

Development and Validation of a Sustainability Competence Instrument Based on Islamic Spirituality for Prospective Teachers in Indonesia

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Abstract

Sustainability competence is increasingly essential in teacher education, yet existing assessment frameworks insufficiently explain how culturally and religiously grounded ethical values can orient sustainability-related judgment and action. This study addressed this gap by developing and initially validating the Sustainability Competence Instrument Based on Islamic Spirituality for Prospective Teachers in Indonesia (SCIISPTI), integrating established sustainability competence frameworks with Islamic spiritual-ethical principles. Following expert review involving 11 specialists, 49 items across seven conceptual domains were administered to 558 Indonesian prospective teachers. Exploratory Factor Analysis using Varimax rotation retained 40 items organized into four empirical dimensions, with strong sampling adequacy ($KMO = 0.959$; Bartlett's $\chi^2(780) = 9000.703$, $p < .001$) and 73.838% explained variance. Internal consistency was high across dimensions ($\alpha = 0.906-0.974$; overall $\alpha = 0.980$). The four dimensions reflect the instrument's empirical organization, while the seven domains preserve its theoretically interpreted competence content. SCIISPTI provides promising initial psychometric evidence for culturally responsive sustainability competence assessment and offers an interdisciplinary approach connecting teacher education, sustainability, psychometrics, and Islamic ethics. More broadly, this study demonstrates how internationally recognized competence frameworks can be contextually grounded without abandoning systematic psychometric evaluation.

A. Introduction

Sustainability education faces a consequential paradox: teachers are increasingly expected to prepare future generations for climate change, resource depletion, and interconnected environmental challenges, yet the competencies required for this role remain difficult to assess in ways that capture how sustainability responsibility is understood and enacted. Sustainability competence (SC) has therefore become central to prospective teacher preparation (Scharenberg et al., 2021; Solís-Espallargas & Morón-Monge, 2020), particularly amid escalating environmental pressures (Nurwidodo et al., 2020; Sukarsono et al., 2024; Sukarsono & Utami, 2019). Education is expected not merely to transmit sustainability knowledge but to cultivate responsible, future-oriented societies (Fuentes-Camacho et al., 2019; Wamsler, 2020). Teachers are pivotal to this transformation because they shape sustainability awareness, attitudes, and behaviors (Scharenberg et al., 2021; Waltner et al., 2020), making SC development in teacher education an urgent educational priority (Corres et al., 2020; Imara & Altinay, 2021).

The challenge, however, extends beyond whether prospective teachers possess sustainability knowledge and skills to how they interpret that competence through culturally embedded systems of ethical responsibility. This issue is particularly salient in Indonesia, home to one of the world's largest Muslim populations (Hidayat & Darmadi, 2019), where sustainability responsibility may intersect with Islamic understandings of stewardship (*khalifah*), environmental ethics, and social justice (Dariah et al., 2025; Farhan et al., 2025; Rekan & Mokhtar, 2025; Salman & Asmanto, 2024; A. Shaleh & Islam, 2024; Wani & Azhar, 2025). Such principles are increasingly articulated through Islamic eco-theological perspectives (Ferdinan et al., 2026; Mustofa et al., 2025; Muthohirin et al., 2025), while culturally grounded Islamic values remain influential in educational meaning-making and moral formation (Mariyono, 2024; Memon et al., 2024; Orgianus et al., 2024).

International scholarship has established a sophisticated conceptual architecture for understanding SC. Wiek et al. (2011, 2015) foregrounded systems thinking, anticipatory, normative, strategic, and interpersonal competencies, while Brundiers et al., (2021) extended this architecture through values-thinking, intrapersonal, implementation, and integrated problem-solving competencies. Subsequent research has shifted attention from conceptualization toward assessment, employing self-report measures, behavioral indicators, and competency-based frameworks across higher and teacher education (Annelin & Boström, 2023; Redman et al., 2021; Rieckmann, 2022; Valdes-Ramirez et al., 2024; Xiao et al., 2024). This trajectory has substantially advanced the measurement of what individuals

know, value, anticipate, and can do. Yet these frameworks were not specifically designed to examine how religiously grounded ethical commitments may orient sustainability judgment, responsibility, and action.

This limitation concerns operationalization rather than the cultural validity of international SC frameworks themselves. Their broadly transferable competence categories may not fully capture variations in the ethical foundations that give sustainability responsibility meaning. In Indonesian teacher education, *khalifah*, compassion (*rahmah*), justice (*'adl*), moderation, accountability, and the prohibition of waste can provide normative grounds for environmental and social responsibility (Bsoul et al., 2022; Dariah et al., 2025; Husamah et al., 2025; Salman & Asmanto, 2024). This concern is reinforced by scholarship positioning spirituality as relevant to contemporary environmental responsibility (Altmeyer, 2021; Husamah et al., 2022; UNESCO, 2018; Westerink, 2013) and by studies demonstrating the broader significance of spirituality and religiosity for value formation, moral reasoning, and educational practice in Indonesia (Bourchier, 2019; Budiyo, 2015; Dewansyah & Nafisah, 2021; Faisal, 2018; Hangabei et al., 2021; Nail & Utama, 2020; A. I. Shaleh & Wisnaeni, 2019).

