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Original Research Paper

THE MANY-FACET RASCH MODEL (MFRN) IN THE ANALYSIS OF INSTRUMENTS MEASURING TEACHERS' ATTITUDES TOWARDS EARTHQUAKE DISASTER PREPAREDNESS IN INDONESIA

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ABSTRACT

Background: The assessment instrument for teachers' attitudes towards earthquake disaster preparedness in schools is a crucial tool in ensuring that schools have an effective emergency plan and that teachers possess the knowledge and skills required to enhance school safety and preparedness in the face of potential earthquakes. This research aims to measure the validity and reliability of the instrument used to assess teachers' attitudes towards disaster preparedness in schools.

Materials and Methods: This study employed a survey research design with an exploratory quantitative approach using Many-Facet Rasch Model (MFRN) analysis. The data used for the analysis of the assessment instrument measuring teachers' attitudes towards earthquake disaster preparedness in schools were field data obtained from a survey conducted by three raters assessing 33 elementary school teachers in Palu City. The instrument consisted of 20 items, resulting in a total of 1980 collected data points.

Results: The analysis using the Many-Facet Rasch Model for assessing teachers' attitudes towards earthquake disaster preparedness in schools yielded significant insights into the characteristics of the instrument and participant responses. The item reliability value was 0.94, indicating that the instrument's quality falls within the "excellent" criteria with a high level of reliability. However, the analysis results indicated that some items assessing teachers' attitudes towards earthquake disaster preparedness in schools had a high level of difficulty. This suggests the need for further examination of disaster preparedness topics in specific areas that teachers may not be adequately prepared for. There was a significant variation in teachers' abilities to answer the instrument's items, highlighting the necessity for a more differentiated approach. Teachers with lower abilities should receive additional assistance and support to ensure that they can also enhance their preparedness. This is essential to ensuring that all schools have adequate understanding and optimal preparedness in the face of potential earthquakes, safeguarding the safety of students and school staff.

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INTRODUCTION

Disaster is defined as an event or a series of events that threaten and disrupt the lives and livelihoods of communities caused by natural, non-natural, or human factors, resulting in loss of life, environmental damage, property damage, and psychological impacts, in accordance with Law No. 24 of 2007 in Indonesia[1]. According to global disaster occurrence data, from 1998 to 2017,

there were 3,148 flood events, 2,049 storms, 563 earthquakes, 405 extreme temperature changes, 378 landslides, 347 droughts, 254 forest fires, 99 volcanic eruptions, and 12 ground shifts. More than 3 billion people suffered property losses as a result of 1,330,723 deaths. From January 2019 to 2020, Indonesia experienced 4,429 disasters, including 1,027 floods, 849 landslides, 788 others, including forest and land fires, 124 droughts, 31 earthquakes, 20 tides and erosion, and seven volcanic eruptions. The number of damaged houses amounted to 11,468 houses, and damage to public facilities, including infrastructure, comprised 152 educational facilities, 128 places of worship, 15 healthcare facilities, 48 offices, and 112 bridges. According to Laily (2020), last night also claimed 7,273,924 casualties, with 3,586 displaced, 114 missing, and 587 deceased[2].

Being located at the convergence of three tectonic plate boundaries, Indonesia is situated in one of the most earthquake-prone zones in the world. Additionally, global weather patterns influence Indonesia's climate, leading to frequent disasters during seasonal transitions in the country. According to the Disaster Data and Information Centre of the National Disaster Management Agency (BNPB), there were 4,650 disasters in Indonesia in 2020, resulting in 418 fatalities and 6,796,707 people being displaced. Besides geographical factors, there are also human resource factors contributing to the lack of knowledge regarding disaster preparedness and mitigation among many individuals. Therefore, disseminating information about disaster preparedness is crucial to making the population better prepared to protect themselves and their loved ones in times of disaster[3].

With an area of 61,841.29 square kilometres, Central Sulawesi is the largest province on the island of Sulawesi and has the highest incidence of natural disasters[4]. Throughout the years 2016–2020, a total of 251 natural disasters, primarily floods and earthquakes, occurred in several cities and administrative regions in Central Sulawesi, according to secondary data based on disaster statistics provided by the National Disaster Management Agency (BNPB)[5]. Due to its high tectonic activity, the city of Palu is considered earthquake-prone. This is because Palu sits on a significant fault line known as the Palu-Koro Fault, part of the Maankuori fault system, stretching approximately 500 kilometres from the Makassar Strait to the northern coast of Bone Gulf. On land, the fault passes through the city centre until it reaches the Lariangi River in the Pipikoro Valley. On September 28, 2018, a magnitude 7.4 earthquake triggered a tsunami that struck the western coast of Sulawesi Island. The earthquake's epicentre was at a depth of 10 kilometres, 26 kilometres north of Donggala Regency and 80 kilometres northwest of Palu City. The earthquake resulted in a 5-metre-high tsunami in Palu City. According to the BNPB, the earthquake and tsunami claimed the lives of 2,256 people. The distribution of casualties included 1,703 people in Palu, 171 in Donggala, 366 in Sigi, 15 in Parigi Moutong, and 1 in Pasangkayu. Many infrastructure structures were destroyed as a result of the earthquake and tsunami. The damage included 68,451 houses, 327 places of worship, 265 schools, 78 offices, 362 shops, 168 cracked roads, 7 bridges, and more. The disaster caused losses amounting to Rp 13.82 trillion[6].

Disaster education in schools is an effective, dynamic, and sustainable way to teach disaster preparedness to students. Schools provide an excellent platform to impart information, knowledge, and skills related to disaster preparedness to those in their vicinity[7]. Schools are vulnerable to the impacts of disasters, and by incorporating disaster education at the school level, their

preparedness will assist the government in enhancing the safety and resilience of schoolchildren while minimising disruptions to education in the event of a disaster. This approach also reduces disaster-related losses and improves social cohesion[8]. Teachers, as the focal point in schools, play a crucial role in helping students understand the various elements necessary for disaster preparedness. It is evident that a teacher's readiness to face disasters will serve as a primary foundation for instilling disaster awareness in students. The preparedness of both teachers and students will reduce the likelihood of disaster impacts[9].

