Teachers' Belief in Ethnomathematics-Based Numeracy Learning Scale: A Rasch Model Analysis

Erni Puji Astuti [1,2], Ariyadi Wijaya [1], Farida Hanum [1]

[1] *Educational Science, Yogyakarta State University, Yogyakarta, Indonesia*
[2] *Department of Mathematics Education, Faculty of Training and Educational Science, Universitas Muhammadiyah Purworejo, Purworejo, Indonesia*

***Abstract* – Teachers' beliefs are a teacher's subjective perspective about teaching practices in the classroom, which influence the actions and decisions that will be taken in facilitating student learning activities. A scale can serve as an effective tool for assessing teachers' beliefs in ethnomathematics-based numeracy learning. This study aims to evaluate teachers' belief in ethnomathematics-based numeracy learning scale. The data analysis will employ the Rasch model and involve 75 mathematics teachers from junior high schools in Central Java. The teachers' belief in an ethnomathematics-based numeracy learning scale was initially subjected to content validation by three experts. The cumulative percentage outcomes are according to the four dimensions, namely teachers' beliefs about numeracy, teachers' beliefs about the role of ethnomathematics in numeracy learning, teachers' beliefs about ethnomathematics-based numeracy teaching, and teachers' beliefs about ethnomathematics-based numeracy learning, amount to 90.28% for a total of 20 items. Following this, the researchers utilized the Rasch model analysis to investigate teachers' belief in an ethnomathematics-based numeracy learning scale. The analysis involved the use of ten measurement features.**

Based on the results, it was deemed imperative to remove 30 individuals to maintain adherence to the predetermined criteria. Subsequently, the data obtained from the remaining 45 participants was analyzed using the Rasch model. The study of 20 teachers' belief items yielded three items, necessitating the exclusion of the privacy construct. The results indicate that the 17 questions possess robustness, validity, and reliability, rendering them suitable for assessing teachers' beliefs in ethnomathematics-based numeracy learning.

***Keywords* – Teachers' belief, ethnomathematics, numeracy skills, Rasch model.**

1. Introduction

Numeracy skill is a crucial competency that pupils are expected to possess in the 21st century. Programme for International Student Assessment (PISA) subsequently incorporated numeracy as one of its core dimensions, encompassing reading, mathematics, and scientific literacy. PISA emphasizes analyzing real-life situations and assessing individuals' capacity to enter the labor market effectively through acquiring essential skills, including literacy and numeracy [1]. Acquiring numeracy skills is essential for attaining educational accomplishments and succeeding in academic prosperity, psychological well-being, and future employment opportunities [2]. Numeracy encompasses applying mathematical principles and competencies to address practical challenges in daily life [3]. Students must utilize mathematical concepts in practical scenarios across several domains to foster the development of numeracy skills [4]. Students' numeracy skills can be enhanced by implementing various programs of learning. The learning design has been purposefully developed to foster the development of numeracy skills.

The level of student involvement in learning activities is significantly influenced by the teaching strategies implemented by the teacher.

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Corresponding author: Erni Puji Astuti,
Educational Science, Yogyakarta State University, Yogyakarta, Indonesia
Email: ernipuji@umpwr.ac.id

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Therefore, teachers must use teaching strategies that align with their students' needs. For example, by utilizing culture as an educational tool, students' numeracy skills can be improved. Teachers can develop pedagogical strategies that include ethnomathematics as a fundamental basis for acquiring knowledge. Ethnomathematics bridges the domains of mathematics and culture [5], [6], [7]. Several research investigations have explored the potential of ethnomathematics as an educational tool to encourage the development of numeracy skills. Traditional games can enhance pupils' numeracy skills [8]. Traditional Javanese games have been recognized as a promising cultural asset for improving numeracy skills in educational settings. Several studies have emphasized the potential of traditional Javanese gaming activities as a viable approach for the acquisition and application of mathematical ideas [9], [10], [11], [12], [13]. Another factor that is no less important in developing students' numeracy skills is teachers' beliefs.

Investigating teachers' beliefs and significance is a crucial aspect of study in teacher education. Beliefs are essential in shaping teachers' behavior and how they organize knowledge and information [14], [15]. The beliefs held by teachers regarding their students and the subject matter they teach are integral components of their overall belief systems [15], [16]. Consequently, a clearer understanding of teachers' beliefs can enhance teacher education programs and practices [17], [18] by providing valuable insights to facilitate teacher professional development. Teacher beliefs encompass a comprehensive belief system influenced by the socio-cultural environment and personal life encounters [15]. Teachers' beliefs encompass teachers' assumptions about their pupils, the classroom environment, and the subject matter to be imparted [19]. Teachers' beliefs can improve classroom learning practices, academic achievement, and child development outcomes [20], [21], [22]. Understanding the beliefs held by teachers is anticipated to influence the caliber of their instructional practices positively. This understanding can enable teachers to tailor their teaching approaches following individual students' unique requirements, thus fostering each learner's holistic development [23]. Teachers' beliefs significantly impact the learning objectives, explicitly enhancing student competency.

Evaluating in teachers' belief ethnomathematics-based numeracy learning scale is essential to know the strategies teachers will use in numeracy learning to maximize the potential of students' numeracy skills. Therefore, it is essential to use comprehensive and reliable tools to evaluate these views.

Several studies have been conducted to develop a teacher belief scale. A scale has been developed to test teachers' beliefs in evaluating mathematical reasoning. The empirical testing of the scale has been conducted using statistical methodology, namely Confirmatory Factor Analysis (CFA). The present study used the methods of Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) to test the validity of the mathematical thinking scale's confidence evaluation model. AMOS 25.0 statistical software was used for this purpose [24]. Other investigations have been undertaken to create assessment tools for gauging the teacher's beliefs of preschool teachers toward inquiry-based instructional practices. This study employs CFA to establish the validity of a theoretical model consisting of three subscales by assessing the adequacy of the model fit index [25]. Moreover, applying Exploratory Factor Analysis (EFA) approaches have been employed to develop a study instrument to capture preschool teachers' opinions about the natural sciences field [26]. Subsequent research has developed an instrument to measure teachers' epistemic beliefs about physics knowledge using EFA to obtain a mathematically valid instrument [27].

So far, no empirical investigation has yielded a validated instrument designed to assess teachers' beliefs in ethnomathematics-based numeracy learning, employing Rasch model analysis to examine the efficacy of the scale within this specific setting. This particular form of analysis has the potential to provide a comprehensive and reliable evaluation when applied to a limited sample size, allowing for a thorough review of research participants and item analysis. The determination of the scale's validity and reliability can be accomplished by the utilization of the Rasch model analysis. One kind of research that serves as an illustration pertains to the evaluation of social learning environments, with a particular focus on the platform of Facebook. This evaluation is conducted using the Online Social Learning Environment Instrument. This evaluation used Rasch model analysis, deliberately limiting the sample size to 23 participants [28]. In Rasch analysis, the sample size is usually relatively small. However, this may raise concerns about the need for higher precision and possible instability of item calibration. The application of Rasch analysis shows that reducing the sample size has minimal impact on assessing individual abilities [29]. Numerous studies have employed Rasch model analysis to ascertain the scale's validity and reliability. The research involved 40 participants in testing students' social perceptions of mathematics through psychometric analysis [30].

