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ENHANCING ETHNOMATHEMATICS KNOWLEDGE MEASUREMENT ACCURACY USING MODERN TEST THEORY IN JAMBI PROVINCE

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Abstract

Ethnomathematics is a potential alternative solution in efforts to preserve culture through the process of cultural integration (ethnography) in mathematics learning. Teachers play an important role in the successful implementation of ethnomathematics. Teachers need to have a deep understanding of the conceptual and practical aspects of ethnomathematics. This knowledge must be known from the start, even when they are still at the stage of becoming prospective mathematics teachers. Therefore, it is important to measure prospective teachers' ethnomathematics knowledge accurately to see the picture of prospective teachers' ethnomathematics knowledge. This research aims to increase the accuracy of measuring the ethnomathematics knowledge of prospective mathematics teachers by comparing several models in the Modern Test Theory approach, which include the Rasch Model, 1, 2, and 3 Parameter Logistics. Data collection was carried out using the *Jambi culture-based ethnomathematics test for prospective mathematics teachers* with respondents as many as 129 prospective mathematics teachers from Jambi Province. The criteria for the level of accuracy of the model are indicated by the Standard Error Measurement (SEM) and Test Information Function produced by each model. Based on the results of this research, it was concluded that using the Rasch Model produces the best level of accuracy. It is hoped that this research can open new avenues in increasing precision in measuring ethnomathematics knowledge for prospective mathematics teachers.

Keywords: *Ethnomathematics; Item Response Theory; Measurement; Accuration*

Abstrak

Etnomatematika merupakan salah satu alternatif solusi potensial dalam upaya pelestarian budaya melalui proses integrasi budaya (etnografi) dalam pembelajaran matematika. Guru memegang peranan penting dalam keberhasilan implementasi etnomatematika. Penting bagi guru untuk memiliki pemahaman yang mendalam tentang aspek konseptual dan praktis dari etnomatematika. Pengetahuan ini harus diketahui sejak awal, bahkan saat mereka masih dalam tahap menjadi calon guru matematika. Oleh karena itu, penting untuk dilakukan pengukuran pengetahuan ethnomatematika calon guru secara akurat untuk melihat gamabaran pengetahuan ethnomatematika calon guru. Penelitian ini bertujuan untuk meningkatan akurasi pengukuran pengetahuan ethnomathematics calon guru matematika dengan membandingkan beberapa model dalam pendekatan Modern Test Theory yang meliputi Rasch Model, 1, 2, and 3 Parameter Logistics. Pengumpulan data dilakukan dengan menggunakan Jambi culture-based ethnomathematics test for prospective mathematics teachers dengan responden sebanyak 129 calon guru matematika Provinsi Jambi. Kriteria tingkat akurasi dari model diindikasikan oleh Standard Error Measurement (SEM) dan Fungsi Informasi Test yang dihasilkan oleh masing-masing Model. Berdasarkan hasil penelitian ini di-peroleh kseimpulan bahwa penggunakan Rasch Model menghasilkan tingkat akurasi terbaik. Diharapkan bahwa penelitian ini dapat membuka jalan baru dalam peningkatan presisi dalam mengukur pengetahuan etnomatematika bagi calon guru matematika.

***Kata kunci**: Etnomatematika; teori response butir; pengukuran; akurasi*

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INTRODUCTION

Preserving national culture is one of the big challenges in the era of globalization. (Ergashev & Farxodjonova, 2020) Globalization allows various foreign cultures to enter various sectors of life, which can threaten the existence of local culture if it is not balanced with serious preservation efforts by all parties. Culture reflects the history, values and way of life of a nation, which differentiates it from other nations. In other words, national culture can be interpreted as an identity and heritage that must be maintained and preserved. Indonesia has cultural diversity, one of which is Jambi Culture. Jambi culture has an important role in the local life of the Jambi community, especially in understanding cultural values that cannot be separated from everyday life. (Bahar et al., 2023; Salam et al., 2022) In the era of globalization, preserving culture means protecting uniqueness and diversity of the world, as well as promoting understanding and tolerance between cultures. The big challenge that we need to face is ensuring that national identity remains amidst the rapid flow of cultural globalization. (Bahar et al., 2023; Salam et al., 2022) Therefore, preserving this culture is an important thing for all to pay attention to. parties in various sectors. The education sector has an important role in efforts to preserve this culture.

Ethnomathematics represents a promising alternative approach for cultural preservation through the integration of ethnographic elements into mathematics education. By embedding mathematical knowledge within the framework of local cultural practices, ethnomathematics facilitates deeper and more meaningful understanding of mathematical concepts among students. In the context of Jambi Province, this approach may involve the incorporation of traditional tools, indigenous measurement systems, and culturally rooted problem-solving methods into classroom instruction. Such integration not only enhances the relevance and engagement of mathematics learning but also contributes to the safeguarding of local cultural heritage. Consequently, the implementation of ethno-mathematics within the Jambi cultural context offers dual benefits: it enriches educational experiences while simultaneously supporting efforts to preserve and revitalize cultural identity.

