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RESEARCH ARTICLE

Spirituality and nature connectedness as mediators between exposure to nature and psychological well-being of school students

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ABSTRACT

Spiritual meditations practiced within green environments develop a perceived interconnection between the self and nature that influences physiological well-being. This study investigates spirituality and natural connectivity as mediators between exposure to nature and psychological well-being in Malaysian school students. This study involved 293 students (178 female and 115 male) from four secondary schools in the Johor Bahru district with survey findings on the Exposure to Nature Scale, Connectedness to Nature Scale, Spiritual Values Scale, and Psychological Well-being Scale. The students in the study fell within the age range of 13 to 16 years, and the average age of the sample was 11.86 ± 2.32 years. Structural equation modeling indicated that high spirituality and nature connectedness mediated the relationship between exposure to nature and psychological well-being. Spirituality significantly influenced the relationship between exposure to nature and psychological well-being more than nature connectedness. These findings indicate that practitioners appreciate the value of certain aspects, like exposure to nature, nature connectedness, and spirituality, as a possible path for enhancing school students' psychological well-being.

Keywords: spirituality; well-being; nature; nature connectedness; students

1. Introduction

As children increasingly embrace indoor play and adopt sedentary lifestyles over time, marked by activities such as excessive screen time and passive behaviors, a concerning trend has emerged. These behaviors have been associated with various negative consequences, notably reduced physical activity, which carries implications for overall health. Additionally, these trends are linked to adverse outcomes such as negative behavior, diminished focus, low self-esteem, and compromised psychological well-being[1]. The importance of addressing these challenges is underscored by the recognition that psychological issues during adolescence can yield serious, long-term effects, impacting both mental and physical health, as well as limiting

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economic prospects in adulthood[2]. Recognizing the gravity of these implications, we now shift our focus to explore potential solutions. Notably, the accessibility of natural outdoor settings and the time children spend in them has been correlated with improved psychological well-being. This transition allows us to investigate the positive impact of nature exposure as a strategic intervention to counteract the adverse effects of sedentary behaviors, thereby promoting holistic well-being.

Ecopsychologists and environmentalists align in asserting that immersing oneself in nature yields substantial benefits for both mental and physical health, particularly among the youth, as supported by a robust body of empirical evidence[3]. The positive outcomes of nature exposure extend to enhanced academic performance and personal development in young individuals[4,5]. Previous studies affirm that nature fosters creativity in adolescents[6], mitigates stress[7], aids children with attention deficit disorder[8], and contributes to overall psychological well-being[9]. This study investigates into the intricate relationship between individuals and nature through the framework of ecological self-theory[10]. At its core, ecological self-theory emphasizes the profound interconnectedness between humans and the environment, emphasizing that individuals are not distinct entities but rather intricately linked to nature, both physically and psychologically[11]. This theory promotes the recognition of nature as an integral facet of one's identity and advocates for responsible stewardship of our ecological selves.

In the context of our research, ecological self-theory serves as a guiding lens through which we investigate the advantages of nature exposure for young individuals. By comprehending and embracing the concept of ecological self, we can gain valuable insights into how nature plays a pivotal role in self-realization, contributing to enhanced mental and physical health, academic performance, and overall personal development among youths[11]. This involves perceiving nature not merely as an external entity but as an intrinsic part or extension of themselves, facilitating an authentic life in nature that aligns with their true essence. Several research also looked at the therapeutic advantages of interaction with nature and natural elements for children. A variety of environments have been investigated where children can be exposed to nature, such as schools and residential areas[12]. In these environments, children can have plenty of opportunities to play or visually connect with nature, and this has been linked to improved psychological well-being[13]. This stems from an understanding of human evolution that is thought to be physiologically inscribed in human nature and continues to play a significant role in our responses to natural surroundings and world elements.

Additionally, recent scientific literature increasingly recognizes the effectiveness of resilience exercises. For example, spiritual meditation and mindfulness sessions reduce stress, excessive thinking, anxiety, and depression[14]. Not surprisingly, a robust area of research in psychology is on spiritual meditation. According to this study, spirituality serves as a bridge between involvement with environment and psychological well-being[15]. Holt et al.[15] found that spending time in nature or green spaces reduces stress in various populations. There is evidence that spiritual meditation can aid students in a broad range of educational settings, including middle school, high school, and college, to reduce stress and improve their academic performance[16]. According to the ecological self-theory, a connection with all things natural and alive has a beneficial impact on well-being[17]. Therefore, connecting with nature provides a pathway to spiritual fulfillment, which in turn improves students' psychological well-being.

Direct or physical interaction in a natural setting improves psychological well-being (e.g., sitting in nature or gardening)[16]. According to Muslim[18], exposure to nature, whether direct or indirect, such as a window view, is positively related to well-being. Exposure to nature, i.e., feelings of connection to the natural world, is connected with emotional, mental, and social wellness and life satisfaction because the sound produced by nature is viewed as more pleasant than other noises (high, low, and ambient)[19]. Students can benefit from increasing their psychological well-being through exposure to nature because it results in fewer signs of

depression, enhances life skills, decreases mental weariness, boosts focus, and reduces the likelihood of aggressive behavior[20].

Nature connectedness is a broad concept that includes everything from cognitive and emotional attachment to nature to personal learning and experiencing encounters[21]. Nature connectedness encapsulates the bond between individuals and the broader natural environment[22]. It represents a quantifiable psychological concept that extends beyond mere interaction with nature, delving into an individual's perception of their connection with the natural world. This term encompasses diverse aspects, including emotional resonance, cognitive awareness, and a profound sense of responsibility toward nature. Physical health and nature connectedness decrease morbidity, anxiety, and cardiovascular and respiratory illnesses, in addition to sadness and stress[23]. Furthermore, nature connection is linked to increased self-esteem, autonomy, environmental mastery, life purpose, and acceptance of oneself[24]. Similarly, Leong et al.[25] studied the sense of connectedness with the natural world concerning cognitive styles using analytic-holistic thinking and Kirton's adaption-innovation. The study found a significant association between Kirton's adaption-innovation and nature connectedness and all nature-related sub-scales, including self, perspective, and experience. Basu et al.[21] showed a fundamental link between human well-being, nature connectedness, and attachment to place.

