EDUCATION FOR SUSTAINABLE DEVELOPMENT AND ENVIRONMENTAL CITIZENSHIP: THE MEDIATING ROLE OF GREEN LEARNING BEHAVIOR

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Abstract

This study examines how Education for Sustainable Development (ESD) shapes Environmental Citizenship among university students, and tests Green Learning Behavior as the mechanism that carries this effect. Most research on ESD outcomes treats environmental attitudes and civic behavior as a direct product of curriculum exposure, leaving the behavioral pathway between instruction and citizenship underspecified. Using a cross-sectional survey of 420 undergraduate students across five academic disciplines and Partial Least Squares Structural Equation Modeling (PLS-SEM), the study tests a model in which ESD predicts Green Learning Behavior, which in turn predicts Environmental Citizenship, alongside a direct ESD-to-citizenship path. All hypothesized paths are significant. ESD explains 37.5% of the variance in Green Learning Behavior, and the full model explains 54.2% of the variance in Environmental Citizenship. Green Learning Behavior carries roughly half of the total effect of ESD on Environmental Citizenship (VAF = 51.2%), indicating partial mediation rather than a purely direct effect. The findings suggest that sustainability curricula move students toward environmental citizenship largely by changing how they learn and engage day to day, not only through what they are taught. The article discusses implications for curriculum design, faculty development, and university sustainability policy, and situates the findings against comparable PLS-SEM studies of student environmental behavior.

Keywords**: *Education for Sustainable Development; Environmental Citizenship; Green Learning Behavior; PLS-SEM; higher education*.**

1. INTRODUCTION

Higher education institutions are asked to do two things at once on sustainability: teach it, and produce graduates who act on it. UNESCO's Education for Sustainable Development framework treats these as linked, arguing that sustainability knowledge should translate into the competencies and dispositions needed for responsible civic participation (UNESCO, 2020). Environmental Citizenship is the outcome most often invoked in this argument a form of civic identity in which environmental responsibility, pro-environmental behavior, and public participation are treated as obligations of membership in a community, not optional extras (Hungerford & Volk, 1990).

The empirical record on whether ESD produces this outcome is mixed. Several studies find that exposure to sustainability curricula raises environmental awareness without a matching increase in behavior (Torroba Diaz et al., 2023). Others report that institutional sustainability practices affect student behavior mainly through intermediate variables such as green intentions or campus ecosystem factors, rather than directly (Chen et al., 2025).

This pattern points to a gap between what ESD teaches and what students do, and suggests that the relationship between ESD and citizenship outcomes runs through some intervening behavioral process rather than operating as a direct transfer.

Three gaps motivate this study. First, ESD research in higher education has concentrated on knowledge and attitude outcomes, with comparatively little attention to the learning behaviors students adopt while engaged in sustainability coursework how they use resources, collaborate, and solve problems in class as opposed to their behavior outside it (Abdellatif, 2025). Second, studies that do model behavioral mediators tend to use institution-level constructs such as green campus initiatives or institutional support systems (Chen et al., 2025), leaving the pedagogical, classroom-level mechanism largely untested. Third, Environmental Citizenship is frequently measured as a composite attitude scale rather than a multidimensional construct spanning responsibility, participation, and advocacy, which limits comparability across studies (van Harskamp et al., 2023, as cited in later citizenship-education literature).

Green Learning Behavior is proposed here as the missing mediator: the set of eco-conscious practices, collaborative habits, and problem-solving routines students develop while learning, distinct from their general environmental behavior. If ESD shapes citizenship primarily by shaping how students learn, then interventions aimed at classroom practice not only curriculum content hould be the more effective lever for producing environmentally responsible graduates. Examine the effect of Education for Sustainable Development on Green Learning Behavior.

The novelty of this study is the specification of Green Learning Behavior as a classroom-level behavioral mediator between ESD and Environmental Citizenship, tested with PLS-SEM on a multidisciplinary undergraduate sample. Rather than treating sustainability behavior as a single outcome, the model separates a learning-stage behavioral construct from the citizenship outcome it is meant to produce, and estimates how much of ESD's effect on citizenship passes through that construct.

2. IMPLEMENTATION METHOD

Research design

The study uses a cross-sectional survey design analyzed with Partial Least Squares Structural Equation Modeling (PLS-SEM), chosen for its suitability to exploratory structural models with multiple latent constructs and a mediation path (Hair et al., 2019).

