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Evaluation of Validity and Reliability Using Rasch Model and SPSS on Students' Mathematical Creative Thinking Ability

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ABSTRACT

Mathematical creative thinking is an important skill for students to face global challenges and advances in science and technology. However, previous research shows that this skill is still low among Indonesian students. Accurate measurement can be ensured by valid and reliable instruments. The purpose of this study is to evaluate the validity and reliability of the mathematical creative thinking ability test instrument using the Rasch Model and SPSS. The research method is quantitative with a survey approach, involving 106 participants from various demographic backgrounds. The results of the validity test using the Rasch model showed that the eight items on the mathematical creative thinking ability test instrument met the criteria with the ideal value range for Outfit MNSQ, Outfit ZSTD, and PTMEA-CORR. In addition, the validity test results using SPSS show that the eight items have a correlation coefficient value that exceeds the r product moment value. The results of the analysis showed that the instruments tested were valid and reliable with a Cronbach's Alpha value of 0.73 using the Rasch Model and SPSS. However, the Rasch Model showed 24 persons that did not fit, which means that the Rasch model's ability to provide more specific results. Both methods can be used effectively to measure the validity and reliability of mathematical creative thinking test instruments and the Rasch Model provides more detailed information in identifying persons who do not fit.

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1. INTRODUCTION

Mathematical creative thinking ability is defined as the intellectual ability of students to generate new ideas in solving problems [1]–[3]. Students have a high ability to solve difficult mathematical problmes by generating new ideas through creative thinking [4][5]. The ability to think creatively mathematically is considered crusial to students' success in learning mathematics or other sciences because it helps students solve problems in innovative ways, look at problems from different perspectives, and incorporate ideas they have learned before [6][7]. Thus, the ability to think creatively mathematically is one of the crucial skills for students to face the advancement of science and technology and global challenges, and is needed in formulating, interpreting, and solving mathematical problems [8][9]. In addition, the ability to think creatively mathematically invites students to find strategies and insights to explore their knowledge in making logical conclusions [10].

However, research conducted by Rodiyah shows that the mathematical creative thinking ability of less than 50% of students which is categorized shows that the mathematical creative thinking ability of mathematics as a boring and scary subject, as well as dependence on raw materials [11]. Indonesian students who are able to work on high and advanced problems that require mathematical creative thinking skills to solve the solution are only about 2% [11]. Then, students' mathematical creative thinking skills are still low due to traditional learning, with an average normalized gain of 0.5425, which is lower than conventional learning with an average normalized gain of 0.7877. [12][13]. Students' low mathematical creative thinking ability can be caused by the assumption that mathematics is a boring and scary subject with a single answer, as well as limited understanding of students who are too fixated on books and other people's opinions, so that their creativity does not develop [14]. Based on some of these studies, students' low mathematical creative thinking skills can occur because many people consider mathematics to be a boring and scary subject, assuming that each problem has only one answer and can only be understood by a few people [14].

Accurate measurement of mathematical creative thinking instruments requires assessments that are not only valid, but also reliable. validity ensures that the measuring tool actually measures the aspect of mathematical creativity in question, while reliability ensures consistency of measurement results under various conditions and time. Validity is the ability of a measurement tool to measure accurately without confusion [15]. Furthermore, validity is an index that indicates that the measuring tool actually measures what it wants to measure, and the validity test assesses whether the tool is valid or not. There are three categories of test validity concepts, namely content validity, construct validity, and empirical validity or criterion validity [16]–[18]. Ikhwan in his research explained that the validity of the content indicates whether the assessment instrument really measures all important aspects of the material or domain in question, while the validity of the construct indicates whether the assessment instrument really measures what should be measured based on the foundation of the underlying theory or concept, and the validity of the criterion indicates whether the assessment instrument can predict or relate to external criteria relevant [19].

Validity is an important aspect of research and evaluation because it ensures that the measurement instrument actually measures what is intended, so that the results obtained are reliable, accurate, reflect the precisely measured construct, and help with the accuracy of interpretations and decisions taken [20]–[22]. A test is said to be valid if it can measure what is to be measured, while a test is said to be reliable if it has persistence [23]. Furthermore, in addition to validity, reliable is also highly prioritized in the research and instruments to be tested. Reliability concerns the consistency and stability of a measuring instrument in providing the same measurement results if repeated, so reliability tests can be used to determine the extent to which a measuring instrument remains consistent and provides stable results on repeated measurement of the same phenomenon or data [16][17]. Some experts also explain that reliability refers to how consistent and reliable the measurement instrument is in providing accurate, reliable, and stable data [18][20][21]. Reliability is important in research because it shows how consistent and reliable a measurement instrument is in producing accurate and trustworthy data [21]. Reliability is also important because it ensures that the evaluation instruments used to measure students' higher-order thinking skills provide consistent, reliable, stable, and healthy results [15][20][22].

