

Psychometric validation of the Nature relatedness scale short-form (NR-6) in Indonesia: Insights from the Rasch model

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This study evaluates the psychometric performance of the 6-item Nature Relatedness Scale (NR-6) in Indonesian context using Rasch measurement theory. Nature relatedness is a key psychological construct associated with both human well-being and environmental sustainability, and the NR-6 provides a concise tool for its assessment. To address this, we applied the Rating Scale Model (RSM) to responses from 836 respondents (aged 17–56 years; $M = 23.08$; $SD = 4.37$) participated in this study. The analysis results indicated that all six items, the five-point Likert scale, and the reliability values met good psychometric criteria, with the assumption of unidimensionality being fulfilled and no differential item functioning (DIF) found based on gender or student status. However, NR-6 items tended to be easily endorsed by respondents, indicating a ceiling effect and limitations in measuring individuals with very high levels of nature relatedness. Additionally, this study provides a comprehensive item interpretation and the conversion of data from an ordinal to an interval scale. These findings are expected to contribute to improving measurement quality in environmental research in Indonesia.

Keywords: Connection with nature, Environmental psychology, Nature relatedness, Rasch model, Validation.

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Introduction

Most of Indonesia's territory remains untouched, with data showing that only 7,000 of the more than 17,000 islands are inhabited (Wolters, 2026). These unexplored areas hold great natural wealth. Data shows that Indonesia is home to more than 17% of the world's total wildlife species, including 515 species of mammals and 1,539 species of birds, and is estimated to be inhabited by 45% of the world's fish species (Wolters, 2026). Amidst such rich and diverse geographical conditions and biodiversity, Indonesian communities have long lived in dependence on and inseparable from nature, manifested through local wisdom and eco-cultural practices (Rahardjanto et al., 2025; Sari et al., 2026). Indonesia's biodiversity has even become a cultural identity, with certain animals serving as symbols of traditional values and culture (Kurniawan et al., 2024; Purwanto et al., 2020). This study seeks to address ecological challenges in order to provide a deeper understanding of the psychological relationship between humans and nature. Therefore, psychometric validation of the NR-6 scale in this study is a fundamental and urgent step to ensure that environmental interventions in Indonesia are based on valid and accurate instruments.

The concept of strengthening the human nature relationship is a recurring theme in environmental psychology, with evidence suggesting that fostering this bond can promote pro-environmental attitudes and behaviors (Tam, 2013). This idea, emphasizing that connecting with, respecting, and protecting nature can contribute to climate change mitigation (Stafford & Jones, 2019), remains a central focus for environmental psychology researchers as sustainability issues grow increasingly urgent (Nisbet & Zelenski, 2013). A more comprehensive understanding of how individuals relate to and benefit from nature is considered essential for fostering positive human-nature interactions and cultivating healthy environments (Kövi et al., 2023). To conceptualize this bond, Nisbet et al. (2009) developed “nature relatedness” (NR), defined as “the thoughts, feelings, and experiences that humans have with nature”. Based on this concept, the widely used 21-item Nature Relatedness Scale (NR-21) was developed for research purposes (Nisbet et al., 2009), alongside its brief, 6-item version (NR-6) (Nisbet & Zelenski, 2013).

Because it is shorter and quicker to administer, the NR-6 is well-suited for use when time or space is limited. Furthermore, the NR-6 offers the advantage of reduced

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redundancy; when the research focus is on inter-variable relationships, these six items are more practical to embed with other instruments to prevent participant fatigue or boredom (Nisbet & Zelenski, 2013). As of this writing, NR-6 publications have been cited over 800 times on Google Scholar and adapted in various countries, including the Philippines (Aruta & Pakingan, 2022), Portugal (Moreira et al., 2022), and Spain (Redondo et al., 2022). Researchers have utilized the NR-6 in diverse contexts, linking it to various psychological constructs. For instance, in Australia, Curll et al. (2022) found that nature relatedness positively predicted climate change concern, which, in turn, correlated with climate action and psychological distress. Kövi et al. (2023) investigated the relationship between nature relatedness and constructs such as mental health, gratitude, spirituality, and quality of life among cross-cultural university students from South Korea, India, Hungary, and Canada.

Validating the NR-6 measurement instrument outside the Western, Educated, Industrialised, Rich, and Democratic (WEIRD) population is a methodological imperative to ensure the universality of psychological constructs and avoid ethnocentric bias (Henrich et al., 2010). In this context, Indonesia provides a unique perspective, given that ecologically it is a global biodiversity hotspot, and socioculturally it is a collectivist society that tends to view nature through a spiritual-communal lens, in contrast to the recreational perspective that dominates in the West (Tam, 2013). Therefore, testing the psychometric properties of NR-6 in Indonesia is crucial to prove whether this construct is cross-cultural (etic) or culture-bound (emic).

In Indonesia, Burhanudin et al. (2019) employed the NR-6 to examine the role of nature relatedness in connecting the intention to use online banking with commitment to sustainability and environmental happiness. In another study, the same researchers also used this scale with samples in Indonesia and India after eliminating two pairs of items (Burhanudin & Unnithan, 2022). Although eliminating these items improved the model statistics, the study did not provide an in-depth psychometric diagnosis of why these items were problematic, whether due to cultural bias, linguistic ambiguity, or inappropriate difficulty levels. The absence of this diagnostic evaluation leaves a significant knowledge gap regarding the psychometric evaluation of NR-6 in Indonesia using the Rasch model approach.