The resulting gap is therefore not simply a shortage of SC instruments in Indonesia. Rather, it reflects a conceptual and psychometric problem concerning whether established competence constructs can adequately represent sustainability responsibility when spiritual-ethical commitments operate as internal foundations of judgment and action rather than as separate religious variables (Annelin & Boström, 2023; Redman et al., 2021; Rieckmann, 2022). Instruments centered on knowledge, skills, attitudes, or intended behavior may consequently overlook how culturally embedded ethical commitments shape problem framing, future-oriented judgment, fairness, collaboration, and responsible action (Altmeyer, 2021; Husamah et al., 2022). Addressing this gap matters beyond a single national setting: it raises a broader assessment question about how internationally recognized competence frameworks can retain conceptual comparability while becoming responsive to culturally and religiously situated understandings of sustainability.

This study addresses that problem through the Sustainability Competence Instrument Based on Islamic Spirituality for Prospective Teachers in Indonesia (SCIISPTI). Its contribution connects sustainability education, teacher education, environmental ethics, Islamic studies, and culturally responsive psychometrics within a common assessment framework. Rather than positioning spirituality alongside SC as an additional variable, SCIISPTI treats *khalifah*, *rahmah*, *'adl*, moderation, and moral

accountability as ethical foundations that may orient how sustainability competencies are exercised. Its novelty therefore lies not in adding Islamic terminology to an established scale, but in operationalizing spiritual-ethical principles in interpreting sustainability problems, evaluating possible futures, committing to fairness, cooperating with others, and initiating responsible action.

This study aimed to develop SCIISPTI and conduct its initial psychometric validation among Indonesian prospective teachers by examining its empirical factor structure, item performance, and internal consistency. Through this approach, the study investigates whether internationally established sustainability competence constructs can be operationalized within a culturally responsive spiritual-ethical framework while preserving the conceptual and psychometric rigor required for sustainability competence assessment.

B. Method

This study employed an instrument-development and psychometric-validation design to develop the Sustainability Competence Instrument Based on Islamic Spirituality for Prospective Teachers in Indonesia (SCIISPTI) and examine its initial psychometric properties. The design comprised sequential stages of domain and item development, expert content review, empirical testing, exploratory factor analysis (EFA), item reduction, and reliability assessment, following established procedures for instrument development and psychometric validation (Alqahtani, 2025; Han & Abdul Rahman, 2025; Husamah et al., 2024; Koch et al., 2024; Suwono et al., 2022). The authors generated initial domains and items through a structured synthesis of literature on Islamic spirituality, environmental sustainability, and sustainability competence assessment in teacher education. Relevant literature was identified through Scopus and Google Scholar using combinations of keywords concerning Islam and sustainability, sustainability competencies, teacher education, instrument development, and psychometric assessment.

Content review involved 11 experts with complementary expertise: five in environmental education and environmental science, four in instrument development, and two bilingual experts. All were certified lecturers with substantial academic and professional experience, held at least a master's degree, and had an education-related background. Experts independently evaluated item clarity, relevance, conceptual alignment, ambiguity, and redundancy and recommended retention, revision, or deletion. This

process produced a 49-item empirical-testing version covering seven conceptual domains – Valuing Sustainability, Promoting Nature, Supporting Fairness, Problem Framing, Future Literacy, Collective Action, and Individual Initiative – rated on a five-point Likert scale.

The empirical assessment involved 558 prospective teachers from different regions of Indonesia, comprising 80.29% female and 19.71% male participants. They represented different stages of undergraduate teacher education: 71 ninth-semester, 186 seventh-semester, 118 fifth semester, and 183 third-semester students. The 49-item SCIISPTI was administered online through Google Forms. Participants were recruited through lecturers across Indonesia using academic networks, including national educational faculty and journal editors' forums, and completed the questionnaire voluntarily after receiving information about the study and data confidentiality.

Data analysis included descriptive statistics, Pearson item-total correlations, EFA, item reduction, and internal-consistency assessment. Common factors were retained using eigenvalues greater than 1.00, followed by Varimax rotation with Kaiser normalization (Cortés et al., 2021; Kaiser, 1970). Items with factor loadings below 0.50 or problematic cross-loadings were excluded, while factor interpretability and item representation were also considered. Reliability was evaluated using Cronbach's alpha, with ≥ 0.70 considered acceptable, 0.80–0.89 high, and ≥ 0.90 excellent, while recognizing that very high coefficients may indicate item redundancy (Barbera et al., 2021; Forero, 2014; Peterson, 1994). Analyses were performed using SPSS version 25.0.

Ethical approval was granted by the Research Ethics Committee, Faculty of Psychology, Universitas Muhammadiyah Malang (E.6.m/346/KE-FPsi-UMM/VII/2025). Participants provided informed consent, participated voluntarily, could withdraw at any stage, and were assured confidentiality; all data were analyzed and reported in aggregate form.