The development of an assessment instrument for teachers' attitudes towards earthquake disaster preparedness in schools is highly important because it has an overall positive impact that helps enhance the safety of students and school staff. It improves teachers' awareness and readiness for earthquake risks, aids in better emergency planning, motivates teacher participation in preparedness training, measures progress in enhancing preparedness over time, and ensures compliance with existing regulations and guidelines. All of these efforts are aimed at safeguarding the safety and preparedness of schools in the face of potential earthquakes. The assessment instrument for teachers' attitudes towards earthquake disaster preparedness in schools is a vital tool in ensuring that schools have effective emergency plans and that teachers possess the knowledge and skills necessary to protect students and staff during disasters. In doing so, this instrument contributes to improving the safety and preparedness of schools in the event of potential earthquakes.

The use of the Many-Facet Rasch Model (MFRM) in measuring teachers' attitudes towards earthquake disaster preparedness in schools will enhance the significance of addressing the multi-dimensional complexity and minimise the effects of various factors influencing responses, including interactions between raters, item characteristics, and individual aspects. By being able to identify and separate relevant dimensions, MFRM enhances the validity and reliability of measurement instruments[10,11], providing a deeper understanding of the variability in teacher responses. Valid and reliable instruments for measuring teachers' attitudes towards earthquake disaster preparedness in schools play a crucial role. Instrument accuracy ensures that the collected data reflects true attitudes, while reliability ensures consistent measurement results over time[12]. A good instrument also allows for comparisons between regions or groups of teachers, promotes awareness of the importance of disaster preparedness, and assists in designing appropriate training programs. Thus, valid and reliable instruments are not only measurement tools but also tools for planning, improving, and educating to reduce the impact of earthquake disasters in schools.

The use of valid and reliable instruments in measuring teachers' attitudes towards earthquake disaster preparedness in schools and the resulting impacts represent the novelty of this research. While the concept of measuring teachers' attitudes towards disaster preparedness is not new, the implementation of robust instruments can yield more accurate and consistent data, which, in turn, allows for more effective planning and precise evaluation of disaster preparedness efforts. With the presence of good instruments, the potential for comparing data across regions, enhancing awareness of the importance of preparedness, and designing appropriate training programmes can be optimised. Furthermore, the emphasis on instrument validity and reliability reflects a deeper scientific approach to understanding teachers' attitudes towards disaster preparedness and provides a strong foundation for ongoing improvements in

preparedness efforts within the school environment.

SUBJECTS AND METHODS

Study design and setting

This research is a survey study with an exploratory quantitative approach. The study will utilise quantifiable data, specifically teachers' responses to an instrument measuring their attitudes related to earthquake disaster preparedness in schools. The exploratory approach was chosen because this research aims to delve into the factors influencing teachers' attitudes and preparedness through the analysis of the Many-Facet Rasch Model. The goal is to gain an in-depth understanding of the dynamics behind teachers' responses and identify relevant factors. This research applies the Many-Facet Rasch Model (MFRM) to measure teachers' attitudes towards earthquake disaster preparedness in schools.

Study participants and sampling

This research involves teachers from various schools located in the city of Palu, Central Sulawesi Province, Indonesia, one of the earthquake-prone regions, serving as the research sample. The sample selection process was carried out by choosing several schools that represent variations in geographical areas. From each school, teachers who are willing to participate will be selected as respondents. An adequate sample size is determined to ensure sufficient representation in the many-facet Rasch model analysis and reliable results.

Data collection tool and technique

Before data collection, the validity of the instrument's content was ensured. The initial step involved forming an expert team to evaluate each statement in the instrument related to disaster preparedness. The expert team consisted of language experts and experts in education and communication. Feedback from the expert team provided insights into the clarity, relevance, and complexity of the statements. Instrument revisions were made based on this feedback to ensure that the statements accurately reflected the concept of preparedness. A pre-test was conducted with a group of teachers to uncover their understanding and interpretation of the revised instrument. Feedback from the pre-test teachers was analysed to improve statements that were still ambiguous or not suitable. The final step involved a reevaluation by the expert team to ensure that the instrument met content validity standards, thereby guaranteeing the accuracy and appropriateness of the instrument in measuring the dimension of teachers' attitudes towards earthquake disaster preparedness in schools.

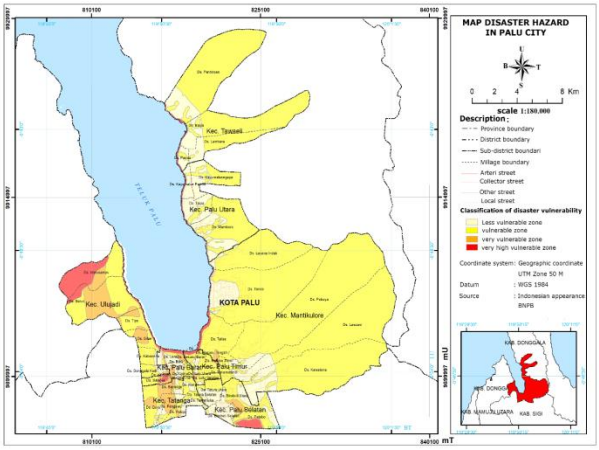


Figure 1. Map Disaster Hazard in Palu City

The data used in the analysis of the instrument assessing teachers' attitudes towards earthquake disaster preparedness in schools are field data obtained from a survey conducted by three raters who assessed 33 elementary school teachers. The instrument consists of 20 items, resulting in a total of 80 data points. The selected schools represent schools in each district of Palu City. Specifically, eight elementary schools in Palu City, Central Sulawesi Province, were involved in the survey, conducted over four months (March–June 2023). The sample selection was done proportionally across all districts in Palu City, considering that all districts in Palu City are categorised as

disaster-prone areas (Figure 1). The instrument measuring teachers' attitudes towards earthquake disaster preparedness in schools consists of dimensions, each comprising two statement items for each dimension (Table 1). This means there are 20 statement items in the instrument. This instrument uses a modified Likert scale, ranging from "highly agree" with a score of 3, "agree" with a score of 2, to "disagree" with a score of 1, to measure the level of teachers' responses to each statement. Each dimension and statement is designed to cover various aspects of teachers' attitudes towards earthquake disaster preparedness in schools.

