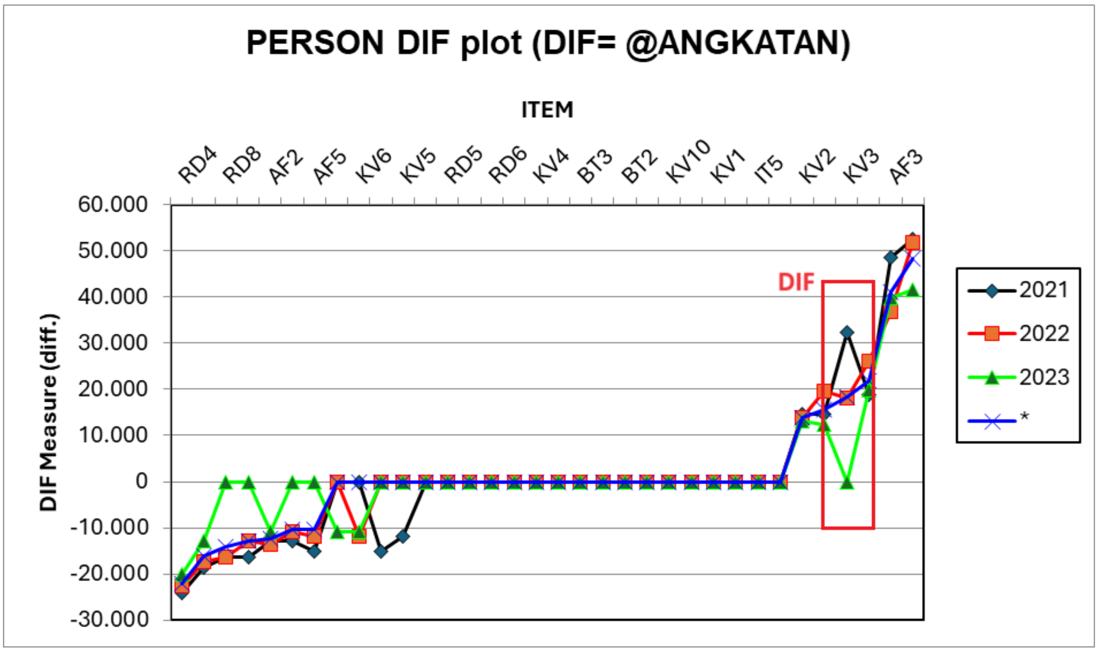

Figure 1. DIF Inventive thinking

The image shows several items that do not align with the DIF measure for each batch. Still, the probability that indicates DIF occurs is only in item KV3, where the probability is <0.05. This shows that item KV3 is detrimental or beneficial to a particular batch. In item KV3, the 2021 batch found it more challenging to answer the question than other batches. Details of the probability values for biased or DIF items are presented in Table 8.

Table 8. DIF generation on inventive thinking

Force		Probability	DIF Contrast	Question Code	Information
2021	2022	0.0034	1.42	KV3	Bias/DIF
2021	2023	0.0001	2.64	KV3	Bias/DIF

It can be seen in the Table 8 that the DIF contrast value is >0.64, so it can be concluded that the DIF or data bias in this item is meaningful (Boonee et al., 2013). This means that the item provides data bias in the analysis. Thus, subsequent analysis shouldn't include the item to avoid data bias.

3.4. Inventive thinking category analysis (LVP Analysis)

After participant data with Rasch modeling was collected and unbiased items were found, the Logit Value of Person (LVP) analysis was carried out to show the science-related students and inventive thinking categories of students in the chemistry education study program, FKIP UNSRI. The results of the inventive thinking data analysis show that the mean value is 2.5 and the PSD value is 1.71. So that the High category is measure > Mean + PSD (4.3), the medium category is mean-PSD (0.88) < Measure < mean + PSD (4.3), and the low category is measure < mean-PSD (0.88). Complete data on the results of the LVP analysis for inventive thinking are presented in Table 9.

Table 9. LVP analysis of inventive thinking

Category	Information	Amount	Percentage
Tall	Measure > 4.3	11	8.15%
Currently	0.88 < Measure < 4.3	118	87.41%
Low	Measure < 0.88	6	17.15%

The Table 9 shows that the inventive thinking of students in the chemistry education study program is predominantly in the moderate category (87.41%). This indicates that it is necessary to improve the inventive thinking ability of students in the chemistry education study program at Sriwijaya University.

3.5. Analysis of differences between student groups (Independent t-test)

An independent t-test was carried out between groups to determine whether the differences between groups were significant. Fortunately, it was carried out between the 2021 and 2022 classes, the 2021 and 2023 classes, and the 2022 and 2023 classes for each inventive thinking and science-related attitude data.

Table 10. Independent t-test inventive thinking

Force		t value	Probability	df	Information
2021	2022	-0.55	0.584	97	t table : 0.213
2021	2023	-0.15	0.880	96	t table : 1.185
2022	2023	0.33	0.741	112	t table : 0.649

The Table 10 data shows that the valuest count is smaller than the t table value, so it can be concluded that there is a significant difference in inventive thinking ability between the 2021 and 2022 classes, between 2021 and 2023, and between 2022 and 2023. The results of this study indicate that inventive thinking is not influenced by differences in class or the length of a person's study period. This is in line with the study's results, which showed that the level of students' inventive thinking was not significantly impacted by either group or time nor was there a significant interaction between the two variables, according to the analysis of MANOVA repeated measures (Samad et al., 2023).

4. CONCLUSION

Based on the results and discussion, it can be concluded that the test instrument meets the Rasch Modeling parameter criteria for validity and reliability. One hundred thirty-five participants fit the Rasch Modeling parameters. There is data bias in the item with code KV3, namely about creativity. The inventive thinking ability of students in the chemistry education study program is predominantly moderate (87.41%). And no, there is a significant difference in inventive thinking abilities between 2021 and 2022 classes, 2021 and 2023, and 2022 and 2023.

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