C. Results and Discussion

This section presents the empirical findings from the development and initial psychometric validation of SCIISPTI, followed by a discussion of their theoretical, interdisciplinary, and practical significance. The results trace the instrument's refinement from its initial conceptual framework to its final empirical structure. At the same time, the discussion interprets these findings in relation to sustainability competence, Islamic spiritual-ethical values, teacher education, and their broader international relevance.

1. Results

a. Development of the Initial SCIISPTI Framework

The initial development of SCIISPTI was grounded in established sustainability competence frameworks, including Brundiens et al., (2021), Wiek et al., (2011, 2015), Redman and Wiek (2021), and Jeong et al., (2015), and integrated with Islamic spirituality-oriented environmental ethics. This conceptual synthesis generated an initial SCIISPTI draft comprising 111 items across 12 domains. The proposed domains were designed to capture the cognitive, affective, and behavioral components of sustainability competence while incorporating spiritual-ethical foundations relevant to the instrument's intended context.

The spiritual-ethical component was informed by previous scholarship on spirituality and Islamic environmental perspectives. Figure 1 summarizes the conceptual synthesis through which established sustainability competence constructs and spirituality-oriented environmental perspectives informed the initial domains and item pool.

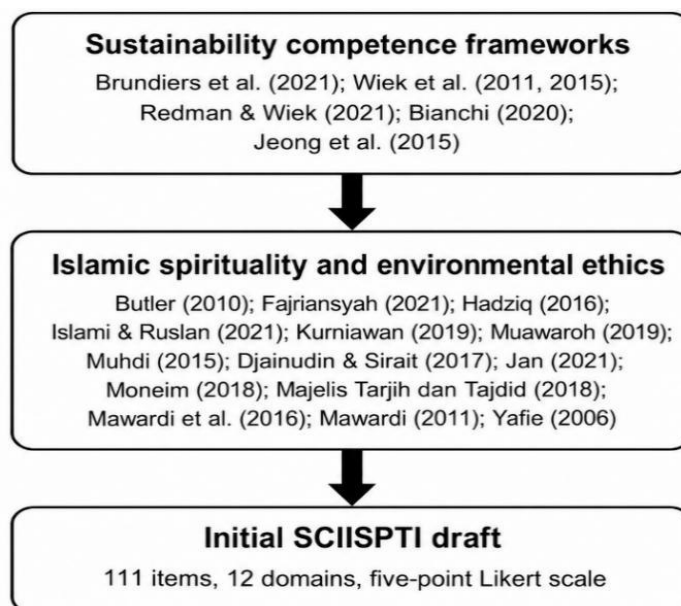


Figure 1. Conceptual synthesis for developing the initial SCIISPTI draft.

b. Descriptive Statistics of the Initial Instrument

Prior to EFA, descriptive statistics and item-total correlations were examined to characterize response patterns across the 49 SCIISPTI items. These analyses provided preliminary information on central tendency, variability, and the relationship of individual items to the overall instrument score.

As shown in Table 1, item means ranged from 3.38 to 4.16, while standard deviations ranged from 0.64 to 1.07, indicating variation in participants' responses across the instrument. The highest mean scores were observed for PN1 and PN2 ($M = 4.16$), whereas VS1 showed the lowest mean ($M = 3.38$); comparatively lower means were also observed for FL2 ($M = 3.56$) and VS7 ($M = 3.58$). Pearson item-total correlations were positive across all items and ranged approximately from 0.30 to 0.80, indicating positive associations between individual items and the overall instrument score. The suitability of the correlation structure for factor analysis was subsequently evaluated using the Kaiser-Meyer-Olkin measure and Bartlett's test of sphericity.

Table 1. Results of descriptive statistical analysis

No.	Item	Mean	Std. Deviation	r	No	Item	Mean	Std. Deviation	r
1.	VS1	3.3800	.77959	.408**	26	PF5	3.7400	.72309	.634**
2.	VS2	3.8800	.82413	.341**	27	PF6	3.7200	.67128	.725**
3.	VS3	4.1400	.80837	.469**	28	PF7	3.8200	.69076	.638**
4.	VS4	3.6800	.76772	.511**	29	FL1	3.7000	.67763	.584**
5.	VS5	3.7200	.70102	.579**	30	FL2	3.5600	.67491	.626**
6.	VS6	3.7000	.73540	.589**	31	FL3	3.7600	.65652	.596**
7.	VS7	3.5800	.70247	.534**	32	FL4	3.6800	.76772	.639**
8.	PN1	4.1600	.73845	.443**	33	FL5	3.7600	.68690	.615**
9.	PN2	4.1600	.73845	.484**	34	FL6	3.7600	.68690	.636**
10.	PN3	3.9000	.81441	.407**	35	FL7	3.9600	.69869	.468**
11.	PN4	4.1000	.67763	.390**	36	CA1	3.8000	.67006	.552**
12.	PN5	3.9200	.66517	.497**	37	CA2	3.7000	.76265	.495**
13.	PN6	4.1400	.67036	.466**	38	CA3	3.7800	.76372	.508**
14.	PN7	3.5600	.83690	.481**	39	CA4	3.7200	.64015	.517**
15.	SF1	4.0000	.72843	.645**	40	CA5	3.8200	.69076	.597**
16.	SF2	3.7800	1.07457	.395**	41	CA6	3.8000	.72843	.538**
17.	SF3	3.9200	.80407	.551**	42	CA7	3.7800	.76372	.591**
18.	SF4	3.7200	.67128	.588**	43	II1	3.9400	.73983	.522**
19.	SF5	3.6800	.68333	.465**	44	II2	3.9600	.72731	.552**
20.	SF6	3.8200	.69076	.600**	45	II3	4.0400	.75485	.401**
22.	SF7	3.9800	.74203	.553**	46	II4	3.8800	.65900	.602**
22.	PF1	3.8200	.71969	.653**	47	II5	3.6600	.77222	.560**
23.	PF2	3.7000	.67763	.692**	48	II6	3.7400	.80331	.585**
24.	PF3	3.7000	.64681	.660**	49	II7	3.8600	.80837	.539**
25.	PF4	3.7400	.72309	.628**					