In the field of education, teachers play a pivotal role in ensuring that ethnomathematics is effectively integrated into classroom practice to maximize its benefits for students (Ergene et al., 2020; Mosimege & Egara, 2023; Prahmana, 2022; Putra & Mahmudah, 2021). As facilitators of the learning process, teachers are responsible for embedding ethnomathematical concepts and methodologies into both the curriculum and instructional strategies they employ (Mania & Alam, 2021). One effective approach is to draw upon everyday experiences and local cultural contexts to illustrate mathematical ideas, thereby enhancing the relevance and engagement of learning materials (Nur et al., 2020). For instance, traditional games or indigenous measuring tools can serve as instructional media, such as the use of woven mats, an artistic tradition in Jambi Province, as project-based learning tools to explore geometric patterns and spatial reasoning. Mat weaving, a longstanding cultural practice in Jambi society, inherently involves complex mathematical structures that can be leveraged to deepen students' conceptual

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understanding. Beyond content delivery, teachers are also tasked with cultivating a classroom environment that values and celebrates cultural diversity, which is a core principle of ethnomathematics (Atmaja, 2023; Nur et al., 2020; Putra & Mahmudah, 2021). To fulfill these responsibilities effectively, it is essential that teachers possess a comprehensive understanding of both the theoretical foundations and practical applications of ethnomathematics (Machaba & Dhlamini, 2021).

This competency should be developed early in their professional formation, beginning at the stage of teacher preparation. Accordingly, rigorous research is needed to examine the reliability of instruments used to measure ethnomathematical knowledge among prospective mathematics teachers (Falani et al., 2020b).

The level of accuracy in measuring the ethnomathematics knowledge of prospective mathematics teachers is very important, because it can be a reference to ensure that prospective mathematics teachers have adequate readiness to implement this approach in their teaching (Falani & Kumala, 2017). Apart from that, accurate measurement is also important to determine which areas may require improvement or further development in ethnomathematics knowledge for prospective teachers. Thus, the level of accuracy of measuring ethnomathematics knowledge has a significant impact on the quality of mathematics teaching and student learning outcomes (Falani et al., 2020b). Thus, research that focuses on increasing the accuracy of prospective mathematics teachers' ethnomathematics knowledge needs to be carried out, one of which is by implementing an approach *Modern Test theory*.

Implementation of the approach *Modern Test Theory* can increase the accuracy of measuring latent variables, which in this research is ethnomathematics knowledge. *Modern Test Theory* which includes models such as Item *Response Theory* (IRT). This approach has advantages, including allowing a more precise assessment and individualization of ethnomathematics knowledge. (Falani, 2020; Falani et al., 2018, 2020a, 2022, 2022; Falani & Kumala, 2017; Keliat et al., 2023) By considering individual characteristics and items in the assessment, *Modern Test Theory* can provide a more accurate estimate of ethnomathematics knowledge compared to traditional measurement methods. Besides that, *Modern Test Theory* also allows for adaptive assessment, where the items selected for each individual can be adjusted based on their responses to previous items. (Falani, 2020) This can increase measurement efficiency and reduce bias in assessment. Therefore, implementation *Modern Test Theory* can be an important step in improving the accuracy of measuring ethnomathematics knowledge and, ultimately, the quality of mathematics education. (Falani et al., 2020b, 2020a)

Preliminary study or *state of the art* by using *Bibliometrice Analysis* help *Vosviewers* (Falani et al., 2022; Keliat et al., 2023). The results of the analysis show that there has been no similar research related to increasing the accuracy of measuring the ethnomathematics knowledge of prospective mathematics teachers using the approach *modern test theory*. This certainly needs serious attention considering that teachers are the spearhead of the success of efforts to preserve the existence of Jambi culture through the integration of

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ethnomathematics in quality learning in the classroom.

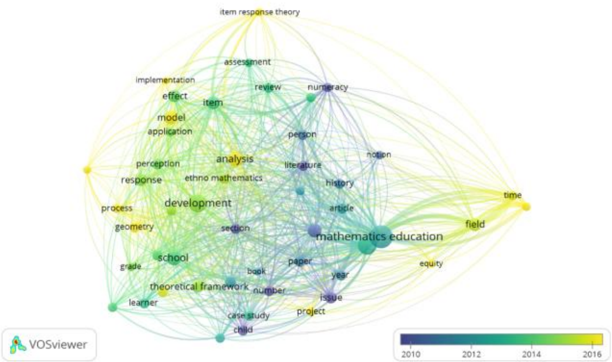

Figure 1. *Overlay Visualization*

Based on the results of the bibliometric analysis, which was carried out involving 134 articles, as shown in Figure 1, it shows that research related to ethnomathematics measurement instruments for prospective teachers has never been carried out before.

Taking into account the description in the previous section, this research aims to improve the accuracy of measuring the ethnomathematical knowledge of prospective mathematics teachers by utilizing a modern test theory approach. The main question to be answered is how the application of modern test theory can improve the accuracy of this measurement. The results of this research are expected to offer a more effective alternative in assessing the ethnomathematical abilities of prospective mathematics teachers.

METHODS

This study employed a quantitative research design grounded in the Modern Test Theory (MTT) framework, also known as Item Response Theory (IRT) (Cardinet et al., 2010; Soesana et al., 2023). MTT offers several psychometric advantages over Classical Test Theory, particularly in its ability to estimate individual ability independently of the specific set of test items administered. This results in scores that more accurately reflect latent traits rather than test-specific performance (Baker & Kim, 2017; Nering & Ostini, 2011; Van der Linden, 2016). Moreover, MTT provides more precise measurements and improved validity, especially for instruments with varying item difficulties (Falani, 2020; Falani et al., 2020a, 2020b, 2022; Keliat et al., 2023). By accounting for both item and person parameters, MTT enables more reliable and generalizable assessments, making it a powerful approach for educational measurement (Van Der Linden & Hambleton, 1997; Reise & Revicki, 2014; Toland, 2014; Zanon et al., 2016).

