



The Influence of Extraversion Personality on Students' Engagement in School Environmental Actions through Pro-Environmental Motivation as a Mediator

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Abstract

Background. Extraverted individuals are generally characterized by sociability, assertiveness, and active participation in social contexts, which may enhance their involvement in environmental initiatives. However, the extent to which these personality traits translate into sustained environmental engagement is likely influenced by students' intrinsic motivation toward environmental responsibility.

Aims. This study investigates the influence of extraversion personality on students' engagement in school-based environmental actions, with pro-environmental motivation examined as a mediating mechanism.

Methods. A quantitative cross-sectional design was employed using survey data collected from 200 senior high school students enrolled in eco-friendly schools. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) to assess both direct and indirect relationships among constructs.

Result. The findings indicate that extraversion personality significantly influences pro-environmental motivation and directly affects students' engagement in environmental actions. Furthermore, pro-environmental motivation significantly mediates the relationship between extraversion and student engagement, highlighting the importance of internal motivational processes in translating personality traits into pro-environmental behavior.

Conclusion. These results contribute to the literature on environmental psychology and educational behavior by demonstrating the dual pathway through which personality and motivation interact to promote student participation in sustainability initiatives.

Implementation. Practically, the study underscores the importance of fostering intrinsic motivation alongside personality-sensitive strategies to strengthen youth engagement in environmental conservation programs.

Keywords: Extraversion personality; pro-environmental motivation; student engagement; environmental education; sustainability



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INTRODUCTION

Personality traits have long been recognized as significant determinants of individual behavior, influencing both cognitive and affective dimensions of human activity (Guo et al., 2024). Among the Big Five personality dimensions, extraversion has been particularly associated with higher levels of social engagement, assertiveness, and activity-seeking behavior (Bogiscevic & Bujisic, 2021). Extraverted individuals typically display a predisposition toward interacting with others, embracing novel experiences, and expressing enthusiasm, characteristics that have been shown to shape how individuals participate in collective or socially oriented activities (Pringle & Robinson, 2024). In educational settings, these personality characteristics may manifest as varying degrees of involvement in school initiatives, including those focused on environmental stewardship (Ardoin et al., 2020).

Current research in environmental education and environmental psychology shows that student engagement in environmental action is shaped by multiple psychological factors, especially personality, motivation, and contextual support. The article positions extraversion personality as an important dispositional factor because extraverted students tend to be sociable, assertive, energetic, and more inclined toward collaborative and visible activities. At the same time, the literature also recognizes **pro-environmental** motivation as a central internal driver that encourages students to engage in environmentally responsible behavior in a meaningful and sustained way.

The state of the art presented in the article indicates that previous studies have generally developed along three lines. First, some studies examine personality traits as predictors of social or behavioral participation. Second, other studies focus on motivation as the main determinant of pro-environmental behavior. Third, a growing body of literature in educational settings emphasizes that student engagement is not produced by a single factor, but by the interaction of dispositional, motivational, and situational variables. However, these strands are often treated separately rather than integrated into one explanatory model.

Thus, the present article falls within a contemporary research trajectory that moves beyond simple direct-effect models and seeks to explain how personality traits translate into actual environmental engagement among students. Specifically, the article advances the field by testing a framework in which extraversion influences students' engagement both directly and indirectly through pro-environmental motivation. This integrated framework is supported empirically in the study, where all direct and mediating paths are significant.

LITERATURE REVIEW

Environmental engagement among students has emerged as a critical area of research, particularly amid escalating global ecological challenges (Reid et al., 2021). Schools serve not only as

sites for academic instruction but also as platforms for cultivating pro-environmental behaviors and attitudes (Mendes et al., 2025). Student participation in environmentally focused activities—ranging from recycling programs to conservation projects—reflects an intersection of personal disposition, motivational factors, and institutional encouragement (Mittal & Bansal, 2024). Understanding the psychological determinants that facilitate or impede such engagement is essential for designing effective educational interventions that foster environmental responsibility (Tran, 2024).

