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Research Article

TURNING RIVERS INTO LIVING LABORATORIES: ACTION-BASED EDUCATIONAL TOURISM TO ENHANCE YOUTH ECOLOGICAL STEWARDSHIP

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Abstract
This study examines the influence of action-based educational tourism on bridging the "knowledge-action gap" within environmental education. The research aims to evaluate how motivation, awareness, knowledge, and active participation through the "SatuBumi River Cleanup" program shape the pro-environmental behavior (PEB) of high school and university students. Using a quantitative-explanatory method with Partial Least Squares Structural Equation Modeling (PLS-SEM), data were collected from 206 respondents via purposive sampling. The results reveal that environmental motivation (beta = 0.403) and active participation (beta = 0.279) are the primary drivers of sustainable behavioral change, while environmental knowledge showed no statistical significance (beta = 0.021). The novelty of this research lies in the integration of Richards' 3S storytelling framework with physical waste mitigation, transforming polluted river ecosystems into "living laboratories" for socio-ecological transformation. This study challenges the traditional information-delivery paradigm by demonstrating that emotional resonance and physical agency are more effective than theoretical instruction. The implication for educational science suggests a shift toward experiential, narrative-driven pedagogy to foster genuine ecological stewardship. By providing empirical evidence of how immersive environments catalyze behavioral shifts, this research contributes to the broader development of science in educational methodology, advocating for the institutionalization of action-based learning to achieve long-term sustainability goals.

Keywords: Environmental Awareness, Environmental Education, Living Laboratories, PLS-SEM, Youth Stewardship.

INTRODUCTION

Indonesia is currently facing critical environmental challenges, with 2,107 disaster events recorded in 2024 alone (Hendrawan et al., 2025). These crises, which range from flash flooding in Sumatra to coastal degradation in Halmahera, are not solely the outcome of natural processes but are strongly influenced by land-use transformation and unsustainable mining operations. Parallel to this, urban centers face a "waste emergency," exemplified by the Sarimukti landfill crisis which mirrors the tragic 195-fatality Leuwigajah disaster (Zakiyatuddin et al., 2023; Saepullah, 2024). This systemic failure underscores an urgent need for medium-to-long-term solutions centered on public waste literacy (Sari et al., 2021; Muqsit et al., 2024; Winursita & Johan, 2024; Pandyaswargo et al., 2025; Sitinjak et al., 2025) and ecological education (Mujio et al., 2023; Delamontano et al., 2025b; Putra et al., 2025).

To address these challenges, educational tourism has emerged as a growing niche that bridges the gap between theoretical knowledge and real-world practice by combining leisure with structured, immersive learning (Mondino & Beery, 2018; Tanti et al., 2020; Guntar et al., 2023). As a "living laboratory," this approach allows participants to learn directly from natural environments, cultural artifacts, and historical sites, fostering a deeper reflection on complex societal and ecological issues (Wolniewicz, 2019; Tanti et al., 2021; Kurniawan et al., 2022; Purnadewi et al., 2023; Riyanto et al., 2024). In the context of environmental education, this model plays a vital role through hands-on initiatives such as mangrove planting, coral reef restoration, and tree adoption campaigns, which have been shown to significantly influence students' social attitudes and responsible character (Ely et al., 2021; Astalini et al., 2024; Indira et al., 2024). Beyond ecological projects, the versatility of educational tourism extends to cultural immersion and heritage expeditions—ranging from Borobudur Temple to traditional Balinese villages, where students engage with indigenous wisdom to foster global citizenship (Yuliarti et al., 2021; Christiani et al., 2022). By embedding learning in tangible environments, this transformative pedagogy fosters not only cognitive development but also the emotional and ethical growth essential for sustainable behavioral change among youth (Dameria et al., 2020; Oe et al., 2022; Tanti et al., 2021).