Research Subjects, Location, and Sampling

The study was conducted from August to September 2024 in Jambi Province, Indonesia, involving 129 prospective mathematics teachers from higher education institutions in Jambi Province. Participants were selected using purposive sampling, with inclusion criteria comprising final-year enrollment in a mathematics education program, prior coursework in ethnomathematics or related subjects, and voluntary participation. This sampling strategy ensured that respondents possessed sufficient academic exposure to the constructs being measured.

Research Instrument and Indicators

The primary instrument used was a dichotomous ethnomathematics knowledge test consisting of 40 multiple-choice items (scored 1 = correct, 0 = incorrect). The items were

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developed based on a synthesis of literature on ethnomathematics, local cultural practices in Jambi, and national mathematics education standards (Bahar et al., 2023; Ramalisa et al., 2023; Prahmana, 2022). The test was structured around seven indicators: Culture awareness; ethnomathematical content knowledge; pedagogical skills; reflective practice; professional growth and lifelong learning; integration of technology; assessment strategies.

Instrument Validation

The validation process involved both qualitative expert review and quantitative psychometric analysis:

- Content Validation

Five experts in mathematics education, psychometrics, and local cultural studies evaluated the items for relevance, clarity, and cultural authenticity. The Content Validity Index (CVI) was calculated, with all retained items exceeding the minimum threshold of 0.80.

- Empirical Validation Using Modern Test Theory

A pilot test was conducted with 40 students to evaluate item fit using the MTT (1,2,3 PLM, Rasch model). Items with infit or outfit mean square values outside the acceptable range (0.7–1.3) were revised or excluded. The final instrument demonstrated strong internal consistency, with a person reliability index of 0.87 and item reliability of 0.91.

Data Collection Procedure

The finalized instrument was administered online using Google Forms to facilitate broad and efficient data collection across multiple institutions. Prior to distribution, participants were provided with a detailed explanation of the study's objectives, procedures, and ethical considerations through an introductory section embedded in the form. Informed consent was obtained digitally, and participation was entirely voluntary. The online format ensured accessibility and flexibility for respondents while maintaining standardized administration. To uphold ethical standards, all responses were collected anonymously, and participants were assured of the confidentiality of their data to minimize response bias and ensure confidentiality.

Data Analysis Techniques

The response data were analyzed using four dichotomous IRT models: Rasch, 1PLM, 2PLM, and 3PLM (Falani, 2020; Falani et al., 2020a). Ability parameters (θ) were estimated using the Marginal Maximum Likelihood Estimation (MMLE) method via IRTPro and R software (packages: ltm, mirt, TAM). The analysis followed the iterative process illustrated in Figure 2, which includes model calibration, ability estimation, and evaluation of model fit.

Following estimation, the Standard Error of Measurement (SEM) for each θ estimate was calculated using the formula 1:

$$SE(\hat{\theta}_{ML}) = \sqrt{Var_{ML}} = \sqrt{\frac{1}{I(\theta)}}, \qquad (1)$$

with,

$$I(\theta) = \sum_{i=1}^{n_1} \frac{(P_i^{'})^2}{P_i(1-P_i)} + \sum_{j=1}^{n_2}\sum_{k=0}^{m_j} \frac{(P_{jk}^{'})^2}{P_{jk}},$$

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As noted by Falani (2020), there exists a quadratic inverse relationship between SEM and the Test Information Function (TIF) as the information value increases, the SEM decreases. This relationship was used to evaluate the precision of each model's ability estimates. Comparative analysis of model performance was conducted using fit indices (AIC, BIC), item/test information functions, and histograms of θ distributions (Figures 4–7).

RESULTS AND DISCUSSION

IRT Model Assumption Test Results

In the initial stage of research data analysis, a prerequisite test of the IRT model assumptions was carried out. The first assumption test is the unidimensionality test. According to Naga (2012), this test aims to ensure that the test used in this research measures one dominant construct or the same dimension, in this case the ethnomathematics knowledge of prospective mathematics teachers in Jambi Province.

The unidimensional test method used in this research is confirmatory factor analysis (CFA), which helps determine whether the empirical data matches the proposed theoretical model. In addition, other techniques such as eigenvalue analysis and screeplot can also be used to evaluate the number of dimensions underlying the data. By ensuring unidimensionality, researchers can be more confident that the scores produced from tests or questionnaires truly reflect the abilities or attributes in question. (Almquist et al., 2020; Hendry, 2003) The results of the Unidimensional Test using the CFA method can be seen in Table 1.

Table 1. Test KMO and Bartlett's

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,683
Bartlett's Test of Sphericity	Approx. Chi-Square	2847,270
	df	903
	Say.	0,000

The Table 1 is SPSS output which shows the results of the KMO (Kaiser Meyer Olkin)-MSA Test and the Bartlett Test. The KMO test aims to assess the adequacy of the sample, with the test criteria if the KMO-MSA value is > 0.5 then the sample used for analysis is sufficient to be analyzed by CFA. Then, the Bartlett's test aims to ensure the homogeneity of the data, with the test criteria being a Sig value < 0.05 so the data is homogeneous. The results of the KMO and Bartlett's tests presented in the table show that the data samples used in this research have met the requirements for adequacy and are homogeneous, so that analysis can be continued using the CFA method.

The CFA method in this research was carried out with the help of SPSS. The extraction process is used to investigate the dominant dimensional factors in the measurements of this research. These factors are identified through eigenvalues > 1, the results of the analysis are presented in the Table 2.