c. Exploratory Factor Analysis (EFA)

Exploratory factor analysis was conducted to identify the underlying empirical structure of SCIISPTI and examine how the proposed items clustered into coherent sustainability competence dimensions. The analysis proceeded iteratively, removing items with inadequate factor loadings, problematic cross-loadings, or insufficient factor representation before re-estimating the factor structure.

The initial EFA yielded a KMO value of 0.957 and a statistically significant Bartlett's test of sphericity, $\chi^2(1176) = 11179.826$, $p < .001$, indicating that the data were suitable for factor analysis. Examination of the rotated solution identified problematic cross-loadings for CA6, FL3, and FL5 across Components 1 and 2 and for SF7 across Components 1 and 3. In addition, FL7, SF5, and SF4 had factor loadings below 0.50, while the fifth component contained only VS2 and VS3. Based on these criteria, we removed the problematic items and reared the EFA.

The second EFA produced a KMO value of 0.959 and a statistically significant Bartlett's test of sphericity, $\chi^2(780) = 9000.703$, $p < .001$, confirming the suitability of the correlation matrix for factor analysis. The resulting solution retained 40 of the 49 empirically tested items and yielded four empirical dimensions. Dimension 1 contained 13 items, Dimension 2 contained 11 items, Dimension 3 contained 10 items, and Dimension 4 contained six items. As reported in Table 2, the retained items showed factor loadings ranging from 0.548 to 0.803.

Table 2. Results of Exploratory Factor Analysis

Dimension (D)	Item	Factor loading	Eigenvalue	% of variance	Cumulative %
D 1	CA5	0.796	22.945	57.363	57.363
	CA4	0.786			
	II7	0.761			
	II6	0.742			
	CA3	0.736			
	II5	0.729			
	CA7	0.717			
	CA2	0.702			
	II1	0.698			
	II2	0.796			
	II4	0.679			
	II3	0.654			
	CA1	0.650			
D 2	PF4	0.803	3.238	8.094	65.457

Dimension (D)	Item	Factor loading	Eigenvalue	% of variance	Cumulative %
D 3	PF3	0.800	2.003	5.008	70.465
	PF5	0.787			
	PF7	0.756			
	PF6	0.748			
	PF1	0.741			
	PF2	0.725			
	FL4	0.681			
	FL1	0.681			
	FL2	0.629			
	FL6	0.617			
	PN6	0.773			
	PN2	0.741			
	SF1	0.721			
	PN5	0.712			
	SF2	0.699			
	SF3	0.688			
	PN3	0.676			
	PN4	0.671			
D 4	PN1	0.643	1.349	3.374	73.838
	SF6	0.548			
	VS1	0.780			
	VS4	0.758			
	VS7	0.733			
	VS5	0.726			
	VS6	0.692			
	PN7	0.608			

The four empirical dimensions jointly explained 73.838% of the total variance. Dimension 1 had an eigenvalue of 22.945 and accounted for 57.363% of the variance. Dimension 2 contributed an additional 8.094%, increasing the cumulative variance explained to 65.457%, while Dimension 3 contributed 5.008%, resulting in a cumulative variance of 70.465%. Dimension 4 accounted for the remaining 3.374%, bringing the total explained variance to 73.838%.

The four dimensions reported in Table 2 and the seven domains presented in Table 3 represent two distinct levels of instrument organization. The four dimensions constitute the empirical factor structure identified from participants' response patterns through EFA, whereas the seven domains organize the substantive content of the retained items according to the conceptual framework used during instrument development. Accordingly, the seven domains should not be interpreted as seven statistically independent factors. The final SCIISPTI therefore comprises 40 items

loading on four empirical dimensions, while the substantive content of these items remains organized within seven theoretically informed domains.