Importance of the Rasch Model Approach for NR-6

Despite its popularity and frequent use, issues concerning the psychometric properties of the NR-6 remain a concern for some researchers. Using a confirmatory factor analysis approach, Luong (2022) supported the utility of a one-dimensional NR-6 model but also found support for a multi-dimensional NR-6 model, as a two-factor model demonstrated a better fit than a one-factor model. This study also examined the measurement equivalence of the NR-6, revealing challenges when comparing observed scores between men and women (Luong, 2022). Conversely, Bartholomew et al. (2023) evaluated the NR-6 in a U.S. sample using the Rasch model approach. They argued that the ordinal measurement commonly employed violates the fundamental assumptions of parametric testing and lacks additive properties, thus hindering valid comparisons within or between tested groups. Their initial findings indicated problems related to local dependency, low reliability, and poor fit. After modifications, specifically combining two pairs of items (items 1 with 6, and items 2 with 3) due to local dependency and collapsing Likert response options 2

and 3 due to non-functioning, the NR-6 was found to fit the Rasch model (Bartholomew et al., 2023).

During its initial development, the NR-6 was analyzed using a Classical Test Theory (CTT) approach on Canadian university students and community sample. The analysis results indicated that the scale possessed a unidimensional structure, with good internal reliability ($\alpha = 0.83\text{--}0.86$), test-retest reliability ($r = 0.84$, $p < 0.01$), and high convergent validity with its longer version ($r = 0.90$, $p < 0.01$) (Nisbet & Zelenski, 2013). However, the authors acknowledged the need for further investigation into the evidence for NR's construct validity and suggested that the short scale might not be adequate in all contexts, particularly when the dimensionality of the construct is the primary research focus (Nisbet et al., 2009; Nisbet & Zelenski, 2013). Considering Indonesia's unique environmental and cultural context, this study seeks to adapt the NR-6 and evaluate its psychometric properties within an Indonesian sample, thereby establishing a reliable instrument for measuring Nature Relatedness based on robust psychometric standards.

For a measurement to be reliable and meaningful, five crucial conditions (Engelhard & Wang, 2024) must be met: (1) The level of the individual's latent characteristic (e.g., attitude or value) being measured should not be influenced by the specific statements (items) used in the questionnaire, implying that items function independently of an individual's true score; (2) Individuals with a higher level of the latent characteristic should consistently demonstrate a greater tendency to select response categories indicating higher agreement, compared to those with lower levels. This highlights the monotonic relationship between the latent trait and item endorsement; (3) The endorsement level for an item should not depend on the specific individuals used to calibrate it, underscoring the sample-free property of item calibration; (4) Every individual, regardless of their characteristic level, should be more likely to give a response indicating higher agreement on items that are generally easier to endorse, compared to more difficult ones. This describes the invariant ordering of item difficulties across different person abilities; (5) The measurement must reflect a single underlying construct or latent variable (unidimensionality), both at the individual and item level, which forms the basis for the given responses. Simply put, these conditions ensure that the measurement process is fair, accurate, and consistent, irrespective of the specific items used, the individuals being assessed, or how the items are calibrated. These requirements can be empirically tested using the Rasch model (Engelhard Jr & Wang, 2024).

While CTT offers a traditional approach to test analysis, the Rasch model provides a more robust and modern framework for item analysis and scale development (Andrich & Marais, 2019). Inspired by principles of physical measurement, the Rasch model assumes that psychological attributes can be measured objectively, allowing for the independent assessment of individual characteristics and items on a common scale (Rasch, 1960; Sumintono & Widhiarso, 2014). This model has been successfully applied in various contexts, such as the development of Kaiser and Wilson, (2000, 2004) General Ecological Behavior scale, one of the most widely used environmental measurement instruments. By ordering test items from easiest to most difficult, the model can precisely assess an individual's knowledge or skill level (Wilson, 2023). Similarly, it can rank pro-environmental behaviors from most to least frequently adopted (Kaiser & Wilson, 2004). Behaviors broadly adopted by a majority, even those with weak environmental intentions, are considered easier

to implement. Conversely, behaviors adopted by only a few likely necessitate strong pro-environmental attitudes or goals for enactment (Gatersleben, 2018). In the Rasch framework, data must be rigorously examined to determine the extent to which the ideal measurement model has been realized (Bond & Fox, 2015; Engelhard, 2013).

The Rasch model is a valuable alternative for addressing issues of indicator weighting and for transforming ordinal raw scores into interval measures (DiStefano & Jiang, 2020; Tennant & Conaghan, 2007). Its unit of measurement, the logit scale (logarithm of odds), allows researchers to perform parametric statistical analysis since the data achieve an interval level of measurement (Linacre & Wright, 1989; Smith et al., 2003). This approach is anticipated to provide a more comprehensive understanding of the NR-6 scale's validity and reliability, from both item and individual perspectives, thereby enhancing the quality of nature relatedness measurement for the Indonesian population and offering valuable methodological insights for international researchers conducting cross-cultural validations of the NR-6.

