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A Prospective Analysis of Factors Influencing the Pro-Environmental Behavior of Iranian Citizens: Environmental Governance and Structural Equation Modeling

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ABSTRACT

Pro-environmental behavior among citizens is a fundamental component of sustainable development and the mitigation of contemporary environmental crises. International experience indicates that environmental policies rarely produce durable outcomes without informed and responsible public participation. Understanding the determinants of pro-environmental behavior is therefore particularly important in urban communities confronted with air pollution, waste generation, excessive energy use, water scarcity, and degradation of natural resources. This study prospectively analyzed the cultural, cognitive, value-based, and ethical factors associated with the pro-environmental behavior of Iranian citizens. The theoretical framework drew on the Theory of Planned Behavior, Norm-Activation Theory, Value-Belief-Norm theory, and contemporary explanations of the knowledge-action gap. The study was applied in purpose and descriptive-correlational in design. The population consisted of residents of District 12 of Tehran, and data were collected from 390 participants using a researcher-developed questionnaire. Partial least squares structural equation modeling was used for data analysis. Environmental education, environmental awareness and knowledge, environmental values, and environmental ethics all had positive and statistically significant effects on pro-environmental behavior. Environmental ethics showed the strongest direct effect and significantly mediated the relationships of education, awareness, and values with behavior. The model explained 71% of the variance in pro-environmental behavior. These findings indicate that increasing general knowledge alone is insufficient. Effective policy requires the reinforcement of biocentric values, the internalization of moral responsibility toward nature, and educational and cultural programs adapted to citizens' social context.

Keywords: pro-environmental behavior; environmental education; environmental awareness; environmental values; environmental ethics; partial least squares structural equation modeling

Introduction

In recent decades, the environment has evolved from a narrowly natural and technical concern into a social, cultural, economic, and ethical issue. Climate change, air pollution, water crises, soil degradation, biodiversity loss, growing volumes of urban waste, and unsustainable resource use indicate a structural imbalance in the relationship between human societies

and nature. International assessments emphasize that the interconnected crises of climate change, biodiversity loss, and pollution cannot be controlled without changes in production, consumption, and human behavior (Ipcc, 2023; Unep, 2021, 2024). Consequently, citizens' pro-environmental behavior has become a central subject in sustainable development, environmental sociology, and environmental psychology.

Pro-environmental behavior refers to deliberate and responsible actions intended to reduce environmental harm or support the conservation of natural resources. Such actions include conserving water and energy, separating and recycling waste, reducing the use of private cars, purchasing environmentally compatible products, participating in environmental activities, and supporting conservation policies (Lou & Li, 2023; Tian & Liu, 2022). These behaviors matter because a substantial proportion of environmental degradation originates in everyday habits, lifestyles, consumption patterns, and individual and collective decisions (Creutzig et al., 2022; Piao & Managi, 2024).

Environmental conditions have also become a major development challenge in Iran. Air pollution in metropolitan areas, water scarcity, soil erosion, extensive waste production, high energy consumption, and deterioration in the quality of urban life show that environmental policy cannot be sufficiently effective without citizen participation. Citizens are not merely recipients of policy; through everyday choices concerning consumption, transport, waste management, and civic participation, they may either intensify or reduce environmental pressures (Undp Iran, 2025; Who, 2024). Identifying the factors that shape the environmental behavior of Iranian citizens is therefore scientifically and practically important.

Recent research indicates that environmental awareness, although a prerequisite for responsible action, is not sufficient by itself to change behavior. People may understand environmental problems but fail to translate that understanding into sustained action. This discrepancy is commonly described as the knowledge-action or attitude-behavior gap ((Díaz et al., 2020; Miller & Rice, 2024). Accordingly, adequate explanations of pro-environmental behavior must address not only information and awareness but also environmental values, social norms, perceived responsibility, environmental ethics, perceived efficacy, and institutional conditions (Niu et al., 2023; Saracevic & Schlegelmilch, 2021).