Despite the integration of environmental education into the national curriculum to foster ecological responsibility (Hassan et al., 2021; Delamontano et al., 2025a; Tanti et al., 2025), a significant "knowledge-action gap" persists. Research indicates that while students often possess high levels of theoretical environmental awareness, their actual participation in pro-environmental behavior (PEB) remains disappointingly low (Boca & Saraçli, 2019; Fenitra et al., 2022). This discrepancy highlights a fundamental weakness in traditional, classroom-based pedagogy: it informs the mind but fails to inspire the hand (Lee et al., 2023). There is an urgent need to move beyond passive content delivery toward experiential, student-centered models that bridge the gap between environmental theory and real-world practice (Kamila et al., 2024; Masriani & Haeny, 2025).

A critical gap exists in current academic literature and practical application. While educational tourism has been recognized for its immersive potential that ranging from heritage site visits to mangrove planting (Mondino & Beery, 2018; Ely et al., 2021), there is a scarcity of empirical research that specifically investigates the nexus between action-based river cleanup tourism and behavioral transformation. Most existing studies focus on general outdoor education (Gómez-Ruiz et al., 2021) or conservation awareness (Leurs & Kirkpatrick, 2024), yet few have rigorously analyzed how direct participation in waste mitigation (Ardianti et al., 2024), mediated by storytelling and contextual reflection, shapes a student's long-term ecological identity (Ananta et al., 2024; Aulia et al., 2024). Furthermore, little attention has been given to the psychological processes by which motivation and awareness are translated into action in these programs as predictors of success (Arcodia et al., 2020; Paramita & Ningrum, 2020).

To address these gaps, this study introduces the "SatuBumi River Cleanup" program as an innovative solution within the educational tourism framework. Unlike conventional programs, this model integrates physical action (river cleanup) with narrative-driven reflection (storytelling) (Paiva et al., 2023), transforming polluted riverbanks into "living laboratories" for socio-ecological change (Nugraha et al., 2024). The novelty of this research lies in its holistic approach: it treats river cleanup not as a one-off volunteer activity, but as a structured educational intervention where storytelling and community engagement serve as catalysts for emotional and cognitive connections (Marikyan et al., 2023). By utilizing Partial Least Squares Structural Equation Modeling (PLS-SEM), this study provides a sophisticated analysis of how motivation, awareness, participation and knowledge as latent variables interact to drive actual behavior. This method is well-suited to modeling structural relationships among multiple latent variables and is effective even with relatively small sample sizes (Hair et al., 2021).

Consequently, the primary objective of this research is to empirically analyze the structural relationships between students' perceptions of river cleanup tourism and their pro-environmental behaviors. Specifically, this study aims to: (1) Evaluate the influence of motivational and cognitive factors on participation in action-based tourism; and (2) Determine the extent to which this participation effectively shapes long-term pro-environmental behavior among youth. The findings are expected to provide actionable insights for policymakers and educators to integrate action-based tourism into school curricula, aligning with Indonesia's vision of fostering global citizenship and sustainable living (Wicaksana & Widodo, 2024).

RESEARCH METHOD

This study employs a quantitative-explanatory research design with a cross-sectional approach. We utilize Partial Least Squares Structural Equation Modeling (PLS-SEM) to test the causal-predictive relationships between latent constructs (Hair et al., 2021). The research stages, from site selection to data interpretation, are illustrated in Figure 1.

Figure 1. Research stages

The figure 1 illustrates the sequential research phases, progressing from the development of the conceptual framework through data collection to the final stage of data analysis. The research was carried out from December 3, 2024, to April 31, 2025, at the Sungai Citarum Km 77, Jl. SDN Cianjur, Babakan, Cihampelas, West Bandung Regency, West Java. This location was selected because it represents a critical area of river pollution and community-based environmental action, making it a relevant setting for studying the transformation of students' pro-environmental behavior through educational tourism activities.