A clear conceptual link between spirituality and nature is also crucial as it exposes the profound connection between spiritual experiences and exposure to nature, shaping individuals' psychological well-being. Spirituality, encompassing internal experiences and belief frameworks, provides significance to one's existence, allowing them to transcend current circumstances[26]. Research indicates that humans frequently immerse themselves in the natural world to fulfil their spiritual needs[27]. Those with a deeper understanding of their inner selves are more likely to recognize and appreciate the therapeutic effects of nature. Notably, deeply spiritual individuals value the emotional benefits over monetary gains. Furthermore, spiritual naturalism, characterized as a perspective, moral system, and daily life practice, encourages individuals to perceive the universe as a natural and sacred whole[28]. This interconnectedness between spirituality and nature underscores the transformative impact of spiritual experiences in natural settings on psychological well-being. Past research involving 87 psychology students found that indirect nature connectedness in movies depicting panoramic views of the natural landscape enhanced spirituality levels[29]. Using the Connectedness to Natural Scale[29] and the Spirituality Mysticism Scale[30], Kamitsis and Francis[31] discovered a fundamental link between nature connectedness and spirituality.

Van Gordon[32] proposed that being in touch with nature and making use of its healing properties might promote mindfulness and self-awareness. Experiencing a harmonious connection with the natural world involves emotional, cognitive, and sensory interactions, along with a subjective feeling of being connected to nature[32]. Recent studies suggested that brief excursions into green spaces or the viewing of images of nature could have a positive impact on mood and attention while reducing stress and improving mental health. Changes in mood and stress often lead to a decrease in blood pressure, heart rate, and salivary cortisol levels. Students who are attracted to outdoor activities and cultivate a sense of purpose may experience enhancements in both their mental and physical well-being[33].

For the relationship between psychological and ecological health, this study utilized ecological self-theory[17] assessed in earlier studies and backed by years of ecopsychology views offering diverse facets of human-nature interaction[32]. Based on this hypothesis, fractured human-nature connections may harm psychological well-being and the environment. Increasing one's nature connectedness improves mental well-being and promotes long-term behavior. Trigwell et al.[24] used this theory to suggest that being connected to all-natural and living things improves one's eudaimonic well-being. Furthermore, the positive impact of nature on well-being, as suggested by ecological self-theory, may be closely tied to spirituality, often perceived as a

connection with nature. According to this theory, an individual's 'ecological self' arises from a profound biological and spiritual bond with the natural world, contributing to our understanding of the beneficial effects of nature on well-being.

The earlier research has indeed shed light on the mediating role of spirituality between nature connectedness and eudaimonic well-being, and Mayer and Frantz[29] have supported nature connectedness as a mediator between nature exposure and well-being. However, a critical gap remains, as there is a lack of empirical evidence demonstrating the simultaneous influence of spirituality, nature exposure, and nature connectedness on psychological well-being. This study seeks to address this gap by investigating the mediating influences of spirituality and nature connectivity on the relationship between exposure to nature and the psychological well-being of school students, particularly in the Malaysian context. While previous research has explored the connections among spirituality, nature connectedness, exposure to nature, and psychological well-being[34], there is a dearth of research specifically on the mediating roles of nature connectedness and spirituality in psychological well-being, especially within the context of school children. Existing studies on these elements and mental well-being have predominantly focused on Western nations, neglecting the unique socio-environmental dynamics of Southeast Asian nations like Malaysia[35].

Muslim et al.[36] emphasizes the significance of the nature-acculturation process in children, highlighting its influence on their preferences and behaviors towards nature-based activities. Notably, studies in tropical nations such as Malaysia indicate that Malaysian infants develop a psychological connection to nature from an early age, perceiving people as an integral part of nature based on their early environmental observations[37]. This study asserts that the psychological well-being of students is significantly influenced by spirituality, nature connectedness, and exposure to nature, making it crucial to explore these factors in the Malaysian context.

In response to these gaps, the research aims to investigate the potential direct and indirect effects of exposure to nature on the psychological well-being of school students in Malaysia. Additionally, the study seeks to explore whether spirituality and nature connectedness mediate the influence of exposure to nature on psychological well-being. By focusing on the Malaysian context, this research aims to provide a nuanced understanding of the interplay between spirituality, nature connectedness, and exposure to nature in shaping the psychological well-being of school students. This not only contributes to the broader literature but also informs the development of targeted intervention methods within the framework of comprehensive school health care.

2. Materials and methods

2.1. Hypotheses of the research

The proposed hypotheses for the associations between the constructs (**Figure 1A,B**) are based on the conditions laid down by Baron and Kenny[38]:

H_1. Exposure to nature (independent variable (IV)) significantly predicts psychological well-being (dependent variable (DV));

H_2. Exposure to nature (IV) significantly predicts nature connectedness and spirituality (mediators);

H_3. Nature connectedness and spirituality (mediators) significantly predict psychological well-being (DV) with controlled exposure to nature (IV); and

H_4. For complete mediation, the association between nature exposure (IV) and psychological well-being (DV) must be reduced to insignificance when nature connectedness and spirituality (mediators) are in the

model. There may be partial mediation if the fourth requirement is not satisfied.

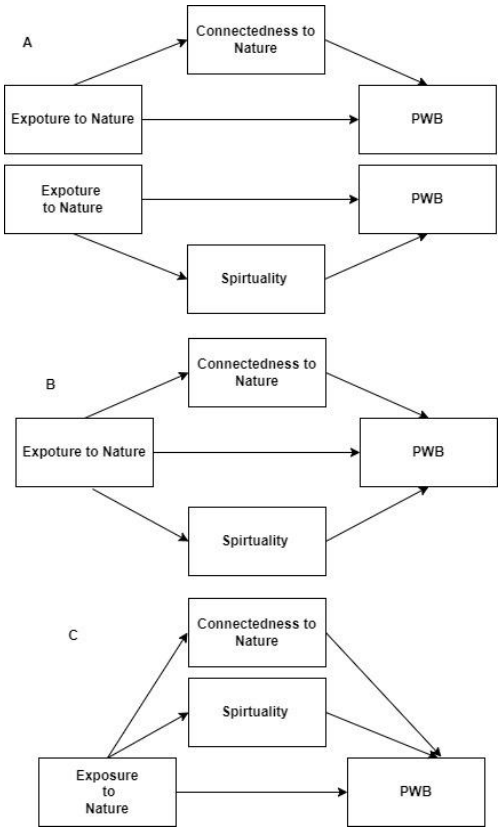

Figure 1. Proposed models for testing.