Pro-environmental motivation has been proposed as a key psychological mechanism linking personality traits to behavioral outcomes (Tian & Liv, 2022). Motivation rooted in environmental concern, personal responsibility, and intrinsic satisfaction can drive students to act consistently in favor of ecological sustainability (Wany et al., 2021). While extraversion provides a social and energetic predisposition, the internalized motivational processes may determine the intensity and persistence of students' engagement in environmentally oriented activities (Yang et al., 2025). By examining pro-environmental motivation as a mediating factor, researchers can uncover the pathways through which personality traits translate into concrete environmental actions (Panno et al., 2021).

Empirical studies have suggested that extraverted individuals are more likely to engage in activities that involve collaboration, visibility, and proactive participation (Landis et al., 2022; Rook et al., 2022). Such tendencies may lead them to participate more readily in environmental initiatives that require communication, teamwork, and leadership (Schabroeck, 2016). However, the mere presence of extraversion does not automatically translate into sustained ecological action; the motivational context plays a pivotal role in shaping the decision to engage in active action (Satchell et al., 2021). Therefore, it is critical to analyze how motivational factors specific to environmental concerns can amplify or attenuate the effect of extraversion on behavioral outcomes (Soutter et al., 2020).

The educational environment itself contributes to the development and expression of both personality traits and motivational dynamics (Kaplam et al., 2019). Supportive school climates, inclusive curricula, and opportunities for experiential learning can foster students' engagement by providing meaningful contexts in which extraverted tendencies can be channeled toward collective environmental goals (Troussas et al., 2025). Moreover, such environments may enhance intrinsic motivation by aligning personal interests with broader ecological objectives (Cardinal et al., 2022). This interplay between personality, motivation, and contextual support underscores the complexity of fostering student engagement in sustainable practices (Wang et al., 2025).

Research in environmental psychology emphasizes that pro-environmental behaviors often result from multifaceted interactions among dispositional, motivational, and situational factors (Kim & Kim, 2024). Personality traits, while relatively stable, interact with motivational drives and external cues to shape action patterns [23]. Understanding these interactions within the educational domain provides valuable insights for developing interventions that are tailored to students' psychological profiles,

thereby maximizing the likelihood of meaningful and enduring engagement in environmental initiatives (Kim, 2021).

Despite growing recognition of personality and motivation in promoting environmental behavior, there remains a paucity of research explicitly examining the mediating role of pro-environmental motivation in educational contexts. Most studies tend to focus either on dispositional predictors or on motivational drivers independently, without integrating these constructs into a coherent explanatory framework. By investigating extraversion as an antecedent and pro-environmental motivation as a mediator, this study seeks to address this gap, offering a nuanced understanding of how psychological factors converge to influence students' participation in school-based environmental actions.

In sum, exploring the influence of extraversion on students' engagement in environmental initiatives through the lens of pro-environmental motivation holds both theoretical and practical significance. The study aims to investigate the direct effect of extraversion on students' environmental engagement, the impact of pro-environmental motivation on this relationship, and the mediating role of motivation in translating personality traits into environmental action. Guided by these objectives, the research is designed to answer the following questions: How does extraversion influence students' engagement in school environmental actions?

The conceptual framework of this study examines the influence of extraversion on students' engagement in school-based environmental actions, with pro-environmental motivation as a mediating factor. Extraverted individuals are characterized by sociability, assertiveness, and energy-seeking behaviors, which may predispose them to actively participate in collective activities, including environmental initiatives. However, the internal motivational processes specifically oriented toward environmental concerns are expected to strengthen the translation of extraverted tendencies into actual engagement.

Based on previous research and theoretical considerations, the framework posits that extraversion positively affects pro-environmental motivation, which in turn enhances students' engagement in school environmental actions. Moreover, pro-environmental motivation is hypothesized to mediate the relationship between extraversion and engagement, providing an explanatory mechanism that clarifies how personality traits influence environmentally responsible behaviors in educational contexts (see Figure 1).