Environmental education is one of the principal instruments for strengthening sustainable behavior. It can improve citizens' understanding of environmental problems and their consequences while fostering favorable attitudes, social sensitivity, and environmental responsibility. Evidence nevertheless suggests that education is more effective when it extends beyond information transfer to include practical experience, social participation, contact with nature, and moral responsibility (Ardoin et al., 2020; UNESCO, 2020; Zhao et al., 2024). Education should therefore empower citizens to act rather than merely increase what they know.

Environmental values are similarly fundamental. Individuals who regard nature as intrinsically valuable and view its protection as a social and moral responsibility are more likely to engage in sustainable action (Li et al., 2022; Tamar et al., 2021). Conversely, consumerist, individualistic, and short-term value orientations may weaken concern for the environmental consequences of routine behavior. Pro-environmental behavior is thus embedded in the value system of individuals and society rather than being a simple product of information.

Environmental ethics adds a further dimension. It comprises moral beliefs and judgments concerning relationships with nature, future generations, other living beings, and natural resources. When environmental protection becomes an internal moral obligation, responsible behavior is more likely to continue even when it requires time, expense, or changes in personal

habits (Shipley & van Riper, 2022; Shrestha & et al., 2025). Environmental ethics may therefore help close the gap between positive attitudes and actual behavior.

Individual motivations are also embedded in social and institutional contexts. Pro-environmental behavior is influenced by social trust, the quality of municipal services, access to recycling facilities, public transport, media messages, incentive policies, and social norms (Meng et al., 2023; Shen & Zhang, 2024). A citizen may hold a favorable attitude toward waste separation but be unable to act when adequate collection infrastructure is absent. Environmental behavior must therefore be examined through a multidimensional approach that includes cognitive and value-based factors as well as social and institutional opportunities.

The present study analyzed the determinants of pro-environmental behavior among Iranian citizens by examining environmental education, environmental awareness and knowledge, environmental values, and environmental ethics. Structural equation modeling enabled simultaneous analysis of their direct and indirect relationships. The study conceptualized environmental behavior not simply as a consequence of awareness but as the product of interactions among education, knowledge, values, ethics, and the social setting. This perspective may assist policy makers, municipal managers, educational institutions, and environmental organizations in designing more realistic and context-sensitive interventions.

Theoretical Background and Literature Review

Pro-environmental behavior is a core concept in sustainable development, environmental sociology, and environmental psychology. It encompasses actions intended to reduce environmental damage or protect natural resources, including conserving water and energy, reducing plastic use, separating and recycling waste, using public transportation, purchasing environmentally compatible products, and participating in environmental initiatives. Contemporary evidence indicates that such behaviors emerge from interacting cognitive, value-based, ethical, social, and institutional influences rather than from awareness alone (Piao & Managi, 2024; Tian & Liu, 2022).

Pro-Environmental Behavior

Pro-environmental behavior can be understood as purposive social action in which individuals consider the environmental consequences of their choices and attempt to reduce their negative effects on nature. Recent approaches distinguish private-sphere behavior, such as lowering energy use, conserving water, and separating household waste, from public-sphere behavior, such as participating in environmental campaigns, supporting environmental policy, and demanding action from responsible institutions (Lou & Li, 2023; Miller & Rice, 2024).

These behaviors are shaped jointly by personal and structural conditions. Positive attitudes, awareness, environmental values, and moral responsibility may increase the likelihood of sustainable action, while urban infrastructure, supportive policies, social norms, and trust in institutions influence whether intentions can be implemented (Meng et al., 2023; Niu et al., 2023). Environmental behavior should consequently be analyzed in relation to cultural, social, and institutional conditions rather than reduced to isolated personal choice.

Environmental Education

Environmental education is a process through which individuals learn about environmental problems, their causes, the consequences of human behavior, and strategies for protecting nature. It may take the form of formal instruction in schools

and universities, informal learning through media and social networks, or participatory education delivered through civil-society organizations and municipal programs ([Ardoin et al., 2020](#); [UNESCO, 2020](#)).

Education is most likely to generate sustainable behavior when it includes practical experience, social participation, direct contact with nature, responsibility, and positive attitude formation rather than information alone. Nature-contact education has been associated with stronger pro-environmental behavior through environmental attitudes and responsibility ([Zhao et al., 2024](#)). Environmental education should therefore incorporate cognitive, affective, ethical, and behavioral components.