Table 2 shows that 13 factors have an eigenvalue > 1. The eigenvalue of the first factor is more than twice the eigenvalue of the second factor. Meanwhile, the eigenfactor values for the second and subsequent ones are almost the same. This indicates that the first factor is the dominant factor in measuring the ethnomathematics test carried out. This shows that the unidimensional assumption is met. Based on the table

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above, it can be seen that the first factor can explain 20.5% of the total variance. Furthermore, the thirteen main factors can cumulatively explain 69.269% of the total variance.

Table 2. Factor analysis extraction results

Total Variance Explained						
	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Com.	Total	% of Variance	Cum.%	Total	% of Var	Cum. %
1	8,815	20,501	20,501	8,815	20,50	20,501
2	3,712	8,633	29,134	3,712	8,63	29,134
3	2,365	5,500	34,634	2,365	5,50	34,634
4	2,110	4,907	39,541	2,110	4,907	39,541
:	:	:	:	:	:	:
13	1,05	2,45	69,26	1,05	2,45	69,2

The SPSS output displays a visualization of the factor extract results in screeplot form to make it easier to see a unidimensional picture based on eigenvalues. The screenshot plot is presented in the Tabel 1.

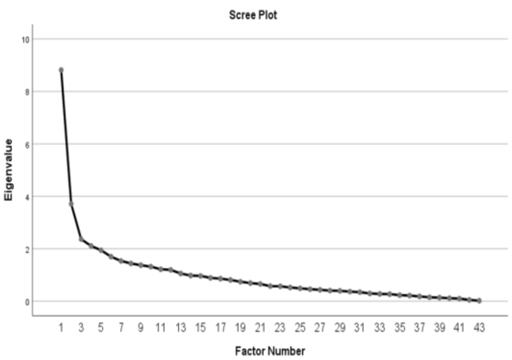

Figure 3. Factor analysis screen plot

In the Screenplot (Figure 3), it can also be seen that there are 12 other factors apart from the first factor, which was the result of the factor analysis extraction carried out. In the Screeplot above, it can be seen that the first factor has an eigenvalue that is more than double that of the factors after it. This has an impact on the slopes formed by the first factor and the subsequent factors being very different significantly. This indicates that the first factor is the dominant factor or dimension in the measurements carried out, which in this case is the ethnomathematics knowledge of prospective mathematics teachers.

Test that assumption second is a test of local independence. In Item Response Theory (IRT), the assumption of local independence means that if the abilities that influence test performance are considered constant, then participants' responses to one question item will not affect their responses to other questions. In other words, participants' answers to one item must be statistically independent from their answers to other items.

Assumption third The modern theory test model assumes invariance. In Item Response Theory (IRT), the invariance assumption (parameter invariance) states that item parameters (such as level of difficulty and differential power) must remain constant across various groups of test takers. This means that the characteristics of the test items do not change even though they are tested on different subpopulations1. This is important to ensure that the test is fair and reliable for various groups of participants. (Akhtar & Sumintono, 2023)

According to Demars (2010) and Naga (2012), the local independence assumption and invariance assumption will be fulfilled when the unidimensional assumption has been met. The tests that

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have been carried out show that the unidimensional assumption has been fulfilled. Therefore, it can be concluded that the local independence assumption and invariance assumption are also met by the research data. So that further analysis can be carried out using the Modern Theory Test Approach.

IRT Model Fit Test Results

After the model assumptions are met, at this stage an IRT model suitability test is carried out. In this study, the models used include Rasch, 1 Logistic Parameter, 2 Logistic Parameters, and 3 Logistic Parameters. Model suitability in this research was carried out using statistical methods, namely by reviewing the chi-square probability (significance) values. The test criteria used are that an item is categorized as suitable for the model if it has a significance value > α. The α value used in this research is 0.05.

This probability value calculation was carried out using BILOG-MG. The output of this probability value can be seen in the Phase 2 output of the analysis results, as presented in the Table 3.

Table 3. Model Suitability in Terms of Chi-Square Probability Values

Category	Model			
	3PLM	2PLM	1PLM	Rasch
Suitable	36	31	36	37
Not suitable	7	12	7	6
BIC	4285,79	4154,64	4134,65	4134,62

Apart from that, the model fit test in this study used the Bayesian Information Criterion (BIC). The goodness of fit test criteria is to compare the BIC value of each model. The IRT model with the smallest BIC value indicates the best level of model fit. (Chalmers, 2024; Monroe & Cai, 2015) Based on the table above, it can be seen that the Rasch Model has the smallest BIC value compared to other models. This strengthens the indication that the Rasch Model is the most effective in analyzing dichotomous data in this research.

Results of Person-Parameter Analysis (Ethnomathematical Knowledge)

Apart from the item parameters, the main parameter of the IRT model is the person parameter which is symbolized by θ. Parameter θ shows the abilities or latent traits of the individual being tested (examinee). In this study, the latent trait measured was prospective teachers' knowledge regarding ethnomathematics. Parameter estimation θ carried out using BILOG software (Multilog et al., 2003), the results can be seen in phase 3. The results of the analysis of person parameters in this study are presented in Table 4.