Table 1. Instrument Items for Assessment of Teacher Attitudes towards Earthquake Disaster Preparedness in Schools

Aspect	Item	Item Number
Preparedness Knowledge	Participants have an understanding of preparedness steps when an earthquake occurs	1
	Participants know what to do after an earthquake occurs at school	2
Engagement in Practice	Participants often participate in earthquake simulation drills at school	3
	Participants felt that preparedness training was very important to be carried out regularly	4
Personal Readiness	Participants have a supply of basic necessities such as water and food in a personal bag at school	5
	Participants felt personally prepared to face emergency situations resulting from earthquakes	6
Evacuation Planning	Participants know the location of a safe meeting point after evacuation due to an earthquake	7
	Participants have an understanding of the evacuation route that must be followed	8
Understanding of Risk	Participants are aware of the risk of earthquakes in the areas where they teach	9
	Participants understand the impact that an earthquake might have on schools	10
Commitment to Preparedness	Participants are committed to continuing to improve disaster preparedness in schools	11
	Participants felt they had a responsibility to maintain student safety during an earthquake	12
Participation in Training	Participants have attended disaster preparedness training held by the school	13
	Participants found such training very helpful in understanding preparedness measures	14
Emergency Plan Readiness	Participants know how to access the school's emergency plan in the event of an earthquake	15
	Participants have an understanding of my role in implementing emergency plans	16
Important Contact Information	Participants know the emergency telephone numbers to call after an earthquake occurs	17
	Participants have a list of important contacts who can be contacted in an emergency situation	18
Communication in Preparedness	Participants felt that good communication with co-teachers and school staff was important in an emergency situation	19
	Participants know how to communicate well during an earthquake.	20

The basic concept of the Many-Facet Rasch Model (MFRM) is to estimate how well a group of items (questions or statements) functions as a measure of a hidden characteristic (latent trait) while accounting for various sources of variation, such as different raters, different items, and so on. The model in the Many-Facet Rasch Model (MFRM) used to measure teachers' attitudes towards earthquake disaster preparedness in schools involves equations and variables that enable the analysis of response data from various interacting factors. MFRM can be represented by the following equation:

$$\log\left(\frac{P(i,j,k,m)}{1-P(i,j,k,m)}\right) = Di + Fj + Gk + Hm - B(i,j,k,m)$$

Where:

Di : Difficulty parameter of item i
Fj : Ability parameter of person j
Gk : Rater severity parameter of rater k
Hm : Category parameter for category m
B(i,j,k,m) : Bias or interaction term specific to the combination of item i, person j, rater k, and category m

The MFRM analysis in solving this equation aims to obtain estimates of the involved parameters, namely, the level of teachers' responses to each dimension, item characteristics, and other influencing factors. This equation-solving method will yield interpretable values that depict the extent of teachers' attitudes towards earthquake disaster preparedness in schools and the factors influencing them. Data analysis is performed using the Manifac software (Facets Rasch).

Ethical consideration

In adhering to ethical considerations, the researcher obtained informed consent from participants who willingly participated in this study, both from trained raters and participants. The researcher ensured the confidentiality of respondents regarding the statements provided in this research. This study also obtained ethical approval from the Research Ethics Commission of the Faculty of Medicine, Health Science University of Muhammadiyah Makassar, with Ethical Approval Recommendation Number: 329/UM.PKE/III/2023.

RESULTS

The results of this research provide information about the psychometric characteristics of each item in the instrument. The analysis in this study includes assessments of unidimensionality assumption, model fit testing (item fit), vertical ruler, test information function, diagnostic rating scale, and rater consistency. The measurement of teachers' attitudes towards earthquake disaster preparedness in schools encompasses individual factors (comprising educational background and experience), item factors (characteristics of questions in the instrument), rater factors (trained raters or enumerators assessing teachers), and dimension factors (aspects of attitudes towards preparedness). These factors are part of the MFRM model used in this study.

DISCUSSION

Unidimensional Assumption Test

The criterion used to test the unidimensionality in MFRM is the raw variance explained by measures with a value greater than 20%[13]. Instruments that meet this threshold are considered to meet the criteria for unidimensionality and construct validity[14,15]. The results of the unidimensionality test on the 20 items in the instrument assessing teachers' attitudes towards earthquake disaster preparedness in schools showed that the items in the instrument have a raw variance explained by measures of 20.06% with an eigenvalue of 0.076. The raw variance explained by measures for all 20 items assessing teachers' attitudes towards earthquake disaster preparedness in schools is greater than the

specified criterion, which is 20% (>20%). Thus, it can be interpreted that the items in the instrument assessing teachers' attitudes towards earthquake disaster preparedness in schools meet the criteria for unidimensionality or are unidimensional in nature.