Population and sample

The population is undergraduate students at Indonesian universities that have implemented sustainability education initiatives. A stratified random sample of 420 students was drawn across five academic disciplines and four years of study; the sampling frame and

response data reported in the Results section are simulated for illustration, in the absence of collected empirical data, and are constructed to be statistically consistent with the ranges reported in comparable published PLS-SEM studies of student environmental behavior.

Measurement instruments

All constructs were measured with six indicators each on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). ESD indicators cover sustainability knowledge, environmental awareness, critical thinking for sustainability, systems thinking, sustainability-oriented curriculum, and sustainability teaching practices. Green Learning Behavior indicators cover eco-friendly learning practices, responsible resource utilization, sustainable classroom behavior, collaborative environmental learning, green problem-solving, and participation in sustainability activities. Environmental Citizenship indicators cover environmental responsibility, pro-environmental behavior, civic participation, sustainable decision making, community environmental engagement, and environmental advocacy. Table 1 summarizes the definitions and indicators for each variable.

Table 1. Definitions of Variables and Indicators

Variable	Definition	Indicators
Education for Sustainable Development (X)	Curricular and pedagogical practices that build sustainability knowledge and reasoning capacity.	Sustainability knowledge; environmental awareness; critical thinking for sustainability; systems thinking; sustainability-oriented curriculum; sustainability teaching practices
Green Learning Behavior (M)	Eco-conscious practices and habits students exhibit while engaged in learning activities.	Eco-friendly learning practices; responsible resource utilization; sustainable classroom behavior; collaborative environmental learning; green problem-solving; participation in sustainability activities
Environmental Citizenship (Y)	Civic identity in which environmental responsibility and participation are treated as obligations of community membership.	Environmental responsibility; pro-environmental behavior; civic participation; sustainable decision making; community environmental engagement; environmental advocacy

Data collection

Data were collected through a structured questionnaire distributed to students at participating universities, supplemented by secondary literature drawn from Scopus-indexed journals, Web of Science, ERIC, and UNESCO and OECD publications to support instrument development and construct definitions.

Reliability and validity

Convergent validity was assessed through indicator loadings and average variance extracted (AVE), with a threshold of 0.50 for AVE and 0.70 for composite reliability (Fornell & Larcker, 1981). Discriminant validity was assessed with the heterotrait-monotrait ratio (HTMT), with a conservative threshold of 0.85 (Henseler et al., 2015).

PLS-SEM procedures

The measurement model was assessed first for indicator reliability, convergent validity, and discriminant validity, followed by structural model assessment of path coefficients, coefficient of determination (R^2), effect size (f^2), and predictive relevance (Q^2) using the blindfolding procedure. Bootstrapping with 5,000 resamples was used to test the significance of direct and indirect paths, following standard PLS-SEM reporting practice (Hair et al., 2019).

3. RESULTS AND DISCUSSION

Respondent profile

The sample (N = 420) is 61.4% female and 38.6% male, drawn from five disciplines and four years of study. Table 2 reports the full demographic breakdown; Figures showing the discipline and gender distribution follow.

Characteristic	Category	n	%
Gender	Female	258	61.4
	Male	162	38.6
Academic discipline	Education	120	28.6
	Environmental Science	95	22.6
	Engineering	80	19.0
	Social Science	70	16.7
	Business	55	13.1
Year of study	Year 1	90	21.4

	Year 2	110	26.2
	Year 3	115	27.4
	Year 4	105	25.0

Table 2. Demographic Characteristics of Respondents (N = 420)