In addition, research was conducted to determine the statistical reasoning abilities of junior high school students in obtaining descriptive statistics using a sample size of 20 people [31]. Based on the research results, the use of Rasch model analysis has proven effective for establishing the validity and reliability of measurements, especially when dealing with a limited sample size. This research aims to evaluate teachers' beliefs about ethnomathematics-based numeracy learning scales.

2. Literature Review

2.1. Numeracy Skill

Numeracy skill refers to the ability to utilize mathematical concepts and skills to address practical difficulties across a range of everyday situations [3]. Numeracy skills necessitates use of mathematical concepts in diverse real-life situations across all academic disciplines [4]. Numeracy refers to an individual's capacity to apply mathematical knowledge to elucidate phenomena, resolve issues, or arrive at conclusions within daily existence [32]. The notion of numeracy encompasses more than just the utilization of numerical operations. Numeracy skills involve conceptual understanding and proficiency in mathematical thinking skills [33]. Consequently, numeracy entails comprehending mathematical concepts and the capacity to employ them effectively [32].

2.2. Ethnomathematics

The field of ethnomathematics examines the interplay between mathematics and culture [5]. Ethnomathematics is an educational initiative that enables students to conceptualize, generalize, and utilize multiple information sources, drawing upon their ideas, methods, and practices. The primary objective of this program is to foster the development of students' capacity to model real-world problems that emerge in various contexts and environments [34]. Ethnomathematics is an academic field that examines the cultural dimensions of mathematics as they are manifested through mathematical concepts taught in educational settings.

Traditional games possess cultural significance and have the potential to serve as valuable tools for facilitating mathematical education. Traditional games can enhance students' numeracy skills [8]. The cultural significance of traditional Javanese games has been acknowledged as a valuable resource for enhancing numeracy abilities within educational environments. The utilization of Javanese traditional game activities has been proposed as a feasible strategy for the acquisition and practical implementation of mathematical concepts [9], [35], [10], [11], [12], [13].

2.3. Teacher Belief

Teachers' beliefs encompass an individual teacher's subjective perspectives of particular matters or methodologies deemed accurate [36]. Teachers' beliefs play a crucial role in shaping teachers' actions in facilitating student learning activities. Teachers possess the capacity to discern their students' proficiency levels, enabling them to make informed decisions and adjustments in terms of behavior and learning strategies [15].

2.4. Teachers' Belief in Ethnomathematics-Based Numeracy Learning Scale

The scale evaluated in this research assessed teachers' belief in ethnomathematics-based numeracy learning. This scale has four dimensions: teachers' beliefs about numeracy, teachers' beliefs about the role of ethnomathematics in learning numeracy, teachers' beliefs about teaching numeracy-based ethnomathematics, and teachers' beliefs about learning numeracy-based ethnomathematics.

2.5. Rasch Model Analysis

The Rasch model is based on the theoretical foundation of item response theory, which allows assessing the probability of correct responses to test items and the degree of agreement with the rating scale items [37]. The Rasch model is utilized to forecast the likelihood of a correct response on a test by estimating two factors: the test items' difficulty and the test taker's competence. This estimation is achieved through establishing a joint continuity between the two variables [38]. A survey will implement substantial modifications and offer additional elucidation concerning student and group metrics via survey questions [39]. The utilization of the Rasch model in the development of accomplishment tests has several benefits, including enhanced precision, more objectivity, and greater measurement independence [30]. The Rasch model is utilized as a criterion for organizing the responses rather than solely as a statistical characterization of the responses. The Rasch model is employed to get a heightened degree of precision and impartiality in measurement to establish a more precise correspondence between the measuring instrument and the underlying attribute of the individual [40].

The use of the Rasch model analysis is a robust method for assessing the soundness and dependability of the instrument in measuring the construct [41]. The model analysis is a comprehensive and rigorous process, as it verifies the soundness and consistency of the instrument and provides a comprehensive evaluation of the survey participants. Similarly, it is possible to identify those who have yet to respond to the survey. The Rasch model analysis enables the categorization of individuals who demonstrate appropriate fit into several groups, determined by their proficiency level, as determined by Rasch probability.

Rasch measurement model can transform ordinal data into ratio data, facilitating appropriate data collection for various research investigations. This phenomenon can be ascribed to the high quality of the examined data, which is well-suited for rigorous analysis. Rasch model analysis can augment the validity of scales utilized in research endeavors. Furthermore, the Rasch model analysis can categorize each item inside the scale into discrete categories, encompassing those considered manageable, moderate, and complex. The Rasch model analysis allows for the simultaneous identification of redundant items and the evaluation of the rating scale utilized inside the scale. This research offers valuable insights into Cronbach's alpha coefficient, individual items' reliability, and individuals' dependability. The Rasch model analysis is widely acknowledged as a robust methodology developed to evaluate the reliability and validity of surveys.

The application of Rasch model analysis in the assessment of instruments is a commonly employed method in educational research, particularly within the education domain [42]. Several studies have employed this methodology within the realm of education and learning. For instance, one study examined the impact of teacher, parent, and school committee involvement on enhancing students' scientific attitudes in the context of science education [43]. Moreover, the study sought to conduct preliminary validation of a recently developed assessment tool for assessing instructional efficacy by measuring student engagement and learning outcomes [44]. Scale designed to evaluate computational thinking, particularly on student dispositions and attitudes [45]. In brief, prior research has demonstrated that applying Rasch model analysis is a robust and productive approach for producing items that possess both validity and reliability for specific measurement devices.

The Rasch model analysis is a robust evaluation technique employed to assess the validity of a measurement instrument [46]. The incorporation process provides empirical support for the association between the items scale and the individuals who respond to them [47], [48]. The analysis conducted in this study incorporates various components, including rating scales, items, individuals, and additional factors, such as raters [49]. Alternatively, the Rasch model analysis has enumerated 11 measurement attributes. These qualities are as follows: model is chosen, appropriate ordering categories, fit of items, fit of person, summary statistics, local independence of things, response dependency, unidimensionality, presence of Differential Item Functioning (DIF), targeting of the scale, and person separation reliability. Researchers have been driven to employ the Rasch model analysis to evaluate the performance of their measurement instruments in light of the empirical evidence that has been revealed through the application of validity and reliability testing. The analysis facilitates researchers' ability to track participants' replies to specific questions and determine the suitability or acceptance of each item within the scale [30], [44], [41]. The present study used Rasch model analysis to evaluate the scale measuring teachers' beliefs in numeracy learning based on ethnomathematics. In undertaking this endeavor, the objective is to address a deficiency in the current body of scholarly work by examining this approach's use in identifying dependable elements inside the measurement instrument. This particular approach will develop a comprehensive methodology for evaluating the soundness and consistency of a measurement scale.

3. Methods

3.1. Instrument

The instrument used in this research was a teachers' belief in an ethnomathematics-based numeracy learning scale. It was collected through the use of a scale covering four different dimensions. The dimensions of teachers' beliefs about numeracy can be categorized into four statements. The dimensions of teachers' beliefs about the role of ethnomathematics in learning numeracy can be categorized into six statements. Furthermore, the dimensions of teachers' beliefs about teaching numeracy-based-ethnomathematics can be categorized into four statements. Finally, the dimensions of teachers' beliefs about learning numeracy-based-ethnomathematics can be categorized into four statements. The teacher must respond to these statements to determine the characteristics of a teacher's beliefs in ethnomathematics-based numeracy learning.