Model Fit Test (Item Fit)

Table 2 presents the results of the model fit test for all 20 items in the instrument assessing teachers' attitudes towards earthquake disaster preparedness in schools as a whole. Table 2 shows that the item reliability of the instrument assessing teachers' attitudes towards earthquake disaster preparedness in schools has a score of 0.94. This means that the instrument's quality falls within the "Excellent" category, or it can be concluded that the instrument assessing teachers' attitudes towards earthquake disaster preparedness in schools has a high level of reliability. Table 2 also indicates that the easiest assessment item is item number 9 (Participants are aware of earthquake risks in the area where they teach), with a measure value of 89, while the most challenging assessment item is item number 5 (Participants have basic supplies like water and food in their personal bags at school), with a measure value of 113. The average difficulty level is 100 logits, with a standard deviation of 8 logits. Most items in the instrument assessing teachers' attitudes towards earthquake disaster preparedness meet the outfit criteria since they have outfit values ranging from 0.5 to 1.5[10,16]. In the Subjek Measurement Report analysis, a reliability value of 0.65 with a weak category was obtained. Additionally, some subjects showed negative Pt Measure Corr values, including teachers 5, 10, 15, 20, 25, and 30. This indicates that there are still some teachers providing information that confuses the raters.

Table 2. Item Fit of the Instrument Assessing Teachers' Attitudes towards Earthquake Disaster Preparedness in Schools.

Total Score	Total Count	Obsvd Average	Fair(M) Average	- Measure	Model S.E.	Infit MnSq	Infit ZStd	Outfit MnSq	Outfit ZStd	Estim. Discrm	Correlation PtMea	Correlation PtExp	Nu items
204	99	2.06	2.06	113	2	.58	-4.3	.57	-4.3	1.79	.45	.25	5 5
207	99	2.09	2.09	112	2	.64	-3.5	.64	-3.5	1.67	.43	.25	20 20
216	99	2.18	2.19	110	2	.47	-5.8	.47	-5.8	1.86	-.13	.25	1 1
216	99	2.18	2.19	110	2	.47	-5.8	.47	-5.8	1.86	-.13	.25	16 16
219	99	2.21	2.22	109	2	.29	-8.7	.31	-8.4	2.26	.58	.25	15 15
231	99	2.33	2.34	106	2	.52	-4.9	.53	-4.8	1.75	.34	.25	2 2
231	99	2.33	2.34	106	2	.52	-4.9	.53	-4.8	1.75	.34	.25	17 17
248	99	2.51	2.52	101	2	1.64	4.2	1.65	4.2	.34	.39	.23	10 10
252	99	2.55	2.56	100	2	1.82	5.1	1.82	4.9	.19	.26	.22	11 11
254	99	2.57	2.58	99	2	1.86	5.2	1.85	5.0	.21	.27	.22	8 8
257	99	2.60	2.61	98	2	.84	-1.1	.92	-.5	1.07	.04	.22	4 4
257	99	2.60	2.61	98	2	1.56	3.5	1.68	4.0	.43	-.09	.22	13 13
258	99	2.61	2.62	98	2	.85	-1.1	.92	-.5	1.07	.05	.22	19 19
264	99	2.67	2.68	96	2	1.67	3.7	1.47	2.6	.66	.40	.20	3 3
264	99	2.67	2.68	96	2	1.67	3.7	1.47	2.6	.66	.40	.20	7 7
270	99	2.73	2.74	93	2	1.56	2.9	1.26	1.4	.82	.44	.19	12 12
275	99	2.78	2.79	90	2	1.06	.4	1.21	1.0	.87	-.28	.18	14 14
276	99	2.79	2.80	90	2	1.07	.4	1.24	1.1	.86	-.30	.17	18 18
278	99	2.81	2.82	89	2	1.89	3.5	1.44	1.8	.78	.38	.17	6 6
278	99	2.81	2.82	89	2	.98	.0	.97	.0	.98	.04	.17	9 9
247.8	99.0	2.50	2.51	100	2	1.10	-.4	1.07	-.5		.19		Mean (Count: 20)
24.2	.0	.24	.25	8	0	.54	4.2	.49	4.0		.26		S.D. (Population)
24.8	.0	.25	.25	8	0	.55	4.4	.50	4.1		.27		S.D. (Sample)

Model, Populn: RMSE 2 Adj (True) S.D. 7 Separation 3.88 Strata 5.51 Reliability .94
Model, Sample: RMSE 2 Adj (True) S.D. 8 Separation 3.99 Strata 5.65 Reliability .94
Model, Fixed (all same) chi-squared: 328.4 d.f.: 19 significance (probability): .00
Model, Random (normal) chi-squared: 17.9 d.f.: 18 significance (probability): .46

To meet the model fit criteria, all items must meet one of the following criteria: the Infit/Outfit Mean Square (MNSQ) values should fall within the range of 0.5 - 1.5, the Outfit Z Standard (ZSTD) values should fall within the range of -2.0 – 2.0, and the Point Measure Correlation (Pt. Mean Corr) values should fall within the range of 0.4 – 0.85. All items in the instrument assessing teachers' attitudes towards earthquake disaster preparedness meet one of these criteria, whether MNSQ, ZSTD, or Pt. Mean Corr, except for items number 11 and 8. Regarding the assessment of Point Measure Correlation, the items in this instrument are in the range of quite good. However, there are still some items with negative Pt Measure Corr values, namely items number 1, 13, 14, 16, and 18. This indicates that these items in the instrument assessing teachers' attitudes towards earthquake disaster preparedness in schools are still ambiguous or confusing for raters when used to assess teachers' attitudes towards earthquake disaster preparedness. Based on this analysis, it can be said that overall, the items in the instrument assessing teachers' attitudes towards earthquake disaster preparedness do not meet the model fit criteria.

Vertical Ruler

Table 3 is the Vertical Ruler for the instrument assessing teachers' attitudes towards earthquake disaster preparedness in schools as a whole, which includes 20 assessment items, 33 teachers, and 3 raters.

Table 3. Vertical Ruler for the Instrument Assessing Teachers' Attitudes towards Earthquake Disaster Preparedness in Schools.

