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The Impact of Subjective Well-Being on Sustainable Actions: Resilience as a Mediator Between Spirituality and Happiness in Future Environmental Engineers in Peru

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Abstract: This study explores the mediating role of resilience in the relationship between spirituality and happiness among environmental engineering students in northern Peru, emphasizing its implications for sustainability in education and professional development. Through a quantitative cross-sectional study involving 392 students from public and private universities, two key hypotheses were tested: the direct influence of spirituality on happiness and the mediating effect of resilience. Data were gathered using validated instruments, including the Personal Spirituality Scale (SPI), Connor-Davidson Brief Resilience Scale (CD-RISC 10), and Subjective Happiness Scale (SHS). Structural equation modeling revealed that spirituality has a significant direct effect on happiness and an indirect effect through resilience. The model showed high explanatory power, with spirituality explaining 87% of the variance in resilience, and both variables accounting for 76% of the variance in happiness. These findings highlight the importance of promoting spiritual and resilience-building practices as key strategies for enhancing subjective well-being, a critical factor for preparing sustainable professionals capable of addressing complex environmental challenges. This study contributes to the understanding of how spiritual resources and resilience mechanisms can support the development of socially and psychologically sustainable future engineers.

Keywords: resilience; spirituality; happiness; environmental engineers; structural equation modeling; subjective well-being; sustainability

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1. Introduction

Environmental engineering students' psychological well-being has become a critical global concern, particularly as these future professionals face intense academic pressures while preparing to address complex environmental challenges. Studies have demonstrated that spiritual resilience plays a crucial moderating role in the connection between psychological resilience and mental health, highlighting the importance of enhancing spiritual resilience for maintaining mental well-being among these technical professionals [1]. In

the context of higher education, environmental engineering students encounter significant psychological challenges that impact their overall well-being and their capacity to develop sustainable solutions, with research revealing notable variations in resilience and happiness levels across genders [2]. Furthermore, research has identified the positive mediating role of spirituality between aggression and resilience in students pursuing technical and scientific careers [3].

The current body of research exposes substantial knowledge gaps in our understanding of how spirituality, resilience, and happiness interconnect within environmental education contexts. Although studies have established that self-esteem serves as a partial mediator in the relationship between spiritual health and resilience [4], the specific mechanisms and predictive factors through which spirituality influences resilience and happiness in environmental professionals remain inadequately understood [5]. A comprehensive systematic review has emphasized the need for more thorough research examining the relationship between spirituality/religiosity and resilience in technical fields [6]. Additionally, studies investigating the connection between trait resilience and mental well-being underscore the importance of better understanding how resilience mediates the relationship between environmental stressors and overall well-being [7].

Research conducted at the national level within state universities has revealed intricate relationships between spiritual health, resilience, and happiness among engineering students. Studies employing the Connor–Davidson Resilience Scale and other validated instruments have documented varying levels of these attributes among students, with findings showing that while most students demonstrate upper medium to high spiritual health (87.3%) and high levels of resilience (69.3%), they maintain only moderate levels of happiness (55.3%) [8]. These results emphasize the critical importance of understanding how these variables interact specifically within environmental engineering educational contexts.

The present study aims to analyze how resilience mediates the relationship between spirituality and happiness among environmental engineering students, with particular attention to implications for sustainable development. Building upon previous research that identified key predictors of subjective happiness in college students [9], this investigation advances two central hypotheses: first, that spirituality exerts a significant and positive influence on environmental engineering students' happiness, and second, that resilience functions as a significant mediator in this relationship. This research offers a novel contribution through its comprehensive examination of these three interconnected constructs and their dynamic relationships within the context of environmental sustainability education.

Subjective well-being represents a critical factor influencing sustainable actions, particularly among environmental engineering students who are positioned to become key contributors to ecological and social systems. Research indicates that individuals with higher levels of subjective well-being demonstrate a greater inclination toward environmentally responsible behaviors, as their positive psychological state strengthens their commitment to environmental values and responsibilities [10]. For environmental engineering students, subjective well-being serves as a foundation for developing innovative and sustainable approaches to address complex environmental challenges, effectively aligning personal well-being with societal needs [11,12]. This study seeks to deepen our understanding of how subjective well-being, resilience, and spirituality interact to foster professionals who are not only technically proficient but also intrinsically motivated to advance sustainability [13].