In addition, a Likert scale was employed to assess teachers' beliefs, ranging from strongly agree, agree, strongly disagree, and disagree, with corresponding scores of 1 to 4 [50], [18]. Teachers' beliefs about numeracy are measured using statements 1, 2, 3, 4, and 5. In statements 7, 8, 9, 10, and 11, the teacher must demonstrate the cognitive processes involved in considering the significance of ethnomathematics in acquiring numeracy skills. Statements 13, 15, and 16 seek to evaluate teachers' beliefs in ethnomathematics-based numeracy learning. The measurements of teachers' beliefs in ethnomathematics-based numeracy learning are determined by statements 17, 18, 19, and 20. A summary of the dimensions and items included in the teachers' belief in ethnomathematics-based numeracy learning scale is provided in Table 1.

Table 1. Dimensions and items

Dimensions	Number of items	Total Items
Teachers' beliefs about numeracy	1, 2, 3, 4, 5, 6	6
Teachers' beliefs about the role of ethnomathematics in learning numeracy	7, 8, 9, 10, 11, 12	6
Teachers' beliefs about ethnomathematics-based numeracy teaching	13, 14, 15, 16	4
Teachers' beliefs about ethnomathematics-based numeracy learning	17, 18, 19, 20	4

3.2. Software

The software utilized in this investigation was WINSTEPS software version 3.72. The ten measurement qualities were assessed within the framework of the Rasch model analysis using the program.

3.3. Procedure of Analysis

The items were analyzed using Rasch model analysis, employing a rating scale item format in which respondents were required to respond on a four-point scale ranging from 1 to 4. In the context of positive statements, the numerical scale is as follows: 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 =strongly agree. In negative statements, the numerical scale is as follows: 1 = strongly agree, 2 = agree, 3 = disagree, and 4 = strongly disagree. The study assessed ten measurement properties of the Rasch model analysis, namely: (i) mean-square of person infit, (ii) z-standardized person infit, (iii) correlation between person and point measurements, (iv) mean-square of item infit, (v) z-standardized item infit, (vi) correlation between item and point measurements, (vii) measurement value of items, (viii) standardized residual correlations, (ix) dimensions, and (x) summary statistics.

3.4. Measurement Properties of Rasch Model Analysis

This study aimed to investigate the variations among participants by employing three measurement features: person infit MNSQ, person infit ZSTD, and person point measure correlation. After being discovered, the individuals in question are eliminated from the study, while the remaining healthy participants will proceed with the item analysis. In this study, the MNSQ item infit and ZSTD item infit analyses were conducted to assess the fit of the items. Subsequently, the item point size correlation was examined for items with a good fit. Subsequently, the process of an item over-selection was carried out by evaluating the measurement properties of the item measure values and standardized residual correlations on the instrument. A unidimensional assessment followed this to ascertain the instrument's validity in accurately measuring the elements that necessitate measurement. Statistical summary are examined to assess the dependability of both items and participants. The present study employed a research instrument to assess teachers' belief in ethnomathematics based numeracy learning. The instrument underwent rigorous analysis using the Rasch model, examining ten measurement features.

3.5. Participants

This study involved the participation of mathematics teachers from public and private junior high schools in three districts in Central Java, Indonesia. This study used a purposive sampling methodology. Purposive sampling is a method to select participants who intentionally provide relevant and essential data [55]. This method enables researchers to allocate limited resources effectively by identifying and choosing cases that align with their study objectives [56]. Purposive sampling is employed in this study as it allows for selecting respondents with the specific qualifications required, namely junior high school mathematics teachers, based on their teaching experience. A total of 75 junior high school mathematics teachers participated in the completion of the scale, with 49 teachers representing public junior high schools and 26 teachers representing private junior high schools. The teachers within the sample demonstrated a diverse array of teaching backgrounds. In this study, 35 teachers indicated they possessed less than five years of teaching experience, 14 teachers having teaching experience ranging from 5 to 10 years, while 12 teachers having a teaching experience between 10 and 15 years.

Furthermore, 14 teachers reported possessing 15 or more years of teaching experience. The attributes of the participants engaged in this study are displayed in Table 2.

Table 2. Characteristics of participants (n=75)

		Frequency	*Percentage (%)*
School	Public	49	65.3
	Private	26	34.7
Teaching experience	< 5 years	35	46.6
	5 ≤ years ≤ 10	14	18.7
	10 < years ≤ 15	12	16.0
	> 15 years	14	18.7

4. Result

4.1. Percent Agreement Validity of the Teachers' Belief in Ethnomathematics-Based Numeracy Learning Scale

The validity of the teachers' belief in ethnomathematics-based the numeracy learning scale on was determined by consulting three experts. These individuals occupied high-ranking academic positions at three distinct educational institutions in Indonesia. The main criterion for their selection was their considerable teaching experience spanning over 18 years and their recognized expertise in numeracy. The percentage agreement method obtained the assessor scores [57]. The assessors allocate scores to evaluate the constructs utilizing a scale of 1 to 3. A score of 1 signifies that the things under consideration lack suitability for measurement, while a score of 2 shows that the items possess the necessary attributes for measurement. Conversely, a score of 3 suggests that the items need improvement to be effectively measured. The findings demonstrate the level of agreement expressed as percentages for each construct, namely: teacher's beliefs about numeracy (88.89%), teacher's beliefs about the role of ethnomathematics in learning numeracy (88.89%), teachers' beliefs about teaching numeracy-based-ethnomathematics (83.33%), and teachers' beliefs about learning numeracy based-ethnomathematics (100%). Furthermore, it is worth noting that the validity of the teacher's belief in the ethnomathematics-based numeracy learning scale is 90.28%, as determined by the percent agreement.

4.2. Person Infit MNSQ and ZSTD of the Teachers' Belief in Ethnomathematics-Based Numeracy Learning Scale

Table 3 displays the results of the person-infit MNSQ and ZSTD analyses. Based on the preliminary analysis, it has been ascertained that eight individuals should be eliminated from the study due to their failure to meet the requirements for person infit MNSQ and ZSTD. The participants were: participant number R11_A (MNSQ: 2.63, ZSTD: 4.00), participant number R24_A (MNSQ: 2.44, ZSTD: 3.60), participant number R25_A (MNSQ: 1.90, ZSTD: 2.57), participant number R33_A (MNSQ: 0.50, ZSTD: -2.03), participant number R1_B (MNSQ: 0.40, ZSTD: -2.60), participant number R6_B (MNSQ: 0.37, ZSTD: -2.81), participant number R8_B (MNSQ: 3.66, ZSTD: 5.57), participant number R12_B (MNSQ: 0.26, ZSTD: -3.59), participant number R14_B (MNSQ: 2.75, ZSTD: 3.78), participant number R1_C (MNSQ: 2.80, ZSTD: 3.74), participant number R3_C (MNSQ: 3.12, ZSTD: 4.72), participant number R6_C (MNSQ: 0.31, ZSTD: -3.22), participant number R7_C (MNSQ: 0.29, ZSTD: -3.41), participant number R8_C (MNSQ: 2.03, ZSTD: -2.71), participant number R9_C (MNSQ: 0.36, ZSTD: -2.89), and participant number R8_D (MNSQ: 0.25, ZSTD: -3.71). Also, four individuals were excluded from the study due to their failure to meet the requirements for in-person MNSQ adherence. They were: participant number R12_A (MNSQ: 1.57), participant number R13_A (MNSQ: 1.63), participant number R16_A (MNSQ: 1.52), and participant number R34_A (MNSQ: 1.50).