The population consists of participants in the SatuBumi River Cleanup program. A sample of 206 respondents was selected using a non-probability purposive sampling technique. The inclusion criteria were: (1) high school or university students, (2) active participants who completed the entire duration of the cleanup and storytelling session, and (3) willingness to complete the post-event survey. Regarding the power of the study, according to the inverse square root method for PLS-SEM, a sample size of 206 far exceeds the minimum requirement (approx 160) to detect an R^2 of 0.10 with a 5% significance level and 80% power (Kock & Hadaya, 2018; Lawless et al., 2020; Sabol et al., 2023). This ensures that the study has sufficient statistical power to produce reliable estimates.

The pedagogical execution of this study conceptualizes river cleanup as a specialized form of niche educational tourism, where the activity transcends simple volunteering to become an intentional transformative experience (Novelli, 2004; Ernawati et al., 2022; Sharma et al., 2023). To operationalize this, the procedure was anchored in Richards' 3S framework—Storytelling, Sense, and Sophistication—to bridge the gap between physical labor and emotional connectivity (Richards et al., 2018; Jabbari et al., 2025). Participants were not merely tasked with waste collection; instead, the process began with immersive storytelling regarding the river's ecological history, followed by guided exploration to foster a 'sense of place' and sensory engagement with the degraded environment. This narrative-driven approach was designed to turn environmental tasks into meaningful experiences, facilitating the internalization of values and elevating individual motivation from a cognitive level to a deeply personal environmental stewardship (Semenova et al., 2021; Andari, 2023).

To ensure institutional relevance and scalability, the procedure further aligned the SatuBumi model with the national Adiwiyata program's philosophy, which emphasizes participatory and inclusive environmental practices within the Indonesian school system (Haryadi & Widodo, 2020; Rahmawati et al., 2024; Utami et al., 2024). By integrating Adiwiyata's pillars that particularly consist of participatory-based environmental activities (Maf'ulla, 2024), the program was structured to move students through a progressive learning flow: from active engagement in cleanup to the development of intermediate psychological outcomes, including heightened awareness and enhanced ecological literacy. This alignment ensures that the intervention is not viewed as an isolated event but as a replicable educational strategy that fosters a consistent, informed, and affective environmental ethic (Lucrezi & Digun-Aweto, 2020). This systematic progression from initial engagement to sustained behavioral intent serves as the foundational logic for the structural model analyzed in this study.

To capture the multidimensional nature of the variables within the SatuBumi program, a rigorous instrumentation process was established to align the theoretical framework with empirical measurement. The data collection relied on a primary quantitative source, designed to evaluate the psychological and behavioral shifts occurring post-intervention as hypothesized in the conceptual model. The instrument was a self-report questionnaire based on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), which provided the necessary granularity for structural equation modeling. Each item was carefully adapted from validated environmental behavior scales and further refined through an expert review process to ensure content validity and contextual relevance. Specifically, the survey was structured to measure five core latent constructs—Environmental Motivation, Knowledge, Awareness, Participation, and Pro-environmental Behavior—with each construct operationalized through five reflective indicators, as visually represented in the conceptual framework in Figure 2.

Figure 2. Conceptual Framework of SatuBumi Educational Tourism River Cleanup

The figures 2 shows how awareness, knowledge, motivation, and participation are expected to drive pro-environmental behavior in the SatuBumi River Cleanup program. And the detailed mapping of these variables, including their specific indicators and the academic sources from which they were adapted, is systematically presented in the Research Instrument Grid in Table 1.

Table 1. Research Instrument Grid

No.	Variable	Indicators / Items	Sources (Adapted from)
1	Environmental Motivation	Interest in cleanup, personal drive, social responsibility, sense of duty, desire to contribute.	(Lucrezi & Digun-Aweto, 2020)
2	Environmental Awareness	Sensitivity to river pollution, understanding of ecological impact, concern for future generations.	(Arcodia et al., 2020)
3	Environmental Knowledge	Knowledge of waste types, river ecosystems, impact of plastic pollution, recycling methods.	(Debrah et al., 2021)
4	Participation	Active cleanup involvement, engagement in storytelling, collaborative actions.	(Mondino & Beery, 2018)
5	Pro-Environmental Behavior	Waste reduction, active recycling, advocacy, sustained cleanup habits, sustainable consumption.	(Boca & Saraçli, 2019)