The theoretical significance of this research lies in its contribution to understanding the complex interplay between spiritual health, resilience, and happiness within envi-

ronmental engineering academic settings. From a practical perspective, the findings will inform the development of targeted interventions and support services for environmental engineering students, particularly in demanding technical programs where psychological resilience is crucial for addressing sustainability challenges. This research addresses the recognized need for a more comprehensive understanding of resilience's predictive factors [14] and provides valuable insights for educational institutions seeking to enhance student well-being through spirituality and resilience-focused interventions in environmental engineering education.

2. Literature Review

2.1. General Review of Spirituality, Resilience, and Happiness in Environmental Engineering Education

The integration of spirituality, resilience, and happiness within environmental engineering education has emerged as a significant area of research, revealing important connections among these constructs and their impact on students' capacity to address sustainability challenges. Recent studies have shown that spirituality and social support significantly affect the resilience of university students, particularly during the final semesters of their academic training [15]. This finding aligns with [16], which identified a positive relationship between forgiveness, gratitude, and spirituality in relation to academic performance, highlighting how spirituality functions as a moderator in the relationship between forgiveness and student happiness.

Research has shown that health-related resilience is positively correlated with spirituality and specific personality traits critical for environmental problem-solving. Ref. [17] reported positive correlations with extraversion, agreeableness, and conscientiousness and identified a negative correlation with neuroticism. These findings are further supported by [18], which established that a strong emphasis on religious and spiritual practices is associated with improved psychological health among university students. Similarly, Ref. [19] reported that university students utilize spiritual coping practices to manage educational challenges, confirming that spirituality constitutes a valuable psychological resource for dealing with academic stressors.

A key element in understanding these interrelations was presented by [8], which revealed that the relationship between spirituality and happiness is mediated by resilience, demonstrating that spiritual health is associated with increased happiness via resilience as a mediating factor. This perspective aligns with the belief benefit hypothesis proposed by Buckingham and [20], which suggests that spirituality and religiosity strengthen resilience and enhance personal well-being. This hypothesis is supported by a significant positive correlation between spirituality scores and resilience scale scores.

The implementation of targeted interventions within the university context has shown promising results. Ref. [21] documented through a systematic review that positive psychology courses within university programs generate significant increases in students' life satisfaction and happiness. Similarly, leadership programs designed to improve the resilience of staff members and their capacity to foster resilience among students have shown positive outcomes [22]. However, Ref. [23] noted that while resilience interventions can reduce stress and anxiety, there is limited evidence regarding their impact on depression.

Research in this field has allowed the identification of distinct resilience profiles among university students. Ref. [24] described three distinct profiles, with the "committed-resilient" profile associated with higher levels of professional optimism, academic satisfaction, and well-being. These findings are complemented by recent studies from [25], which consistently confirm the positive influence of religion and spirituality on well-being, highlighting how these factors contribute to improved quality of life, a

search for meaning, and their association with happiness and personal fulfillment within the university setting.

2.2. Spirituality as a Determinant of the Happiness of Environmental Engineering Students

This hypothesis is supported by multiple studies that have documented a significant positive correlation between daily spiritual experiences and levels of happiness among environmental engineering students [26,27]. This relationship is evident through religious practices, meditation, and prayer, which contribute to spiritual well-being, happiness, and sustainable mindsets [28], with spirituality serving as a moderator between forgiveness, gratitude, and happiness in technical education contexts [16]. Research has confirmed that higher levels of spirituality are associated with better health, life satisfaction, and environmental consciousness [29], and spirituality also functions as a valuable resource for managing technical academic stress and enhancing students' psychological, cognitive, and social functioning in environmental engineering programs [30]. Therefore, the following hypothesis is proposed:

Hypothesis 1. *Spirituality has a significant positive influence on the happiness of environmental engineering students.*

2.3. The Mediating Role of Resilience in the Relationship Between Spirituality and Happiness in Environmental Engineering Students