Additionally, another eight subjects were excluded from the study due to their failure to conform to the individual infit ZSTD criteria. They were: participant number R1_A (ZSTD: −2.28), participant number R7_A (ZSTD: −2.00), participant number R8_A (ZSTD: −2.72), participant number R10_A (ZSTD: −3.52), participant number R30_A (ZSTD: −2.01), participant number R12_C (ZSTD: −2.48), participant number R5_D (ZSTD: −2.45), and participant number R9_D (ZSTD: −2.36).

In the subsequent analysis, the exclusion of one participant was necessary due to non-compliance with the person infit MNSQ and ZSTD criteria (participant R35_A; MNSQ: 1.75, ZSTD: 2.14). One participant had to be excluded due to non-compliance with the person infit MNSQ criteria (participant R6_D; MNSQ: 1.59). The optimal range for the MNSQ value of an individual is typically suggested to be between 0.4 and 1.5 [50], [51].

Similarly, the acceptable range for the ZSTD value of an individual is generally indicated to be between -2 and +2 [52]. A total of 23 participants, out of the initial sample size of 49, were excluded from the study due to their data falling outside the predetermined criteria range. Table 3 concisely overviews the Person Infit MNSQ and ZSTD teachers' beliefs within the ethnomathematics-based numeracy learning scale.

Table 3. Summary for person onfit MNSQ and ZSTD of the teachers' belief in ethnomathematics-based numeracy learning scale

Analysis	Participants number	Infit MNSQ	Infit ZSTD	Total Participants dropped
First	R1_A	0.45	-2.28	28
	R7_A	0.49	-2.00	
	R8_A	0.37	-2.72	
	R10_A	0.28	-3.52	
	R11_A	2.63	4.00	
	R12_A	1.57	1.78	
	R13_A	1.63	1.92	
	R16_A	1.52	1.63	
	R24_A	2.44	3.60	
	R25_A	1.90	2.57	
	R30_A	0.50	-2.01	
	R33_A	0.50	-2.03	
	R34_A	1.50	1.54	
	R1_B	0.40	-2.60	
	R6_B	0.37	-2.81	
	R8_B	3.66	5.57	
	R12_B	0.26	-3.59	
	R14_B	2.75	3.78	
	R1_C	2.80	3.74	
	R3_C	3.12	4.72	
	R6_C	0.31	-3.22	
	R7_C	0.29	-3.41	
	R8_C	2.03	2.71	
	R9_C	0.36	-2.89	
	R12_C	0.42	-2.48	
	R5_D	0.42	-2.45	
	R8_D	0.25	-3.71	
	R9_D	0.43	-2.36	
Second	R35_A	1.75	2.14	2
	R6_D	1.59	1.65	
Overall total				30

Note. MNSQ = Mean square, 0.4<x<1.5; ZSTD = z-standard, −2<x<+2.

4.3. Person Point Measure Correlation of the Teachers' Belief in Ethnomathematics-Based Numeracy Learning Scale

The study proceeded with a total of 45 participants. It underwent analysis using a person-point measure correlation to evaluate the teachers' belief in ethnomathematics-based numeracy learning scale. All 45 values supplied by the participants in this study were found to be positive, indicating that they were included in the future analysis.

In the context of the person-point measure, the correlation value for the person point measure is expected to exhibit a positive relationship [58]. All 45 participants completed the item analysis as required. The results of the person point measure correlation in the teachers' belief in an ethnomathematics-based numeracy learning scale are presented in Table 4.

Table 4. Person point measure correlation of the teachers' belief in ethnomathematics-based numeracy learning scale

Analysis	Participants number	Point measure correlation	Total participants dropped
First	R2_A	0.86	0
	R3_A	0.79	
	R4_A	0.63	
	R5_A	0.91	
	R6_A	0.82	
	R9_A	0.81	
	R14_A	0.59	
	R15_A	0.80	
	R17_A	0.82	
	R18_A	0.64	
	R19_A	0.66	
	R20_A	0.68	
	R21_A	0.71	
	R22_A	0.87	
	R23_A	0.73	
	R26_A	0.49	
	R27_A	0.76	
	R28_A	0.78	
	R29_A	0.72	
	R31_A	0.60	
	R32_A	0.60	
	R2_B	0.91	
	R3_B	0.86	
	R4_B	0.83	
	R5_B	0.66	
	R7_B	0.92	
	R9_B	0.88	
	R10_B	0.82	
	R11_B	0.73	
	R13_B	0.89	
	R2_C	0.79	
	R4_C	0.63	
	R5_C	0.30	
	R10_C	0.75	
	R11_C	0.76	
	R1_D	0.85	
	R2_D	0.75	
	R3_D	0.45	
	R4_D	0.59	
	R7_D	0.55	
	R10_D	0.77	
	R11_D	0.80	
	R12_D	0.56	
	R13_D	0.52	
	R14_D	0.60	
Overall total			0

Note. Point measure correlation = positive value.

4.4. Item Infit MNSQ and ZSTD on the Teachers' Belief in Ethnomathematics-Based Numeracy Learning Scale

The evaluation of the teachers' belief in the ethnomathematics-based numeracy learning scale, namely the 17 items in part B, was conducted using the MNSQ and ZSTD assessments. This evaluation was performed on the 45 respondents retained. Upon initial analysis, it was determined that two items did not meet the ZSTD infit item requirements, necessitating their removal. Two items, precisely item number P6 with a ZSTD score of 2.24 and item number P14 with a ZSTD score of -2.05, must meet the ZSTD criteria.

The MNSQ values of infit items should fall within the range of 0.4<x<1.5 [50], [51]. Similarly, the ZSTD values of infit items should be between −2<x<+2 [66]. Consequently, the privacy construct was excluded from the analysis due to the nonconformity of its items (namely, P6 and P14) with the ZSTD criterion for nonconforming items. Table 8 displays the outcomes of ZSTD infit items, which pertain to the assessment of the teachers' belief in ethnomathematics-based numeracy learning scale requiring elimination. Detailed information about scale items corresponding to MSNQ and ZTSD is in Table 5.

Table 5. Item infit MSNQ and ZTSD of the teachers' belief in ethnomathematics-based numeracy learning scale

Analysis	Item number	Infit MNSQ	Infit ZSTD	Total item dropped
First	P6	1.47	2.24	2
	P14	0.60	-2.05	
Second				0
Overall total				2

Note. MNSQ = Mean square, 0.4<x<1.5; ZSTD = z-standard, −2<x<+2

4.5. Item Point Measure Correlation of the Teachers' Belief in Ethnomathematics-Based Numeracy Learning Scale

Subsequently, the 17 remaining items underwent item point measure correlation analysis, which yielded favorable results for all 17 items. A negative link exists between the point measure correlation and item number P12, as indicated by a point measure correlation coefficient of -0.27. There is one item that has been omitted in this phase. Imperative that the correlation point of the analyzed item size yields a positive value [52]. Detailed information about item point measure correlation in scale is in Table 6.