The indicators listed on table 1 serve as the foundation for the research questionnaire, ensuring that each variable is measured through specific and relevant metrics. By adapting these items from established academic literature, the instrument maintains high standards of theoretical validity and reliability for the study. The primary data obtained in this study were processed and analyzed using RStudio software 2024.09.0+375 version, employing the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique to address the research objectives. The statistical evaluation was executed in two distinct phases to ensure the robustness of the findings. The first stage involved the Measurement Model (Outer Model) Assessment, which rigorously examined the reliability and validity of the latent constructs (Hair et al., 2021). Convergent validity was established by ensuring factor loadings exceeded the 0.707 threshold and the Average Variance Extracted (AVE) surpassed 0.50. To confirm internal consistency and data trustworthiness, the study evaluated Cronbach's alpha, composite reliability (rhoC), and rhoA values, with a required minimum coefficient of 0.70. Furthermore, discriminant validity was scrutinized using both the Fornell-Larcker criterion and the Heterotrait-Monotrait (HTMT) ratio, ensuring the ratio remained below 0.90 to confirm the distinctiveness of each construct.

Upon successful validation of the measurement model, the second stage focused on the Structural Model (Inner Model) Assessment to test the hypothesized relationships among motivation, awareness, knowledge, participation, and pro-environmental behavior. This phase determined the strength and direction of the structural paths through path coefficients (beta) and assessed the model's explanatory power using R-squared (R^2) analysis for endogenous variables (Sabol et al., 2023). To evaluate statistical significance, a non-parametric bootstrapping procedure with 10,000 subsamples was employed to calculate t-statistics and p-values, where relationships were deemed significant at $p < 0.05$ (Fajar et al., 2024). By integrating these complex statistical outputs with the research framework, the analysis provides a clear clarification of how participation in action-based river cleanup tourism effectively catalyzes the transformation of sustainable behavioral outcomes among students, as visually summarized in the analysis workflow in Figure 3.

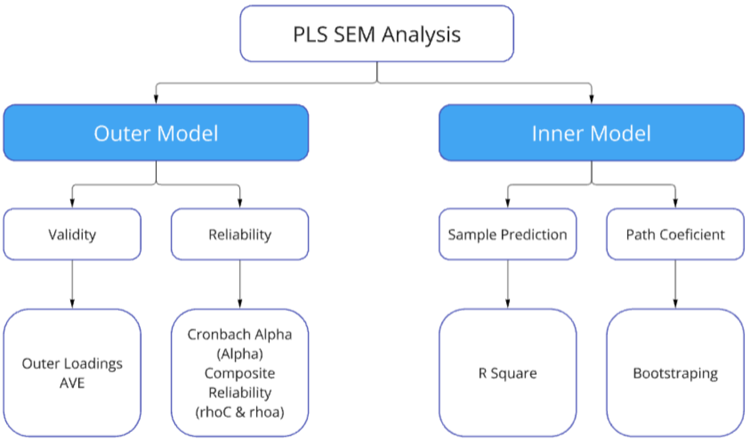

Figure 3. PLS-SEM Analysis Methods

The diagram on Figure 3 outlines the two-stage PLS-SEM evaluation process, starting with the outer model to confirm the validity and reliability of the measurement scales. Once the quality of the measurement is established, the inner model analysis is performed to assess the strength of the relationships and the predictive power of the structural framework. The researcher utilized RStudio to generate graphical representations of the data model, which facilitated clearer understanding and effective presentation of the statistical model structure. RStudio served as the integrated development environment (IDE) for the R programming language, which was used for computation and data modeling (Hair et al., 2021). Several essential R packages were activated to support data processing and analysis, including tidyverse, seminr, and psych.