The mediation hypothesis is supported by various studies that have examined the interrelationship between spirituality, resilience, and happiness among university students, particularly in technical and sustainability-focused programs. Recent research has demonstrated that spiritual health is directly associated with happiness and resilience, with resilience serving as a mediating variable between spiritual health and happiness [8]. This finding is reinforced by [31,32], which reported that spirituality indirectly influences life satisfaction and positive affect through resilience, which is especially relevant for students facing complex environmental challenges. The mediating role of resilience is better understood through the psychological immunity-psychological elasticity (PI-PE) model, which provides a comprehensive framework that distinguishes between two pathways of psychological resilience in technical education contexts [33]. This relationship is further supported by the findings of [6], which identified a moderate positive correlation between spirituality/religiosity and resilience through a systematic review. Additionally, Ref. [34] identified factors that contribute to resilience in university students, such as regular sleep, low levels of perceived stress, and high self-esteem—factors particularly crucial for environmental engineering students—whereas [35] suggested that resilience development trajectories vary according to the type of adversity experienced in combination with the use of adaptive and proactive coping strategies—factors that may be influenced by spirituality and environmental consciousness. On the basis of this evidence, the following hypothesis is proposed:

Hypothesis 2. *Resilience significantly mediates the relationship between spirituality and happiness in environmental engineering students.*

Figure 1 presents the research model, which proposes the two previously established hypotheses.

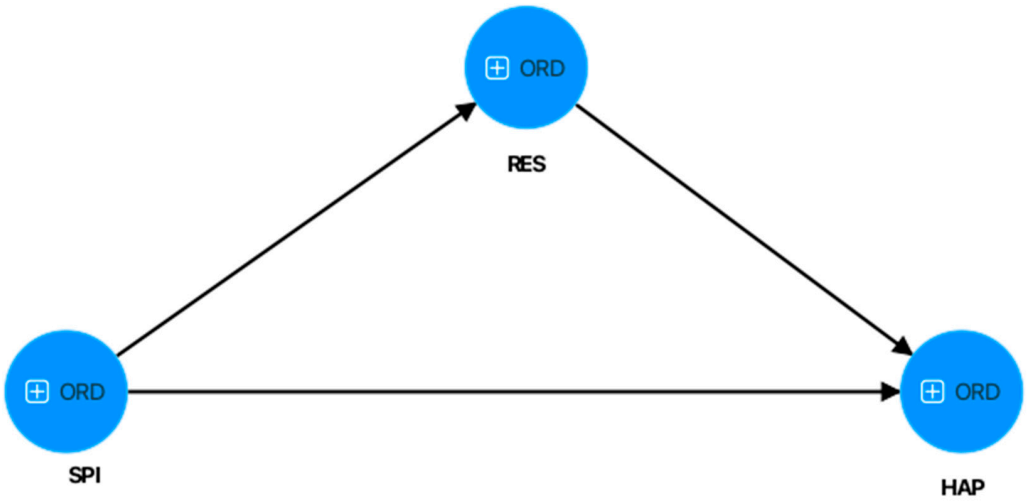


Figure 1. Model proposed. Note: SPI = spirituality; RES = resilience; HAP = happiness.

3. Materials and Methods

To evaluate the research hypotheses, a quantitative study with an explanatory scope was conducted using a cross-sectional experimental design. This approach was chosen to provide a snapshot of the relationships between spirituality, resilience, and happiness among environmental engineering students at a specific point in time. The explanatory scope allowed for identifying and understanding the underlying mechanisms linking these constructs, specifically the mediating role of resilience. The study design also aimed to assess the degree to which spirituality directly and indirectly influences happiness through resilience.

3.1. Participants

The study involved 392 environmental engineering students from public and private universities located in northern Peru. The sample was selected through nonprobabilistic convenience sampling, a method that allows the selection of participants who are accessible and willing to voluntarily participate in the research. As noted by [36], this type of sampling is particularly useful when investigating emergent phenomena in educational contexts, where the accessibility and willingness of participants are critical factors for the feasibility of the study.

As shown in Table 1, of the total number of environmental engineering students surveyed, 69.13% (271 participants) were female, and 30.87% (121 participants) were male. Regarding the year of study, 40.82% (160 participants) were in their first year, followed by 29.59% (116 participants) in their third year and 14.80% (58 participants) in their second year. Concerning religious beliefs, 81.12% (318 participants) reported having some religious affiliation, whereas 18.88% (74 participants) indicated that they did not.