Measr	-Subjek	-items	+raters	Scale
2				(3)
			Rater A Rater B Rater C	
		20 5		---
1		1 15 16		
	19 29 9		•	
	15 25 5	17 2		
	13 14 23 24 3 33 4			
* 0 *	18 27 31 7	* 10 11 8 *		* 2 *
	10 16 17 20 26 28 30 32 6 8	13 19 4		
	1 11 21	3 7		
	12 2 22	12		
-1		14 18		
		6 9		---
-2				(1)
Measr	-Subjek	-items	+raters	Scale

The vertical ruler in Table 3 is a form of calibration, which involves placing the measured variables on a single scale in MFRM. The vertical ruler is a tool used to measure how effectively the scale or measuring instrument used in the measurement functions[12]. In MFRM, the vertical ruler refers to elements in the analysis that assist in measuring an individual's characteristics or abilities in a specific dimension[17]. The concept of the vertical ruler is highly relevant in MFRM because this model examines the interaction between various sources of variation or "factors" in measurement data, such as items, individuals, raters, and possibly assessment categories[18].

The vertical ruler helps measure how effectively each factor measures the desired characteristics of individuals[19]. The three facets or variables analyzed, which are the subjects being assessed for earthquake disaster preparedness attitudes (column 2), assessment items (column 3), and rater assessments (column 4), are all placed on the same scale or value (measure) scale, namely in logit units (column 1). By placing these three facets on a scale with the same unit of measurement (in logit units), the quality of these three facets/variables (earthquake disaster preparedness, raters, and assessment items) can be analyzed or compared.

Based on the vertical ruler, it can be seen that the teachers' attitudes towards earthquake disaster preparedness in schools that are the most positive/prepared is teacher 9 with a measure value of 108 logit, while the teacher with the least positive/prepared attitudes towards earthquake disaster preparedness is teacher 12 with a measure value of 93 logit. The average measure of teachers' attitudes towards earthquake disaster preparedness is 100 (with a standard deviation of 4 logit). The assessment item that is the easiest is item number 9 (Participants are aware of the earthquake risk in the area where they teach) with a measure value of 89 logit, and the most challenging assessment item is item number 5 (Participants have basic supplies such as water and food in their personal bags at school) with a measure value of 113. The average difficulty level is 100 logit, with a standard deviation of 8 logit. Rater A has the highest measure (severity) value, which is 114 logit, while rater B has the lowest measure or severity value (110 logit). The average rater severity is 112 logit with a standard deviation of 2 logit.

Between teachers' attitudes towards earthquake disaster preparedness and the quality of raters, there is a gap (represented as an empty space on the map) of 17 logit at the bottom of the map and 6 logit at the top of the map. The distribution of rater severity (110-114 logit) is greater than the distribution of teachers' attitudes towards earthquake disaster preparedness (93-108 logit), indicating a mismatch between the distribution of rater severity and teachers' attitudes towards earthquake disaster preparedness in schools. This can be interpreted as the severity levels of raters being more diverse when compared to teachers' attitudes towards earthquake disaster preparedness. Between the item difficulty levels and rater severity, there is a gap of 21 logit at the bottom and 1 logit at the top of the vertical ruler. The distribution of rater severity (110-114 logit) is greater than the distribution of item difficulty levels (89-113 logit), indicating a mismatch between the distribution of item difficulty levels and teachers' attitudes towards earthquake disaster preparedness. This can be interpreted as the severity levels of raters being relatively more diverse when compared to the difficulty levels of assessment items.

Between the item difficulty levels and teachers' attitudes towards earthquake disaster preparedness in schools, there is a gap at both the top and bottom of the vertical ruler. At the top of the vertical ruler, there is a gap of 5 logit between the most difficult assessment item (item 5: 113 logit) and the teachers' attitudes towards earthquake disaster preparedness that are the most favorable/prepared (teacher 9:108 logit). At the bottom, there is a gap of 4 logit between the easiest item (item 9:89 logit) and the teachers' attitudes towards earthquake disaster preparedness that are the least prepared (teacher 12:93 logit). From this data, it can be observed that the distribution of teachers' attitudes towards earthquake disaster preparedness (93-108 logit) is narrower than the distribution of item difficulty levels (89-113 logit), indicating a mismatch between the distribution of item difficulty levels and teachers' attitudes towards earthquake disaster

preparedness in schools. This suggests that the assessment items have relatively less diversity in their difficulty levels in measuring teachers' attitudes towards earthquake disaster preparedness. Therefore, it is necessary to add easier items (below the vertical ruler) by reducing the difficulty level by approximately 4-5 logit to align the distribution of the quality of teachers' attitudes towards earthquake disaster preparedness in schools and the difficulty level of items in the assessment instrument of teachers' attitudes towards earthquake disaster preparedness in schools.

In general, it can be concluded that the severity of raters has a larger distribution compared to the distribution of assessment items and teachers' attitudes towards earthquake disaster preparedness. This can be interpreted as the severity levels of raters being more diverse compared to the assessment items and teachers' attitudes towards earthquake disaster preparedness. For the assessment items in this instrument, it is necessary to add easier items with difficulty levels approximately 4-5 logit lower to align the distribution of teachers' attitudes towards earthquake disaster preparedness and the difficulty levels of items in the assessment instrument of teachers' attitudes towards earthquake disaster preparedness in schools.

Diagnostic Rating Scale

Diagnostic analysis in the context of MFRM refers to a set of methods and techniques used to examine the extent to which the model fits the observed data[20]. The goal of diagnostic analysis is to identify problems or anomalies in the model, check the model's assumptions, and provide insights into how well the model explains the actual measurement data[21,22]. The results of diagnostic analysis of the rating scale in the instrument for assessing teachers' attitudes towards earthquake disaster preparedness in schools as a whole can be seen in table 4.