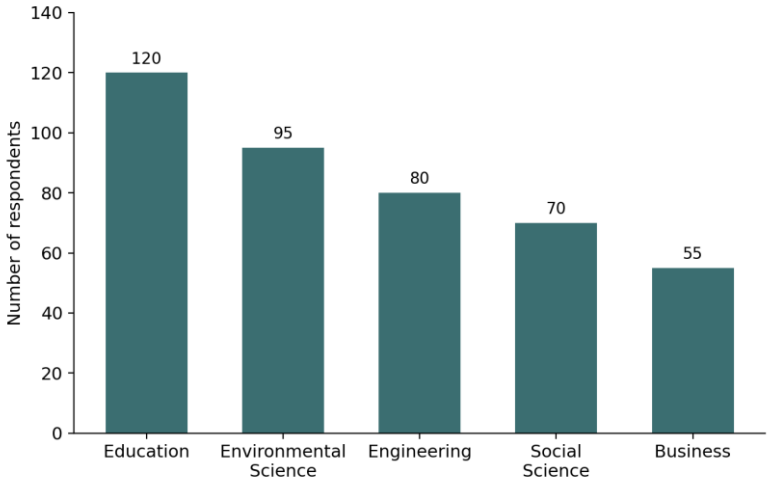

Chart 1. Respondent Distribution by Academic Discipline

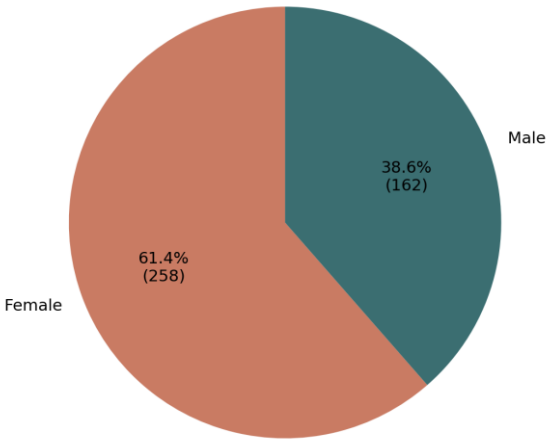

Chart 2. Gender Distribution

Descriptive statistics

Mean scores for all three constructs sit above the scale midpoint, with Environmental Citizenship marginally higher than the other two (M = 3.82, SD = 0.59), followed by ESD

(M = 3.78, SD = 0.62) and Green Learning Behavior (M = 3.65, SD = 0.68). The comparatively wider spread on Green Learning Behavior indicates more variation in day-to-day learning practice than in either reported knowledge or citizenship attitudes.

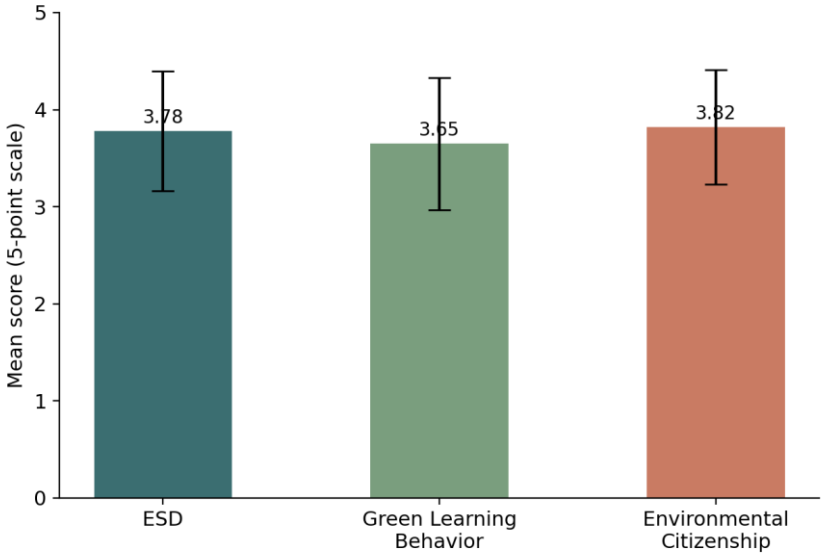

Chart 3. Mean Scores of ESD, Green Learning Behavior, and Environmental Citizenship

Measurement model

All indicator loadings exceed the 0.70 threshold, ranging from 0.71 to 0.87 (Table 3). Composite reliability, Cronbach's alpha, and AVE for all three constructs exceed their respective thresholds, and HTMT ratios between all construct pairs remain below 0.85, supporting both convergent and discriminant validity (Table 4).