The tidyverse package, known for its coherent and consistent suite of tools, was employed to simplify tasks related to data transformation, exploration, visualization, and statistical analysis (Wickham et al., 2019). For the structural equation modeling component, the seminr package was used. This package offers a flexible and user-friendly framework specifically designed for Partial Least Squares Path Modeling (PLS-PM), enabling comprehensive estimation of both measurement (reflective or composite) and structural models (Hair et al., 2021). Additionally, the psych package was utilized for its robust psychometric functions, including exploratory and confirmatory factor analysis, reliability testing such as Cronbach’s alpha, principal component analysis, and a variety of descriptive and inferential statistics (Armutcu et al., 2023).

RESULTS AND DISCUSSION

At this stage, the researcher assessed convergent validity by examining the outer loading values of each indicator. According to the rule of thumb proposed by Hair et al. (2021), an acceptable threshold for outer loadings is 0.70, while an alternative benchmark is 0.50 for the squared loading values (Hair et al., 2021). The initial assessment of the measurement model revealed that several indicators did not meet the established psychometric requirements, necessitating a systematic refinement process. Preliminary analysis identified twelve problematic indicators—specifically AKAL1, AKAL2, PAL1, PAL3, PAL4, PAL5, MLA4, MLA5, PKPL4, PKPL5, PPLB2, and PPLB3—which failed to reach the 0.70 loading threshold. This lack of individual item reliability initially suppressed the convergent validity of the constructs, where the Average Variance Extracted (AVE) for most variables fell below the 0.50 benchmark. Consequently, the model underwent multiple iterations of adjustment, where indicators with the lowest loadings were progressively eliminated to enhance the model's structural integrity. This iterative refinement resulted in a stable final model comprised solely of high-performing items. The final results of this process, demonstrating that all retained indicators surpass the 0.70 loading requirement and all latent constructs meet the mandatory 0.50 AVE threshold, are systematically presented in Table 2 (Outer Loadings) and Table 3 (Average Variance Extrated).

Table 2. Outer Loadings

Variable	Indicator	Outer Loadings	Note
Environmental Awareness	AKAL3	0.911	valid
	AKAL4	0.935	valid
	AKAL5	0.943	valid
Environmental Knowledge	PAL2	1.000	valid
Environmental Motivation	MLA1	0.839	valid
	MLA2	0.909	valid
	MLA3	0.871	valid
Participation	PKPL1	0.890	valid
	PKPL2	0.882	valid
	PKPL3	0.740	valid
Pro-Environmental Behavior	PPLB1	0.805	valid
	PPLB4	0.828	valid
	PPLB5	0.851	valid

The results on Table 2 show that all indicator items have outer loading values exceeding the required threshold, confirming that each measure effectively represents its underlying construct. Consequently, these findings establish strong convergent validity, allowing the analysis to proceed to the next stage of structural model evaluation.

Table 3. Average Variance Extrated (AVE)

Variable	AVE
Awareness	0.865
Knowledge	1.000
Motivation	0.763
Participatory	0.706
Behaviour	0.686

The Average Variance Extracted (AVE) on Table 3 values for all constructs are well above the 0.50 benchmark, indicating that the indicators share a high proportion of variance with their respective variables. This result confirms the existence of strong convergent validity across the entire measurement model, ensuring that each concept is distinct and accurately captured. Before conducting the discriminant validity test, the researcher examined the cross-loading values of each indicator. An indicator is considered valid if its loading on its associated construct is higher than its loadings on other constructs. If this condition is met for all indicators, they are deemed valid and can be included in the subsequent reliability assessment.

Based on the results generated in the R Studio, Table 4 demonstrates that the cross-loading values of each indicator were higher for their respective constructs than for any other constructs. This confirms the discriminant validity of all indicators, allowing the analysis to proceed to the reliability testing stage. The reliability results are evaluated using Cronbach's Alpha, composite reliability (rhoC), and rhoA. If all three reliability coefficients exceed the threshold of 0.70, the constructs are considered to have adequate internal consistency.