Table 4. Parameter Descriptive Statistics θ (Ethnomathematical Knowledge)

Statistics	3PLM	2PLM	1PLM	Rasch
Mean	0,00458	-0,01	-0,01	1,199
Standard Error	0,08459	0,082	0,082	0,060
Median	0,3212	0,254	0,195	1,337
Mode	1,2057	1,112	0,537	1,447
Standard Deviation	0,96083	0,929	0,936	0,683
Sample Variance	0,92319	0,863	0,877	0,467
Kurtosis	0,50417	0,196	0,471	0,650
Skewness	-0,76611	-0,61	-0,71	-0,668
Range	4,7124	4,748	4,909	3,802
Minimum	-3,0847	-3,09	-3,16	-1,298
Maximum	1,6277	1,656	1,746	2,504

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Statistics	3PLM	2PLM	1PLM	Rasch
Sum	0,5908	-1,09	-0,69	154,761
Count	129	129	129	129
Largest	1,6277	1,656	1,746	2,504
Smallest	-3,0847	-3,09	-3,16	-1,298
Confidenc Level (95,0%)	0,167	0,162	0,163	0,119

The distribution of the level of ethnomathematics knowledge based on estimation results using the IRT models used in this study is presented in the form of a histogram (Figure 4-7).

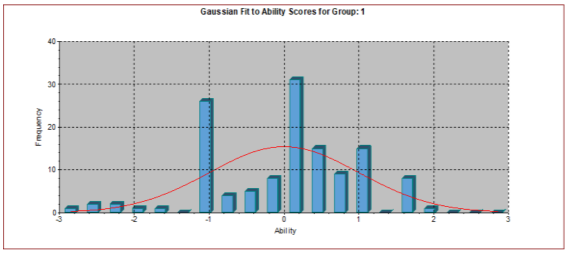

Figure 4. Histogram parameter θ model Rasch

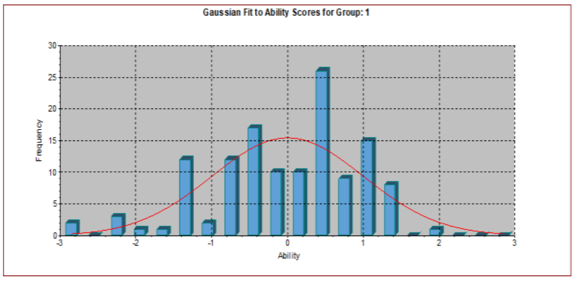

Figure 5. Histogram of parameter θ 1PLM

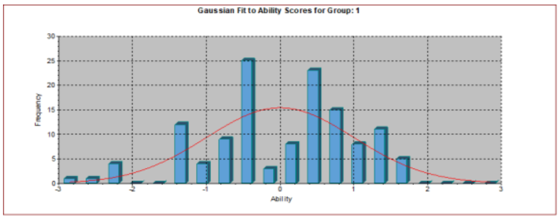

Figure 6. Histogram of parameter θ 2 PLM

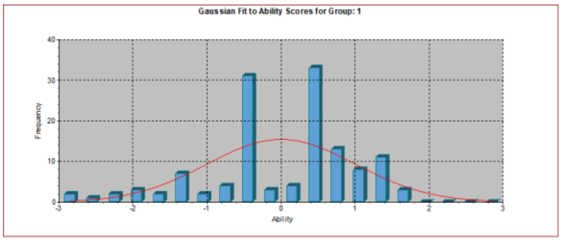

Figure 7. Histogram of parameter θ model 3 PLM

Figures 4 through 7 illustrate the distribution of estimated ability parameters (θ) derived from four Item Response Theory (IRT) models, namely, the Rasch model, 1PLM, 2PLM, and 3PLM, used to assess the ethnomathematics knowledge of prospective mathematics teachers. As shown in Figure 4, the Rasch model produces a relatively symmetrical and concentrated distribution of ability estimates, indicating a consistent measurement across participants. In contrast, Figures 5 to 7 reveal increasing variability and dispersion in the θ distributions as model complexity increases from 1PLM to 3PLM. The 2PLM and 3PLM models, in particular, exhibit wider spreads and more skewed distributions, suggesting greater sensitivity to item discrimination and guessing parameters. These visual patterns support the quantitative findings of the study, reinforcing the Rasch model's capacity to yield stable and interpretable ability estimates, while also highlighting the trade-offs associated with more complex IRT models in terms of parameter estimation and interpretability.

Information Function of the Ethnomathematical Knowledge Test

Information value indicates the reliability and accuracy of a test measurement. The value of the information function from a test does not appear directly in the BILOG program

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output but must be calculated manually. But in plain view, we can see in Figures 8, 9, & 10