Methods

Participants

A total of 836 participants were recruited from South Kalimantan Province, Indonesia, using a purposive sampling technique. This research design utilised a cross-sectional approach, and data collection took place from July to September 2022 via an online questionnaire on SurveyMonkey.com. Before starting, participants received research information and provided informed consent. Demographic questions were collected at the end of the survey. To incentivize participation, respondents were entered into a lottery for a prize of IDR 50,000 (approximately USD 3.3). The participants' ages ranged from 17 to 56 years ($M = 23.08$, $SD = 4.37$). The sample comprised 573 women (68.5%) and 263 men (31.5%); 600 university students (78.1%) and 236 non-college students (21.9%). Ethical approval for the study was obtained from the Faculty of Medicine, Lambung Mangkurat University, Indonesia (227/KEPK-FK ULM/EC/VIII/2022).

Instrument

The Nature Relatedness Scale Short Form (NR-6), developed by Nisbet and Zelenski (2013), comprises six items designed to assess an individual's subjective connection to the natural environment. Participants responded to statements using a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), where higher scores indicate a stronger sense of nature relatedness. The instrument was adapted into Indonesian through a forward translation process involving two individuals, including an expert in the field of social psychology and a linguistic expert. The results of the forward translation were synthesised with the research team and translators to ensure measurement quality. The back translation involved one psychology expert and one linguistic expert, who were different from those involved in the forward translation process. This adaptation process into Indonesian was carried out to conduct a cross-cultural study of the language used in the Indonesian context (Beaton et al., 2000).

Data Analysis

Data analysis was conducted using WINSTEPS software (ver. 3.65) with Joint Maximum Likelihood Estimation (Linacre, 2008b). The Rating Scale Model

(RSM) (Andrich, 1978), a polytomous Rasch model, was chosen for this study because all items in the NR-6 scale had a uniform number of response categories (Wright & Masters, 1982). RSM extends the dichotomous Rasch model by adding a common rating scale threshold structure for all items. This assumes that response categories have consistent meaning across the instrument, treating distances between difficulty thresholds as a characteristic of the overall rating scale rather than individual items (Bond & Fox, 2015). The formula for RSM is:

$$\ln \frac{P_{nik}}{P_{ni(k-1)}} = B_n - D_i - F_k$$

Here, RSM describes the probability of a person selecting a specific category (P_{nik}) over the one immediately below it ($P_{ni(k-1)}$) as a logarithmic function of the difference between the person's ability/location (B_n), the item's difficulty/location (D_i), and the step calibration (F_k) (Andrich, 1978). Step calibration represents the rating scale threshold where the probability of observing adjacent categories ($k-1$ and k) for an item is equal (Linacre, 2004). The Rasch model provides an ideal measurement framework where instrument items must possess specific properties for meaningful measurement. These properties include item fit, rating scale analysis, and the fulfillment of assumptions such as unidimensionality, local independence, monotonicity, and freedom from Differential Item Functioning (DIF).

For each item, standardized squared residuals are calculated from the observed and expected data and then averaged across all observations (N). Fit is considered "acceptable" when observations closely match model expectations, and residuals are within anticipated ranges. In Rasch terminology, "underfit" and "overfit" describe conditions where observed variance is unexpectedly smaller or larger than predicted. The fit index summarizes the accumulation of residuals, which follow a chi-square distribution (Boone et al., 2014). The Mean Square (MNSQ) statistic represents the chi-square statistic divided by its degrees of freedom. An ideal MNSQ value is 1, with an accepted range between 0.5 and 1.5. Items within this range are deemed "productive for measurement" (Wright & Linacre, 1994).

Monotonicity is evident when the probability of endorsing an item or a specific response category consistently increases with an individual's higher level of the measured trait or ability. Rating scale analysis evaluates how the response categories function within the item response data, providing evidence of the psychometric utility of individual rating scale categories (Wind, 2023). Linacre (1999, 2004) outlines key guidelines for assessing an instrument's rating scale function: (1) Each category should have at least 10 observations; (2) Average measures for each category should advance monotonically; (3) Outfit MNSQ should be less than 2.0; and (4) Step calibrations should advance monotonically.

Unidimensionality means that all items collectively measure a single, underlying construct or trait. Principal Component Analysis of Residuals (PCAR) is used to extract common factors that explain the most residual variance, assessing if and how strongly additional dimensions exist within the dataset (Linacre, 1998). PCAR results showing a small Eigenvalue for the first contrast (typically < 2.0) confirm that the observed noise is random, indicating the absence of significant additional factors in the data (Boone & Staver, 2020).

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Local independence signifies that the response to one item does not influence the response to any other item. A Q3 statistic (Yen, 1984) a residual correlation value between item pairs exceeding 0.20 in a positive direction is used to identify violations of local independence (Christensen et al., 2017).

Differential Item Functioning (DIF) occurs when individuals with the same latent construct measure respond differently to an item due to unrelated sample characteristics (Engelhard, 2013). In this study, DIF on the NR-6 scale will be examined based on gender (men vs. women) and student status (students vs. non-students). The DIF contrast output from WINSTEPS indicates the difference in item difficulty between two groups, with a value of at least 0.5 logits considered noticeable for DIF (Linacre, 2008a). DIF is categorized based on the Mantel-Haenszel test (Mantel & Haenszel, 1959; Mantel, 1963) using criteria of negligible (< 0.43), slight to moderate ($0.43 \leq \text{size} < 0.64$), and moderate to large (≥ 0.64) (Zwick et al., 1999).