Table 4. Rating Scale Diagnostics

Kategori	Thresholds	Observed Count	Observed %	Observed Average	Outfit
Disagree (1)	None	129	7.0	11	1.7
Agree (2)	-10	727	37.0	8	0.8
Highly agree (3)	10	1124	57.0	18	0.9

Table 4 shows that the observed average on the rating scale for teachers' attitudes towards earthquake disaster preparedness in schools starts from 11 logits for scale 1 (not suitable), 8 logits for scale 2 (suitable), and 18 logits for scale 3 (very suitable). It is evident that there is an increase between 1 and 2, and between 2 and 3. This indicates that when assessing teachers' attitudes towards earthquake disaster preparedness in schools, raters can determine the scale of values that they consider appropriate for the evaluated teachers' attitudes. In other words, the rating scale in this instrument can be well understood and does not confuse raters when evaluating teachers' attitudes towards earthquake disaster preparedness in schools. Table 4 also shows that the Andrich Threshold values move from non-negative to negative (-10) and continue to rise sequentially towards positive (10). This means that the rating scale can be considered valid.

The diagnostic rating scale measurement in the MFRM on the rating scale indicates that the category that is most frequently chosen/used is scale 3 (very suitable). Table 4 also shows that on the rating scale for teachers' attitudes towards earthquake disaster

preparedness in schools, from scale 1 to scale 3, none of them have outfit values less than 0.5, but for scale 1, it exceeds 1.5. Therefore, it can be concluded that the diagnostic rating scale for responses on the rating scale for teachers' attitudes towards earthquake disaster preparedness in schools may not function well.

Test Information Function (TIF)

TIF (Test Information Function) is a measure used to assess how well a set of items (questions or statements) in a measurement instrument can provide good information about the characteristics or abilities of the individuals being measured[23]. TIF measures how well the items in the instrument can differentiate between individuals with different levels of characteristics or abilities[24]. The higher the TIF value at a point on the measurement scale, the more information the items in the instrument generate at that point. The generated information can help identify individuals' abilities more accurately[25,26].

Figure 1 is a TIF graph that illustrates the functionality or meaningfulness of the information obtained from an assessment instrument. This feature serves as an initial screening to indicate the effectiveness of the measurement being conducted. Figure 3 is a TIF graph for the assessment instrument of teachers' attitudes towards earthquake disaster preparedness in schools, broken down by assessment aspect. The X-axis represents the difficulty level of the assessment items, while the Y-axis represents the probability categories, which are the abilities of the subjects (raters and teachers' attitudes towards earthquake disaster preparedness in schools).

In the Test Information Function (TIF) graph for all items, it can be observed that high information is obtained at a measure value of 0. This means that the assessment items measuring teachers' attitudes towards earthquake disaster preparedness in schools, for both assessment aspects, will provide high information when given to raters with moderate severity or used to assess teachers' attitudes towards earthquake disaster preparedness in schools with varying abilities. In other words, these twenty assessment items will provide a lot of information when given to objects with diverse measures, i.e., raters with low, moderate, and high severity, or used to assess teachers' attitudes towards earthquake disaster preparedness in schools with diverse abilities (not suitable, suitable, and very suitable).

Konsistensi Rater/Penilai

Consistency among raters in MFRM refers to the extent to which assessments or ratings given by various raters for the same individuals or items align[17]. This is important in situations where there are multiple raters providing assessments for specific items or individuals. In MFRM, rater consistency can be measured using the "severity" parameter associated with each rater[27]. This parameter describes the level of strictness or selectivity in the assessments given by each rater. The higher the severity parameter, the stricter or more selective the assessments provided by that rater[27].

Rater consistency in the study can be determined from the fit values (especially outfit values) or fitness values obtained as per Table 5. In the rater consistency table, raters are sorted by their measure values (severity) from high to low. Among the three raters assessing teachers' attitudes towards earthquake disaster preparedness in schools, all raters exhibit fit consistency because they meet the fitness criteria (outfit and infit values between 0.5-1.5 logit). This means that all raters are consistent in their assessments of teachers' attitudes towards disaster preparedness in schools. In addition to rater consistency, the analysis results can also identify rating errors made by raters when assessing teachers' attitudes towards earthquake disaster preparedness in schools, as shown in Table 6. These errors refer to cases where raters assess teachers' attitudes towards

disaster preparedness in schools as higher or lower than they should be.

Table 5. Rater Consistency Table

No	Measure	Infit	Outfit	Pt. Mea Corr	Rater	
1	114	1.00	1.07	0.44	1	Rater A
2	113	1.01	1.08	0.43	3	Rater C
3	110	0.99	1.06	0.45	2	Rater B

Table 5 shows that the analysis results are sorted based on the measure (severity) values obtained, from high measure values to low measure values. Among the three raters who assessed teachers' attitudes towards earthquake disaster preparedness in schools, all of them meet the fitness criteria because they have outfit and infit values within the range of 0.5-1.5 logit. This means that all three raters, Rater A, Rater B, and Rater C, are consistent in their assessments of teachers' attitudes towards earthquake disaster preparedness in schools. In addition to the infit and outfit values, rater consistency can also be assessed by examining the rating errors they made when assessing teachers' attitudes towards earthquake disaster preparedness in schools. These rating errors can be seen in Table 6.