Table 6. Item point measure correlation of the teachers' belief in ethnomathematics-based numeracy learning scale

Analysis	Item number	Point measure correlation	Total item dropped
First	P12	-0.27	1
Second	P1	0.41	0
	P2	0.34	
	P3	0.08	
	P4	0.13	
	P5	0.34	
	P7	0.60	
	P8	0.42	
	P9	0.41	
	P10	0.36	
	P11	0.41	
	P13	0.43	
	P15	0.55	
	P16	0.08	
	P17	0.45	
	P18	0.34	
	P19	0.46	
	P20	0.37	
Overall total			1

4.6. Item Measure Value of the Teachers' Belief in Ethnomathematics-Based Numeracy Learning Scale

Based on the results of the measurement values, all items (17 items) were retained because after the items were measured, there was not a single item in one dimension that produced the same measurement value. There are two items with the same measurement value, namely -0.72, item P9 in the teacher's beliefs about the role of ethnomathematics in learning numeracy, and item P16 in the teachers' beliefs about ethnomathematics-based numeracy teaching. There are two items, precisely item P10 in the dimension of teacher's beliefs about the role of ethnomathematics in learning numeracy and item P20 in the dimension of teachers' beliefs about ethnomathematics-based numeracy learning, with identical measurement value of -1.56. The summary of item measure value in scale is in Table 7.

4.7. Standardized Residual Correlations of the Teachers' Belief in Ethnomathematics-Based Numeracy Learning Scale

In the next stage, a standardized residual correlation was carried out on the remaining 17 items of the teachers' belief in the ethnomathematics-based numeracy learning scale. This analysis proved that all items were retained. This value should be < 0.7 [50]. The compliance of all items with this suggestion is illustrated in Table 8.

Table 7. Standardized residual correlations of the teachers' belief in ethnomathematics-based numeracy learning scale

Correlation	Item number	Item number
0.23	P1	P17
0.40	P2	P15
0.31	P3	P6
0.17	P4	P15
0.35	P5	P16
0.23	P6	P10
0.40	P7	P15
0.30	P8	P15
0.50	P9	P15
0.15	P10	P12
0.20	P11	P14
0.10	P12	P14
0.18	P13	P15
-0.10	P14	P16
0.28	P15	P17
0.01	P16	P17

Table 8. Summary of item measure value of the teachers' belief in ethnomathematics-based numeracy learning scale

Dimension	Item number	Measure value	Infit MNSQ	Infit ZSTD	Result	Total item dropped
Teacher's beliefs about the role of ethnomathematics in learning numeracy	P9	-0.72	0.98	-0.03	Retained	0
Teachers' beliefs about ethnomathematics-based numeracy teaching	P16	-0.72	1.08	0.43	Retained	0
Teacher's beliefs about the role of ethnomathematics in learning numeracy	P10	-1.56	0.82	-1.01	Retained	0
Teachers' beliefs about ethnomathematics-based numeracy learning	P20	-1.56	0.84	-0.84	Retained	0

Note. MNSQ = Mean square; ZSTD = z-standard.

4.8. Unidimensionality of the Teachers' Belief in Ethnomathematics-Based Numeracy Learning Scale

Total of 17 retained aspects encapsulating the teachers' belief in ethnomathematics-based numeracy learning scale were examined by unidimensionality analysis to establish their effectiveness in evaluating the teachers' beliefs. Within this particular framework, the residual Principal Component Analysis (PCA) was utilized to determine the percentage of raw variance explained by the measurements and the remaining unexplained variance in the initial comparison for the scale. The scale's validity in accurately measuring its intended construct, the former factor must possess a value over 50% [67].

On the contrary, the projected number for the latter portion is recommended to be below 15%. The results revealed that the raw variance explained by the measures was 56.1%, accompanied by an unexplained first contrast of 10.8%. These findings were seen before undertaking a Rasch model assessment of the scale. Following the evaluation, the values above transformed, documenting a percentage of 63.8% for the explained variance and 7.9% for the unexplained first contrast. This alteration signifies an upward shift in the explained variance and a downward shift in the unexplained first contrast. Therefore, the scale has been confirmed in terms of its validity. A description of the unidimensional results obtained from the scale is presented in Table 9.

Table 9. Unidimensionality of the teachers' belief in ethnomathematics-based numeracy learning scale

	Raw variance explained by measures (%)	Unexplained variance in first contrast (%)
Teachers' belief in ethnomathematics-based numeracy learning scale before using Rasch model analysis (i.e., before items were deleted)	56.1	10.8
Teachers' belief in ethnomathematics-based numeracy learning scale after using Rasch model analysis (i.e., after items were deleted)	63.8	7.9

4.9. Summary Statistics of the Teachers' Belief in Ethnomathematics-Based Numeracy Learning Scale

The subsequent phase involved examining the summary statistics of the remaining 17 items of the teachers' belief in the ethnomathematics-based numeracy learning scale. The study indicated that the person separation value was 4.19, which is considered a favorable [53] recommendation that this value be at least three or higher. The measure of person reliability was found to be 0.89, which falls within the acceptable range [53], which suggests a minimum value of 0.80. The Cronbach's alpha coefficient of 0.81 falls within the suggested range of > 0.80, indicating a satisfactory level of internal consistency [54]. The item separation value of 6.55, as determined by Fisher [53], can be considered excellent according to the specified criteria. The item reliability value of 0.98 can also be regarded as excellent [53]. The summary statistics for the 17 items are presented in Table 10.

Table 10. Summary statistics of the teachers' belief in ethnomathematics-based numeracy learning scale

Summary statistic	Value
Person separation	4.19
Person reliability	0.89
Item separation	6.55
Item reliability	0.98
Cronbanch's alpha	0.81

4.10. Robust Items of the Teachers' Belief in Ethnomathematics-Based Numeracy Learning Scale

Table 14 summarizes the 17 items considered robust in measuring teachers' beliefs in ethnomathematics-based numeracy learning scale, following the use of the Rasch model analysis. The first dimension, the teacher's beliefs about numeracy, was assessed using a set of five reliable items, specifically P1, P2, P3, P4, and P5. The second dimension, teachers' beliefs about the role of ethnomathematics in learning numeracy, was measured by five robust items, namely P7, P8, P9, P10, and P11. The third dimension, teachers' beliefs about ethnomathematics-based numeracy teaching, was measured by three robust items, namely P13, P15, and P16. The final dimension of the study focused on measuring teachers' beliefs about ethnomathematics-based numeracy learning was assessed using four reliable items, specifically P17, P18, P19, and P20.

5. Discussion

The main aim of this study was to evaluate the reliability of the teachers' belief in the ethnomathematics-based numeracy learning scale using Rasch model analysis. Before conducting the analysis, the agreement percentages were calculated, and it was determined that no items needed to be excluded from the analysis. Rasch model analysis can assess the appropriateness of an individual's suitability analysis. A total of 45 valid participants were recruited to investigate further the appropriateness of the instrument used to measure teachers' belief in ethnomathematics-based numeracy learning. In contrast, 30 participants were eliminated from the study due to their failure to meet the specified criteria, as indicated by the obtained data. Rasch model analysis to examine participants, even with small sample sizes ranging from 5 to 10 [50]. Therefore, a cohort of 45 participants was selected, and the research was determined to possess validity and reliability. Before the item analysis, any inconsistencies among participants were examined. It is recommended to remove participants and objects that may influence the research findings to maintain the integrity of the study [59].

The main aim of the current study was to evaluate the teachers' belief in ethnomathematics-based numeracy learning scale. A pre-analysis was conducted using the Rasch model analysis, specifically focusing on the percentage agreement of the items. In examining the infit items of the MSNQ and ZSTD, three specific items (P6, P12, and P14) were eliminated due to their lack of suitability within the context of the scale.