Table 1. Sociodemographic characteristics of the sample (n = 392).

Characteristics	fi	%
Gender		
Female	271	69.13
Male	121	30.87
Year of Study		
First year	160	40.82
Second year	58	14.80
Third year	116	29.59

Table 1. *Cont.*

Characteristics	fi	%
Fourth year	35	8.93
Fifth year	7	1.79
Sixth year	16	4.08
Religious Belief		
Yes	318	81.12
No	74	18.88

Note: fi = absolute frequency; % = percentage.

3.2. Instruments

The instrument selection was conducted through an exhaustive review of the specialized literature, which enabled the identification and adaptation of validated measures to assess the study's three primary components: spirituality, resilience, and happiness. The final questionnaire consisted of the following instruments:

1. Personal Spirituality Scale (SPI): The scale developed and validated by [37], comprising 12 items that assess dimensions of spiritual connection and spiritual practices, was used. This scale has demonstrated appropriate psychometric properties in Latin American contexts, with a clear factorial structure and satisfactory internal consistency.
2. Connor–Davidson Brief Resilience Scale (CD-RISC 10): The version validated by [38] for Peruvian university students was employed. This instrument consists of 11 items measuring the capacity for adaptation and recovery in the face of adversity and has demonstrated excellent psychometric properties in the local university context.
3. Subjective Happiness Scale (SHS): The adapted and validated version by [39] for the adult population of metropolitan Lima was applied. This scale includes 5 items that evaluate subjective well-being and life satisfaction, showing adequate validity and reliability indices in the Peruvian context.

All the items were rated on a 5-point Likert scale ranging from (1) "strongly disagree" to (5) "strongly agree". The questionnaire was administered through an online Google Forms survey organized into three main sections:

1. Informed Consent: This section explains the study's purpose, the voluntary nature of participation, and data confidentiality.
2. Sociodemographic Information: This information included information on gender, year of study, and religious beliefs.
3. Measurement scales: This section comprises the 26 items corresponding to the three aforementioned instruments.

The selection of these instruments was grounded in their proven validity within the Peruvian university context and their capacity to accurately assess the study's variables of interest.

3.3. Procedure and Data Analysis

Data collection was conducted from May to September 2024 at public and private universities in northern Peru. Prior to implementation, the necessary permissions were obtained from university authorities for administering the online survey. Once authorization was secured, the survey link was distributed through institutional email and academic WhatsApp groups, where the study's purpose was explained, and voluntary participation was invited.

To ensure consistency in data collection across participating universities, a standardized protocol was implemented. This included uniform training for survey administrators, identical instructions for participants, and a synchronized data collection period.

Data analysis was conducted in multiple stages. First, data cleaning and preprocessing were performed via Microsoft Excel version 365. Second, descriptive statistics were calculated to characterize the sample. Third, a confirmatory factor analysis (CFA) was conducted to assess convergent validity via indicators such as factor loadings and average variance extracted (AVE), which exceeded the thresholds of 0.70 and 0.50, respectively. As a result of the CFA, items HAP5 and RES10 were removed because the factor loadings were significantly less than 0.70. Internal consistency reliability was evaluated via Cronbach's alpha and composite reliability (CR), whereas discriminant validity was verified via the Fornell and Larcker criterion and the heterotrait-monotrait (HTMT) ratio.

Finally, structural equation modeling (SEM) was performed via the partial least squares (PLS-SEM) technique with SMART-PLS software v.4.0, version 8.0, to test the proposed research hypotheses.

4. Results

4.1. Confirmatory Factor Analysis and Construct Quality Testing

In this research, partial least squares structural equation modeling (PLS-SEM) was applied, for which a confirmatory factor analysis (CFA) was performed to verify the convergent validity of the measurement model. Table 2 shows the factor loadings for each item, which, according to the standards of [40], present acceptable values above 0.70. In addition, all the constructs analyzed reach average variance extracted (AVE) values above the threshold of 0.50, following the recommendations of [41].