A notable advantage of the Rasch model over CTT is the availability of reliability and separation indices for both persons and items (Schumacker & Smith, 2007). Item reliability assesses whether the sample is sufficient to precisely locate items on the latent variable, while person reliability indicates whether the instrument adequately discriminates the sample into enough distinct levels for the research purpose (Boone et al., 2014). Person separation is used for classifying individuals, whereas item separation is used to verify the hierarchy of items (Boone et al., 2014). These indices offer a more robust assessment than true score

models, often outperforming Cronbach's Alpha (Clauser & Linacre, 1999; Linacre, 1997; Smith Jr, 2001).

Reliability ranges from 0 to 1, with recommended interpretations similar to Cronbach's Alpha. Separation, conversely, can range from 0 to infinity; a larger index denotes clearer distinguishable levels of function in the measurement (Duncan et al., 2003). Both indices are categorized by specific criteria: for item and person reliability, ranges are < 0.67 = "poor", $0.67-0.80$ = "fair", $0.81-0.90$ = "good", $0.91-0.94$ = "very good", and > 0.94 = "excellent" (Fisher, 2007). The person separation index (G) is transformed into strata (H) using the formula $H=(4G+1)/3$ (Wright & Masters, 1982, 2002). Strata criteria are: 2 or less = "poor", 2-3 = "fair", 3-4 = "good", 4-5 = "very good", >5 = "excellent" (Fisher, 2007).

Results

Item fit statistics

Table 1 summarizes the statistics for all items on the NR-6 scale. No items exhibited MNSQ (Mean Square) values for infit and outfit outside the established criteria (0.5-1.5). This indicates that all six items are productive for measuring Nature Relatedness (NR). Furthermore, all items displayed point-measure correlations greater than 0.3. Item locations (difficulties) ranged from -0.94 logits (Item 2) to 0.70 logits (Item 1), with an average item location of 0 logits (a characteristic of the Rasch model) and a standard deviation of 0.51 logits.

Table 1. Summary of the Rasch model item statistics for NR-6 scale Indonesia

Item	Location (S.E)	Infit MNSQ	Outfit MNSQ	Point-measure correlation
1. My ideal vacation spot would be a remote, wilderness area. [<i>Tempat liburan ideal saya adalah daerah terpencil dan alam liar</i>]	0.70 (0.06)	1.17	1.18	0.77
2. I always think about how my actions affect the environment. [<i>Saya selalu memikirkan tentang bagaimana perilaku saya berdampak terhadap lingkungan alam</i>]	-0.94 (0.06)	1.07	1.18	0.70
3. My connection to nature and the environment is a part of my spirituality. [<i>Hubungan saya dengan alam dan lingkungan adalah bagian dari spiritualitas saya</i>]	0.25 (0.06)	0.91	0.91	0.79
4. I take notice of wildlife wherever I am. [<i>Saya memperhatikan kehidupan liar di mana pun saya berada</i>]	0.22 (0.06)	0.98	0.96	0.79
5. My relationship to nature is an important part of who I am. [<i>Hubungan saya dengan alam adalah bagian penting dari diri saya</i>]	-0.25 (0.06)	0.82	0.79	0.80
6. I feel very connected to all living things and the earth. [<i>Saya merasa sangat terhubung dengan semua makhluk hidup dan bumi</i>]	0.03 (0.06)	0.99	1.00	0.76

Note: The English version is original scale. Statement in brackets is Indonesian version.

Figure 1 presents a Wright Map, which visually illustrates the relative order of each NR-6 scale item's location (right side of the dashed line) and the distribution of latent NR scores among the study participants (left side of the dashed line). A higher position on the map for a participant indicates a stronger sense of nature relatedness. Similarly, for items, a higher position denotes an indicator of stronger nature relatedness. Item 1, located at the top, represents the most difficult NR indicator to endorse, while conversely, Item 2 is positioned at the bottom. Visually, the

distribution of respondents is concentrated in the middle of the map and tends towards the upper part rather than the lower part. It was found that 59 respondents (7%) had the maximum NR measurement score, and no respondents had the minimum latent score. This indicates a "Poor" ceiling effect but an "Excellent" floor effect (Fisher, 2007). The average NR value for the sample in this study was 1.94 logits (SD = 2.23), which was above the average item location. The maximum value found was 6.92, the minimum value was -3.75, with a skewness of 0.62 and a kurtosis of -0.05.

These findings indicate that, overall, this scale tends to be easily agreed upon by the sample.