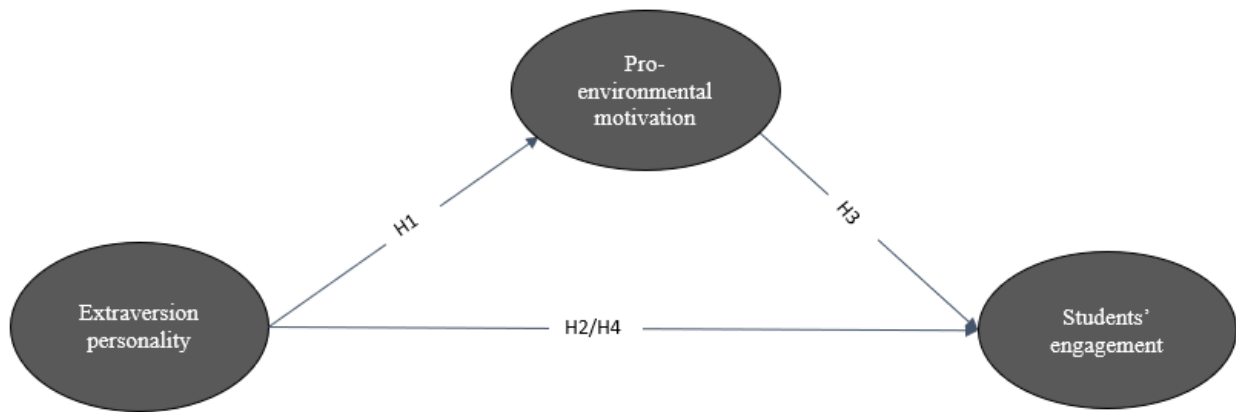


Figure 1. Conceptual framework

Based on the conceptual framework, the following hypotheses are proposed:

H1: Extraversion personality positively influences students' pro-environmental motivation.

H2: Extraversion personality positively influences students' engagement.

H3: Pro-environmental motivation positively influences students' engagement.

H4: Pro-environmental motivation mediates the relationship between extraversion personality and students' engagement.

METHODS

Research Design

This study employed a quantitative, cross-sectional design to investigate the influence of extraversion personality on students' engagement in school-based environmental actions, with pro-environmental motivation as a mediating variable. A Partial Least Squares Structural Equation Modeling (PLS-SEM) approach was used to examine both direct and indirect relationships between constructs. PLS-SEM was selected because it is suitable for predictive modeling, works well with smaller sample sizes, and does not require strict normality assumptions, making it appropriate for educational research contexts.

Participants

Participants were 200 senior high school students enrolled in eco-friendly schools in Jakarta. A purposive sampling method ensured that students included had prior involvement in at least one school-based environmental initiative, such as recycling, tree planting, or environmental campaigns. Participants' ages ranged from 16 to 18 years, with a balanced distribution of gender and grade levels. Demographic information was collected to support descriptive analysis and potential subgroup comparisons.

Instruments

Three instruments were administered. The Extraversion dimension was measured using the Big Five Inventory (BFI) extraversion subscale by Zumbo & Taylor (1993), containing [e.g., 8] items rated on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). Pro-environmental motivation was assessed using an adapted scale that captures intrinsic, identified, and introjected motivational components from Candamia (2018). Students' engagement in school environmental actions was measured through a structured questionnaire evaluating participation frequency, diversity, and intensity in environmental activities by (Aldhafeeri & Aiotaibi (2022). Reliability and validity were confirmed via Cronbach's alpha (>0.70) and pilot testing for clarity and context relevance.

Data Collection Procedure

Data were collected through self-administered questionnaires in classrooms under supervision of trained research assistants. Participants were informed about the study purpose, assured of confidentiality, and instructed to respond honestly. Completion took approximately 20–25 minutes. Ethical approval was obtained from Universitas Negeri Jakarta, and informed consent was obtained from both students and parents/guardians, in accordance with the principles of the Declaration of Helsinki.

Data Analysis Using PLS-SEM

Data were analyzed using PLS-SEM with [SmartPLS software]. The analysis followed a two-stage approach (Hair et al., 2017): (1) measurement model assessment to evaluate reliability and validity of constructs, including indicator reliability, internal consistency (composite reliability), convergent validity (Average Variance Extracted, AVE), and discriminant validity (Fornell-Larcker criterion and HTMT ratio); and (2) structural model assessment to test hypothesized relationships, including path coefficients, R^2 values, effect sizes (f^2), and predictive relevance (Q^2). The mediating effect of pro-environmental motivation was examined using bootstrapping with 5,000 resamples to obtain bias-corrected confidence intervals. Significance was determined at $p < 0.05$.