Table 3. Retained SCIISPTI items across the seven theoretical domains

No.	Domain	Item
1.	Valuing Sustainability	1. I am aware of the core values and principles of Islamic teachings that underlie the socio-economic model and their relationship to sustainability. 2. I can evaluate issues and actions based on the sustainability values and principles expressed in Islamic teachings. 3. I can align personal choices and actions with the sustainability values and principles expressed in Islamic teachings. 4. I can express and discuss the sustainability values, principles, and goals expressed in Islamic teachings, while considering multiple perspectives. 5. I tend to act in accordance with the sustainability values and principles expressed in Islamic teachings.
2.	Promoting nature	6. I understand the main components of the environment and their interdependence (<i>al-ihsân</i>/goodness). 7. I know that our well-being, health and security depend on the well-being of nature as prescribed in the Qur'an and Hadith. 8. I know that humans shape ecosystems and that human activities can rapidly and permanently damage ecosystems as Allah SWT has warned in the Qur'an (e.g. Ar-Rum verse 41). 9. I can see and imagine humans living side by side with nature and respecting other forms of life beyond themselves (<i>Hablum min al-alam</i>). 10. I can find opportunities to spend time in nature (<i>tadabbur</i>) and help restore it (the task of the vicegerent of humans). 11. I care about the harmonious relationship between nature and humans. 12. I am critical of the idea that humans are more important than other forms of life (Islam forbids destructive and arbitrary actions).
3.	Supporting fairness	13. I understand that Islam has a very comprehensive concept of ethics and justice for the present and future generations related to the protection of nature (<i>al-'adl</i>/justice). 14. I recognize the importance of preserving nature to ensure the well-being of future generations (sustainability is part of the core teachings of Islam). 15. I can apply the principles of justice and equality for present and future generations as criteria for environmental conservation and the sustainable use of natural resources (<i>al-'adl</i>/justice). 16. I have a sense of humanity and solidarity with future generations (<i>amanah</i> as a caliph on earth).
4.	Problem framing	17. I recognize that identifying equitable and inclusive actions requires an effort to view sustainability issues from the perspectives of multiple stakeholders (<i>hablum min annas</i>).

No.	Domain	Item
5.	Future literacy	18. I am able to integrate multiple stakeholder perspectives, while considering all forms of life and the environment, to identify and frame present and future sustainability challenges (maqasid shariah principle).
		19. I am able to use a transdisciplinary approach to identify and frame present and future sustainability challenges (the function of knowledge in Islam and the Muslim obligation to learn as much as possible).
		20. I can continually explore sustainability issues to expand the range of alternatives and solutions (role as <i>khairun annaas</i>).
		21. I am able to determine suitable strategies for mitigating, adapting to, and solving sustainability-related problems (role as <i>khairun anaas</i>).
		22. I apply a variety of sustainability competence to frame current and future challenges.
		23. I am able to listen actively and demonstrate empathy in collaboration with others to identify and frame present and future sustainability challenges.
		24. I understand the differences among desired, preferred, and alternative futures in sustainability scenarios (as in the Qur'an surah al-Nahl verse 90).
		25. I understand the differences among the short-term implications of medium- and long-term approaches in sustainability scenarios.
		26. I can formulate alternative future scenarios for sustainability by drawing on scientific evidence, creativity, and sustainability values.
		27. I take a future-oriented approach in planning, assessing, and evaluating sustainability actions.
6.	Collective action (the concept of <i>ta'awun</i> in Islam)	28. I know how to work with diverse participants to create an inclusive vision for a more sustainable future.
		29. I understand the importance of empowering individuals and organizations to work together.
		30. I can act on a shared narrative of a sustainable future.
		31. I am committed to working with others to contribute to an inclusive and sustainable future.
		32. I want to give back to society and nature.
7.	Individual initiative	33. I prioritize sustainability values and interests when taking collective action.
		34. I acknowledge my capacity to contribute to positive environmental change.
		35. I recognize that every individual is committed to society and the environment.
		36. I recognize that every action has an impact, even if it is indirect.
		37. I can apply the principles of reduction, efficiency, and reuse in managing resources.

No.	Domain	Item
		38. I can encourage others, especially my students, to make more sustainable choices (the concept of <i>al-amr bi al-ma'ruf wa al-nahyu an al-munkar</i>).
		39. I am an advocate of individual and collective care for those in need and for the planet.
		40. I believe in anticipating and influencing sustainable change.

Note. The seven domains represent the theoretically interpreted content of the 40 retained items and should not be interpreted as seven separate empirical factors. The four empirical dimensions are reported in Table 2.

As shown in Table 3, the 40 retained items were theoretically organized into Valuing Sustainability (five items), Promoting Nature (seven items), Supporting Fairness (four items), Problem Framing (seven items), Future Literacy (four items), Collective Action (six items), and Individual Initiative (seven items). These domains represent the conceptual organization of the instrument content rather than separate empirical factors; statistically, the 40 items are represented by the four-dimensional structure identified through EFA.

d. Reliability

Internal consistency was assessed for each of the four empirical dimensions and for the overall 40-item SCIISPTI using Cronbach's alpha. The resulting coefficients indicated high internal consistency across all dimensions and the overall instrument, as presented in Table 4.