Note: The proposed models underwent examination in sequential phases, with single mediation model tests (A) preceding the multiple mediation model tests (B and C).

2.2. Participants and procedures

Out of 350 questionnaires distributed among secondary school students (13–16 years), there was a 92.6% return rate and 324 questionnaires. The sample's average age was 11.86 ± 2.32 years. The data-cleaning process excluded 31 respondents due to incomplete responses. After the initial elimination process, data from 293 students were obtained. The evaluation of non-response bias compared early and late responders on the study's main variables. Early respondents were 158 school students who completed the survey during the first half of the period, and late respondents were 166 school students during the second half. According to the findings, the mean scores of the primary constructs employed in this study did not change significantly (i.e., exposure to nature, nature connectedness, spirituality, and psychological well-being), indicating an absence of non-response bias[35,39].

This study got the thumbs-up from the Universiti Putra Malaysia (UPM) Ethics Committee. They made sure to really look out for the rights and well-being of the people in the study, especially the secondary school students in Johor Bahru, Malaysia. The official approval had a code, JKEUPM: IBS-P101, showing that they carefully checked everything in the study to make sure it followed all the ethical rules. The approval process was a big part of the study. They looked closely at all the things put in place to protect the rights of the chosen secondary school students. They paid extra attention to making sure everyone agreed to take part (informed consent), keeping things private (confidentiality), and making sure any possible problems were as small as possible. To make sure participants' rights were kept safe, they made the process of saying "yes" to the study really detailed. They explained everything about what the study was for, how it would work, and what might

happen. The students and, if needed, their parents, could ask questions and were clearly told that they could stop being part of the study at any time without any bad effects. So, in simple terms, the study got a big green light from UPM, and they made sure everything was done right to protect the rights and well-being of the secondary school students in Johor Bahru, Malaysia.

Johor Bahru, the most populous and culturally diverse state in Malaysia, was chosen to generalize the study findings[40]. The randomization process began by selecting eight out of the 41 public secondary schools in the Johor Bahru district using a simple random selection method. However, due to bureaucratic hurdles, only four of these schools were eventually included in the study. To initiate the selection procedure, we first enumerated all the branches (streams) in both lower and upper grades. Subsequently, participants were chosen using a computer-based randomization technique. A specific branch was selected at random, and from there, students were also randomly selected from both lower and upper school classes. This process resulted in a total of 87 students being chosen from each of the selected schools. Parental permission (written) was obtained before participation in the study. Participants received questionnaire packets containing consent forms and questionnaire booklets during their class sessions and were requested to sign the consent forms before answering any questions.

2.3. Measures

Exposure to nature. The Francis'[41] Nature Exposure Scale measured nature exposure. This four-item scale evaluates the extent of exposure to nature beyond typical settings, encompassing both experiences in daily life and activities. A sample item was *"How much do you pay attention to natural environments in your daily life?"* Each of the four items was evaluated using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). In this study, the reliability of exposure to nature was 0.73, with a construct reliability (CR) of 0.830, while convergent validity (Average Variance Extracted: AVE) was 0.503 (Appendix: **Table A1**).

Nature connectedness. Mayer and Frantz[29] established the Connectedness to Nature Scale to examine nature connectivity. It contains 14 queries and a five-point Likert scale was used for each item. The higher average scores on this scale indicated a stronger sense of nature connectedness. An example item is *"I frequently have a sensation of oneness with the natural world around me."* The Cronbach's α coefficient of the original scale was 0.84, CR was 0.883, and AVE was 0.604.

Psychological well-being was assessed using the Ryff[42] scales, which encompassed 18 items distributed across six subscales: autonomy, environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance. Each of these subscales consisted of 3 items. For instance, the autonomy subscale featured an item such as *"I'm usually inspired by folks who hold strong beliefs."* In this study, Cronbach's α for this subscale was 0.75, with an AVE of 0.51 and a CR of 0.723. The environmental mastery subscale also comprised 3 items, with an example being *"I generally believe that I am in control of the circumstances around my life."* For this subscale, Cronbach's α was 0.71, AVE was 0.58, and CR was 0.765. Similarly, the personal growth subscale, consisting of 3 items, included a sample item: "*I long ago gave up attempting to drastically alter or better my life.*" In this study, it had a Cronbach's α of 0.85, an AVE of 0.67, and a CR of 0.876. The positive relations with others subscale, also comprising 3 items, featured an example item: *"Maintaining close relationships has been difficult and frustrating for me."* In this study, it had a Cronbach's α of 0.70, an AVE of 0.52, and a CR of 0.71. The purpose in life subscale, with 3 items, included an example item: *"While some individuals stray through life, I am not one of them."* In this study, it had a Cronbach's α of 0.87, an AVE of 0.64, and a CR of 0.78. The self-acceptance subscale, the final component of psychological well-being, comprised 3 items, with an example item being: *"I enjoy most aspects of who I*

am." In this study, it had a Cronbach's α of 0.76, an AVE of 0.56, and a CR of 0.87. Each of these six subscales employed a 5-point Likert scale.

Spirituality. The Spiritual Values Scale with 20 items by Hatch[43] measured spirituality. This instrument was utilized and modified by the University College of Medical Science, the Institute of National High Education Research, and UPM. The original scale's Cronbach's α was 0.86[44], showing good reliability and validity. Commonly utilized in Malaysia, this scale utilizes a five-point Likert scale, with responses ranging from 1 (strongly disagree) to 5 (strongly agree). The instrument consists of twenty items, with four of them being negative in nature. A sample item is *"I pray for the health and well-being of all living things, including plants and animals."* In this study, the Cronbach α value for the scale was 0.75, AVE was 0.69, and CR was 0.930. The scales were translated from English to Malay by two translators fluent in both languages. The Malay version of the instrument was used to present each instrument, and double-translation procedures were carried out before describing the instruments. Two translators, fluent in both English and Malay and native Farsi speakers, initially translated the scales. After a joint meeting, they reviewed the translations and resolved any inconsistencies. The revised translation then underwent scrutiny by a Malay literature expert. To ensure accuracy, the edited translation was given to two English-fluent translators. An English language expert, unaware of the original constructs, performed a back translation into English. In the final stage, the original, translated, and re-translated versions were presented to a third translator proficient in both English and Malay. At this point, the Malay version of the scales was finalized and approved. Well-trained research assistants administered pencil and paper surveys to target classes. Well-trained research assistants administered pencil and paper surveys to target classes.