DISCUSSION

Validity and Reliability

The Confirmatory Factor Analysis (CFA) results indicate that all three constructs—Extraversion Personality, Pro-Environmental Motivation, and Students' Engagement—exhibit strong measurement properties (see Table 1 and Figure 2). For Extraversion Personality, all eight items show outer loadings ranging from 0.833 to 0.926, surpassing the recommended threshold of 0.70. The construct demonstrates excellent internal consistency, with Cronbach's alpha ($\alpha = 0.955$), rho_A (0.956), and

composite reliability (CR = 0.963), while the AVE of 0.763 confirms that a substantial proportion of the variance in the indicators is explained by the latent variable.

Similarly, Pro-Environmental Motivation and Students’ Engagement exhibit robust outer loadings, ranging from 0.804 to 0.945 and 0.840 to 0.927, respectively. Both constructs achieve high reliability indices ($\alpha = 0.967$, CR = 0.973, AVE = 0.816 for Pro-Environmental Motivation; $\alpha = 0.959$, CR = 0.965, AVE = 0.776 for Students’ Engagement), indicating strong internal consistency and convergent validity. Overall, these results confirm that the measurement model is reliable and valid, providing a solid foundation for subsequent structural model analysis using PLS-SEM.

Table 1. Confirmatory Factor Analysis

| Construct | Items | Indicators | Outer Loading | α | rho_A | CR | AVE |
|------------------------------|--------|--|---------------|----------|-------|-------|-------|
| Extraversion personality | EXTRA1 | I am someone who is talkative. | 0.863 | 0.955 | 0.956 | 0.963 | 0.763 |
| | EXTRA2 | I am someone who is outgoing and sociable. | 0.926 | | | | |
| | EXTRA3 | I am someone who is full of energy. | 0.884 | | | | |
| | EXTRA4 | I am someone who enjoys being around people. | 0.844 | | | | |
| | EXTRA5 | I am someone who tends to seek excitement. | 0.846 | | | | |
| | EXTRA6 | I am someone who is assertive in social situations. | 0.833 | | | | |
| | EXTRA7 | I am someone who likes to start conversations. | 0.868 | | | | |
| | EXTRA8 | I am someone who enjoys group activities. | 0.918 | | | | |
| Pro-environmental motivation | PEM1 | I participate in environmental activities because I feel it is personally important. | 0.945 | 0.967 | 0.968 | 0.973 | 0.816 |
| | PEM2 | I engage in environmental actions because I believe they are the right thing to do. | 0.928 | | | | |
| | PEM3 | I take part in school environmental programs because I enjoy them. | 0.804 | | | | |
| | PEM4 | I am motivated to act for the environment to fulfill personal goals. | 0.866 | | | | |
| | PEM5 | I participate in eco-friendly activities to feel responsible for nature. | 0.940 | | | | |
| | PEM6 | I join environmental campaigns because I feel it contributes to society. | 0.868 | | | | |

| | | | | | | |
|----------------------|------|---|-------|-------|------|-------------|
| | PEM7 | I engage in school green projects because I want to improve my skills. | 0.937 | | | |
| | PEM8 | I take environmental actions because it aligns with my personal values. | 0.929 | | | |
| Students' engagement | STE1 | I actively participate in school recycling programs. | 0.876 | 0.959 | 0.96 | 0.965 0.776 |
| | STE2 | I join school tree planting activities regularly. | 0.927 | | | |
| | STE3 | I contribute ideas and efforts to environmental campaigns. | 0.891 | | | |
| | STE4 | I volunteer for school environmental projects enthusiastically. | 0.872 | | | |
| | STE5 | I encourage my peers to take part in eco-friendly activities. | 0.882 | | | |
| | STE6 | I dedicate time to school gardening or conservation programs. | 0.899 | | | |
| | STE7 | I follow school rules related to environmental protection. | 0.858 | | | |
| | STE8 | I try to implement environmentally responsible behaviors in my daily school life. | 0.840 | | | |