Table 4. Cross Loadings

Indicator	Awareness	Knowledge	Motivation	Participatory	Behavior
AKAL3	0.911	0.642	0.575	0.098	0.462
AKAL4	0.935	0.646	0.577	0.139	0.486
AKAL5	0.943	0.699	0.596	0.109	0.487
PAL2	0.712	1.000	0.478	0.130	0.401
MLA1	0.503	0.398	0.839	0.21	0.541
MLA2	0.666	0.491	0.909	0.261	0.541
MLA3	0.479	0.367	0.871	0.428	0.596
PKPL1	0.127	0.102	0.333	0.89	0.451
PKPL2	0.12	0.098	0.269	0.882	0.322
PKPL3	0.06	0.129	0.262	0.74	0.332
PPLB1	0.401	0.349	0.492	0.32	0.805
PPLB4	0.335	0.246	0.454	0.464	0.828
PPLB5	0.526	0.192	0.633	0.336	0.851

Data reliability was assessed through Cronbach's Alpha, composite reliability (rhoC), and rhoA values. As shown in the Table 4, all three reliability coefficients exceeded the 0.70 threshold, indicating that each construct in this stage of the study is statistically reliable and can be considered trustworthy. To ensure the internal consistency of the data, a reliability test was conducted using Cronbach's alpha along with rhoC and rhoA coefficients. The following Table 5 presents these results, confirming that all constructs meet the established reliability standards for further structural analysis.

Table 5. Reliability Test

Variable	alpha	rhoC	rhoA
Awareness	0.922	0.951	0.923
Knowledge	1.000	1.000	1.000
Motivation	0.844	0.906	0.846
Participatory	0.790	0.877	0.822
Behaviour	0.772	0.867	0.779

The results on Tabel 5 indicate that all variables have coefficients well above the 0.70 threshold, which demonstrates that the measurement instrument is highly reliable and capable of producing consistent results. Following the evaluation of the outer model, the next stage involved assessing the inner model, specifically through R-squared (R^2) analysis and bootstrapping. The R^2 value on Table 6 is used to estimate the predictive accuracy of the model for the tested sample, while bootstrapping on Table 7 identifies the relationships between exogenous (independent) and endogenous (dependent) variables. The analysis yielded an R^2 value of 0.502, which indicates a moderate level of predictive power, suggesting that the model sufficiently explains the variance in the dependent construct.

Table 6. R Square Test

Variable	R Square	Criteria
Behavior	0.502	Moderate

Table 7. Bootstraping

Variable	Original Sample	T Stat
Awareness -> Behavior	0.213	2.285
Knowledge -> Behavior	0.021	0.251
Motivation -> Behavior	0.403	4.959
Participatory -> Behavior	0.279	5.045

The structural model analysis using PLS-SEM reveals that the "SatuBumi" educational tourism framework possesses moderate yet meaningful predictive power, with an R-squared (R^2) on Table 6 value of 0.502 . This indicates that 50.2% of the variance in students' pro-environmental behavior (PEB) is explained by the interplay of motivation, awareness, knowledge, and participation. The bootstrapping results on Table 7, utilizing 10,000 subsamples, confirmed that four of the five hypothesized relationships were statistically significant, with T-statistics exceeding the 1.96 threshold.

The bootstrapping procedure was executed to evaluate the structural relationships hypothesized in the model, with the final path estimates visualized in Figure 4. The results indicated that the original sample values were consistently greater than zero, suggesting positive directions across the tested pathways. The magnitude of these path coefficients reflects the relative strength of the associations, where higher values indicate more robust linkages between the latent constructs. To determine statistical significance, a T-statistic threshold of 1.96 was applied at a 5% significance level. As illustrated in the structural model, four of the five variable relationships were confirmed to be statistically significant. Conversely, the path between 'Knowledge → Behavior' yielded a T-statistic of only 0.251, falling well below the critical value and thus failing to reach significance. These findings, which highlight the dominance of motivation and participation over theoretical knowledge, are further detailed in the path analysis results presented in Table 7.