Table 3 presents the results of the reliability and discriminant validity tests for the constructs. To assess construct reliability, Cronbach's alpha (α) and composite reliability (CR) (rho_a and rho_c) coefficients were used. According to the criteria proposed by [41,42], values above 0.70 are considered adequate. As shown in the table, all the constructs meet this minimum threshold, indicating satisfactory reliability.

Table 2. Results of the confirmatory factor analysis (CFA).

Items		Factor Loading	Standard Deviation (STDEV)	*p*-Values	AVE	Construct
In general, I consider myself: 1 = A not very happy person; 7 = A very happy person.	HAP1	0.781	0.043	0.000	0.594	Happiness (HAP)
Compared to most of my friends and/or colleagues, I consider myself to be 1 = Less Happy; 7 = Happiest.	HAP2	0.735	0.064	0.000		
Some people are very happy. They enjoy life no matter what happens; they make the most of everything. To what extent does this characterization describe you? 1 = Not at all; 7 = A lot.	HAP3	0.825	0.029	0.000		
Some people are very happy. Even if they have good reasons to feel sad, they can always be as happy as they want to be. To what extent does this description represent you? 1 = Not at all; 7 = A lot.	HAP4	0.739	0.045	0.000		

Table 2. *Cont.*

Items		Factor Loading	Standard Deviation (STDEV)	*p*-Values	AVE	Construct
I am able to adapt when changes arise.	RES1	0.766	0.060	0.000	0.652	Resilience (RES)
I am able to handle unpleasant/painful feelings such as sadness, fear, and anger.	RES10	0.882	0.039	0.000		
I can cope with anything.	RES2	0.891	0.051	0.000		
When I face problems, I try to see the positive side of them.	RES3	0.717	0.033	0.000		
Facing difficulties can make me stronger.	RES4	0.873	0.048	0.000		
I tend to recover quickly after illness, injury, or other difficulties.	RES5	0.883	0.037	0.000		
I believe I can achieve my goals, even if there are obstacles.	RES6	0.889	0.051	0.000		
Under pressure, I stay focused and think clearly.	RES7	0.856	0.053	0.000		
I am not easily discouraged by failure.	RES8	0.808	0.037	0.000		
I believe I am a strong person when faced with life challenges and difficulties.	RES9	0.749	0.036	0.000		
I believe in a higher being or force that provides me with support and sustenance in difficult times.	SPI1	0.891	0.056	0.000	0.754	Spirituality (SPI)
I feel a sense of connection and harmony with myself.	SPI10	0.837	0.027	0.000		
I have a personal relationship with an upper being or force.	SPI11	0.785	0.037	0.000		
Sometimes I feel connected to the universe.	SPI12	0.803	0.039	0.000		
I practice meditation to get in touch with myself.	SPI2	0.811	0.059	0.000		
Accepting and respecting the diversity of people is a value for me.	SPI3	0.939	0.074	0.000		
My faith in a higher being or force helps me face the challenges in my life.	SPI4	0.893	0.041	0.000		
I practice silence to get in touch with myself.	SPI5	0.806	0.052	0.000		
Maintaining and strengthening my relationships with others is important to me.	SPI6	0.784	0.073	0.000		
All living beings deserve respect.	SPI7	0.818	0.082	0.000		
Helping other people is a value for me.	SPI8	0.831	0.067	0.000		
I practice prayer to get in touch with an upper being or force.	SPI9	0.823	0.039	0.000		

Table 3. Reliability, discriminant validity, and coefficients of determination.

Construct	α	CR (rho_a)	CR (rho_c)	Q^2 Predict	R^2	HAP	RES	SPI	HTMT
HAP	0.773	0.780	0.854	0.852	0.762	0.771			0.402
RES	0.868	0.878	0.892	0.983	0.871	0.230	0.674		0.251
SPI	0.851	0.870	0.878		-	0.298	0.274	0.616	0.288

Additionally, the coefficient of determination (R^2) indicates that the SPI accounts for 87% of the variability in RES, whereas the SPI and RES together explain 76% of the variation in HAP.