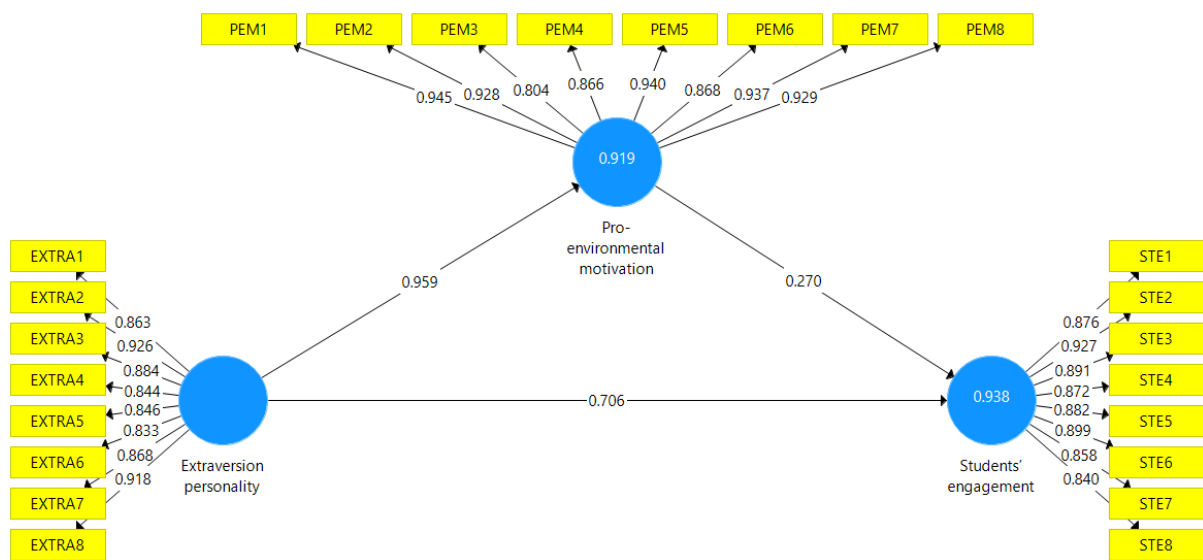


Figure 2. PLS Algorithm

The results of the Fornell-Larcker criterion presented in Table 2 indicate adequate discriminant validity among the constructs. For each latent variable, the square root of the Average Variance Extracted (AVE) is higher than the correlations with other constructs. Specifically, Extraversion Personality has a square root AVE of 0.873, which exceeds its correlations with Pro-Environmental

Motivation (0.959) and Students’ Engagement (0.965). Similarly, Pro-Environmental Motivation (0.904) and Students’ Engagement (0.881) both demonstrate higher square root AVE values than their respective inter-construct correlations, confirming that each construct shares more variance with its indicators than with other constructs.

The HTMT (Heterotrait-Monotrait) ratio presented in Table 3 further supports the model's discriminant validity. All HTMT values are below the commonly accepted threshold of 0.90, with the highest value being 0.895 between Extraversion Personality and Pro-Environmental Motivation. Values between other constructs, such as 0.707 and 0.781, are well below the threshold, indicating that the constructs are empirically distinct and measure separate theoretical dimensions. Together, these results provide strong evidence that the measurement model meets the requirements for discriminant validity, ensuring the reliability of subsequent structural analyses using PLS-SEM.

Table 2. Fornell-Larcker criterion

| Construct | EXTRA | PEM | STE |
|------------------------------|-------|-------|-------|
| Extraversion personality | 0.873 | | |
| Pro-environmental motivation | 0.959 | 0.904 | |
| Students’ engagement | 0.965 | 0.947 | 0.881 |

Table 3. HTMT ratio

| Construct | EXTRA | PEM | STE |
|------------------------------|-------|-------|-----|
| Extraversion personality | - | | |
| Pro-environmental motivation | 0.895 | - | |
| Students’ engagement | 0.707 | 0.781 | - |

Structural model assessment

The structural model assessment indicates that the model demonstrates strong explanatory and predictive power. As shown in Table 4, the R² values for Pro-Environmental Motivation (0.919) and Students’ Engagement (0.938) suggest that the independent variable, Extraversion Personality, explains a substantial proportion of the variance in both endogenous constructs. The adjusted R² values (0.918 for Pro-Environmental Motivation and 0.937 for Students’ Engagement) further confirm the robustness of the predictive model, indicating strong predictive power.