2.4. Pilot study

Five high school students and four experts in educational psychology examined three versions of the questionnaire to determine the content quality of the scales. The Malay version was then pilot-tested, and the variations between the versions were evaluated. The validity of the translated questionnaires and the clarity of the items were examined in the pilot study with 50 secondary school students. The findings of the pilot study revealed that all scales had adequate internal consistency, with Cronbach's α values of 0.824 for psychological well-being, 0.741 for exposure to nature, 0.789 for connectedness to nature, and 0.768 for spiritual values. There is no any modifications made to the questionnaire based on the feedback received from high school students and educational psychology experts. It's important that some modifications were made to the questionnaire based on the feedback received from high school students and educational psychology experts.

2.5. Data analysis

The single mediation analysis preceded multiple mediation analyses to evaluate the suggested models (**Figure 1A,B**). Researchers conducted path analysis using linear regression to examine the mediating effects of spirituality and nature connectedness on the link between exposure to nature and psychological well-being. The mediation modeling examines how/why alterations in the connections among the research variables occurred[38]. Furthermore, the suggestion by MacKinnon et al.[45] to investigate both single and multiple mediator models based on Baron and Kenny's[38] conditions motivated the mediation study.

For the mediation tests, biased-corrected bootstrap sample distribution addressed the shortcomings of Baron and Kenny's approach[46]. The bootstrapping approach is a statistical method where data is repeatedly sampled with replacement to estimate the distribution of a statistic. In contrast to Baron and Kenny's method, which depends on traditional hypothesis testing, bootstrapping offers a more reliable and adaptable way to evaluate indirect effects in mediation analysis. The bootstrapping approach generates fresh samples by repeatedly sampling original data at random. Researchers can test hypotheses more accurately with bias-

corrected bootstrapping than with a traditional test like the Sobel test[47]. It may also identify the importance of mediated effects, including indirect effects not distributed normally[48]. The researchers utilized a 95% bias-corrected confidence interval based on 5000 bootstrap estimations and bootstrap maximum likelihood estimation[45].

The fit of the hypothesized model to the data and parameter estimations were evaluated using AMOS (Analysis of Moment Structure) version 26, and data analysis was conducted using IBM SPSS version 26. Path analysis with AMOS allows researchers to find correlations between several variables while accounting for measurement errors, but regression analysis with SPSS does not[49]. All statistical tests had a significance threshold of =0.05, two-tailed. The Pearson correlations and assumption checks conducted before the primary mediation analysis revealed no constructs that needed modification, no substantial correlations among independent variables, and no outliers. For the normality, linearity, homoscedasticity, and error independence, for correlation and regression, all statistical assumptions were met[50]. The results of a multicollinearity diagnostic test based on Meyers et al.[50] which included examining correlation, variance inflation factor (VIF), tolerance, condition index, and variance proportions, revealed that multicollinearity was not an issue.

3. Results

3.1. Profile of respondents

The study was conducted in Johor Baru, Malaysia, primarily in urban areas, with a focus on participants residing in apartments (n = 233), offering valuable insights into an urbanized setting. Johor Baru is located at the southern end of Peninsular Malaysia, along the north bank of the Straits of Johor, opposite Singapore. This geographic context underscores the unique urban landscape in which the research took place. In terms of economic status, the average family income was 2500 RM, providing a glimpse into the socio-economic background of the study's population. This information helps contextualize the living conditions and economic circumstances of the participants. Regarding gender distribution, among the respondents, 178 (60.8%) were females, and 115 (39.2%) were males, offering insight into the gender representation within the sample. T-test results indicated gender differences in exposure to nature and nature connectedness among school students.

The age range of the students was 13 to 16 years old, capturing the adolescence phase of the participants (M = 14.2, SD = 7.3). ANOVA results displayed significant differences in exposure to nature, spirituality, and psychological well-being based on courses. Academic backgrounds were diverse, with the majority in the science stream (39.6%, n = 116), followed by 34.1% (n = 100) in the accounting course, 18.1% (n = 53) in the arts stream, and 6.1% (n = 18) in the engineering course. A small percentage (2%, n = 6) pursued other courses, highlighting varied academic interests within the sample. Ethnicity played a significant role in the demographic composition, with the majority being Malay (51.5%, n = 151), followed by Chinese (34.8%, n = 102), Indians (11.6%, n = 34), and other ethnic groups (2%, n = 6). ANOVA results indicated ethnic differences only in the spirituality variable, reflecting the ethnic diversity within the study population. Religious diversity was evident, with 51.5% identifying as Muslims (n = 151), followed by Buddhists (31.1%, n = 91), Hindus (10.9%, n = 32), Christians (5.8%, n = 17), and a small percentage identifying with other beliefs (0.7%, n = 2). ANOVA results demonstrated significant differences in all variables based on religious diversity, adding a crucial layer to the demographic profile and providing insight into the religious composition of the participants (**Table 1**).

Table 1. Demographic information of the participants, their connections with NLEs, and their relationships with the study variables.