For discriminant validity, the criterion of [43] was applied, which establishes that a model has discriminant validity when the square root of the average variance extracted (AVE) (values on the diagonal) is greater than the correlations with other constructs (values off-diagonal in the same row and column). Table 3 confirms that each construct meets this criterion. Furthermore, the heterotrait-monotrait ratio (HTMT) criterion was applied, and all the constructs presented values below the threshold of 0.85 [44], indicating that the instrument has adequate discriminant validity.

Goodness-of-fit indices in a measurement model are essential for verifying convergent validity [45], as they provide researchers with a reference framework regarding the degree of fit between observed values and theoretically expected values [40]. Table 4 presents the values for these indices, with the standardized root mean square residual (SRMR) achieving a value of 0.079, meeting the threshold suggested by [46] of being below 0.85, which is considered acceptable.

Table 4. Model fit.

Criteria	Estimated Model	Threshold	Author	Decision
SRMR	0.079	<0.85	[46]	Acceptable
d_ULS	2.183			
d_G	1.529			
χ^2/df	1.352	Between 1 and 3	[47]	Acceptable
NFI	0.989	>0.90	[47]	Acceptable

Additionally, the chi-square over degrees of freedom ratio (χ^2/df) is 1.352, within the recommended range of 1–3, indicating an adequate model fit according to [47]. Finally, the normed fit index (NFI) reaches a value of 0.989, exceeding the threshold of 0.90 and meeting the criteria established by [47], suggesting that the model has an acceptable fit.

4.2. Testing the Research Hypotheses

Table 5 and Figure 2 demonstrate that for Hypothesis 1 (H1), there is a significant indirect effect from SPI to HAP via RES, with a path coefficient of β = 0.044 * and a *p*-value of *p* = 0.037 *, suggesting that social performance indirectly influences happiness through resilience. Similarly, Hypothesis 2 (H2) reveals a significant direct effect from SPI to HAP, with a path coefficient of β = 0.254 *** and a *p*-value of *p* = 0.000 ***, indicating that social performance directly impacts happiness among individuals. Both hypotheses H1 and H2 have statistically significant effects, as shown by their *p*-values, and are thus accepted.

Table 5. Path, *p*-value, confidence intervals, standard deviation, and decision coefficients.

Hypothesis	*β*	*p*-Value	Confidence Intervals		SD	Decision
			2.50%	97.50%		
SPI → RES → HAP	0.044 *	0.037	0.010	0.094	0.021	Accepted
SPI → HAP	0.254 ***	0.000	0.051	5.037	0.051	Accepted

Note: *β* = path coefficient; SD = standard deviation; *** $p < 0.001$; * $p < 0.05$.

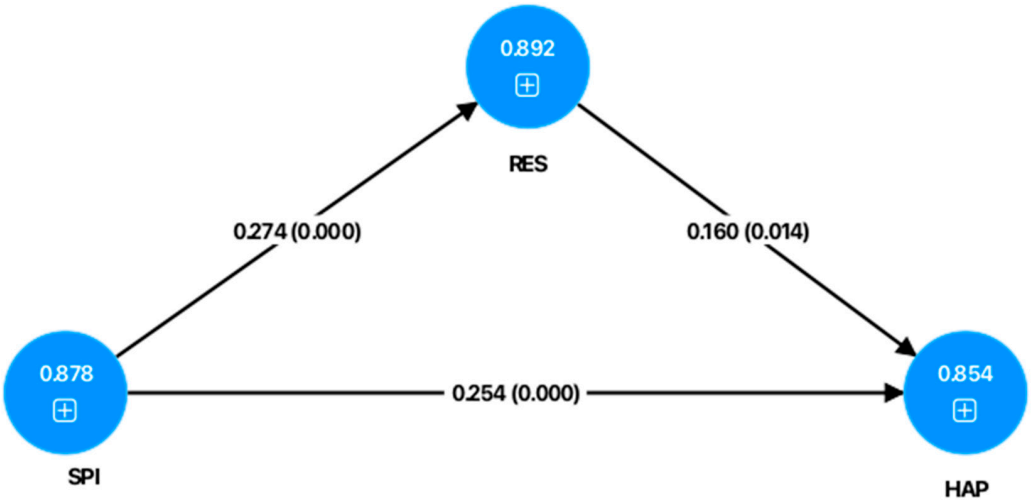


Figure 2. Resolved model.