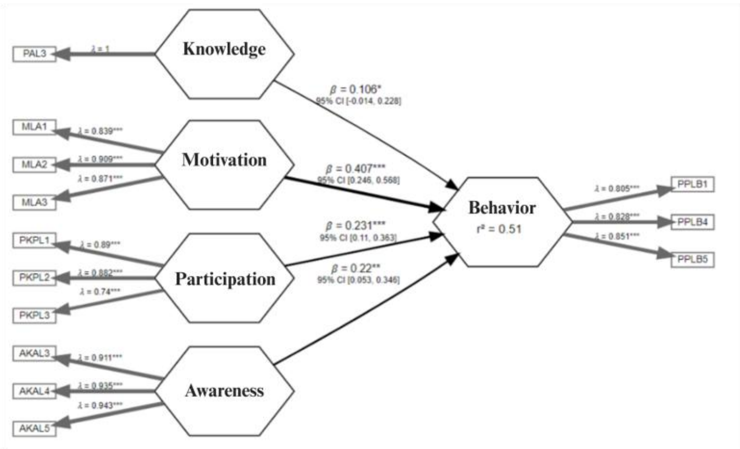

Figure 4. Framework of SatuBumi Educational Tourism River Cleanup

The final structural model presents the path coefficients (beta) and outer loadings for each indicator, providing a comprehensive visual of the significant drivers behind pro-environmental behavior. These statistical results on Figure 4 highlight that while motivation and participation act as primary influences, the overall framework successfully captures more than half of the variance in the behavioral outcome. Among the tested variables, environmental motivation emerged as the most dominant driver (beta = 0.403; T = 4.959). This is evidenced by high outer loading values for indicators MLA1, MLA2, and MLA3, suggesting that participants were primarily driven by an internalized sense of responsibility and a desire for meaningful experiences rather than mere external incentives. Following motivation, active participation (beta = 0.279; T = 5.045) showed a robust influence. The strength of indicators such as PKPL1, PKPL2, and PKPL3 confirms that physical engagement in the river cleanup serves as more than a symbolic gesture; it functions as a potent experiential tool that aligns students' actions with sustainable intent.

Furthermore, environmental awareness exhibited a significant positive impact (beta = 0.213; T = 2.285), particularly through indicators AKAL3, AKAL4, and AKAL5, which focus on the urgent need for pollution mitigation. This confirms that emotional and cognitive recognition of the ecological crisis acts as a vital catalyst for behavioral transformation. In stark contrast, environmental knowledge failed to demonstrate a significant impact on behavior (beta = 0.021; T = 0.251). With only one indicator (PAL2) meeting the validity criteria, it is evident that participants' knowledge remained largely conceptual and normative, lacking the emotional anchoring required to trigger actual behavioral shifts.

These findings align with the "Value-Belief-Norm" theory, where personal values and intrinsic norms are better predictors of pro-environmental behavior than factual information alone. The insignificance of the knowledge-behavior pathway in this study reinforces the "Knowledge-Action Gap" identified by (Boca & Saraçli, 2019), suggesting a global trend where environmental literacy often fails to translate into stewardship without experiential reinforcement.

While traditional pedagogy often prioritizes information transmission, this research reinforces the arguments of (Mondino & Beery, 2018) and (Purnadewi et al., 2023), who posit that “living laboratories” are superior for fostering ecological identity. The importance of intrinsic drivers is further reinforced by evidence indicating that high-quality interaction and meaningful engagement play a critical role in strengthening student motivation and ensuring the successful attainment of academic or behavioral objectives (Kurniawan et al., 2025). Overall, the findings suggest a critical transformation in educational approaches, indicating that among younger populations, notably high school and university students, environmental education should emphasize practical application and immersive participation rather than theoretical understanding alone.