Demographic characteristics	**Category**	***N* (%)**	**Exposure to nature**		**Nature connectedness**		**Psychological well-being**		**Spirituality**	
			***M* ± SD**	***t/f* (*p*)**	***M* ± SD**	***t/f* (*p*)**	***M* ± SD**	***t/f* (*p*)**	***M* ± SD**	***t/f* (*p*)**
Gender	Females	178 (60.8%)	0.54 ± 3.28	$T = -1.782$ ($p = 0.075$)	105.93 ± 17.22	$T = 2.306$ ($p = 0.021$)	1.95 ± 0.74	$T = 1.765$ ($p = 0.076$)	4.57 ± 5.16	$T = 0.459$ ($p = 0.647$)
	Males	115 (39.2%)	4.54 ± 3.28		104.34 ± 15.86		1.89 ± 0.64		4.48 ± 4.39	
Course	Science stream	116 (39.6%)	4.77 ± 2.88	$F = 7.620$ ($p = 0.001$)	1.89 ± 0.69	$F = 0.661$ ($p = 0.516$)	106.14 ± 16.14	$F = 4.927$ ($p = 0.007$)	4.38 ± 2.87	$F = 8.917$ ($p < 0.001$)
	Accounting course	100 (34.1%)	4.47 ± 2.88		1.93 ± 0.68		103.79 ± 16.88		4.78 ± 3.01	
	Arts stream	53 (18.1%)	4.86 ± 3.11		1.92 ± 0.66		104.70 ± 15.95		5.01 ± 3.26	
	Engineering course	18 (6.1%)	5.43 ± 3.63		1.94 ± 0.68		104.26 ± 16.10		4.68 ± 2.93	
	Other courses	6 (2%)	4.38 ± 3.63		1.88 ± 0.68		105.82 ± 16.74		4.70 ± 3.17	
Ethnicity	Malay	151 (51.5%)	4.12 ± 4.45	$F = 0.472$ ($p = 0.624$)	1.89 ± 0.69	$F = 2.321$ ($p = 0.098$)	105.01 ± 16.71	$F = 0.198$ ($p = 820$)	4.47 ± 2.88	$F = 9.745$ ($p < 0.001$)
	Chinese	102 (34.8%)	4.96 ± 4.50		1.93 ± 0.66		104.92 ± 15.89		4.86 ± 3.11	
	Indian	34 (11.6%)	4.46 ± 4.66		1.92 ± 0.66		104.13 ± 16.92		5.43 ± 3.63	
	Other ethnic groups	6 (2%)	4.43 ± 4.62		1.94 ± 0.69		106.14 ± 15.95		4.38 ± 2.87	
Religion	Muslims	151 (51.5%)	5.47 ± 3.19	$F = 45.74$ ($p < 0.001$)	2.03 ± 0.73	$F = 23.94$ ($p < 0.001$)	96.45 ± 17.22	$F = 30.72$ ($p < 0.001$)	55.69 ± 3.40	$F = 45.778$ ($p < 0.001$)
	Buddhists	91 (31.1%)	4.90 ± 4.71		1.96 ± 0.67		103.67 ± 13.85		4.83 ± 3.02	
	Hindus	32 (10.9%)	3.65 ± 2.68		1.82 ± 0.65		105.17 ± 15.38		4.35 ± 2.75	
	Christians	17 (5.8%)	5.47 ± 3.19		2.07 ± 0.73		105.17 ± 15.59		4.75 ± 2.73	
	Other beliefs or faiths	2 (0.7%)								

3.2. Descriptive statistics

The correlation analysis in **Table 2** sheds light on how spirituality, connectedness to nature, exposure to nature, and psychological well-being are related. One key finding is the strong and positive connection (r = 0.463, $p < 0.001$) between spirituality and connectedness to nature. This means that people who feel a spiritual connection are likely to also feel connected to the natural world. On the other hand, the analysis shows no strong link (r = 0.069, $p > 0.001$) between the time spent in nature and one's spirituality, suggesting that how much time someone spends in nature doesn't strongly influence their spiritual beliefs. Furthermore, though spending time in nature is weakly but significantly linked (r = 0.226, $p < 0.001$) to better psychological well-being, both connectedness to nature (r = 0.271, $p < 0.001$) and spirituality (r = 0.337, $p < 0.001$) only show modest connections with psychological well-being. In summary, these findings suggest that spirituality and connectedness to nature are moderately connected, but their individual impacts on psychological well-being are relatively modest. Furthermore, the mean score for connectedness to nature (M = 4.273) surpasses that of other scales, including psychological well-being (M = 3.905), exposure to nature (M = 3.337), and spirituality (M = 2.693). This indicates that participants in the study manifested a higher degree of connectedness to nature compared to their scores on the other scales.

Table 2. Correlations between variables of interest, means, and standard deviations.

No.	Constructs	Mean	SD	1	2	3	4
1	NE	3.337	0.626	1			
2	CN	4.273	0.626	0.162**	1		
3	SP	2.693	0.276	0.069	0.463**	1	
4	PWB	3.905	0.529	0.226**	0.271**	0.337**	1

Note: Exposure to Nature = NE, Connectedness to Nature = CN, Spirituality = SP, Psychological well-being = PWB. **p = 0.001.

Table 3. Model-of-fit evaluation of the research model.

Fit indices	Threshold value	Authors	Results
CMN/DF	<5.0	Bentler[51]	1.666
GFI	>0.90	Chau[52]	0.903
IFI	>0.90	Chau[62]	0.918
CFI	>0.90	Bentler[61]	0.917
TLI	>0.90	Bentler and Bonett[53]	0.904
RMSEA	<0.08	Byrne[54]	0.048

3.3. Measurement model

The collected data was subjected to exploratory factor analysis to determine its suitability for factorial analysis. The analysis used the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity (BTS) for verification. The KMO value was found to be 0.848, which suggested that the scale was appropriate for factor analysis. Similarly, the results of Bartlett's sphericity test (χ^2 = 18,132.321; $p < 0.001$) indicated that the data was interrelated, thereby supporting its suitability for factor analysis. All factor eigenvalues were greater than the threshold of 1.0, which is consistent with Kaiser's rule of thumb. Consequently, the measurement model integrated four latent constructs. The outcomes of the Confirmatory Factor Analysis (CFA) unveiled an acceptable measurement model, featuring convergent validity for each item exceeding 0.50 and substantial factor loadings for all items on their respective factors. The modeling of all constructs followed the calculation of convergent construct validity. The measurement model produced a very good fit to the data in an initial test:

χ^2(DF) = 1.666, p = 0.000, χ^2/df = 401.521, GFI = 0.903, IFI = 0.918, CFI = 0.917, TLI = 0.904, RMSEA = 0.048. The factor loadings of the indicators on the latent variables were consistently significant (i.e., >0.50, p < 0.001), indicating that the indicators effectively represented the latent constructs (**Table 3**).