Effect size analysis (f²) presented in Table 5 reveals that Extraversion Personality has a large effect on both Pro-Environmental Motivation (f² = 11.314) and Students’ Engagement (f² = 0.651), highlighting its dominant influence in shaping students’ environmental attitudes and behaviors. In

contrast, Pro-Environmental Motivation exerts a small effect on Students' Engagement ($f^2 = 0.095$), suggesting that while it mediates the relationship, its direct contribution is moderate. Table 6 shows Q^2 values of 0.738 for Pro-Environmental Motivation and 0.720 for Students' Engagement, indicating strong predictive relevance and confirming that the model reliably predicts out-of-sample observations. Collectively, these findings support both the explanatory and predictive validity of the PLS-SEM model.

Table 4. R-square effect

| Construct | R Square | R Square Adjusted | Result |
|------------------------------|----------|-------------------|-------------------------|
| Pro-environmental motivation | 0.919 | 0.918 | Strong predictive power |
| Students' engagement | 0.938 | 0.937 | Strong predictive power |

Table 5. F-square effect

| Construct | PEM | STE | Result |
|------------------------------|--------|-------|--|
| Extraversion personality | 11.314 | 0.651 | Large effect (on EPM) Large effect (on STE) |
| Pro-environmental motivation | | 0.095 | Small effect (on STE) |

Table 6. Q-Square

| Construct | SSO | SSE | $Q^2 (=1-SSE/SSO)$ | Result |
|------------------------------|------|---------|--------------------|-----------------------------|
| Pro-environmental motivation | 1600 | 419.129 | 0.738 | Strong predictive relevance |
| Students' engagement | 1600 | 448.097 | 0.720 | strong predictive relevance |

Hypothesis result

The hypothesis testing results indicate that all proposed relationships in the model are statistically significant and supported (see Table 7 and Figure 3). Specifically, H1 shows that Extraversion Personality has a strong positive effect on Pro-Environmental Motivation ($\beta = 0.959, p < 0.001$), suggesting that students who exhibit higher levels of extraversion are more intrinsically motivated to engage in environmentally responsible behaviors. Similarly, H2 demonstrates a significant direct effect of Extraversion Personality on Students' Engagement ($\beta = 0.706, p < 0.001$), indicating that extraverted students are more likely to participate actively in school-based environmental actions.

The mediating role of Pro-Environmental Motivation is also confirmed. H3 indicates a significant positive effect of Pro-Environmental Motivation on Students' Engagement ($\beta = 0.270, p = 0.007$), while H4 confirms the indirect effect of Extraversion Personality on Students' Engagement through Pro-Environmental Motivation ($\beta = 0.259, p = 0.006$). These findings collectively support the hypothesized

model, highlighting that extraversion not only directly influences engagement but also indirectly promotes it by enhancing students’ pro-environmental motivation, thereby providing empirical evidence for both direct and mediating pathways within the PLS-SEM framework.

Table 7. Hypothesis result

| Hypothesis | Construct*) | β | Bias | Confidence Interval | | T Statistics | P Values | Result |
|------------|---------------------|-------|--------|---------------------|--------|--------------|----------|-----------|
| | | | | 2.50% | 97.50% | | | |
| H1 | EXTRA-> PEM | 0.959 | 0.000 | 0.938 | 0.971 | 117.505 | 0.000 | Supported |
| H2 | EXTRA -> STE | 0.706 | 0.006 | 0.546 | 0.926 | 7.322 | 0.000 | Supported |
| H3 | PEM -> STE | 0.270 | -0.007 | 0.042 | 0.425 | 2.726 | 0.007 | Supported |
| H4 | EXTRA -> PEM -> STE | 0.259 | -0.007 | 0.039 | 0.406 | 2.746 | 0.006 | Supported |

Abbreviation: EXTRA=Extraversion personality; PEM=Pro-environmental motivation; STE=Students’ engagement