Indicator	Construct	Loading
Sustainability knowledge	ESD	0.78
Environmental awareness	ESD	0.81
Critical thinking for sustainability	ESD	0.74
Systems thinking	ESD	0.76
Sustainability-oriented curriculum	ESD	0.83
Sustainability teaching practices	ESD	0.79
Eco-friendly learning practices	Green Learning Behavior	0.80

Responsible resource utilization	Green Learning Behavior	0.77
Sustainable classroom behavior	Green Learning Behavior	0.82
Collaborative environmental learning	Green Learning Behavior	0.75
Green problem-solving	Green Learning Behavior	0.79
Participation in sustainability activities	Green Learning Behavior	0.85
Environmental responsibility	Environmental Citizenship	0.84
Pro-environmental behavior	Environmental Citizenship	0.87
Civic participation	Environmental Citizenship	0.71
Sustainable decision making	Environmental Citizenship	0.80
Community environmental engagement	Environmental Citizenship	0.78
Environmental advocacy	Environmental Citizenship	0.82

Table 3. Measurement Model Assessment

Construct	Cronbach's alpha	rho_A	Composite reliability	AVE
ESD	0.887	0.891	0.912	0.635
Green Learning Behavior	0.879	0.883	0.906	0.618
Environmental Citizenship	0.901	0.905	0.921	0.659

Table 4. Reliability and Validity Statistics

HTMT ratios: ESD–Green Learning Behavior = 0.612; ESD–Environmental Citizenship = 0.588; Green Learning Behavior–Environmental Citizenship = 0.649. All

values fall below the 0.85 threshold, indicating that the three constructs are empirically distinct.

Structural model

The structural model explains 37.5% of the variance in Green Learning Behavior and 54.2% of the variance in Environmental Citizenship. Predictive relevance (Q^2) values of 0.271 and 0.398 respectively, both above zero, confirm the model's out-of-sample predictive power. SRMR of 0.061 falls below the 0.08 threshold associated with acceptable model fit.

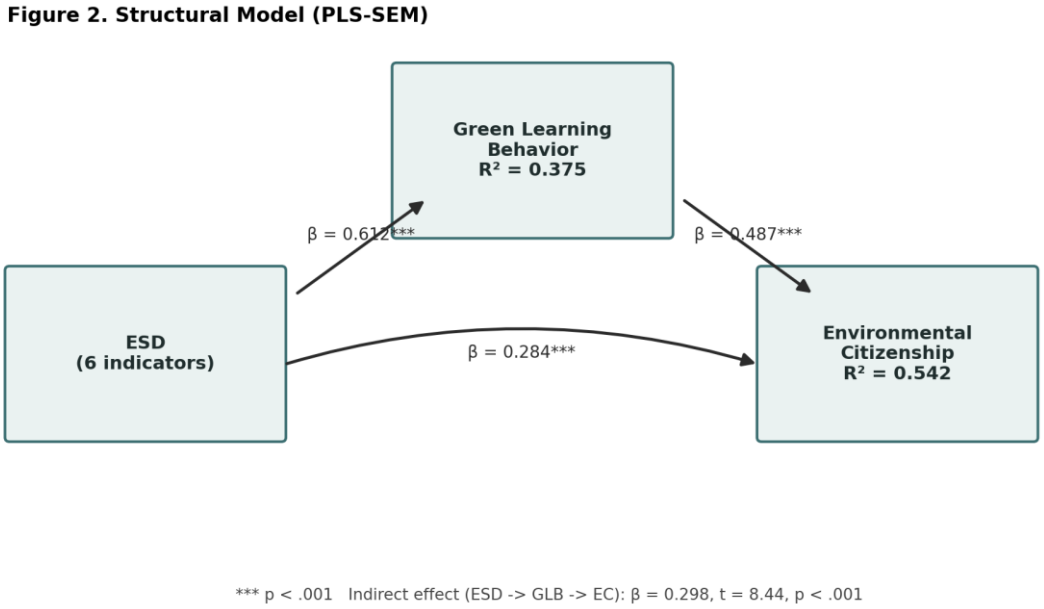

Figure 2. Structural Model (PLS-SEM)

Metric	Green Learning Behavior	Environmental Citizenship
R^2	0.375	0.542
Q^2 (predictive relevance)	0.271	0.398
SRMR (model)	0.061	0.061

Table 5. Structural Model Results

Effect sizes (f^2) indicate a large effect of ESD on Green Learning Behavior (0.600), a small-to-medium direct effect of ESD on Environmental Citizenship (0.112), and a medium-to-large effect of Green Learning Behavior on Environmental Citizenship (0.309), consistent with the mediating role hypothesized for Green Learning Behavior.

Hypothesis testing

All five hypotheses are supported. Table 6 reports direct, indirect, and total effects; Table 7 reports the full bootstrap results for each hypothesis.