Table 6 shows the effect sizes, which are acceptable and strengthen the predictive capacity of the model proposed. It also strengthens the testing of the research hypotheses.

Table 6. Effect size.

Construct	RES	SPI	HAP
HAP	0.652	0.893	-
RES	-	0.943	0.763
SPI	0.782	-	0.982

5. Discussion

The results of this research provide significant empirical evidence of the complex interrelationship among spirituality, resilience, and happiness in environmental engineering students. Analysis of the proposed hypotheses reveals important findings that enhance the understanding of these constructs within the context of sustainable engineering education.

Regarding the first hypothesis, the results confirm that spirituality has a significant and positive influence on environmental engineering students' happiness ($\beta = 0.254$, $p < 0.001$). This finding aligns with those of previous studies by [26,27], which documented positive correlations between spiritual experiences and levels of happiness among university students. The strength of this relationship suggests that spirituality serves as a valuable psychological resource for environmental engineering students' well-being and their capacity to address sustainability challenges, which is consistent with the findings of [30] on spirituality's role as a coping mechanism in facing complex technical and environmental challenges.

For the second hypothesis, the results demonstrate that resilience significantly mediates the relationship between spirituality and happiness ($\beta = 0.044$, $p < 0.05$) in environmental engineering education. This finding expands on the conclusions of [8], which initially identified this mediating effect. The presence of this mediation suggests that spirituality not only directly influences happiness but also enhances environmental engineering students' resilience, which in turn contributes to higher levels of well-being and sustainable mindset development. This triangular relationship supports the psychological immunity-psychological elasticity (PI-PE) model proposed by [33], highlighting how spiritual resources can activate resilience mechanisms that lead to greater well-being and environmental consciousness.

A notable aspect of our findings is the high coefficient of determination observed, with spirituality explaining 87% of the variability in resilience, whereas both variables together explain 76% of the variance in happiness among environmental engineering students. These results are substantially stronger than those reported in previous studies, such as [31,32], suggesting that these relationships may be particularly pronounced in the Peruvian environmental engineering education context. This difference could be attributed to the high percentage of students with religious beliefs in our sample (81.12%), which aligns with the observations of Buckingham and [20] on the belief benefit hypothesis.

The validity of our findings is further strengthened by robust psychometric indicators, with model fit indices meeting established criteria (SRMR = 0.079, NFI = 0.989), exceeding the thresholds recommended in the specialized literature. This suggests that the identified relationships are not statistical artifacts but represent genuine patterns within the studied population of environmental engineering students.

The implications of these findings are particularly relevant for the design of interventions within environmental engineering education. In line with the recommendations of [21], our results suggest that environmental engineering programs could benefit from incorporating elements that foster both spiritual development and resilience building to enhance sustainability education. This is especially pertinent given the psychological challenges faced by environmental engineering students as they prepare to address complex ecological challenges, as highlighted by a study on resilience enhancement programs [22].

5.1. Theoretical and Practical Implications

This research offers significant theoretical contributions to the fields of environmental education psychology and sustainable engineering development. First, it expands the theoretical understanding of the relationships among spirituality, resilience, and happiness by demonstrating not only direct effects but also the mediating role of resilience in environmental engineering education. The high explanatory power of the model ($R^2 = 0.762$ for happiness) suggests that the combination of spirituality and resilience may constitute a more robust theoretical framework for understanding environmental engineering students' well-being and their capacity for sustainable practice than models that consider these factors in isolation.

Second, identifying the mediating effect of resilience contributes to theory by providing empirical evidence of the mechanisms through which spirituality influences happiness and sustainable mindset development. This finding supports and expands the psychological immunity-psychological elasticity (PI-PE) model, suggesting that spiritual resources may activate resilience mechanisms that lead to greater well-being and environmental consciousness.

From a practical perspective, the results have direct implications for designing interventions in environmental engineering education. The evidence for the mediating effect of resilience suggests that environmental engineering programs could benefit from integrating spiritual development and resilience-building into their sustainability curricula. This integration could include implementing workshops that combine spiritual practices with resilience-building strategies focused on environmental challenges.