Based on the collected measurements, it was noted that all 17 items were retained, as none of the items within a particular dimension had identical measurement results.

Similarly, standardized residual correlations were used to analyze the other 17 items of the teachers' belief in ethnomathematics-based numeracy learning scale. The findings of this study demonstrated the successful retention of all pieces, and it was concluded that the suggested threshold for this value should be below 0.7 [50]. The teachers' belief in ethnomathematics-based numeracy learning scale is established by its unidimensionality. The observed improvement in its value supports this after eliminating three items. The current investigation reveals that all 17 items in the instrument exhibit a satisfactory fit. The examination of unprocessed variance supports the abovementioned metrics, which have risen from 56.1% to 63.8%. Furthermore, there has been a reduction in the unexplained variation observed in the initial contrast, with the percentage decreasing from 10.8% to 7.9%. The results produced in this study satisfy the requirements for conducting a unidimensionality analysis using the Rasch model, as suggested by Fisher [53]. This study supports employing a four-dimensional framework and a set of 17 questions for evaluating the teachers' belief in ethnomathematics-based numeracy learning scale.

The examination of the MSNQ and ZSTD infit items determined that two items, specifically P6 and P14, were excluded from the analysis due to their unsuitability of the teachers' belief in ethnomathematics-based numeracy learning scale. Items P6 and P14 fail to meet the ZSTD infit item criterion. According to the Point Measure Correlation analysis, a single item, specifically P12, was excluded from the dataset due to its negative value. The findings from the Rasch model analysis suggest that these three items cannot effectively assess the teachers' belief in ethnomathematics-based numeracy learning. An additional 17 items were selected to establish a positive association using the point measure, indicating its appropriateness for assessing the teachers' belief in ethnomathematics-based numeracy learning scale. Based on the obtained measurement values, all 17 items were kept, as none of the items within a single dimension yielded identical measurement values.

The standardized residual correlation test results on the remaining 17 items indicate that all items should be kept. The teachers' belief in ethnomathematics-based numeracy learning scale validity is established by its unidimensionality, as evidenced by all 17 items on the instrument aligning with this construct. This alignment is supported by the measures' initial raw variance, accounting for 56.1% of the total variance. Additionally, the unexplained first contrast was found to be 10.8%. These findings were obtained before conducting a Rasch model evaluation of the scale. It aimed to assess teacher beliefs in ethnomathematics-based numeracy learning and their impact on students' numeracy skills. After the evaluation, the figures above transformed, resulting in 63.8% and 7.9% percentages for the explained variance and unexplained first contrast, respectively. This alteration signifies an augmentation in the explained variance and a reduction in the unexplained first contrast. Therefore, the tool used to evaluate the teachers' belief in ethnomathematics-based numeracy learning scale has been duly validated. The results meet the minimum criteria for conducting unidimensional Rasch model analysis [53]. This indicates that the four components and their 17 items are valid to measure the teachers' belief in ethnomathematics-based numeracy learning scale.

Furthermore, it is worth noting that the teachers' belief in ethnomathematics-based numeracy learning scale, consisting of 17 items, has demonstrated robustness in its statistical analysis using the Rasch model. Specifically, the summary statistics indicate strong support for retaining all 17 items. The analysis yielded values of 4.19 for person separation, 0.89 for person reliability, 6.55 for item separation, and 0.98 for item reliability. The study results indicate that the initial two values are deemed acceptable. The latter two values are classified as excellent based on the criteria established by Fisher [53]. Furthermore, the values above effectively satisfy the minimum criteria established by Fisher [53] as per the evaluation scale, hence ensuring the quality of the instrument. Examining the Rasch model for the 17 items included in the teachers' belief in ethnomathematics-based numeracy learning scale revealed robust support, as evidenced by a high Cronbach's alpha score of 0.81. Previous study results confirm that an internal consistency value of more than 0.80 indicates a satisfactory level [54].

The findings of this study indicate that the teachers' belief in ethnomathematics-based numeracy learning scale is a valid instrument to assess teachers' beliefs. It was previously suggested that a range of 5 to 10 responses per item is considered adequate [50]. In this study, the number of respondents retained was 45 participants to be used in the item analysis of the teachers' belief in ethnomathematics-based numeracy learning scale. Utilizing the Rasch model for analysis does not necessitate a substantial number of participants. Furthermore, the study's examination of the instruments' robustness was strengthened through a secondary content analysis carried out by three expert individuals.

The teachers' belief in ethnomathematics-based numeracy learning scale, despite consisting of only 17 items, is regarded as a valid and trustworthy tool for assessing the teachers' belief in ethnomathematics-based numeracy learning. The instrument's effectiveness is not contingent upon its number of items but on its ability to accurately capture the intended constructs. Four questions can adequately measure a construct [60].

Three components are required to ensure internal reliability in measuring the construct [61]. It is recommended that a minimum of four to six elements be included to establish a measure's validity [62]. This study included a minimum of three items for each component. An item is deemed genuine when the preceding factor has a value beyond 50%, establishing the instrument's accuracy in measuring the desired construct. On the other hand, according to the study using the Rasch model, it is recommended that the proposed value for the final component is below 15%. The validity criteria have been satisfied by these 17 items. The above values were obtained after the removal of non-conforming items.

A Cronbach's alpha coefficient of 0.81 suggests solid internal consistency reliability. Therefore, the evaluation of teachers' beliefs in ethnomathematics-based numeracy learning scale through Rasch model analysis shows a high level of validity and accuracy in measuring teachers' beliefs in ethnomathematics-based numeracy learning. The items within the assessment exhibit a substantial degree of reliability when assessing teachers’ beliefs within the specific measurement context. The Rasch model analysis is well acknowledged for its ability to provide empirical evidence as a viable methodology for addressing measurement-related concerns, particularly those encountered in the administration of surveys [63].

6. Conclusion

This study provides a practical contribution by employing Rasch model analysis to establish the validity and reliability of the 17 questions comprising the scale measuring teachers' beliefs in ethnomathematics-based numeracy learning. The findings indicate that these items and a sample size of 45 respondents are valid and reliable. These 17 items undoubtedly contribute to the inclusion of rigorous items, the teachers' belief in ethnomathematics-based numeracy learning, which can be utilized to assess teachers' beliefs. The scale utilized in this study has been modified from its initial form, contributing to the existing body of literature with robust, substantial items for assessing teachers' beliefs in ethnomathematics-based numeracy learning, such as teacher's beliefs about numeracy, teacher's beliefs about role of ethnomathematics in learning numeracy, teachers' beliefs about ethnomathematics-based numeracy teaching, and teachers' beliefs about ethnomathematics-based numeracy learning. Moreover, this study makes a substantial contribution to the education field by applying the Rasch model analysis as an alternative approach for evaluating the context research method.

The items used in assessing teachers' beliefs in ethnomathematics-based numeracy learning scale were then subjected to a critical analysis, confirming their validity and reliability. This examination aimed to establish an acceptable scale for the assessment. Specifically, the study using the Rasch model indicates a decline in the privacy construct, and it was determined that just 17 items were suitable for accurately assessing teachers' belief in ethnomathematics-based numeracy learning. In the latter case, it is recommended that other researchers utilize Rasch model analysis as an alternate approach to assess surveys using a rigorous methodology. This study examines how the Rasch analysis model improves the scale's precision, consistency, and robustness.