These measurements of validity and reliability can be measured using a variety of supporting statistical applications. First, the SPSS application is a statistical software that helps in terms of data calculation. Advantages of SPSS which include the provision of various test coefficients and statistics to

measure indirect, direct, total, and partial influence in linear and logistical regression analysis [24]. In addition, SPSS has the ability to calculate univariate statistics, perform Little's MCAR (Missing Complete At Random) tests, apply data imputation methods such as EM (Expectation Maximization), provide interpretation of interval mean values, and offer deterministic and stochastic techniques to fill in the missing data [24][25]. Furthermore, the Rasch Model is one of the methods in analyzing data through Ministep Software which can provide accurate data analysis results [26]. The advantage of the Rasch Model compared to other approaches is that it has the ability to predict lost data [27]. The Rasch Model also has advantages that can be used to maximize computation, namely its ability to generate interval sizes for each individual and item at the logit scale, scale item and individuals based on relationship to latent constructs, and calculate the probability of an item's response. In addition, the model excels in terms of objectivity, stable estimation of item parameters, and its ability to overcome the limitations of classical test theory [28][29].

Some previous studies are in line with the previous explanation. One of the studies conducted for the trial of the instrument using SPSS 20 in a study on students' creative thinking ability with realistic mathematics learning showed that there were 4 valid questions because the significance value was < 0.05 and the 4 questions had a good level of reliability because Cronbach's Alpha value was 0.602 > 0.6 [30]. It is also in line with research on mathematical creative thinking skills in geometry materials at the elementary school level, resulting in valid and reliable instruments to measure creative thinking skills in students using the Content Validity Ratio and Alpha Cronbach assisted by Microsoft Excel with the results of 10 out of 21 questions declared valid and the reliability is very high (0.82) [31][32]. Furthermore, research on the validity of creative thinking skills instruments conducted using IBM SPSS with the results of data analysis indicated that the developed instruments had good validity, with a Content Validity index value of 0.86 for creative thinking skills instruments, and 0.84 for collaboration skills instruments. The instrument also has high reliability, with a reliability value of 0/78 for creative thinking skills and 0.75 for collaboration skills [33]. Then, a similar study that examined validity and reliability using the formula of the Aiken's V and SPSS tables had results in the analysis of the content validation test, the value of categorization accuracy in the Aiken's V Table with a coefficient of 0.87 showed a figure of 0.95. On the other hand, the results of the data reliability test show r = 0.899 with a coefficient of 0.878 in the Table. Therefore, the subject matter is declared valid and reliable, so it is worth using [34].

Based on several studies that have been conducted, there has not been much research related to validity and reliability tests to measure students' mathematical creative thinking skills using the Rasch Model and SPSS at the same time. Therefore, researchers want to research further related to this. This study aims to determine the ability of mathematical creative thinking by measuring the validity and reliability of the instrument using Rasch Model and SPSS. The problem formulations in this study are: (1) What is the validity level of the mathematical creative thinking ability instrument when analyzed using the Rasch Model and SPSS; (2) What is the reliability level of the mathematical creative thinking ability test instrument when analyzed using the Rasch Model and SPSS.

2. RESEARCH METHODS

2.1 Research Design and Participants

This study uses a quantitative research method through a survey approach conducted by analyzing numerical or nominal data from population samples to understand the patterns, distributions, and relationships between variables in large or small populations [36][37]. The subject selection technique was carried out using purposive sampling. The total subjects used by the researcher are broken down in the table below.

Table 1. Participant Demographics

Demographics	Description	Code	Sum
Age	16	A	15
	17	B	29
	18 years and older	C	62
Domicile	Jakarta	D	70

Demographics	Description	Code	Sum
	Bogor	E	24
	Depok	F	4
	Bekasi	G	5
	Tangerang	H	3
Gender	Male	L	56
	Female	P	50

In Table 1, data about the participants in this study are presented. The data displayed included the age, domicile, and gender of the participants. Data from participants was obtained by providing mathematical creative thinking test instruments to students.

2.2 Instruments

The measuring instrument used in this study refers to several indicators that show mathematical creative thinking ability, where the indicators in question include the following important elements.