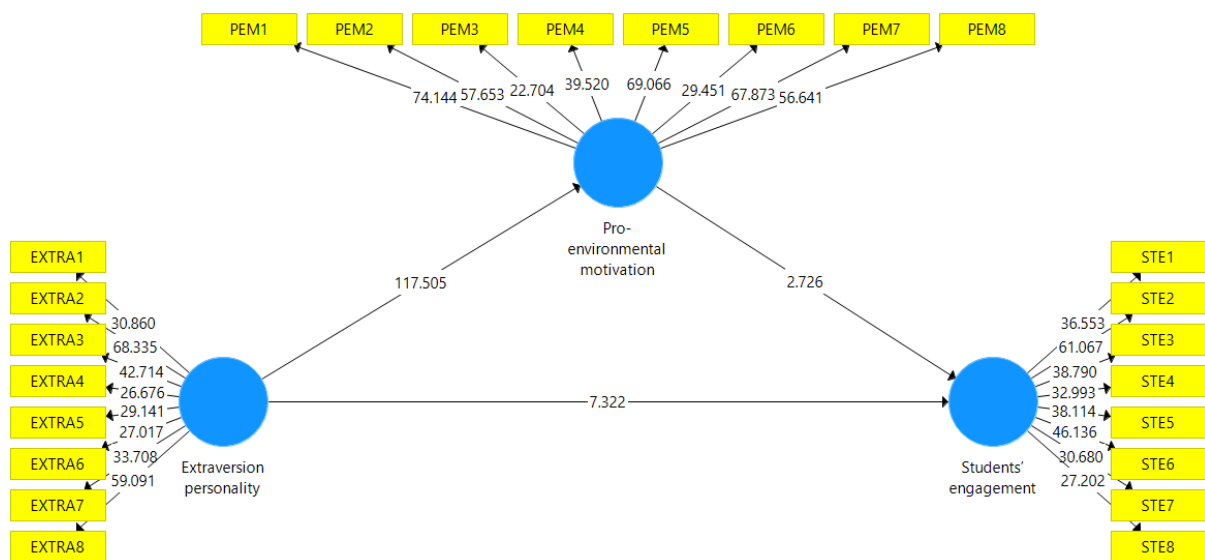


Figure 3. PLS-SEM model

The findings of this study indicate that Extraversion Personality positively influences students’ pro-environmental motivation, confirming H1. Extraverted students, characterized by sociability, assertiveness, and high energy, are more likely to internalize the importance of engaging in environmentally responsible behaviors. This aligns with previous studies, such as Grosz et al. (2020) [29], which suggested that extraverted individuals tend to seek novel experiences and social interactions, making them more receptive to group-oriented environmental initiatives. The results highlight that personality traits serve as fundamental determinants of motivational orientation in educational contexts.

Similarly, the positive influence of Extraversion Personality on Students' Engagement in school-based environmental actions supports H2. Extraverted students not only internalize motivational factors but also actively translate them into observable behaviors, such as participating in recycling programs, tree planting, and environmental campaigns. This finding corroborates research by Lu and Winstone et al. (2020)[30] who reported that students with higher extraversion scores were more involved in extracurricular and prosocial activities. Personality traits thus exert a multifaceted role in promoting environmental stewardship among youth.

The results further confirm H3, demonstrating that Pro-Environmental Motivation positively influences students' engagement in environmental activities. This reinforces the notion that internalized motivation serves as a critical driver of behavioral enactment. Students who perceive environmental actions as personally meaningful and aligned with their values are more likely to participate consistently and intensively. This is consistent with findings by Brizga & Vijaikis (2024)[31], who emphasized that intrinsic and identified motivations are strong predictors of pro-environmental behaviors in educational settings.

Importantly, the mediation analysis validates H4, confirming that Pro-Environmental Motivation mediates the relationship between Extraversion Personality and Students' Engagement. This indicates that extraverted students are more likely to engage in environmental actions because their personality fosters higher pro-environmental motivation. This aligns with self-determination theory (Deci & Ryan, 2000)[32], which posits that intrinsic motivation channels personality-driven tendencies into sustained behavior. Prior empirical studies, such as Barszcz et al. (2023) [33], similarly documented that motivation mediates the link between individual traits and pro-environmental actions.

The convergence of direct and indirect effects underscores a dual pathway through which extraversion shapes engagement. Directly, extraverted students demonstrate higher participation in group activities due to their social orientation and assertiveness. Indirectly, these personality traits cultivate pro-environmental motivation, which strengthens both the likelihood and quality of engagement. This dual mechanism contributes to a more nuanced understanding of student behavior, suggesting that interventions should address both personality-aligned social opportunities and motivation-enhancing strategies.