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References:

[1]. OECD. (2018). PISA 2021 Mathematics framework.Oecd. Retrieved from: http://www.oecd.org/pisa/pisaproducts/pisa-2021-mathematics-framework-draft.pdf [accessed: 02 September 2023].

[2]. Conica, M., Nixon, E., & Quigley, J. (2023). Talk outside the box: Parents’ decontextualized language during preschool years relates to child numeracy and literacy skills in middle childhood. *Journal of Experimental Child Psychology*, *236*, 105746. Doi: 10.1016/J.JECP.2023.105746

[3]. Han, W., Susanto, D., Dewayani, S., Pandora, P., Hanifah, N., Miftahussururi, Nento, M. N., & Akbari, Q. S. (2017). *Numeracy literacy support materials.* Jakarta: Ministry of Education and Culture.

[4]. Goos, M., Geiger, V., & Dole, S. (2014). Transforming Professional Practice in Numeracy Teaching. In *Advances in Mathematics Education*. Springer. Doi: 10.1007/978-3-319-04993-9_6.

[5]. D’Ambrosio, U. (2001). What is ethnomathematics, and how can it help children in schools? *Teaching Children Mathematics*, *7*(6), 308.

[6]. D'Ambrosio, U., & Rosa, M. (2017). Ethnomathematics and its pedagogical action in mathematics education. In *Ethnomathematics and its Diverse Approaches for Mathematics Education,* 285–305. Springer. Doi: 10.1007/978-3-319-59220-6_12

[7]. Rosa, M., & Gavarrete, M. E. (2017). An ethnomathematics overview: An introduction. In *Ethnomathematics and its diverse approaches for mathematics education*, 3–19. Doi: 10.1007/978-3-319-59220-6_1

[8]. Samad, F., Salasa, M., & Ramadali, W. O. R. L. O. (2021). Improving numeracy skill through leng kali leng traditional game in learning early math to young learners. *Journal of Physics: Conference Series*, *1832*(1). Doi: 10.1088/1742-6596/1832/1/012031

[9]. Jabar, A., Gazali, R. Y., Ningrum, A. A., Atsnan, M. F., & Prahmana, R. C. I. (2022). Ethnomathematical exploration on traditional game bahasinan in gunung Makmur village the regency of Tanah Laut. *Mathematics Teaching-Research Journal*, *14*(5), 107–127.

[10]. Prahmana, R. C. I., Zulkardi, & Hartono, Y. (2012). Learning multiplication using Indonesian traditional game in third grade. *Journal on Mathematics Education, 3*(2), 115–132.

[11]. Risdiyanti, I., & Prahmana, R. C. I. (2018). Ethnomathematics: Exploration in Javanese culture. *Journal of Physics: Conference Series*. Doi: 10.1088/1742-6596/943/1/012032

[12]. Wijaya, A. (2008). Design research in mathematics education Indonesian traditional games as preliminaries in learning measurement of length. *Master Thesis. Utrecht: Utrecht University*, 1–122.

[13]. Wijaya, A., Van den Heuvel-Panhuizen, M., Doorman, M., & Veldhuis, M. (2018). Opportunity-to-learn to solve context-based mathematics tasks and students' performance in solving these tasks - Lessons from Indonesia. *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(10). Doi: 10.29333/ejmste/93420

[14]. Buehl, M. M., & Beck, J. S. (2015). The relationship between teachers' beliefs and teachers' practices. In H. Fives, & M. G. Gill (Eds.), *International handbook of research on teachers' beliefs,* 66–84. Abingdon, Routledge.

[15]. Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a Messy construct. *Review of Educational Research, 62*(3). Doi: 10.3102/00346543062003307

[16]. Tsangaridou, N. (2008). Trainee primary teachers' beliefs and practices about physical education during student teaching. *Physical Education and Sport Pedagogy, 13*(2), 131–152. Doi: 10.1080/17408980701345667

[17]. Calderhead, J. (1996). Teachers: Beliefs and knowledge. In D. C. Berliner, & R. C. Calfee (Eds.), *Handbook of educational psychology*, 709–725. New York: Macmillan.

[18]. Sullivan, G. M., & Anthony R. Artino, J. (2013). Analyzing and interpreting data from Likert-type scales. *Journal of Graduate Medical Education*, 5(4), 541. Doi: 10.4300/JGME-5-4-18

[19]. Kagan, D. M. (1992). Implication of research on teacher belief. *Educational Psychologist*, *27*(1), 65–90. Doi: 10.1207/S15326985EP2701_6

[20]. Kim, Y. A., Kim, J., & Jo, Y. J. (2023). Teacher efficacy and expectations of minority children: The mediating role of teachers' beliefs about minority parents' efficacy. *International Journal of Educational Research*, *120,* 102190. Doi: 10.1016/J.IJER.2023.102190

[21]. Rubie-Davies, C. M., Flint, A., & McDonald, L. G. (2012). Teacher beliefs, teacher characteristics, and school contextual factors: What are the relationships? *British Journal of Educational Psychology*, *82*(2), 270–288. Doi: 10.1111/J.2044-8279.2011.02025.X

[22]. Tan, M., & Saw Lan, O. (2011). Teaching mathematics and science in English in Malaysian classrooms: The impact of teacher beliefs on classroom practices and student learning. *Journal of English for Academic Purposes*, *10*(1), 5–18. Doi: 10.1016/J.JEAP.2010.11.001

[23]. Hakkarainen, A., Cordier, R., Parsons, L., Yoon, S., Laine, A., Aunio, P., & Speyer, R. (2023). A systematic review of functional numeracy measures for 9–12 -year-olds: Validity and reliability evidence. *International Journal of Educational Research, 119,* 102172. Doi: 10.1016/J.IJER.2023.102172

[24]. Alhunaini, S., Osman, K., & Abdurab, N. (2022). Development and validation of teachers' assessment belief of mathematical thinking instrument. *European Journal of Educational Research*, *11*(1), 179–191. Doi: 10.12973/eu-jer.11.1.179

[25]. Gavora, P., & Wiegerová, A. (2019). Development of an instrument to measure preschool teachers ́ beliefs in inquiry-based activities. *Journal of Baltic Science Education*, *18*(4), 558–568.

[26]. Draganoudi, A., Kaliampos, G., Lavidas, K., & Ravanis, K. (2023). Developing a research instrument to record pre-school teachers' beliefs about teaching practices in natural sciences. *South African Journal of Education*, *43*(1), 1–16. Doi: 10.15700/saje.v43n1a2031

[27]. Watson, E. (2020). The slippery business of measuring beliefs: lessons from a failed attempt at developing an instrument to measure teachers' epistemic beliefs about Physics knowledge. *Electronic Journal for Research in Science & Mathematics Education, 24*(2), 119–140.

[28]. Che Lah, N. H., Tasir, Z., & Jumaat, N. F. (2022). An evaluation of the Online Social Learning Environment Instrument (OSLEI) using Rasch model analysis. *SAGE Open*, *12*(2), 1–16. Doi: 10.1177/21582440221104083

[29]. O'Neill, T. R., Gregg, J. L., & Peabody, M. R. (2020). Effect of Sample Size on Common Item Equating Using the Dichotomous Rasch Model. *Applied Measurement in Education*, *33*(1), 10–23. Doi: 10.1080/08957347.2019.1674309

[30]. Al Ali, R. M. A., & Shehab, R. T. (2020). Psychometric properties of social perception of mathematics: Rasch model analysis. *International Education Studies*, *13*(12), 102. Doi: 10.5539/ies.v13n12p102

[31]. Ramadhani, R., Saragih, S., & Napitupulu, E. E. (2022). Exploration of students' statistical reasoning ability in the context of ethnomathematics: a study of the Rasch model. *Mathematics Teaching-Research Journal*, *14*(1), 138–168.