Table 2. Indicators and Scoring Guidelines

Number	Aspects of the Indicator Mathematical Creative Ability	Students' Response to Questions or Problems	Score
1.	Aspects of Smoothness	Blank answers or giving ideas that are not in accordance with the problem.	0
		Presenting ideas that are not in accordance with the solution to the problem.	1
		Presenting ideas that are in accordance with problem solving but the answer is wrong.	2
		Giving a lot of ideas that are suitable but the answer is wrong.	3
		Presenting a variety of ideas that match the accurate and clear completion process.	4
2.	Flexibility Aspect	Blank answers or answering in various ways but the answer is incorrect.	0
		Answering in one way, but the answer is wrong.	1
		Provides a single solution with appropriate calculation steps, resulting in an accurate answer.	2
		Presents a variety of solution methods, but there are errors in the calculation process that result in incorrect final results.	3
		Answering in various ways, the calculation process and correct answers.	4
3.	Aspects of Originality	Blank answers or inappropriate answers.	0
		Respond in a unique yet elusive style.	1
		Provide a response or answer with a unique approach, but the calculation is not yet complete.	2
		Answer in a unique way but there is an error in the steps of calculating the wrong answer.	3
		Answer with your own rules, calculation steps until the result is correct.	4
4.	Elaboration Aspects	Blank answers or incorrect answers.	0
		The answer is incorrect and does not come with any explanation.	1
		The answer is incorrect, but is accompanied by some explanation although it is less thorough.	2
		Errors were found in answering but accompanied by details.	3
		Answer correctly with details.	4

Source: [38]

Table 2 is an indicator and scoring guideline for the mathematical creative thinking ability test instrument used to check the results of students' work. This instrument goes through the content validation

process, where the validation of the content of a test reflects the extent to which the test measures the understanding of the material that should be mastered in accordance with the teaching content contained in the GBPP [19]. The validation testing stage was carried out by involving two experts in their fields, namely a lecturer and a math teacher at school. The following is a summary of the results of their assessment.

Table 3. Instrument Validation Results

Before Validation	After Validation
A trapezoid-shaped garden isosceles with the side length of the base 2ameters and a meter, and 4 meters high. In the garden will be planted trees with spacing between trees at least 2 meters. What is the maximum number of trees that can planted in the garden with using the solution that you understand?	An isosceles trapezoidal garden with a base side length of 2a meter and a meter, and a height of 4 meters. In the park, trees will be planted with a distance of 2 meters between trees. Determine the maximum number of trees that can be planted in the garden.

The mathematical creative thinking ability test instrument that is tested has gone through content validation as shown in Table 3. There are changes to the questions after they are validated, so that students are easier to understand and solve the questions.

3. RESULTS AND DISCUSSION

3.1 Validity of Mathematical Creative Thinking Ability Instrument with Rasch Model

Testing the validity and reliability of measuring instruments to assess mathematical creative thinking ability can be done by applying the Rasch Model. Below is a table containing the results of the validity and consistency analysis that has been processed using the Rasch Model. These results provide an overview of the extent to which the research instruments used are able to measure the validity of the construct in question consistently and accurately. It is hoped that these results can provide confidence in the quality of the instruments used in this study.

3.1.1 Item Fit

Item fit refers to the extent to which each item in the instrument conforms to the measurement model used. The analysis of fit items ensures that each question in the test does a good job of measuring the validity of the construct. The assessment of item suitability is based on three key parameters: the mean square (MNSQ) value of the Outfit, the z-standardized value of the Outfit (ZSTD), and the point measure correlation value (PT-MEASURE CORR) [39]. The ideal values for the three key parameters of Outfit Mean Square (Outfit MNSQ), Outfit Z-Standardized Values (ZSTD), and Point Measure Correlation (PTMEA-CORR) are in the range of 0.5-1.5, -2.0 to 2.0, and 0.4-0.85, respectively [33].

Table 4. Item Fit Output Results in Winsteps

Entry Number	MNSQ	ZSTD	PT-Measure
1	0.83	-1.2	0.54
2	0.91	-0.5	0.54
3	0.85	-1,1	0.66
4	1.14	1.0	0.54
5	1.23	1.6	0.54
6	1.14	1.0	0.55
7	1.01	0.1	0.58
8	1.03	0.3	0.58

Table 4 presents the results of the item fit analysis sorted by the degree of mismatch. Evaluation of the Outfit Mean Square (Outfit MNSQ), Outfit Z-Standardized Values (ZSTD), and Point Measure Correlation (PTMEA-CORR) values shows that all items are within the expected range of values.

Therefore, it can be concluded that the eight items in this mathematical creative thinking ability test instrument are declared fit.

3.1.2 Person Fit

The person-fit method can be applied to control the behavior of test takers, it is important because it measures the participant's understanding of the material being tested, not just their ability to give correct answers, and is useful in the validity of measurements during the implementation of the test because it results in objective decisions [40].