3.4. Single-mediator models

In single mediation analyses, both nature connectedness and spirituality were identified as mediators in the association between exposure to nature and psychological well-being. The initial three conditions proposed by Baron and Kenny[38] were satisfied, as follows: (a) exposure to nature (IV) significantly predicted psychological well-being (DV) with a 95% confidence interval (CI) of 0.085 to 0.395 (**Figure 2A**); (b) exposure to nature (IV) significantly predicted the two mediators, spirituality, and nature connectedness, with 95% CIs of 0.087 to 0.415 and 0.056 to 0.443, respectively (**Figure 2B**); and (c) both spirituality and nature connectedness significantly predicted psychological well-being (DV) while controlling for exposure to nature (IV) with 95% CIs of −0.063 to 0.335 and 0.035 to 0.273, respectively (see **Figure 2B**). In addition, the fourth condition was satisfied. The direct impact of exposure to nature on psychological well-being lost its significance in both the model incorporating spirituality (95% CI = 0.299, 0.516) and the model involving nature connectedness (95% CI = −0.073, 0.218). In single mediation models, spirituality had a slightly larger indirect effect (b = 0.188) than did nature connectedness (b = 0.137) (**Figure 2B** and **Table 4**).

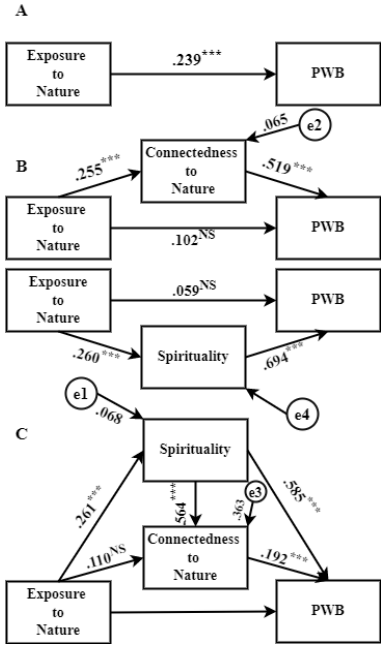

Figure 2. Mediator models' results.

Note: The standardized regression coefficients are shown in path models with single and multiple mediation analyses. *p < 0.05, **p < 0.01, ***p < 0.001, NS = not significant.

3.5. Multiple-mediator models

With the two mediators, the final model confirmed the indirect effect of nature connectedness on psychological well-being (**Figure 2C** and **Table 4**). Exposure to nature significantly predicted psychological well-being. The comprehensive indirect effect encompasses the following three effects: (a) the indirect impact of exposure to nature via spirituality; (b) the indirect effect of exposure to nature through nature connectedness; and (c) the indirect effect of exposure to nature through the sequence of nature connectedness and then spirituality (**Table 3** and **Figure 2C**). As shown in **Figure 2A**, the association between exposure to nature and psychological well-being was significant in the direct model. In the complete mediation model with spirituality

and nature connectedness, the β coefficient from the relationship between exposure to nature and psychological well-being decreased and became insignificant (**Table 5**). Thus, nature connectedness and spirituality mediated this path in the third model. Unlike the results of the prior single mediator models, the indirect influence of exposure to nature through nature connection was non-significant.

Table 4. Competing models' fit indices.

Index	Mediation model I (spirituality)	Mediation model II (nature connectedness)	Mediation model III (spirituality × nature connectedness)
χ^2	147.44	230.414	401.521
df	98	128	241
RMSEA	0.042	0.081	0.048
SRMR	0.046	0.052	0.070
CFI	0.957	0.919	0.917
IFI	0.958	0.921	0.918
AIC	223.440	316.414	519.521
BIC	363.286	474.661	736.651

Note: N = 293. The boldface type represents the best model.

The researchers employed fit indices, including the Bayesian Information Criterion (BIC) and the Akaike Information Criterion (AIC), to compare the three mediation models. Smaller values indicate a better fit for the model. Among these three models, the first mediation model surpasses the others in terms of the aforementioned fit indices (**Table 3**). The first model has the lowest values on AIC, BIC, and ECVI. When model I and model II were compared, the significant chi-square difference, $\Delta\chi^2$ (1, N = 293) = 82.974, p < 0.001. The findings confirmed that the first mediation model was better than the other two models (**Table 4**).

Table 5. Direct, indirect, and total effects of exposure to nature on the psychological well-being of school students.

	Total effect			Direct effect			Indirect effect			Hypotheses
Single-mediator models	**Effect**	**Lo**	**UP**	**Effect**	**Lo**	**UP**	**Effect**	**Lo**	**UP**	
H_1. NE → PWB	0.239***	0.327	0.609							Supported
H_{2a}. NE → CP	0.183**	0.087	0.415							Supported
H_{2b}. NE → SP	212**	0.056	0.443							Supported
H_{3a}. Mediator 1: CN										Supported
NE → PWB				0.102	−0.040	0.262				
NE→ CN → PWB							0.137*	0.035	0.273	
H_{3b}.Mediator 1: SP										Supported
NE → PWB				0.059	−0.073	0.218				
NE → CP → PWB							0.188**	0.063	0.335	
H_4. Multiple-mediator model										Supported
NE → PWB	0.392**	0.078	0.353	0.035	−0.098	0.201				
NE → CN → SP → PWB							0.129*	0.003	0.076	

Note: Exposure to Nature = NE, Connectedness to Nature = CN, Spirituality = SP, Psychological well-being = PWB; Lo = lower; UP = upper; SP, mediated through spirituality; CN, mediated through connectedness to nature; SP → CN, mediated through spirituality and then connectedness to nature in sequence. *p < 0.05, **p < 0.01, ***p < 0.001.