As shown in Table 4, Cronbach's alpha coefficients ranged from 0.906 to 0.974 across the four empirical dimensions, while the overall 40-item instrument yielded an alpha of 0.980. Dimension 1 showed the highest coefficient ($\alpha = 0.974$), followed by Dimension 2 ($\alpha = 0.972$), Dimension 3 ($\alpha = 0.937$), and Dimension 4 ($\alpha = 0.906$). These coefficients indicate high internal consistency across the empirical dimensions and the overall instrument, although values exceeding 0.90 warrant cautious interpretation because they may reflect substantial similarity among some items.

Table 4. Cronbach's alpha value

Dimension	Cronbach's alpha
Dimension 1	0.974
Dimension 2	0.972
Dimension 3	0.937
Dimension 4	0.906
Total	0.980

2. Discussion

The central finding of this study is that sustainability competence among Indonesian prospective teachers is empirically more integrated than its initial conceptual organization suggests. Although SCIISPTI was theoretically organized into seven domains, EFA identified four empirical dimensions explaining 73.838% of the variance. This convergence should not be interpreted as a loss of conceptual breadth; rather, it suggests that cognitive, ethical, interpersonal, future-oriented, and action-related competencies may operate as interconnected capacities. This interpretation corresponds with Brundiers et al. (2021), who position values-thinking alongside intrapersonal, interpersonal, and implementation-oriented competencies, and Wiek et al. (2011, 2015), who conceptualize systems thinking, anticipatory, normative, strategic, and interpersonal competencies as distinguishable but interdependent. SCIISPTI therefore distinguishes between empirical structure and theoretical content: the four dimensions represent statistical organization, whereas the seven domains retain the substantive meanings of sustainability competence.

This distinction matters because sustainability competence is unlikely to function in educational practice as a collection of isolated abilities. The empirical convergence suggests that prospective teachers may connect sustainability values, problem framing, future-oriented judgment, fairness, collaboration, and action when responding to sustainability challenges. Thus, empirical parsimony does not necessarily imply conceptual reduction. Rather, theoretically distinguishable competencies may become functionally interconnected within particular educational, cultural, and ethical contexts. This interpretation extends the relational understanding of sustainability competence advanced by Brundiers et al., (2021) and Wiek et al., (2011, 2015) by showing how such interdependence may be expressed among Indonesian prospective teachers. The seven domains consequently remain important for explaining competence content even though they should not be interpreted as seven independent empirical factors.

The removal of nine items further demonstrates the balance between theoretical comprehensiveness and empirical parsimony required in instrument development. Items displaying inadequate loadings, problematic cross-loadings, or insufficient factor representation did not provide sufficiently distinctive information within the emerging empirical structure. Their removal refined SCIISPTI without necessarily eliminating the theoretical meanings associated with their original domains. Factor analysis therefore

served not merely as an item-reduction procedure but as an empirical mechanism for examining how theoretically developed competencies were differentiated in participants' responses (Cortés et al., 2021; Kaiser, 1970). The resulting 40-item structure provides a more parsimonious operationalization of the conceptual framework while maintaining substantive coverage across the seven theoretically informed domains.

More importantly, SCIISPTI contributes to sustainability competence assessment not simply because it was developed in Indonesia or incorporates Islamic terminology. Its distinctive contribution lies in positioning Islamic spiritual-ethical principles as normative foundations through which sustainability competencies may acquire ethical direction. Established frameworks emphasize systems thinking, anticipatory thinking, normative judgment, interpersonal collaboration, and strategic action as capacities required to address complex sustainability problems (Brundiers et al., 2021; Redman & Wiek, 2021; Rieckmann, 2018; Wiek et al., 2011, 2015). SCIISPTI extends this architecture by incorporating stewardship (*khalifah*), compassion (*rahmah*), justice (*'adl*), moderation (*wasatiyyah*), accountability, and responsibility. The argument advanced here is that sustainability competence concerns not only what individuals can do, but also the ethical grounds through which those capabilities are interpreted and directed toward responsible action.

This position is supported by Islamic environmental scholarship emphasizing responsibility, balance, justice, moderation, avoidance of waste, and care for creation as foundations of sustainable conduct (Islami & Ruslan, 2021; Kurniawan, 2019; Moneim, 2018; Muawaroh, 2019; Muhdi, 2015). Indonesian scholarship similarly connects environmental responsibility with religious ethics and socially responsible conduct (Mawardi, 2011; Mawardi et al., 2016; Yafie, 2006). SCIISPTI operationalizes these perspectives by treating spirituality not as a separate religious variable alongside sustainability competence, but as an ethical orientation that can shape how prospective teachers understand problems, anticipate consequences, evaluate fairness, collaborate, and assume responsibility for action.