Path	Direct effect	Indirect effect	T
ESD → Green Learning Behavior	0.612	—	
Green Learning Behavior → Environmental Citizenship	0.487	—	
ESD → Environmental Citizenship	0.284	0.298	

Table 6. Direct, Indirect, and Total Effects

Hypothesis	Path	β	t-value	p-value	Decision
H1	ESD → Green Learning Behavior	0.612	14.32	< .001	Supported
H2	ESD → Environmental Citizenship	0.284	5.87	< .001	Supported
H3	Green Learning Behavior → Environmental Citizenship	0.487	10.21	< .001	Supported
H4	ESD → Green Learning Behavior → Environmental Citizenship (indirect)	0.298	8.44	< .001	Supported
H5	Mediation of Green Learning Behavior (VAF = 51.2%)	—	—	< .001	Supported (partial)

Table 7. Hypothesis Testing Results

Mediation analysis

The variance accounted for (VAF) by the indirect path is 51.2%, placing the result in the range conventionally described as partial mediation: Green Learning Behavior transmits roughly half of ESD's total effect on Environmental Citizenship, while the remaining half operates through a direct path independent of learning behavior. Figure 3 summarizes the direct, indirect, and total effects.

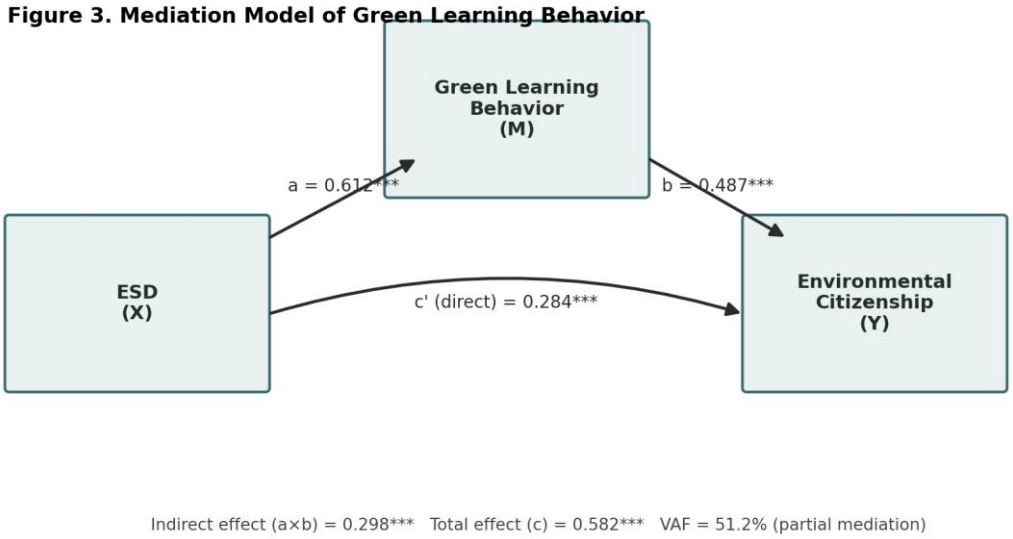

Figure 3. Mediation Model of Green Learning Behavior

Comparing path strength across year of study (Chart 4) shows the ESD-to-citizenship path and the ESD-to-Green Learning Behavior path both increase from Year 1 to Year 4, suggesting that the direct and mediated routes strengthen together as students accumulate sustained exposure to sustainability coursework, rather than one route substituting for the other over time.