Moreover, these findings have practical implications for educational policy and curriculum design. Schools seeking to enhance environmental stewardship among students could consider activities that leverage extraverted tendencies, such as collaborative campaigns, group projects, and leadership roles in eco-initiatives. Simultaneously, embedding motivational strategies—such as emphasizing personal relevance, value alignment, and skill development—can enhance engagement for all students, irrespective of personality traits. This dual approach aligns with recommendations from recent

educational psychology literature (Kim et al., 2020), which emphasize integrating personality-sensitive pedagogies with motivation-focused interventions to optimize student outcomes.

Finally, the results contribute to the broader literature on personality, motivation, and pro-environmental behavior in educational settings. By confirming that extraversion influences engagement both directly and indirectly through motivation, this study extends existing research that primarily examined either personality or motivation in isolation. It provides empirical support for models that conceptualize student engagement as a multidimensional outcome shaped by both dispositional traits and internalized motivational processes. Consequently, these findings offer a foundation for future research to explore similar pathways across diverse educational contexts and environmental programs, advancing a more comprehensive understanding of the determinants of sustainable behavioral engagement among youth.

Despite the growing literature on personality and pro-environmental behavior, there remains limited research that explicitly examines the mediating role of pro-environmental motivation in the relationship between extraversion personality and students' engagement in school environmental actions. Previous studies have generally focused either on dispositional predictors or on motivational determinants independently, leaving a gap in understanding how personality traits are translated into concrete environmental participation through internal motivational mechanisms, particularly in school contexts.

This study offers novelty by developing and testing an integrated model in which extraversion personality influences students' engagement in school environmental actions both directly and indirectly through pro-environmental motivation. The study contributes to the literature by demonstrating a dual-path mechanism linking personality, motivation, and environmental engagement among senior high school students in eco-friendly schools. This provides a more comprehensive explanation of student participation in sustainability initiatives and extends the application of environmental psychology into school-based environmental education.

CONCLUSION

This study provides empirical evidence that Extraversion Personality significantly influences students' pro-environmental motivation and engagement in school-based environmental actions, with pro-environmental motivation serving as a mediating factor. The results underscore that students' personality traits are fundamental determinants of both their internalized motivation and active participation in ecological initiatives, highlighting the intertwined nature of dispositional and motivational factors in promoting sustainable behaviors within educational contexts. Moreover, the findings emphasize the importance of fostering intrinsic motivation to translate personality-driven tendencies into consistent and meaningful engagement in environmental programs.

From a practical perspective, these findings have important implications for educational policy and curriculum design. Schools can enhance student participation in environmental initiatives by creating opportunities that align with students' extraverted tendencies, such as group projects, collaborative campaigns, and leadership roles in eco-friendly activities. Simultaneously, implementing strategies that nurture pro-environmental motivation—such as emphasizing personal relevance, value alignment, and skill development—can further strengthen engagement, ensuring that students of diverse personality profiles are encouraged to participate actively in environmental stewardship.

Despite the valuable insights provided, this study has several limitations. First, the use of a cross-sectional design restricts the ability to establish causal relationships among personality, motivation, and engagement. Longitudinal studies would provide stronger evidence of the temporal and causal dynamics. Second, the sample was drawn from eco-friendly schools, which may limit the generalizability of the findings to broader educational contexts or to schools with less established environmental programs. Third, the reliance on self-reported measures may introduce response biases, including social desirability, which could influence the accuracy of reported engagement behaviors and motivational levels.

Future research should consider addressing these limitations by incorporating longitudinal or experimental designs, expanding the participant pool to include diverse school settings, and integrating objective behavioral measures of environmental engagement. Additionally, examining other personality traits, motivational dimensions, or contextual factors such as peer influence and school culture may provide a more comprehensive understanding of the determinants of pro-environmental behavior among students.

In conclusion, this study contributes to the literature on personality, motivation, and pro-environmental behavior by demonstrating that extraversion fosters both intrinsic motivation and active engagement in environmental actions. The findings offer actionable insights for educators and policymakers to design interventions that capitalize on students' dispositional strengths while simultaneously nurturing motivational pathways, thereby promoting a culture of sustainability and responsible environmental citizenship within educational settings.

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