This integration connects competence with moral purpose. *Khalifah* frames agency through responsibility for social and ecological systems; *rahmah* extends concern toward human and nonhuman well-being; *'adl* provides an ethical basis for social and intergenerational fairness; and *wasatiyyah* emphasizes balance and moderation. These principles connect what prospective teachers know and can do with why sustainability-oriented action may be considered morally necessary. This interpretation aligns with

scholarship that identifies spirituality and ethical commitments as relevant to environmental and sustainability-oriented conduct (de la Cruz & Valdivieso, 2024; Filho et al., 2022; Marshall, 2025; Severino-González et al., 2022; Zarate-Torres et al., 2025). SCIISPTI thus advances the proposition that culturally embedded spiritual ethics can operate within sustainability competence rather than merely as an external correlate of environmental attitudes or behavior.

This contribution becomes clearer in comparison with the Environmental Literacy Instrument Based on Spirituality (ELIS). ELIS integrates spirituality into environmental literacy, whereas SCIISPTI addresses a broader configuration of competencies required to interpret, anticipate, evaluate, and respond to sustainability challenges (Husamah et al., 2022). Its conceptual coverage includes Future Literacy, Problem Framing, Valuing Sustainability, Supporting Fairness, Collective Action, and Individual Initiative. SCIISPTI therefore extends beyond environmental knowledge, attitudes, and moral awareness toward prospective teachers' perceived capacities for complex problem interpretation, future-oriented judgment, collaboration, and responsible action. Its contribution lies in operationalizing spiritual-ethical orientation across multiple components of sustainability competence rather than restricting spirituality to environmental literacy.

The findings also reinforce the view that sustainability competence extends beyond knowledge acquisition. Prospective teachers require capacities to understand complex challenges, consider alternative futures, make ethically informed judgments, and translate knowledge into educational action (Fang et al., 2023; Husin et al., 2025; Yadav et al., 2022). The inclusion of Future Literacy and Problem Framing connects SCIISPTI with future-oriented pedagogy and critical engagement with uncertain sustainability trajectories (Laherto et al., 2023; Rasa, 2025; Thomas, 2009). This orientation aligns with competency-based perspectives that integrate knowledge, anticipation, normative judgment, collaboration, and action (Imara & Altinay, 2021; Rieckmann, 2018). SCIISPTI therefore conceptualizes sustainability competence as an integrated capacity to understand, judge, anticipate, cooperate, and act rather than merely demonstrate awareness of sustainability concepts.

The psychometric evidence provides promising but preliminary support for this conceptual architecture. Cronbach's alpha coefficients of 0.906–0.974 across the four dimensions and 0.980 overall indicate high internal consistency relative to commonly

accepted thresholds. Nevertheless, coefficients approaching or exceeding 0.95 may signal substantial similarity among retained items. High reliability should therefore not automatically equate to construct validity or optimal item composition. The reliability estimates are more appropriately interpreted alongside the exploratory factor structure as initial psychometric evidence. This distinction is important because SCIISPTI's contribution depends not merely on high reliability but on whether its empirical organization remains theoretically meaningful and stable beyond the present sample (Demssie, 2021; Taber, 2018).

SCIISPTI also provides an interdisciplinary bridge among sustainability education, teacher education, psychometrics, environmental ethics, and Islamic studies. Sustainability education defines the competence problem; teacher education establishes its professional context; psychometrics examines empirical organization; environmental ethics clarifies normative relationships between humans and ecological systems; and Islamic studies contributes culturally situated concepts of stewardship, justice, compassion, moderation, and accountability. This integration addresses a problem none of these fields can resolve independently: how to assess sustainability competence without separating capability from ethical orientation and cultural meaning. This integration aligns with competency-based sustainability education that connects knowledge, values, judgment, and action (Imara & Altinay, 2021; Rieckmann, 2018; Wiek et al., 2011, 2015).

Practically, SCIISPTI may provide teacher education institutions with a diagnostic framework for identifying areas requiring curricular or pedagogical strengthening. Competence assessment can help institutions examine whether curricula systematically develop sustainability-oriented capacities (Eliyawati et al., 2023; Waltner et al., 2019; Xiao et al., 2024). Resulting profiles may inform project-based learning, interdisciplinary sustainability courses, community engagement, scenario analysis, and reflective learning (Berzosa et al., 2017; Kioupi & Voulvoulis, 2022). Repeated administration may also support evaluation of changes associated with courses or sustainability programs. Nevertheless, because SCIISPTI relies on self-reported competence, its present use is more defensible for diagnostic and developmental purposes than for high-stakes decisions or direct claims concerning actual teaching performance.

At the policy level, assessing prospective teachers' sustainability competencies may support teacher education initiatives associated with SDG 4 on Quality Education and SDG 13 on Climate Action (Bodansky, 2022; Costa et al., 2024; Filho et al., 2023; Zickafoose et al., 2024). This connection matters because education is expected to

cultivate sustainability awareness, responsibility, and future-oriented capacities (Fuertes-Camacho et al., 2019; Wamsler, 2020). SCIISPTI may therefore support curriculum evaluation and institutional monitoring of sustainability-related learning outcomes. However, perceived competence remains conceptually different from demonstrated professional performance. At this stage, the instrument should support institutional reflection and developmental assessment rather than serve as a stand-alone accountability or certification measure.