Table 5. Misfit Order Person Fit Output Results on Winsteps

Entry Number	MNSQ	ZSTD	PT-Measure Corr
3	**0.47**	-1.3	**0.06**
11	**0.18**	**-2.5**	0.59
16	1.74	1.3	**0.06**
20	**3.38**	**2.4**	**-0.34**
32	**2.53**	1.4	**-0.39**
34	**2.46**	**2.7**	**-0.03**
36	**3.57**	**2.7**	**-0.45**
41	**0.47**	-1.0	**-0.32**
52	**0.37**	-1.3	**0.19**
56	**1.53**	1.1	**0.20**
59	**0.47**	-1.4	**0.07**
61	**0.27**	-2.0	**0.01**
75	**0.19**	**-2.1**	0.54
80	**2.37**	1.6	**-0.57**
84	**0.32**	**-2.3**	0.73
85	**2.10**	**2.1**	**0.08**
93	**2.16**	**2.1**	**0.03**
94	**2.29**	**2.6**	**0.09**
98	**1.82**	1.3	**0.31**
99	**2.16**	**2.1**	**0.03**
104	**1.66**	1.5	**-0.12**
105	**0.24**	**-2.2**	0.46
106	**1.73**	1.5	**0.03**

In Table 5, displays the results of the respondent fit analysis (person fit) organized by level of misfit. Based on the person fit analysis output, it was found that 83 respondents (78.3%) met the Outfit Mean Square (Outfit MNSQ), Outfit Z-Standardized Values (ZSTD), and Point Measure Correlation (PTMEA CORR) standards. Meanwhile, 23 respondents (21.6%) did not meet these criteria, indicated by yellow shading in the table. [33].

3.2 Instrument Reliability Using the Rasch Model

The following are the results of the reliability test analyzed using the Rasch Model based on the Summary Statistics output table.

Table 6. Summary Statistics Output Results in Winsteps

Number	Statistics	Person	Item
1	(KR-20)	0.73	-
2	Reliability	0.71	0.91
3	Separation	1.58	3.20

Based on Table 6, it shows that Cronbach Alpha (KR-20) value of 0.73, which falls within the range of 0.7 to 0.8, indicates a high level of reliability. Person reliability was recorded at 0.71, falling into the fair category, while item reliability reached 0.91, falling into the excellent category. The person's discriminating

power of 1.58 was classified as bad, while the item's discriminating power of 3.20 was categorized as good. [33].

3.3 Validity and Reliability of Mathematical Creative Thinking Ability Instruments with Rasch Model

The following is a table of validity and reliability test results analyzed using SPSS software. This table displays a variety of important parameters that show the extent to which the research instrument is able to measure the intended variable consistently and accurately. In the validity test, the indicators used ensure that each item in the instrument represents the construct being precisely measured. Meanwhile, reliability testing is carried out to measure the internal consistency of the measuring instrument, which is expressed by the Cronbach's Alpha coefficient value. This analysis aims to ensure the quality and reliability of the instruments used in this study.

3.3.1 Instrument Validity Using SPSS

Analysis of the validity of the measuring instruments to assess creative thinking skills in mathematics was conducted using SPSS software. The results of this analysis are presented in the form of Bivariate output as seen below. The study involved a total of 106 students as participants.

Table 7. Bivariate Output Results on SPSS

Number	Item	Pearson Correlation	Criteria
1	Item 1	0.534	
2	Item 2	0.534	
3	Item 3	0.679	
4	Item 4	0.567	Medium
5	Item 5	0.575	
6	Item 6	0.570	
7	Item 7	0.606	
8	Item 8	0.637	

In Table 7, it is shown that eight items of the mathematical creative thinking ability test instrument get a correlation coefficient value with a medium level of validity [33]. Therefore, the eight items on the mathematical creative thinking ability test instrument can be said to be valid.

3.3.2 Instrument Reliability Using SPSS

The reliability analysis of the measurement tools used to evaluate creative thinking skills in the context of mathematics has been conducted using SPSS software. The results of this analysis are presented in the form of reliability statistics output.

Table 8. Reliability Statistical Output Results on SPSS

Cronbach's Alpha	N of Items
0.729	8

Based on the data presented in Table 8, a Cronbach's alpha value of 0.729 was obtained for all eight items tested. This exceeds the 0.50 significance threshold set as the reliability criterion, indicating an adequate level of reliability.[33]. So, it can be concluded that the eight items are reliable or consistent.

4. CONCLUSIONS

Based on the results of the validity analysis of measuring instruments to assess mathematical creative thinking ability, which was carried out using two methods, namely the Rasch Model and SPSS, it was found that in the fit items using the Rasch Model in Winsteps and SPSS there were eight items that fit or it can be said that all the test instrument numbers tested met the fit criteria, while in the person fit criteria there were 83 (78.3%) who met the criteria and 23 (21.6%) who did not meet the criteria. Therefore, it can be concluded that the measuring instrument to assess mathematical creative thinking ability has been proven valid, both

through testing with Winsteps and SPSS software. Furthermore, reliability analysis of the mathematical creative thinking ability measuring instrument using the Rasch Model and SPSS produced an identical value of 0.73, which indicates an adequate level of reliability. A comparison of the data analysis results from these two methods revealed that the calculation of validity through the Rasch Model with Winsteps software was able to provide more detailed and specific information in identifying respondents who did not fit the model.

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