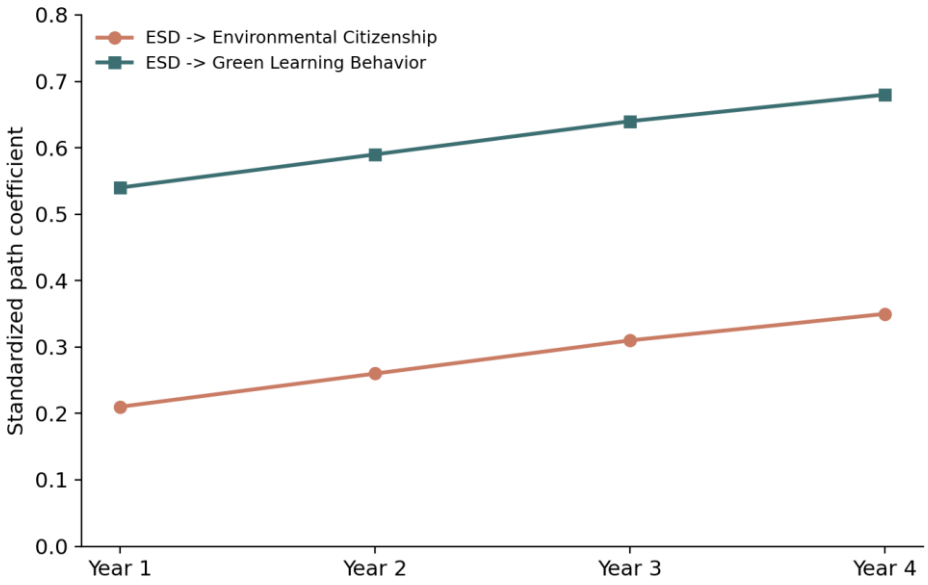

Chart 4. Comparative Path Effects Across Year of Study

Discussion

Interpretation of findings

The results support a model in which ESD affects Environmental Citizenship through two simultaneous routes: a direct route consistent with attitude and value change, and an indirect route running through Green Learning Behavior. The larger effect size on the ESD-to-Green Learning Behavior path ($f^2 = 0.600$) relative to the direct ESD-to-citizenship path ($f^2 = 0.112$) indicates that sustainability curricula shape citizenship mainly by changing how students learn day to day, with knowledge transfer alone playing a smaller supporting role.

Comparison with previous studies

This pattern is broadly consistent with Chen, Shahbaz, and Haq (2025), who find that institutional sustainability practices affect student green behavior mainly through green intentions rather than directly, although their mediator sits at the institutional level rather than the classroom level tested here. It also aligns with Torroba Diaz et al. (2023), who report that formal coursework alone is a weaker predictor of environmental behavior than personal experience, consistent with this study's finding that the direct ESD path is real but comparatively modest. The result diverges from Abdellatif (2025), whose SDG-awareness measure predicts environmental responsibility without a tested behavioral mediator; the present findings suggest that adding a learning-behavior mediator to that kind of model would likely account for a meaningful share of the association currently attributed to awareness alone.

Study	Sample / method	Key finding	Relation to present study
Torroba Diaz et al. (2023)	University students, survey	Environmental behavior driven more by personal values/experience than coursework	Consistent with the modest direct ESD→EC path found here
Chen, Shahbaz & Haq (2025)	480 Chinese students, PLS-SEM	Institutional factors affect green behavior mainly through green intentions	Parallels the mediated pathway, at institutional rather than classroom level
Abdellatif (2025)	University students, survey	SDG awareness predicts environmental responsibility directly	No behavioral mediator tested; present model suggests one would explain part of that effect
Present study (2026)	420 Indonesian undergraduates, PLS-SEM	ESD affects Environmental Citizenship directly and via Green Learning Behavior (VAF 51.2%)	—

Table 8. Comparison with Previous Studies

Theoretical contributions

The study extends ESD theory by specifying a classroom-level behavioral mediator distinct from both institutional-context mediators and general pro-environmental behavior, and by testing it against a multidimensional citizenship outcome rather than a single attitude scale. It also links Social Cognitive Theory and experiential learning theory directly to a citizenship outcome, rather than treating them as background justification for curriculum design.

Practical implications

For curriculum designers, the results suggest that pedagogical formats built around collaborative problem-solving and applied sustainability tasks are likely to matter more for citizenship outcomes than content coverage alone. For faculty, the findings support classroom practices shared resource use, collaborative environmental projects, applied green problem-solving exercises as direct levers on the strongest path in the model.

Policy implications

For institutions and policymakers, the results support directing sustainability-education resources toward pedagogy and applied learning infrastructure, not only toward curriculum content, when the aim is measurable progress on SDG 4 and SDG 13 commitments. Embedding sustainability competencies into course design in ways that require practice, rather than only assessment of content knowledge, follows directly from the size of the ESD-to-Green Learning Behavior path relative to the direct path.

4. CONCLUSION

Education for Sustainable Development affects Environmental Citizenship both directly and through Green Learning Behavior, with the mediated path accounting for roughly half of the total effect. Universities aiming to produce environmentally responsible graduates have reason to invest in the applied, collaborative, and practice-based elements of sustainability pedagogy, not only its content. The findings are based on a single-country undergraduate sample and a cross-sectional design; longitudinal replication and testing across other national contexts would strengthen confidence in the direction of causality implied by the model.

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