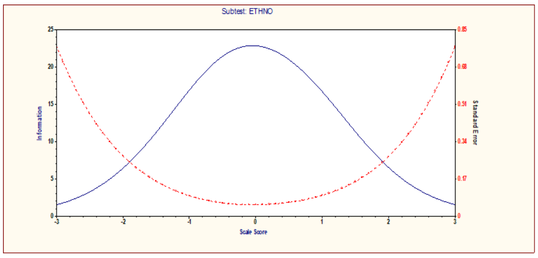

Figure 8. Rasch Model TIF

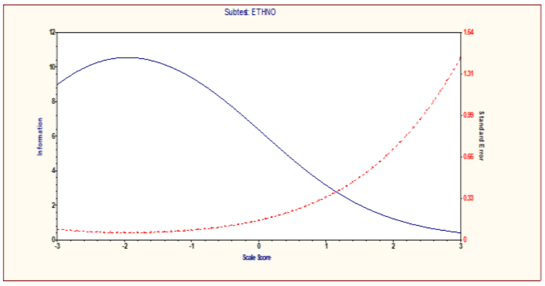

Figure 9. 1 PLM TIF

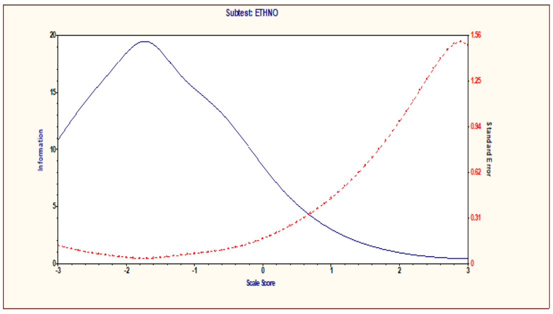

Figure 10. 2 PLM TIF

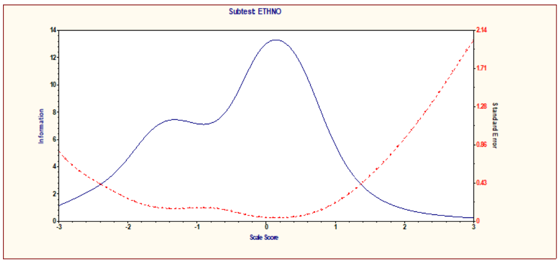

Figure 11. 3 PLM TIF

Based on Figure 8 – 11, it can be seen that the model that produces the highest test information function value is the Rasch model. The value of the information function of this test has an inverse relationship with the standard error measurement of a model. This can be seen in each curve image above; the blue line depicts the test information function, while the red line depicts SEM. Therefore, it can be concluded that the SEM value for the Rasch model is smaller compared to other models. A summary of the information and SEM function values is summarized in Table 5.

Table 5. SEM and TIF values

	Model			
SEM	3PLM	2PLM	1PLM	Rasch
Var	0,711	0,645	0,739	0,198
S.E	40,9	44,23	50,12	32,09
Stdv	6,394	6,651	7,080	5,67
TIF	1,406	1,551	1,354	5,046

To see the stability of the SEM and TIF estimation results, response data was replicated using the item parameters and person parameters obtained from the analysis results for each previous model. Then the data was generated using Wingen software, 5 replications for each model. Then, the SEM and TIF values are estimated again for return. The results of the five replications were then compared to see the stability of the SEM and TIF values produced by each model. The comparison of SEM and TIF values is presented in Figures 12 and 13.

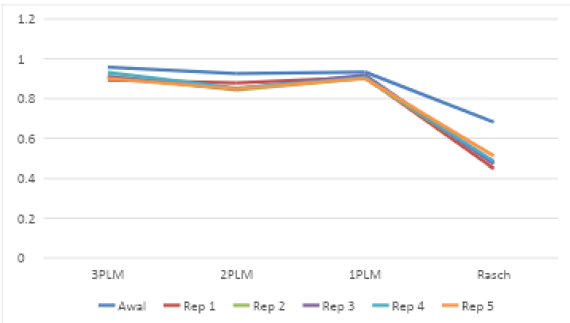

Figure 12. Comparison curve of SEM values from replications for each model

Based on Figure 12, it can be seen that the analysis using the Rasch model produces a relatively stable SEM value that is smaller than the other models,

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then the SEM values are respectively the 2 PLM, 1 PLM, and 3 PLM models. Then, from Figure 13, it can be seen that the analysis using the Rasch model produces a relatively stable TIF value that is higher than the other models, then the SEM values are respectively the 2 PLM, 1 PLM, and 3 PLM models.

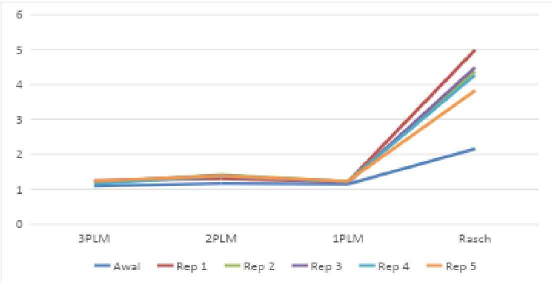

Figure 13. Comparison curve of TIF values from replications in each model

Based on the results shown in Figure 13, it can be seen that the Rasch model produces Standard Error of Measurement (SEM) values that are relatively stable and smaller compared to other models. This shows that the Rasch model has higher measurement precision, indicating that the results obtained from this model are more consistent and reliable. The sequential order of SEM values is: the Rasch model has the smallest SEM, followed by the 2PLM model, 1PLM model, and 3PLM model which has the largest SEM.

Apart from that, from Figure 13 it can also be seen that the Rasch model produces Test Information Function (TIF) values that are relatively higher and stable compared to other models. This shows that the Rasch model provides more and more accurate information about the abilities of the individuals being tested. Sequentially, the TIF value shows that the Rasch model has the highest value, followed by the 2PLM model, 1PLM model, and 3PLM model which has the lowest TIF value.

From these two analyses, it can be concluded that the Rasch model is not only more accurate in measuring individual abilities with smaller SEM values, but also provides richer and more stable information with higher TIF values. Therefore, in the context of measuring individual abilities resulting from tests, the Rasch model appears to be a superior choice compared to other models. This model offers a good combination of measurement precision and information quality, making it an effective tool in educational evaluation and ability assessment.

This research aims to increase the accuracy of measuring ethno-mathematics knowledge of prospective mathematics teachers in Jambi Province using the MTT approach. Ethnomathematics knowledge is an important aspect of mathematics education that integrates local cultural knowledge with mathematical concepts. By combining these two elements, prospective teachers can develop teaching methods that are more relevant and interesting for students, especially in culturally rich areas such as Jambi (Ramalisa et al., 2023).