Internationally, SCIISPTI demonstrates how established sustainability competence frameworks can be contextualized through culturally meaningful ethical and religious values while remaining subject to psychometric scrutiny. This is relevant because sustainability competence and teacher preparation are increasingly discussed across diverse educational systems (Scharenberg et al., 2021; Solís-Espallargas & Morón-Monge, 2020; Corres et al., 2020). The approach may inform culturally responsive assessment in other Muslim-majority or multicultural contexts, but contextualization should not be confused with universal transferability. Differences in language, interpretations of spirituality, teacher education systems, curricula, and sustainability priorities may alter item meaning and empirical structure (Annelin & Boström, 2023; Redman et al., 2021; Rieckmann, 2022). Cross-cultural application therefore requires translation, cultural adaptation, local expert review, Confirmatory Factor Analysis, and measurement-invariance testing before international comparisons can be considered psychometrically defensible.

More broadly, the study illustrates that international relevance need not require cultural homogenization. Global sustainability education requires common conceptual foundations while remaining responsive to culturally situated understandings of responsibility and ethical action. SCIISPTI negotiates this tension by retaining internationally recognizable sustainability competencies while examining how they are expressed through Islamic spiritual-ethical orientations. This approach is compatible with scholarship emphasizing education's role in developing responsible, future-oriented societies and teachers' role in shaping sustainability awareness and behavior (Fuertes-Camacho et al., 2019; Wamsler, 2020; Scharenberg et al., 2021; Waltner et al., 2020). Its broader contribution is therefore methodological as well as contextual: culturally responsive assessment can participate in international sustainability scholarships when contextual meaning is preserved, and cross-cultural equivalence remains an empirical question rather than an assumption.

This study has several limitations that should be considered when interpreting its findings. The empirical structure was derived from Indonesian prospective teachers without confirmation in an independent sample, leaving the stability of the four-dimensional solution across populations and contexts yet to be established. Reliance on self-reported responses also warrants caution, particularly for items concerning spirituality, ethics, and responsible behavior that may be sensitive to social desirability. In addition, the current psychometric evidence is limited to exploratory factor structure and internal consistency, with no further examination of measurement invariance, test-retest reliability, criterion-related validity, or predictive validity. The very high alpha coefficients suggest possible item redundancy, while the absence of evidence linking SCIISPTI scores to observed teaching practice or actual sustainability behavior constrains claims about behavioral correspondence. These limitations position SCIISPTI as a theoretically grounded instrument with promising initial psychometric evidence rather than a universally validated measure.

D. Conclusion

This study developed SCIISPTI as a theoretically grounded instrument for assessing sustainability competence among prospective teachers by integrating established sustainability competence frameworks with Islamic spiritual-ethical principles. Initial psychometric evidence yielded 40 retained items organized into four empirical dimensions, while seven theoretically informed domains preserve the substantive breadth of sustainability competence. This distinction indicates that sustainability values, future-oriented thinking, problem framing, fairness, and individual and collective action may be empirically interconnected while remaining conceptually meaningful. Importantly, SCIISPTI positions *khalifah*, *rahmah*, *'adl*, *wasatiyyah*, and moral accountability not as additional religious variables, but as ethical foundations that may orient how sustainability competencies are understood and exercised.

The study contributes to sustainability and teacher education by connecting competence assessment, environmental ethics, psychometrics, and Islamic perspectives within an interdisciplinary framework. For teacher education institutions, SCIISPTI provides a promising basis for diagnosing sustainability-related competence and informing curriculum development and educational interventions. More broadly, its development demonstrates how internationally recognized sustainability competence frameworks can

be contextualized through culturally and religiously meaningful ethical foundations without abandoning systematic psychometric evaluation.

Given the exploratory nature of the present evidence, further research should confirm the four-dimensional structure using independent samples and Confirmatory Factor Analysis, examine measurement invariance across demographic, educational, cultural, and national contexts, and assess test-retest reliability and convergent, discriminant, criterion-related, and predictive validity. Further investigation should also examine potential item redundancy and relationships between SCIISPTI scores, observed teaching practices, and sustainability-related behavior.

Ultimately, preparing teachers for sustainability requires more than developing what they know and what they can do; it also requires cultivating the ethical foundations that guide why, for whom, and with what responsibility those competencies are exercised. SCIISPTI offers an initial empirical pathway for bringing these dimensions together in culturally responsive teacher education.

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Declaration of Competing Interest

The authors declare no known competing financial or non-financial interests that could have influenced the work reported in this paper.

Declaration of Generative AI

During the preparation of this manuscript, the authors used ChatGPT Plus (GPT-5.6) to improve the clarity and readability of the text. The authors carefully reviewed and edited the tool's output and take full responsibility for the content of this article. The authors made all substantive intellectual contributions, including conceptualization, analysis, interpretation of data, and final decisions regarding content, arguments, and

conclusions. The authors take full responsibility for the integrity, originality, and academic quality of this article.

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