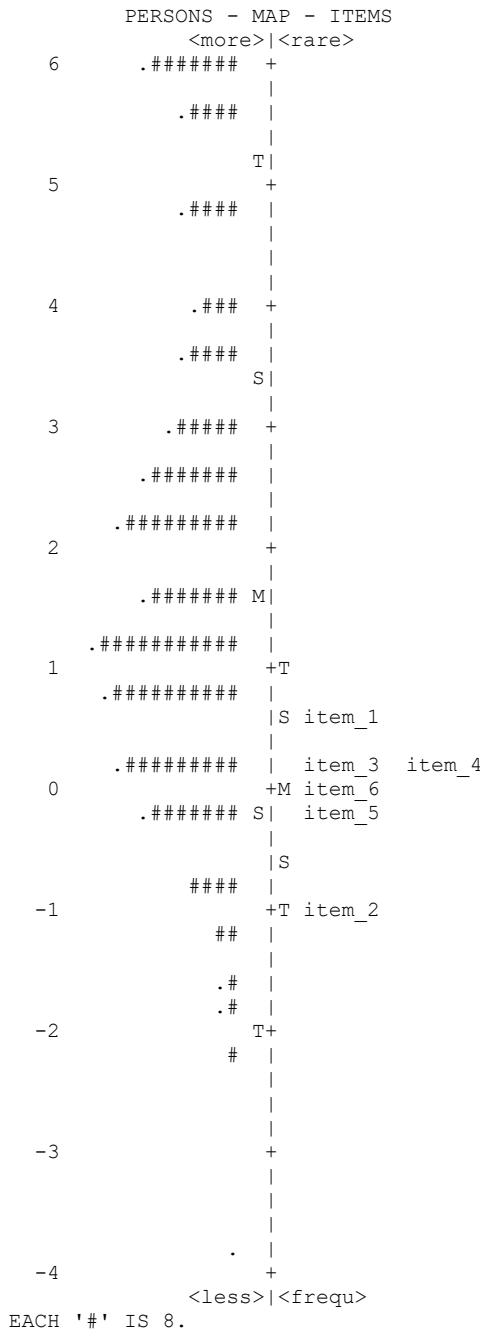


Figure 1. Wright map of NR-6 scale Indonesia

Note: M= Average of sample NR measurements or average of item locations; S= one standard deviation; T= two standard deviations.

Rating scale functioning

The evaluation of the NR-6 scale's rating scale functioning confirmed that all response categories met the recommended psychometric criteria. As detailed in Table 2, each rating scale category consistently showed an Observed Count exceeding 10 observations. The Observed Average for these categories demonstrated a clear monotonic increase, ranging from -1.64 to 3.99 logits, indicating that participants with higher nature relatedness scores, on average, selected higher response options. Furthermore, the Outfit MNSQ values for all five response categories were below 2.0, satisfying established criteria, and the Threshold values exhibited a monotonic increase, confirming proper step calibration. Visually, the probability curves for each rating scale category, as presented in Figure 2, displayed distinct peaks across the horizontal axis without any overlapping curves, further underscoring the effective differentiation between response options.

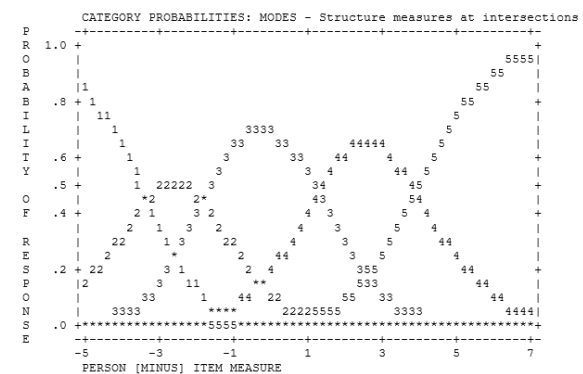


Figure 2. Category Probability Curve for the NR-6 scale.

Unidimensionality, local independent and DIF

PCAR indicated an Eigenvalue of 1.5 for the first unexplained variance contrast, accounting for 11% of the variance. In contrast, 55.5% of the variance was explained by the measurement itself (Eigenvalue of 7.5). These results suggest no evidence of items potentially measuring a different underlying trait or distinct construct (Boone, 2016). Therefore, we conclude that the assumption of unidimensionality for the NR-6 scale was met. Furthermore, the assumption of local independence was also fulfilled, as evidenced by the absence of any item pairs with a positive residual correlation exceeding 0.20 (Table 3). In other words, each item provides unique and independent information, without any overlap in meaning (redundancy) that could distort the measurement.

Finally, Differential Item Functioning (DIF) analysis revealed no items biased by respondent characteristics, whether gender or student status. For gender, the largest measurement contrast between groups was found for Item 1, while for student status, it was found for Item 6.

Table 2. Statistics of Rating Scale Analysis

Category	Observed count (%)	Observed Average	Outfit MNSQ	Threshold
1	47 (1)	-1.64	1.38	NONE
2	323 (7)	-0.94	0.90	-3.32
3	1767 (38)	0.55	0.95	-1.81
4	1773 (38)	2.07	1.00	1.26
5	752 (16)	3.99	1.07	3.87

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Table 3. Residual correlation between item pairs.

	item 1	item 2	item 3	item 4	item 5	item 6
item_1	-					
item_2	-0.16	-				
item_3	-0.27	-0.15	-			
item_4	-0.12	-0.27	-0.16	-		
item_5	-0.24	-0.18	-0.19	-0.26	-	
item_6	-0.34	-0.25	-0.19	-0.20	0.00	-

Tabel 4. DIF test results of NR-6 Indonesian version

	Rasch DIF				Mantel Hanzl	
	Measure (S.E.)	Contrast (S.E.)	95% CI	Prob.	Size	Prob.
item 1						
Man	0.40 (0.11)	-0.41 (0.13)	-0.66, -0.16	0.002	-0.35	0.001
Woman	0.82 (0.07)					
item 6						
College Students	0.10 (0.12)	0.27 (0.14)	-0.01, 0.54	0.050	-0.15	0.141
Non-College Students	-0.18 (0.07)					

Note. *n* Man= 230, *n* Woman= 547, *n* College Students= 571, *n* Non-College Students = 206.