The MTT approach, which includes IRT, offers more sophisticated tools and techniques in measuring individual abilities than classical approaches. MTT allows for a more accurate and reliable assessment of an individual's abilities based on their responses to test items. This is important in the context of measuring ethnomathematics knowledge, because variability in cultural and mathematical understanding among preservice teachers may be very high.

This study focuses on improving the accuracy of measuring ethnomathematics understanding in prospective mathematics teachers in

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Jambi Province through the MTT approach. To achieve this goal, several types of models were used, namely the one-parameter logistic model (1PLM), two-parameter logistic model (2PLM), three-parameter logistic model (3PLM), and the Rasch model. The research findings indicate that the Rasch model provides the best performance, in terms of the value of the item information function and the magnitude of the Standard Error of Measurement (SEM).

The present study affirms the superiority of the Rasch model in measuring the ethnomathematical knowledge of prospective mathematics teachers, as evidenced by its ability to yield the highest item information function (IIF) values among the models examined. The IIF serves as a critical indicator of how much information an item contributes to estimating an individual's latent trait, with higher values reflecting greater measurement precision (Baker & Kim, 2017; Demars, 2010). The Rasch model's capacity to produce high-grain information across the ability continuum underscores its diagnostic strength and supports its application in educational contexts requiring fairness, objectivity, and invariance (Akhtar & Sumintono, 2023; Falani, Akbar, & Naga, 2020a). These findings are consistent with prior research demonstrating the Rasch model's robustness in psychometric evaluation and its alignment with the principles of construct validity and measurement precision (Falani et al., 2022; Keliat et al., 2023). Compared to other IRT models, which may exhibit parameter instability or require larger sample sizes for accurate estimation (Falani & Kumala, 2017; Nering & Ostini, 2011), the Rasch model offers a more parsimonious yet powerful framework for developing culturally responsive assessments. In the context of ethnomathematics, where cultural specificity and contextual relevance are paramount (Ergene et al., 2020; Ramalisa, Falani, & Pasaribu, 2023), the Rasch model facilitates the construction of instruments that are both psychometrically sound and culturally grounded. Thus, this study not only reinforces the methodological advantages of the Rasch model but also contributes to the broader discourse on equitable assessment practices in mathematics education.

In addition to its superior item information function, the Rasch model also yielded the lowest Standard Error of Measurement (SEM) values compared to the 1PLM, 2PLM, and 3PLM models. SEM serves as a critical indicator of measurement precision, with lower values reflecting greater consistency and reliability in estimating individual ability levels (Baker & Kim, 2017; Demars, 2010). The reduced SEM observed in the Rasch model suggests that the scores derived from this approach are less affected by random error, thereby enhancing the trustworthiness of the assessment outcomes. This finding is particularly significant in educational assessment, where the accuracy and reliability of measurement are essential to ensure that evaluations genuinely reflect learners' competencies. Previous studies have similarly emphasized the Rasch model's stability and efficiency in producing reliable estimates across diverse testing conditions (Falani et al., 2020b; Akhtar & Sumintono, 2023). By minimizing measurement error and maximizing interpretive clarity, the Rasch model reinforces its role as a robust psychometric framework for developing equitable and diagnostically powerful instruments in teacher education and beyond.

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The superior performance of the Rasch model observed in this study can be attributed to its foundational properties as a probabilistic measurement model. As a specific case of the one-parameter logistic model (1PLM), the Rasch model operates under the assumption that all test items possess equal discrimination power, and that item difficulty is invariant across individuals (Baker & Kim, 2017; Van der Linden & Hambleton, 1997). This assumption simplifies the model structure, enhancing its interpretability and facilitating the development of linear, sample-independent measures. In contrast, the two-parameter (2PLM) and three-parameter logistic models (3PLM) introduce additional complexity by allowing item discrimination and guessing parameters to vary, which, while potentially increasing model fit, may compromise parameter stability and interpretability, particularly in smaller samples (Falani & Kumala, 2017; Monroe & Cai, 2015). The Rasch model's parsimony and its capacity to produce invariant item and person estimates make it especially advantageous in educational assessment contexts where fairness, transparency, and diagnostic clarity are paramount (Akhtar & Sumintono, 2023; Toland, 2014). These characteristics reinforce the model's suitability for developing robust, culturally responsive instruments, as demonstrated in the present study.

A key advantage of the Rasch model lies in its fundamental property of placing both individuals and test items on a common latent trait scale, typically expressed in logits. This shared metric enables direct and meaningful comparisons between a respondent's ability level and the difficulty of each item, thereby facilitating precise interpretations of performance outcomes (Baker & Kim, 2017; Van der Linden, 2016). Such comparability is particularly valuable in educational assessment, where fairness, transparency, and consistency are essential to ensuring that test results accurately reflect individual competencies rather than being confounded by test-specific characteristics. By anchoring measurement on a unified scale, the Rasch model supports the development of equitable assessment instruments that are invariant across diverse populations and testing conditions (Akhtar & Sumintono, 2023; Falani et al., 2022). This property reinforces the model's utility in contexts where diagnostic accuracy and interpretive clarity are critical, such as in evaluating the ethnomathematical knowledge of prospective mathematics teachers.