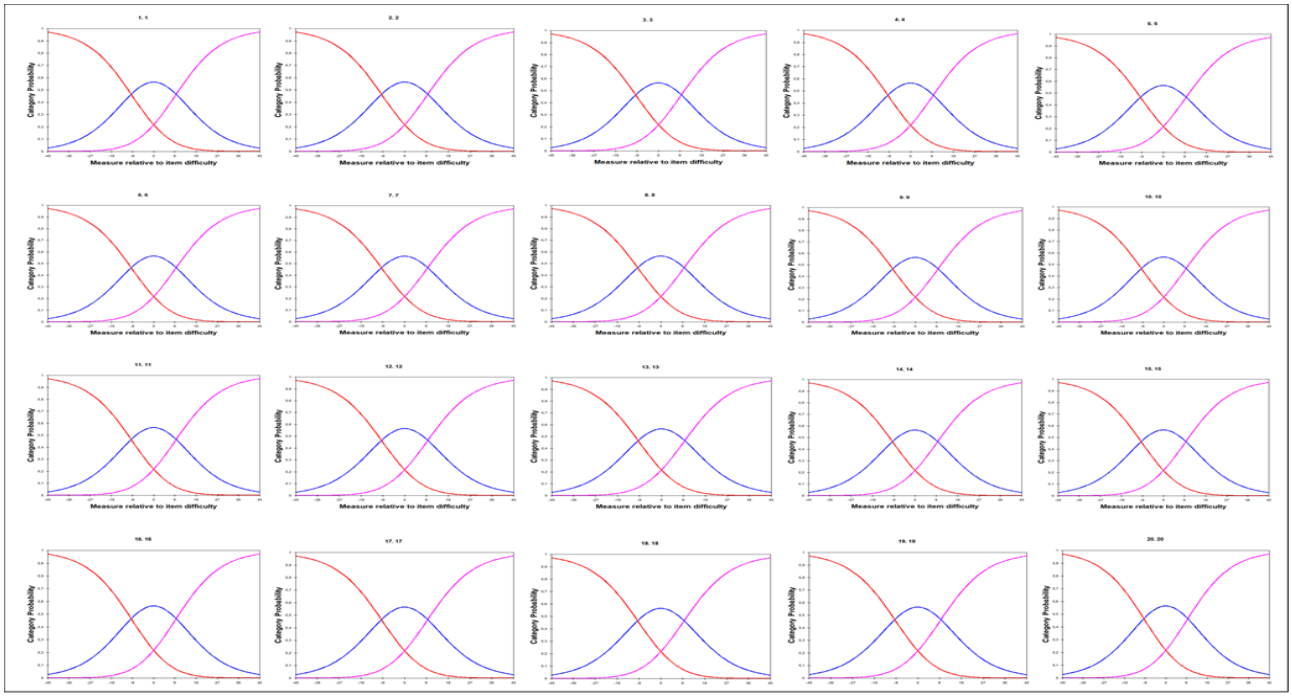


Figure 2. Test Information Function Instrument for Assessing Teachers' Attitudes towards Earthquake Disaster Preparedness in Schools

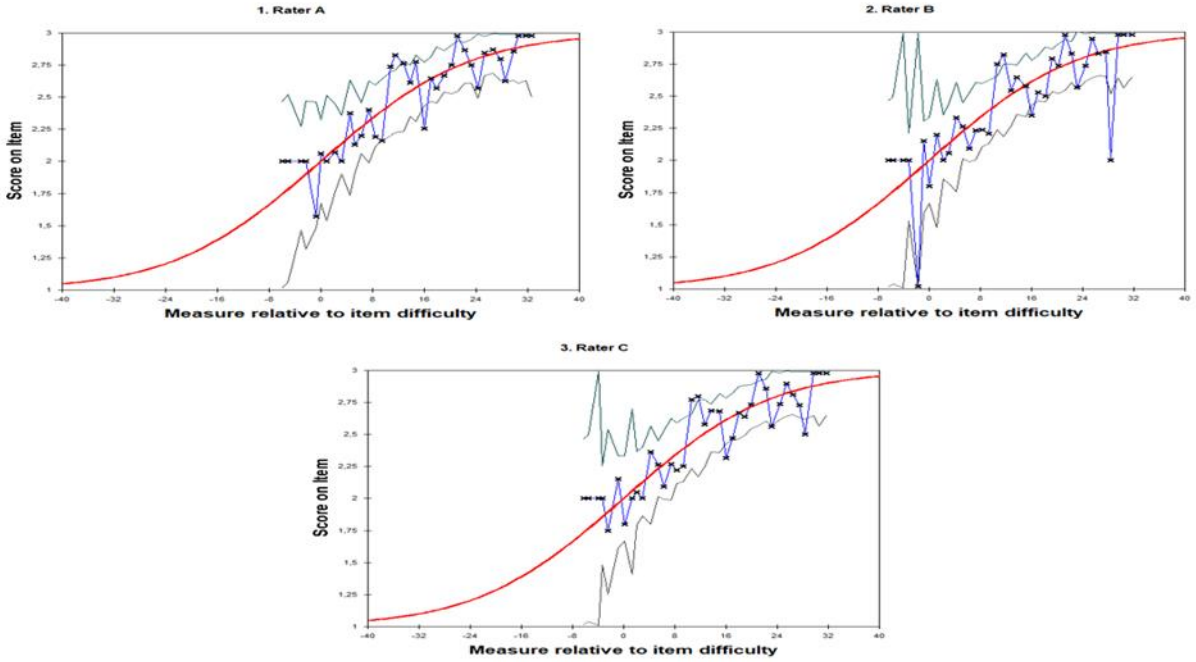
Table 6. Rater Judgment Errors

No	Rater	Number Of Errors	Subject (Teacher)
1	Rater A	6	Teacher 5, Teacher 10, Teacher 15, Teacher 20, Teacher 25, Teacher 30
2	Rater B	5	Teacher 5, Teacher 10, Teacher 15, Teacher 20, Teacher 25
3	Rater C	5	Teacher 5, Teacher 10, Teacher 15, Teacher 20, Teacher 25

Table 6 shows the raters who made errors in assessing teachers' attitudes towards earthquake disaster preparedness in schools based on the FACETS output. Rater A made the most errors, a total of 6 times. Rater A made errors when assessing the attitudes of teachers 5, 10, 15, 20, 25, and 30. Raters B and C made errors 5 times each. Raters B and

C made errors when assessing the attitudes of teachers 5, 10, 15, 20, and 25. From the data, it is also known that teachers' attitudes towards earthquake disaster preparedness in schools that received the most assessment errors were teachers 5, 10, 15, 20, and 25 (each 3 times). Table 6 shows the results of the analysis of rating errors made by the raters.