4. Discussion

The study significantly contributes to the existing literature by advancing the ecological self-theory and filling critical gaps in empirical evidence. Our findings offer new insights and depth to the understanding of

the ecological self. Specifically, this research enriches current knowledge in three key ways. First, within the ecological self-theory framework, it enhances our understanding of how engagement with nature, encompassing both exposure and connectedness, influences an individual's psychological well-being. The study also explores the role of spirituality in this dynamic relationship through distinct models, introducing a crucial layer of empirical evidence where limited data existed previously[29,36]. An essential contribution lies in our innovative approach to examining the school environment in the Malaysian context. This is particularly noteworthy given that prior investigations into these factors and their impact on psychological well-being predominantly focused on Western cultures or developed countries. Consequently, our findings provide compelling evidence that these relationships are applicable across diverse cultural contexts. Moreover, our results highlight the significance of spirituality as a more influential factor than nature connectedness in shaping how exposure to nature affects psychological well-being. These quantitative findings robustly support the ecological self-theory, unveiling a profound connection between human spirituality and nature, akin to a form of spiritual meditation[55]. In essence, our study not only advances theoretical underpinnings but also contributes empirical evidence, making it a valuable addition to the ecological self-theory literature.

Even though the results from single-mediator models displayed that students' engagement of each spirituality or nature connectedness offers advantages, it is vital to note that both mediators come with limitations. For example, when students are engaged in school activities, such as studying, socializing, and eating lunch, they can be untuned to the benefits of being outdoors, while engaging in meditation or spatiality requires their focus and attention. Engagement in outdoor meditation may help university students manage their mental health issues while lowering overall mood disturbance, as demonstrated by prior studies[56]. More importantly, this study displayed that nature connectedness and spirituality experienced higher values for ecopsychology. The findings were in agreement with earlier research, which revealed connecting with nature and being in a state of mindfulness could reduce distress and lead to psychological improvements[57].

In this study, the data findings are compatible with previous studies, such as Kassymova et al.[58], who found that the uniqueness of spirituality in nature had a quick and much-needed short-term influence on the participants' psychological responses. Accordingly, natural greenery or spirituality can help students cope with stress[58]. Utilizing natural areas or green spaces has increased to reduce stress among students[15]. Despite the insignificant link between exposure to nature and psychological well-being in three meditation models, the mediation test retained exposure to nature. The literature depicted that exposure to nature and psychological well-being may be enhanced through mediation, such as the students' spirituality[29]. In other words, the spiritual practices of students with exposure to nature will result in a perceived interconnection between their personality and nature, thus influencing their psychological well-being. Teachers need to understand how the connection to nature and spiritual practice independently and jointly relate to the psychological responses of school students. Musa[59] supported this argument and noted that the relationship between the well-being of students and spiritual activities was strengthened and increased through religious practices carried out in the classroom. Implications of this finding extend to the development of interventions and programs aimed at promoting mental well-being through nature engagement. Understanding the prominence of spirituality in this relationship emphasizes the need to consider and foster spiritual aspects alongside encouraging interactions with the natural environment. It underscores the holistic nature of the ecological self, where the spiritual dimension holds a distinctive sway over the individual's psychological well-being.

This aligns seamlessly with the ecological self-theory, which posits that individuals are interconnected with their environment on various levels. Recognizing spirituality as a central element in this interconnectedness reinforces the theory's premise and expands its application beyond the physical and emotional dimensions. Moreover, the connection between exposure to nature, spirituality, and psychological

well-being draws parallels to the concept of spiritual meditation. Just as meditation involves a profound connection with one's spiritual self, our findings suggest that exposure to nature, coupled with heightened spirituality, can create a similar meditative experience. This connection aligns with the holistic principles of the ecological self-theory, emphasizing the interdependence of nature, spirituality, and well-being in the human experience.

According to interconnected school efforts, the recent findings highlighted the significance of offering the appropriate assistance and resources to enable students to immerse themselves outdoors in a spiritual-meditative state. School programs that prescribe nature and park exposure effectively increase the duration of nature immersion within the school's green campus grounds. This study recommends regular training programs for school teachers and students outdoors. These programs should ideally include spiritual meditation practices in pertinent courses or natural classroom greening techniques. Nonetheless, practitioners are reminded of the barriers to participation, practice, and experience, mainly attributed to time availability and constraints. However, the results of this study can be used to support the integration of religiously based spiritual activities or meditations in program coordination and policymaking to attain psychological health goals. Specifically, these programs are suited for school students vulnerable to diverse stressors that lead to the onset of psychopathological states, like anxiety and depression. The ultimate gains are reduced healthcare costs, improved resilience, and better mental and physical health outcomes.

In addition, the study's practical recommendations for schools, stemming from its insightful findings, emphasize the integration of nature immersion and spiritual-meditative practices into various aspects of the educational environment. To achieve this, schools can design nature-centric curricula that weave natural elements into subjects, cultivating an understanding and appreciation for the environment. Teacher training programs are crucial, equipping educators with the knowledge and skills to seamlessly integrate nature-based activities and spiritual-meditative practices into their teaching methods. Encouraging outdoor learning experiences, creating designated outdoor spaces for contemplation, and implementing mindfulness and meditation programs within the school routine are concrete steps to foster a connection between students and the natural world, enhancing their psychological well-being.

However, the implementation of these recommendations is not without challenges. Resource constraints may hinder the development and maintenance of outdoor spaces, and schools may face resistance in integrating new elements into established curricula. Teacher preparedness is a key consideration, requiring training initiatives to ensure educators are comfortable incorporating nature-centric and spiritual-meditative practices into their teaching. Cultural sensitivity is paramount, recognizing diverse perspectives on nature and spirituality. Additionally, accessibility issues, especially in urban areas, may limit the feasibility of outdoor activities. Overcoming these challenges demands strategic planning, collaboration, and a commitment to creating an inclusive and enriching educational environment that aligns with the study's findings.

The study's findings hold significant policy implications for advancing psychological health goals in schools. One key recommendation may involve the incorporation of evidence-based mental health programs into the school curriculum. Policymakers could prioritize funding for the development and implementation of such programs, ensuring they are tailored to the diverse needs and developmental stages of students. Moreover, the study may underscore the necessity of training educators and staff in recognizing and addressing mental health issues. Policies focusing on comprehensive mental health training for school personnel can contribute to creating a supportive and nurturing environment for students. To achieve psychological health goals, program coordination and effective policymaking are paramount. The study results could guide policymakers in establishing interdisciplinary collaborations between education and health departments. This coordination might facilitate the seamless integration of mental health initiatives into the broader educational framework.