Table 4 presents a summary of the DIF tests for these two items. Potential DIF was only observed for gender differences, not for student status. However, despite being statistically significant, both the contrast and its magnitude remained below the threshold, falling into the “negligible” category (Linacre, 2008a; Zwirk et al., 1999). Thus, we conclude that all NR-6 items function fairly across differences in both gender and student status.

Reliability, separation, and score conversion

The reliability (0.98) and separation (8.04) values for the NR-6 items were both categorized as “Excellent.” On the

other hand, the person reliability index for the sample was 0.80, falling into the “fair” category. The person separation value of 2.01, which translates to 3.01 strata, is classified as “good” (Fisher, 2007), indicating at least three distinct levels of Nature Relatedness (NR) within the sample. For comparison, the Cronbach's Alpha reliability value was found to be 0.87. All indices surpassed the recommended thresholds (Duncan et al., 2003). Finally, an ordinal-to-interval conversion table is provided (Table 5) that allows to produce interval-level data from ordinal raw scores, making the data suitable for parametric statistical analysis.

Table 5. Converting from Ordinal-to-Interval-Level Scores for the NR-6

Raw score (ordinal)	Interval	
	Logit (M= 0.00, S.D= 1.00)	Scale ^a (M= 17.54, S.D= 1.80)
6	-6.42	6.00
7	-5.12	8.33
8	-4.30	9.81
9	-3.76	10.78
10	-3.32	11.56
11	-2.94	12.24
12	-2.59	12.88
13	-2.25	13.50
14	-1.90	14.13
15	-1.53	14.78
16	-1.14	15.49
17	-0.71	16.26
18	-0.24	17.10
19	0.24	17.98
20	0.73	18.85
21	1.20	19.70
22	1.66	20.53
23	2.12	21.35
24	2.58	22.18
25	3.06	23.03
26	3.55	23.92
27	4.08	24.87
28	4.71	26.00
29	5.60	27.60
30	6.93	30.00

^a measurement range that corresponds to the raw score range

Discussion

The Standards for educational and psychological testing (American Educational Research Association [AERA], American Psychological Association [APA], & National Council on Measurement in Education [NCME], 2014) highlight three fundamental aspects of measurement: validity, reliability, and fairness. Therefore, evaluating the NR-6 as a popular measure of nature relatedness is crucial to benefit participants and users in Indonesia. This study aimed to provide an in-depth analysis of nature relatedness measurement using the NR-6 in an Indonesian sample, employing the Rasch model approach, recognized as an influential psychometric framework across various fields (Aryadoust et al., 2019; Edelsbrunner & Dablander, 2019).

In contrast to findings by Bartholomew et al. (2023), the Indonesian version of the NR-6 in this study met the expected criteria without requiring modifications. The first contrast shows an eigenvalue of 1.5 with a variance of 11%. This means that the NR-6 construct in Indonesia operates through one dominant dimension (general factor), which is quite different from previous findings (Luong, 2022; Nisbet & Zelenski, 2013). This study also confirmed that the unidimensionality of the NR-6 was met, meaning the majority of variance in the data was explained by a single primary dimension (Linacre, 1998). Ensuring that a theorized construct holds true in the data is a critical process in measurement (Rios & Wells, 2014) and serves as evidence of validity based on internal structure (AERA, APA, & NCME, 2014).

Moreover, all six items were found to be productive for measurement and free from local dependence in this research. Unlike Bartholomew et al. (2023), who found local independence in items 1, 2, 3 and 4 in their study. In other words, Indonesian respondents distinguished between items more sharply than the US sample. More specifically, item 3 concerns indicators of nature spirituality related to strong theological roots, and item 1 concerns recreational preferences that favour solitude in the wilderness, which is typical of Asian societies that tend to be more communal than the United States (Mangunjaya & McKay, 2012; Wong & Zhao, 2016). Furthermore, item 4 (I pay attention to wildlife wherever I am) in the Indonesian context is often incidental when it comes to the wilderness (von Rintelen et al., 2017). The item ordering visually represented by the Wright Map (Figure 1) offers new insights and aids in interpreting the NR-6 construct, particularly within the Indonesian sample. Higher item locations indicate greater difficulty in endorsement, meaning a higher level of Nature Relatedness is required to agree with that item. Conversely, lower item locations suggest easier endorsement, reflecting more common levels of Nature Relatedness in the population.

Item 2, located at the very bottom of the map, indicates a relatively high level of cognitive environmental awareness among Indonesians. Its ease of

endorsement might reflect societal norms that encourage environmental concern, even if practical actions aren't always consistent. As this item primarily addresses cognitive understanding rather than actual behavior, responses could be influenced by social desirability bias, where individuals tend to answer in socially acceptable ways. In Indonesia, environmental discourse is prevalent in schools, media, and government campaigns (Parker & Prabawa-Sear, 2019).