5.2. Limitations and Future Research

This research has several limitations that warrant careful consideration. A primary limitation stems from the cross-sectional design, which captures the relationships between variables at a single point in time, thus constraining our ability to establish definitive causal relationships between subjective well-being and sustainable actions. This design limitation particularly affects our understanding of how spirituality, resilience, and happiness dy-

namically influence environmental engineering students' sustainable behaviors over time. While the current findings provide valuable insights into these relationships, the cross-sectional nature of the data prevents us from determining whether changes in spirituality and resilience precede changes in happiness and sustainable behaviors, or vice versa.

A second significant limitation relates to the sample composition, which was predominantly drawn from environmental engineering students in northern Peru. Although this regional focus provided valuable insights into a specific educational context, it may limit the generalizability of findings to other cultural, geographical, and institutional settings. The unique characteristics of Peruvian higher education and local environmental challenges may influence the observed relationships in ways that differ from other contexts.

Furthermore, the study's scope was constrained by not incorporating certain potentially influential variables. Specifically, personality traits and organizational support structures were not examined, despite their potential significance in shaping sustainable professional motivations and behaviors. This omission limits our understanding of how individual differences and institutional factors might moderate the relationships among spirituality, resilience, and sustainable actions.

To address these methodological constraints, future research should implement comprehensive longitudinal designs that can effectively track the temporal dynamics of these relationships throughout students' academic progression. Such studies would be particularly valuable for examining how the mediating effect of resilience evolves over time and how spiritual practices and resilience-building experiences accumulate to influence sustainable behaviors. Additionally, future research should expand its geographical and institutional scope by including diverse samples from different regions, cultures, and educational systems, enabling cross-cultural comparisons and enhancing the generalizability of findings.

Moreover, subsequent studies should incorporate personality variables (such as conscientiousness and openness to experience) and organizational factors (including institutional support systems and environmental policies) to develop more comprehensive models of sustainable behavior development. This expanded framework would provide deeper insights into how individual differences and institutional contexts interact with spirituality and resilience to shape sustainable professional development.

The implementation of such comprehensive longitudinal studies would not only establish temporal precedence and causal directionality but also reveal developmental patterns that could inform more effective interventions in environmental engineering education programs. This broader perspective is especially crucial for understanding how personal, institutional, and cultural factors collectively contribute to the development of sustainable mindsets in future environmental engineers.

6. Conclusions

This research contributes significantly to understanding the mediating role of resilience in the relationship between spirituality and happiness in environmental engineering students. The findings reveal several novel contributions to the field of sustainable engineering education.

First, spirituality not only directly influences happiness but also exerts an indirect effect through resilience among environmental engineering students. This finding suggests that developing resilience may be a key mechanism through which spirituality contributes to sustainable professional development.

Second, the research reveals the exceptional explanatory power of the model, with spirituality explaining 87% of the variance in resilience, whereas both variables together account for 76% of the variance in happiness among future environmental engineers. These

results significantly exceed the prediction levels reported in prior studies and suggest that the interaction between spirituality and resilience may be more fundamental to developing sustainable engineering professionals than previously considered.

A third significant finding is the empirical validation of resilience's mediating role, providing a more comprehensive framework for understanding how spiritual resources can translate into greater well-being and environmental consciousness. This discovery has important implications for the development of more effective interventions in environmental engineering education.

In terms of sustainability implications, this research makes a significant contribution to understanding how psychological resources can foster sustainable development through environmental engineering education. The findings demonstrate that the interplay between spirituality, resilience, and happiness not only enhances students' well-being but also strengthens their capacity to address complex environmental challenges. By revealing how these psychological factors interact, this study provides valuable insights for developing more effective educational strategies that can cultivate environmentally conscious professionals. The strong mediating role of resilience, in particular, suggests that building psychological resilience may be crucial for maintaining long-term commitment to sustainable practices in environmental engineering. These findings directly contribute to the UN Sustainable Development Goal 4 (Quality Education) by enhancing our understanding of how to better prepare environmental professionals, while also supporting Goal 13 (Climate Action) through the development of resilient professionals capable of addressing environmental challenges. Thus, this research not only advances our theoretical understanding of psychological well-being in environmental education but also provides practical insights for fostering sustainability through the development of more effective and resilient environmental engineering professionals.

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