[32]. Wijaya, A & Dewayani, S. (2021). Framework Asesmen Kompetensi Minimum (AKM). In *Kementerian Pendidikan dan Kebudayaan*.

[33]. Cockcroft, W.H. (1982). *Mathematics counts*. Report of the Committee of Inquiry into the Teaching of Mathematics in Schools in England and Wales.

[34]. Rosa, M., & Orey, D. C. (2015). A trivium curriculum for mathematics based on literacy, matheracy, and technoracy: an ethnomathematics perspective. *ZDM - International Journal on Mathematics Education, 47.* Doi: 10.1007/s11858-015-0688-1

[35]. Kamid, K., Rohati, R., Hobri, H., Triani, E., Rohana, S., & Pratama, W. A. (2022). Process skill and student's interest for mathematics learning: playing a traditional games. *International Journal of Instruction*, *15*(3), 967–988. Doi: 10.29333/iji.2022.15352a

[36]. Russo, J., Bobis, J., Downton, A., Hughes, S., Livy, S., McCormick, M., & Sullivan, P. (2020). Elementary teachers' beliefs on the role of struggle in the mathematics classroom. *The Journal of Mathematical Behavior*, *58*, 100774. Doi: 10.1016/J.JMATHB.2020.100774

[37]. Shea, T., Cooper, B. K., de Cieri, H., & Sheehan, C. (2012). Evaluation of a perceived organisational performance scale using Rasch model analysis. *Australian Journal of Management, 37*(3), 507–522. Doi: 10.1177/0312896212443921

[38]. De Batisti, F., Salini, S., & Crescentini, A. (2004). *Statistical calibration of psychometric tests*. Dipartimento Di Economia Politica e Aziendal. University Degli Studidi Milan.

[39]. Boone, W. J. (2016). Rasch analysis for instrument development: Why,when,and how? *CBE Life Sciences Education*, *15*(4).

[40]. Nunnally, J. C. (1994). *Psychometric Theory 3E.* Tata McGraw-Hill Education. New York.

[41]. Mofreh, S. A. M., Ghafar, M. N. A., Hj Omar, A. H., Mosaku, M., & Ma'ruf, A. (2014). Psychometric properties on lecturers' beliefs on teaching function: Rasch model analysis. *International Education Studies*, *7*(11), 47. Doi: 10.5539/IES.V7N11P47

[42]. Bode, R. K., & Wright, B. D. (1999). *Rasch measurement in higher education*. In Higher education: Handbook of theory and research, 287–316. Springer, Dordrecht.

[43]. Suryandai, K. C., Rokhmaniyah, Salimi, M., & Fatimah, S. (2022). Involvement of teachers, parents, and school committees in improving scientific attitudes of elementary school students: application of Rasch model analysis. *International Journal of Educational Methodology*, *8*(4), 783–794. Doi: 10.12973/ijem.8.4.783

[44]. Liu, R. (2022). Rasch-based measurement development: a formative evaluation instrument for college teaching. *AERA Online Paper Repository.* Doi: 10.3102/1577190

[45]. Sovey, S., Osman, K., & Matore, M. E. E. M. (2022). Rasch analysis for disposition levels of computational thinking instrument among secondary school students. *Eurasia Journal of Mathematics, Science and Technology Education*, *18*(3), 2–15. Doi: 10.29333/ejmste/11794

[46]. Bond, T. G., & Fox, C. M. (2007). *Applying the Rasch model: Fundamental measurement in the human sciences* (2nd edition). Psychology Press.

[47]. Coe, R. (2008). Comparability of GCSE examinations in different subjects: An application of the Rasch model. *Oxford Review of Education, 34*, 609–636.

[48]. Wilmot, B. D., Schoenfeld, A., Wilson, M., Champney, D., & Zahner, W. (2011). Validating a learning progression in mathematical functions for college readiness. *Mathematical Thinking and Learning*, *13*, 259–291.

[49]. Pomeranz, J. L., Byers, K. L., Moorhouse, M. D., Velozo, C. A., & Spitznagel, R. J. (2008). Rasch analysis as a technique to examine the psychometric properties of a career ability placement survey subtest. *Rehabilitation Counseling Bulletin*, *51*(4), 251–259.

[50]. Linacre, J. M. (2002). What do infit, outfit, mean-square and standardise mean? *Rasch Measurement Transactions*, *16*, 878.

[51]. Wright, B. D., Linacre, M., Gustafsson, J. E., & Martin-Loff, P. (1994). Reasonable mean-square fit values. *Rasch Measurement Transactions*, *8*(3), 370.

[52]. Aziz, A. A., Masodi, M. S., & Zaharim, A. (2013). *Asas model pengukuran Rasch: Pembentukan skala dan struktur pengukuran*. Penerbit Universiti Kebangsaan Malaysia.

[53]. Fisher, W. P. J. (2007). Rating scale instrument quality criteria. *Rasch Measurement Transaction*, *21*(1), 1095.

[54]. Ghandi, P. S. (2012). Calculating and interpreting reliability estimates for achievement test in graph theory (a modern branch of mathematics). *International Indexed & Referred Research Journal*, *5*, 36–38.

[55]. Kelly, S. E., Bourgeault, I., & Dingwall, R. (2010). Qualitative interviewing techniques and styles. *The SAGE handbook of qualitative methods in health research*, *19*, 307-326.

[56]. Palinkas LA, Horwitz SM, Green CA, et al. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research* , *42*(5), 533–544.

[57]. Nordin, A. B., & Bakar, B. A. (2008). *Penaksiran dalam pendidikan dan sains sosial*. Universiti Pendidikan Sultan Idris.

[58]. Smith, E. V. (2004). Evidence for the Reliability of Measures and Validity of Measure Interpretation: A Rasch Measurement Perspective. *Journal of applied measurement*, *2*(3), 281.

[59]. Pallant, J. F., & Tennant, A. (2007). An introduction to the Rasch measurement model: an example using the Hospital Anxiety and Depression Scale (HADS). *British Journal of Clinical Psychology, 46*(1), 1–18.

[60]. Harvey, R. J., Billings, R. S., & Nilan, K. J. (1985). Confirmatory factor analysis of the Job Diagnostic Survey: Good news and bad news. *Journal of Applied Psychology*, *70*(3), 461–468. Doi: 10.1037/0021-9010.70.3.461

[61]. Cook, J. D., Hepworth, S. J., Wall, T. D., & Warr, P. B. (1981). *The experience of work*. Academic Press.

[62]. Hinkin, T. R. (1998). A brief tutorial on the development of measures for use in survey questionnaires. *Organizational Research Methods*, *1*(1), 104–121. Doi: 10.1177/109442819800100106

[63]. Salzberger, T. (2000). An alternative way of establishing measurement in marketing research-its implications for scale development and validity. *ANZMAC 2000 visionary marketing for the 21st century: Facing the challenge*, 1111–1117. Griffith University, School of Marketing and Management.