The notable distance (greater than 0.5 logits) between Item 2 and Item 5 indicates a shift from a more cognitive dimension of Nature Relatedness (knowledge and awareness of impact) towards a more affective-existential dimension (deep feelings of connection and self-identification with nature). In essence, this gap can be interpreted as a disconnect between “knowing” and “feeling.” Item 2 can be endorsed without deep emotional involvement or personal values, simply by acknowledging social norms. In contrast, item 5 requires the internalization of ecological values into one's self-identity, necessitating personal reflection and an emotional connection to nature. This finding highlights the gap between awareness and attachment, and the challenge in transforming knowledge into consistent, identity-driven behavior. Therefore, fostering sustainable behavioral change may require efforts to cultivate a sense of ownership and emotional connection to nature, beyond merely increasing knowledge.

Item 6, which captures strong feelings of connection to all living things and the earth, is indeed similar to item 5. However, its slightly higher position than item 5 reveals an interesting nuance. While Item 5 emphasizes a connection to nature as part of personal identity, item 6 broadens this scope to a universal level of connection. This connection is more holistic and abstract, demanding a deeper ecological understanding that might not be familiar to all respondents. Item 5 could represent a starting point where an individual begins to feel a profound affiliation with their immediate environment, while item 6 signifies a stage where this awareness expands to encompass the entire web of life and the planet. In other words, it moves beyond “me and nature” to “I am part of the whole ecosystem.” In the local context, this concept of universal connection often stems from spiritual or philosophical values that view all creation as a unity, or from an understanding of humanity's global dependence on nature (Großmann, 2021; Suprianto, 2023).

For some Indonesians, nature relatedness can be interpreted as a powerful spiritual experience. Endorsing item 3 might require individuals to move beyond a materialistic view of nature, seeing it as sacred or even divine. This interpretation can be rooted in religious teachings, local wisdom that views nature as a source of strength or life guidance, or personal experiences that trigger spiritual reflection in nature (Effendi et al., 2020; Halim et al., 2025; Wardhani et al., 2024). Item 4, on the other hand, indicates an active level of observation and curiosity towards natural details. Beyond simply enjoying

general scenery, this involves an interest in local flora and fauna. In Indonesia, where wildlife may not always be easily encountered in dense urban areas (Spencer et al., 2023), endorsing this item could mean an individual consciously seeks out or possesses a special sensitivity to the presence of other living beings.

The close location of Items 3 and 4 on the Wright Map suggests that these two forms of connection can be experienced in various contexts, not limited to wild or untouched nature. One might find spiritual dimensions in a city park, or experience the wonder of life by observing birds, insects, or wild animals in their daily environment. Unlike the previous two items, item 1 captures a more specific preference, making it the most discriminating indicator on the scale. Agreement with this item signifies a very strong connection to nature, not only at a cognitive, attentional, or spiritual level, but also through actual life activity preferences, such as choosing vacation destinations. In Indonesia, the majority of people prefer easily accessible, well-facilitated, and popular holiday locations (Damanik, 2013; Untari et al., 2019). Hence, through Wright Map analysis, there is a clear hierarchy of terrorists with three indicators proposed by Nisbet et al. (Nisbet et al., 2009; Nisbet & Zelenski, 2013). Item 2, which is cognitive-based (NR-Perspective), appears to be more easily endorsed than items based on internalisation of nature (NR-Self) and physical experience (NR-Experience). These findings indicate that the connection with nature in Indonesia begins with moral awareness before developing into identity integration and intense physical involvement. Therefore, only individuals with very high NR, who likely possess strong ecocentric values and seek immersive experiences in the wilderness, tend to endorse this item.

The average location of the NR-6 items being below the sample's average ability indicates that the nature relatedness construct in this population tends to be high, or that the NR-6 items are relatively easy to endorse. The observed ceiling effect further suggests that the scale may be less sensitive in measuring individuals with very high latent trait levels (Boone et al., 2014), confirming the limitations of the short version of the NR scale previously articulated (Nisbet & Zelenski, 2013). In practice, while the NR-6 is efficient and valid for detecting general nature relatedness, the scarcity of difficult items due to the brief length of the scale restricts its discriminative power to precisely differentiate among individuals at extremely high levels of the latent trait.

This finding is also supported by the analysis of the five-point likert scale's functioning. Although all response categories technically meet Rasch criteria, categories 1 and 2 exhibit a "near-threshold" pattern characterized by very low frequency of use and thresholds that fall within the extreme logit range (Linacre, 2010). This pattern is common when most respondents are at high levels of the latent trait, so that the disagree category is rarely the most likely response. Underutilized categories do not indicate rating scale malfunction, but rather reflect a mismatch

between the sample distribution and the range of categories at the lower end of the scale (Smith, 2003). In the context of this study, near-threshold functioning aligns with the ceiling effect found, although the scale still functions well overall. Nevertheless, all response options functioned well in this study, a finding that contrasts with Bartholomew et al. (2023) who had to collapse scoring categories (e.g., scoring '2' and '3' identically as '2'). Furthermore, the absence of significant DIF based on gender and student status indicates that the NR-6 satisfies the aspect of fairness.