The analysis of rating errors can be seen in Table 7. Rater A made errors when assessing teachers 5, 10, 15, 20, 25, and 30. Rater A made errors when assessing teachers' attitudes towards earthquake disaster preparedness in schools with assessment items 6 and 13. Rater A gave lower scores, namely 1 instead of the expected 3, resulting in a difference of 2 points. In Table 6, the Resd. column shows a value of -2, which means that Rater A rated 2 units lower for teachers 5, 15, and 25 on assessment item 6. For teachers 10, 20, and 30, on assessment item 13, Rater A also gave a lower score (1) than what was expected (3), resulting in a difference of 2 units in the assessment. There are no positive values in the Resd. column, indicating that Rater A did not rate teachers with higher scores than expected. In general, Rater A tended to make errors in assessing teachers' attitudes towards earthquake disaster preparedness in schools by giving lower scores than expected.



Gambar 3. Graph score item vs measure relative to item difficulty

Rater B and C made errors when assessing teachers 5, 10, 15, 20, and 25. Rater B and C made errors when assessing teachers' attitudes towards earthquake disaster preparedness in schools with assessment items 6 and 13. Rater B and C gave lower scores, namely 1 instead of the expected 3, resulting in a difference of 2 points. In Table 6, the Resd. column shows a value of -2, which means that Rater B and C rated 2 units lower for teachers 5, 15, and 25 on assessment item 6. For teachers 10 and 20, on assessment item 13, Rater B and C also gave a lower score (1) than what was expected (3), resulting in a difference of 2 units in the assessment. There are no positive values in the Resd. column, indicating that Rater B and C did not rate teachers with higher scores than expected. In general, Rater B and C tended to make errors in assessing teachers' attitudes towards

earthquake disaster preparedness in schools by giving lower scores than expected.

Figure 3 shows the responses from Rater A, B, and C in a simultaneous display with the ideal model curve (in red) and the confidence interval curve (gray on the upper and lower sides). Responses that do not fit will fall outside the confidence interval curve.

Table 7. Rater Error Analysis

No	Score	Exp.	Resd.	Rat.	S	Nu	Item
1	1	3	-2	Rater A	5	6	Participants feel personally prepared to deal with an emergency situation due to an earthquake
2	1	3	-2	Rater A	15	6	Participants feel personally prepared to deal with an emergency situation due to an earthquake
3	1	3	-2	Rater A	25	6	Participants feel personally prepared to deal with an emergency situation due to an earthquake
4	1	3	-2	Rater A	10	13	Participants have attended disaster preparedness training held by the school
5	1	3	-2	Rater A	20	13	Participants have attended disaster preparedness training held by the school
6	1	3	-2	Rater A	30	13	Participants have attended disaster preparedness training held by the school
1	1	3	-2	Rater B	5	6	Participants feel personally prepared to deal with an emergency situation due to an earthquake
2	1	3	-2	Rater B	15	6	Participants feel personally prepared to deal with an emergency situation due to an earthquake
3	1	3	-2	Rater B	25	6	Participants feel personally prepared to deal with an emergency situation due to an earthquake
4	1	3	-2	Rater B	10	13	Participants have attended disaster preparedness training held by the school
5	1	3	-2	Rater B	20	13	Participants have attended disaster preparedness training held by the school
1	1	3	-2	Rater C	5	6	Participants feel personally prepared to deal with an emergency situation due to an earthquake
2	1	3	-2	Rater C	15	6	Participants feel personally prepared to deal with an emergency situation due to an earthquake
3	1	3	-2	Rater C	25	6	Participants feel personally prepared to deal with an emergency situation due to an earthquake
4	1	3	-2	Rater C	10	13	Participants have attended disaster preparedness training held by the school
5	1	3	-2	Rater C	20	13	Participants have attended disaster preparedness training held by the school

Information:
Score : The value given by the rater
Exp. : Assess the teacher's expected/should attitude
Resd. : Difference in score and exp. (Negative: lower rating; Positive: higher rating)
Rat. : Rater name
S : Assessed teacher (Subject)
Nu : Sequence number of assessment items
Item : Description for the assessment item

CONCLUSION

Limitations and suggestions for further research: This study requires further investigation with a larger sample size. The instrument used in this research still needs improvement, especially for items that did not fit. Additionally, the instrument needs to be thoroughly understood by the assessors or raters to enhance rater consistency in assessing teachers' attitudes toward earthquake disaster preparedness in schools.

The analysis using the Many-Facet Rasch Model in assessing teachers' attitudes toward earthquake disaster preparedness in schools provided significant insights into the instrument's characteristics and participant responses. The analysis results indicated that some items assessing teachers' attitudes toward earthquake disaster preparedness in schools had a high level of difficulty. This suggests the need to focus on disaster preparedness topics that teachers may be less prepared for.

Furthermore, there was a noticeable variation in teachers' abilities to respond to different items. Some teachers demonstrated lower abilities than expected, while others showed higher abilities. In this context, a more differential approach is needed to provide additional assistance or support to teachers with lower abilities so that they can also achieve better results.

In addition to item and participant factors, the Many-Facet Rasch Model analysis also revealed variations in the responses of the raters involved in the assessment. There were significant differences in the scoring provided by different raters, indicating the potential for improved consistency in the assessment process. A recommendation arising from these findings is the provision of more detailed training or guidelines to the raters, with the aim of reducing variability in scoring.

In conclusion, the Many-Facet Rasch Model is a valuable tool for analyzing the evaluation instrument for teachers' attitudes toward earthquake disaster preparedness in schools. The findings from this analysis provide a richer and more comprehensive insight into the instrument, participants (teachers), and the assessment process. By considering the aspects revealed in the MFRM model, targeted improvement measures can be taken to enhance the instrument's validity and fairness in the evaluation process.

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Conflicts of interest

There are no conflicts of interest.

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