Policymakers could incentivize schools to adopt comprehensive mental health policies, emphasizing a holistic approach that includes preventive measures, early intervention, and ongoing support. Program coordination may also involve partnerships with community mental health organizations to extend services beyond the school setting, fostering a continuum of care for students.

The societal benefits stemming from prioritizing psychological health in schools are also profound. By investing in preventive measures, policymakers can anticipate reduced healthcare costs associated with mental health issues. Improved mental and physical health outcomes among students can lead to a more productive and resilient workforce in the future. Additionally, a psychologically healthy population may experience lower rates of absenteeism and increased workplace productivity. The ripple effects extend to reduced burdens on the healthcare system, as proactive mental health measures in schools can contribute to mitigating the long-term impact of mental health challenges on individuals and society at large. Overall, prioritizing psychological health in schools is not just an investment in the well-being of students but also a strategic approach with far-reaching societal benefits.

5. Conclusions, limitations and future directions

In summary, this research contributes significantly to the existing literature by exploring distinct models, enhancing our comprehension of the link between exposure to nature and the psychological well-being of school students. The study presents evidence that the relationship between exposure to nature and psychological well-being is independently mediated by both nature connectedness and spirituality. Particularly noteworthy is the finding that spirituality emerges as the more influential factor in mediating the association between nature experience and psychological well-being. Moreover, the multiple mediator models affirm that both nature connectedness and spirituality play substantial roles in mediating the relationship between exposure to nature and psychological well-being. These findings broaden our understanding of the underlying mechanisms connecting exposure to nature and psychological well-being.

The study's primary limitation is in its cross-sectional design. As a result, a longitudinal study that can offer more information than a cross-sectional research technique merits future research. There were certain limitations in using a correlational research design because this was a correlational study. Even after thorough analysis, conclusions, and generalization of the results, the study methodology and the conclusion drawn from the data may be subject to some limitations. The sample frame utilized in this study limits the study's generalizability. This study's participants were quite specific; they were all Johor Bahru secondary school students in Form Four. Because of the age disparities between the two levels, the study results may not be generalizable to elementary school kids. Nevertheless, given the intricate nature of the connection between nature connectedness and spirituality, employing a qualitative approach is a viable research method. This approach provides researchers with the opportunity to delve into relevant factors, such as the duration, types of activities, or specific natural settings that facilitate spiritual practices. To address knowledge gaps comprehensively, future research should adopt a mixed-methods approach, integrating both quantitative and qualitative techniques.

Author contributions

Conceptualization, SR and ZZ; methodology, NA; software, ZZ; validation, ZM, SR and AMM; formal analysis, ZZ; investigation, SNMS; resources, AMM; data curation, ZZ; writing—original draft preparation, NA; writing—review and editing, SR; visualization, ZM; supervision, SR; project administration, NA; funding acquisition, SR and NA. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare no conflict of interest.

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Appendix

Table A1. A list of questionnaire items used in this study.

Construct	Items
Exposure to nature	• How much do you pay attention to natural environments in your daily life? • To what extent do you actively seek out opportunities to connect with nature beyond typical settings? • How often do you engage in activities that involve direct exposure to natural surroundings? • In your daily routine, how much importance do you place on incorporating experiences with nature?
Connectedness to nature	• I frequently have a sensation of oneness with the natural world around me. • I often feel a sense of oneness with the natural world around me. • I consider the natural world to be a community of which I am a member. • Other living species' intellect is something I acknowledge and value. • I frequently feel cut off from nature. • I picture myself as part of a bigger cyclical process of existence when I think of my life. • I have a strong bond with plants and animals. • I believe that all humans and nonhumans on Earth have common life energy. • I feel like I'm a part of the natural environment, as a tree is a part of a forest. • I frequently feel that I am a little component of the natural environment around me, no more essential than the grass on the ground or the birds in the trees. • I find joy and peace in spending time in natural settings. • I often seek out opportunities to engage with nature in my daily life. • I am mindful of the impact my actions have on the natural environment. • I feel a deep sense of connection when I observe the beauty of nature.
Psychological well-being	• I am usually inspired by individuals who hold strong beliefs. • I generally believe that I am in control of the circumstances around my life. • I have a sense of purpose that gives meaning to my life. • I actively seek opportunities for personal growth and development. • I am open to new experiences and challenges that contribute to my personal growth. • I feel confident in my ability to make choices that align with my values and beliefs. • I have a clear sense of direction and purpose in my life. • I often find meaning and fulfillment in my daily activities. • I am satisfied with the progress I have made toward becoming the person I want to be. • I embrace change and adapt well to new situations. • I am generally optimistic about my future. • I feel a sense of mastery and competence in managing my environment. • I actively engage in activities that contribute to the well-being of the environment. • I am effective in handling the responsibilities and challenges of daily life. • I have a sense of autonomy and independence in my decision-making. • I enjoy positive and meaningful relationships with others. • Maintaining close relationships is rewarding and fulfilling for me. • I accept myself, including both positive and negative aspects of who I am.
Spirituality	• Every negative experience in life is an opportunity for learning and growth. • A higher power guides events in my life. • My religious beliefs play a role in my ability to forgive others. • Engaging in spiritual activities is a regular part of my routine. • My spiritual convictions significantly impact absolutely every aspect of my life. • During challenging times, I turn to God for guidance and support. • I find inherent meaning and significance in life. • I include prayers for the well-being of others, encompassing plants and animals. • I believe in the interconnectedness of all living beings. • Reflecting on life's challenges helps me uncover deeper spiritual insights. • I actively seek moments of mindfulness and contemplation. • I feel a sense of inner peace when connecting with my spiritual beliefs. • I view nature as a manifestation of the divine. • Acts of kindness and compassion are integral to my spiritual practice. • I see beauty and purpose in the diversity of religious beliefs. • I find solace and comfort in sacred texts or teachings. • The practice of gratitude is essential in my spiritual journey. • I strive to align my actions with my spiritual principles. • I feel a sense of unity with the universe and all living beings. • Cultivating a spiritual perspective enhances my overall well-being.