In terms of reliability, the item reliability and item separation values falling into the "excellent" category indicate that the sample size was adequate for accurately calibrating item positions (Boone et al., 2014). Meanwhile, the person reliability, classified as "fair", suggests that while the scale sufficiently differentiates levels of nature relatedness among individuals, there is still room for improvement, such as through the addition of more items. Finally, the conversion of ordinal raw scores to interval data is recommended, as ordinal data only represents order, not consistent distances between values (Stevens, 1946). This conversion is crucial for the data to meet the requirements for parametric analysis and more accurate quantitative interpretation.

Limitations and Future Directions

The generalizability of these findings is limited by the online data collection method, which potentially excluded individuals with limited internet access or digital literacy (Bethlehem, 2010). This implies that the sample may not be fully representative, and thus the results might not be entirely applicable to broader populations, particularly digitally underserved groups. Regarding the nature relatedness construct, demographic background or residential location are interesting factors that could potentially influence measurement but were not explored in this study. Specifically, the dominance of student respondents and research samples centred on South Kalimantan Province with its wetland characteristics limited the generalisation of findings to densely populated metropolitan areas or other conservation areas.

Although this research recommends adding items to enhance the NR-6's sensitivity, we did not specifically identify underrepresented construct domains nor design systematic item development strategies. An additional limitation relates to the depth of information obtained through the NR-6 (Nisbet et al., 2009). As a short-form instrument, the NR-6 is designed to provide a general overview of nature relatedness, and thus is less capable of capturing specific aspects in depth such as NR-Self, NR-Perspective, and NR-Experience which are typically captured in greater detail in the NR-21 version (Nisbet & Zelenski, 2013). Therefore, future studies are advised to employ a more structured approach, such as expert review or qualitative exploration, to refine the scale's breadth. Additionally, items from the longer NR version could be

considered as an alternative to address the limited construct representation in the short form.

The ceiling effect observed in this study reflected in the 7% of respondents achieving the maximum score and the generally easy item endorsement—has important implications for future research. Because the ceiling effect limits the instrument's ability to detect upward change, the NR-6 may be less sensitive for intervention studies or pre-post designs where increased nature connection is expected, particularly among individuals who already have high scores. Scales with limited upper-range item difficulty provide weaker discrimination at the upper end of the trait continuum (Boone & Staver, 2020). Consequently, researchers aiming to measure higher or more nuanced levels of nature connection might consider using the NR-21 or supplementing the NR-6 with more “difficult” items. It remains an open question whether the ceiling effect observed here reflects cultural factors unique to Indonesia or whether it reflects patterns found in other contexts.

The following interpretations of item ordering on the Wright Map are intended as exploratory hypotheses rather than confirmed explanations. Rasch item difficulties show relative ease of endorsement, but interpreting why an item is easier or harder requires additional qualitative validation. For example, the lower placement of Item 2 may tentatively reflect normative environmental messaging in Indonesia, while the higher placement of Item 1 may suggest that wilderness-related preferences are less common. However, as these interpretations are post-hoc and not yet supported by cognitive interviewing or response-process evidence, they should be considered preliminary. Future studies should empirically test these interpretations using qualitative methods to establish whether respondents indeed understand and experience the items in the ways suggested here. This process would provide crucial evidence of validity based on response processes (Padilla & Benitez, 2014) which was not accommodated in the current research.

Conclusion

Using the Rasch model, this study provides preliminary evidence supporting the psychometric adequacy of the Indonesian version of the Nature Relatedness Scale Short Form (NR-6) within this sample. All six items demonstrated acceptable fit, the scale met key Rasch assumptions including unidimensionality and ordered rating scale functioning and no evidence of local dependence or Differential Item Functioning (DIF) was found for gender or student status. Together, these findings suggest that the NR-6 can serve as a concise tool for assessing general levels of nature relatedness in similar populations.

However, these results should be interpreted with caution. The presence of a ceiling effect and the “fair” level of person reliability indicate limited sensitivity at higher levels of the trait, which may constrain the scale’s usefulness for intervention studies, pre-post evaluations, or research aimed at detecting subtle changes over time. In addition, the interpretations of item hierarchy presented

in this study remain exploratory; they were derived from post-hoc analysis of item locations and have not yet been validated through cognitive interviewing or other response-process methods. Furthermore, the sample drawn from a single province, predominantly composed of students, and collected online limits the generalizability of the findings beyond this context.

For these reasons, the present study should be viewed as an initial psychometric examination rather than a definitive validation. Future research should evaluate the NR-6 in more diverse Indonesian populations, investigate its performance in longitudinal or intervention designs, and consider adding more difficult items to expand coverage at the upper end of the construct. Studies incorporating qualitative approaches would also be valuable for clarifying how respondents interpret the NR-6 items and for strengthening the validity evidence needed to support broader applications of the scale.

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Conflict Of Interest

The authors declared no conflict of interest associated in this study.

Data Availability Statement

All existing data sources in study are available by submitting request to writer.

Pre-Registration Statement

This research was not pre-registered.

Informed Consent Statement

Informed consent was obtained from all individual participants involved in the study.

Ethics Statement

This research had ethical approval from the Faculty of Medicine and Health Science, Universitas Lambung Mangkurat, Indonesia.

Authorship Contribution

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