Furthermore, the Rasch model provides a foundational framework for implementing adaptive assessment, wherein test items are dynamically tailored to match the ability level of each individual examinee. In such assessments, individuals demonstrating higher proficiency are presented with more challenging items, while those with lower ability levels receive relatively easier items. This targeted item administration enhances both the precision and efficiency of measurement by reducing the number of items required to obtain reliable ability estimates (Van der Linden & Hambleton, 1997; Chalmers, 2024). The Rasch model's unidimensional and probabilistic structure facilitates this adaptability by ensuring that item difficulty and person ability are placed on a common scale, allowing for real-time estimation and item selection. As a result, adaptive testing not only minimizes respondent burden but also

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maximizes the diagnostic value of each response, making it particularly advantageous in educational contexts where individualized assessment is essential for informed instructional decision-making (Akhtar & Sumintono, 2023; Falani et al., 2020b).

This study demonstrates that the application of the Rasch model enables a more accurate and consistent assessment of prospective mathematics teachers' ethnomathematical knowledge in Jambi Province. The findings reveal that, relative to the 1PLM, 2PLM, and 3PLM models, the Rasch model yields more precise estimates of individual ability and produces measurements with higher reliability. These advantages are attributed to the Rasch model's capacity to generate invariant item and person parameters, as well as its superior performance in minimizing measurement error and maximizing item information. Such psychometric robustness has significant implications for the design and implementation of teacher education programs, particularly in ensuring that assessment tools are both equitable and diagnostically informative. In the context of Jambi Province, these findings support the development of culturally responsive and methodologically sound evaluation frameworks that can enhance the quality of mathematics education and inform evidence-based improvements in teacher training.

The application of the Rasch model in educational assessment enables the development of teacher training programs that are responsive to individual competency levels. By providing precise estimates of each prospective teacher's ability, the Rasch model facilitates the design of differentiated training pathways that align with specific developmental needs. This individualized approach not only enhances the effectiveness of pedagogical interventions but also ensures that all candidates receive appropriate support to strengthen their understanding of ethnomathematics. In the context of Jambi Province, such targeted training strategies are essential for improving the overall quality of mathematics education and fostering culturally grounded instructional practices. The use of Rasch-based assessment thus contributes to a more equitable and evidence-informed framework for teacher preparation.

Additionally, the Rasch model also allows for fairer and more consistent assessments, which is important for ensuring that all individuals tested are treated fairly. By using the Rasch model, educational assessment can be carried out in a more transparent and reliable way, which in turn can increase public confidence in the education system.

However, although the Rasch model performed best in this study, it is important to remember that each model has advantages and disadvantages. The 1PLM, 2PLM, and 3PLM models also have their uses and can provide valuable information in different contexts. For example, 2PLM and 3PLM models can provide additional information about the discriminative power of test items, which can be useful in test development and test item analysis.

Apart from that, using the Rasch model also requires a deep understanding of the theory and basic assumptions of the model. Therefore, it is important for educators and researchers to receive adequate training in the use of the Rasch model and related data analysis techniques. This can help ensure that the model is used correctly and that the results obtained truly reflect the abilities of the individual being tested.

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The findings of this study offer substantial contributions to the field of mathematics education, particularly in the context of culturally responsive assessment. By validating the use of the IRT to measure ethnomathematical knowledge among prospective teachers, the research provides a psychometrically sound framework for evaluating competencies that are often overlooked in conventional assessments. This has practical implications for the design of teacher training programs, as it enables institutions to identify specific areas of strength and improvement with greater precision. Moreover, the study reinforces the importance of integrating local cultural knowledge into mathematics education, thereby promoting inclusivity and relevance in pedagogical practices. The methodological rigor demonstrated in this research also sets a precedent for future studies aiming to develop reliable instruments in diverse educational settings. Collectively, these contributions support the advancement of equitable assessment standards and inform policy decisions that seek to enhance the quality and cultural responsiveness of teacher education.

This research also opens up opportunities for further research. For example, future studies could explore the use of the Rasch model in different contexts, such as assessing ethnomathematics knowledge at higher educational levels or in different cultural contexts. In addition, further research could also explore the use of the Rasch model in the development and testing of more comprehensive and specific evaluation tools for ethnomathematics knowledge. Future studies could focus on developing and testing more comprehensive and specific evaluation tools for ethnomathematics knowledge. In addition, further research can also explore effective learning interventions to increase ethnomathematics knowledge in various educational contexts.

CONCLUSION AND SUGGESTION

The results of this study reveal that the application of the MTT approach can improve the accuracy of measuring ethnomathematical knowledge in prospective mathematics teachers in Jambi Province. Through the use of IRT, this study produces a more precise and reliable assessment instrument in evaluating the competence of prospective educators. These findings have important implications for the development of teacher education programs and improving the quality of mathematics learning in the region. Overall, this study confirms that the Rasch model is an effective and consistent option for improving the accuracy of measuring ethnomathematical knowledge in prospective mathematics teachers in Jambi Province. By using the Rasch model, educational assessment can be carried out in a more accurate, consistent and fair way, which in turn can improve the quality of education and public trust in the education system. This research also highlights the importance of developing and using valid and reliable evaluation tools in educational contexts, as well as the importance of adequate training for educators and researchers in the use of the Rasch model and related data analysis techniques. Thus, this research makes a significant contribution to the development of mathematics education in Jambi Province and opens up opportunities for further research in this field. Future research is encouraged to explore the development of Computerized Adaptive Testing (CAT)

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systems based on the Rasch model, which hold promise for delivering more efficient, individualized, and scalable assessments in teacher education.

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