Beyond the statistical metrics, the interpretive strength of the SatuBumi model lies in its integration of Richards’ 3S framework (Storytelling, Sense, and Sophistication) within the context of a river cleanup. The choice to conduct the program at the Citarum River, a stark representation of Indonesia’s environmental crisis, was critical in translating otherwise abstract environmental challenges into lived, emotionally compelling realities.

A particularly impactful element was the use of storytelling. Narratives delivered by local community members regarding the river’s history and the efforts of environmental defenders served to evoke empathy and forge personal connections. This narrative-based approach bridged the gap between emotional engagement and agency, allowing students to move beyond passive observation to a state of active stewardship (De Meyer et al., 2021). This integration of action-based learning and reflective narrative constitutes the primary novelty of this research, offering a replicable strategy that enhances the standard volunteer cleanup into a transformative educational intervention.

The findings carry important implications for both academic and practical domains. For educators, they underscore the need to move beyond classroom-centered instruction toward action-based tourism learning models, where task-based activities and narrative-driven approaches can stimulate critical awareness and higher-order thinking, ultimately enabling students to engage directly with real-world problem-solving (Kaize et al., 2024). At the policy level, this study contributes a validated framework for strengthening Indonesia’s Adiwiyata program by demonstrating how river-based outdoor learning, when aligned with national ecological priorities, can help cultivate a generation of leaders with a consistent, informed, and emotionally grounded environmental ethic.

Despite its substantive contributions, this study is not without limitations that merit critical consideration and open avenues for further inquiry. First, because data were collected immediately after the intervention, the observed outcomes may partly reflect a short-term “peak-experience” effect rather than sustained behavioral change; accordingly, future research should adopt longitudinal designs to assess whether pro-environmental intentions persist over a 6–12 months period. Second, the study’s exclusive focus on the Citarum River, as an inland, heavily industrialized watershed, limits the extent to which the findings can be generalized to other ecological contexts with different socio-environmental dynamics. This constraint highlights the importance of testing the SatuBumi model across diverse ecosystems, such as coastal zones characterized by marine pollution or forest landscapes shaped by deforestation pressures, in order to assess whether its experiential and narrative-based mechanisms remain effective under varying environmental conditions. Finally, although prioritizing youth participation is strategically justified, expanding future samples to include broader community demographics would allow researchers to determine whether the narrative-driven approach exerts a comparable influence across generational groups.

CONCLUSION

This study confirms that the SatuBumi River Cleanup, positioned as a form of educational tourism, effectively promotes pro-environmental behavior among high school and university students. The findings explicitly show that behavioral change is driven primarily by intrinsic motivation and active physical participation, rather than by environmental knowledge alone. The non-significant knowledge–behavior pathway highlights a central limitation of conventional environmental education: theoretical awareness, without emotional engagement and direct experience, fails to translate into action. By integrating hands-on river restoration with Richards’ 3S storytelling framework, the program transformed the ecological crisis of the Citarum River into a concrete and personally meaningful responsibility for participants. Beyond addressing the research objectives, this study advances the concept of active stewardship as a more effective paradigm than passive learning in environmental education. It demonstrates that narrative-driven reflection, when embedded in experiential action, can bridge the knowledge–action gap and foster enduring ecological identities among youth. Accordingly, future efforts should focus on institutionalizing action-based learning within formal curricula, experimenting with participant-generated storytelling, and testing the model longitudinally across diverse ecological contexts to ensure its scalability and long-term impact.

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AUTHOR CONTRIBUTIONS

Conceptualization, E.D., C.E., Y.W., E.N.; Methodology, E.D., C.E., Y.W.; Software, E.D.; Validation, C.E., Y.W., E.N.; Formal Analysis, E.D.; Investigation, E.D.; Resources, E.D.; Data Curation, E.D., Y.W.; Writing – Original Draft Preparation, E.D.; Writing – Review & Editing, C.E., Y.W., E.N.; Visualization, E.D.; Supervision, C.E., Y.W., E.N.; Project Administration, E.D.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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