Environmental Awareness and Knowledge

Environmental awareness concerns knowledge of environmental problems, the consequences of ecological degradation, the contribution of human behavior to environmental crises, and possible harm-reduction strategies. Knowledge may foster favorable attitudes and sensitivity. Citizens who understand water scarcity, air pollution, waste generation, and excessive energy use may be more willing to reconsider routine behavior ([Tamar et al., 2021](#); [Tian & Liu, 2022](#)).

Awareness alone, however, does not guarantee behavioral change. Consumer habits, behavioral costs, lack of facilities, weak social norms, and distrust of institutions may prevent informed citizens from acting sustainably. Awareness is more likely to become behavior when accompanied by environmental values, responsibility, supportive norms, and a feasible opportunity for action ([Miller & Rice, 2024](#); [Niu et al., 2023](#)).

Environmental Values

Environmental values are fundamental beliefs about the importance of nature, natural resources, living organisms, and future generations. They guide everyday priorities and decisions. Individuals with strong biospheric and altruistic values tend to regard environmental protection as part of their social responsibility rather than as an optional personal preference ([Li et al., 2022](#); [Tamar et al., 2021](#)).

Values may strengthen sustainable behavior through attitudes, personal norms, and environmental identity. When nature is viewed as intrinsically valuable, individuals may avoid harmful actions even when doing so is difficult or costly. Consumerist and self-focused values, in contrast, may weaken sensitivity to environmental consequences ([Piao & Managi, 2024](#); [Saracevic & Schlegelmilch, 2021](#)).

Environmental Ethics

Environmental ethics comprises moral principles and beliefs concerning the human relationship with nature, future generations, animals, natural resources, and ecosystems. From this perspective, the environment is not merely a resource for economic use; it possesses moral significance and deserves care. Environmental ethics can move behavior beyond personal utility and transform it into internal, responsible commitment ([Shipley & van Riper, 2022](#)).

Many sustainable behaviors may impose immediate inconvenience or cost. Reduced consumption, waste separation, less frequent use of private vehicles, and participation in environmental activities may require time, habit change, or acceptance of limitations. Under these conditions, moral commitment may provide a stable motivation for responsible behavior. Moral emotions, including guilt, moral pride, and responsibility, have been linked to stronger pro-environmental action ([Niu et al., 2023](#); [Shipley & van Riper, 2022](#)).

Social Norms and Institutional Context

Pro-environmental behavior takes shape within social relationships, collective norms, and institutional structures. Social norms communicate whether specific behaviors are accepted, valued, or expected. When citizens perceive that important others value conservation, recycling, and reduced consumption, they may be more likely to adopt similar behavior (Piao & Managi, 2024; Saracevic & Schlegelmilch, 2021).

Institutional context is equally important. Recycling infrastructure, effective public transport, incentive policies, public education, trust in municipal management, and institutional transparency may facilitate sustainable action. Positive attitudes are unlikely to generate persistent behavior when citizens lack practical opportunities to act (Meng et al., 2023; Shen & Zhang, 2024). Pro-environmental behavior is therefore produced by the interaction between personal motivation and structural opportunity.

Synthesis of the Literature

The literature depicts pro-environmental behavior as a multidimensional phenomenon. Education can increase knowledge and social sensitivity; awareness can clarify the consequences of human action; environmental values can orient individuals toward sustainability; and environmental ethics can convert responsible behavior into an internal commitment. Social norms and institutions may either facilitate or constrain the conversion of these attitudes and values into actual behavior.

Despite an extensive literature, fewer studies have examined education, awareness, values, ethics, and behavior simultaneously within a structural model. The present study addressed this gap by testing the direct effects of environmental education, environmental awareness and knowledge, environmental values, and environmental ethics on citizens' pro-environmental behavior and by examining environmental ethics as a mediator.

Conceptual Model and Research Hypotheses

The conceptual model treated environmental education, environmental awareness and knowledge, and environmental values as predictor variables. Environmental ethics was included as an internal normative construct and a mediator because sustainable behavior may persist only when protection of the environment is understood as a personal moral commitment. The dependent variable was pro-environmental behavior, encompassing conservation, recycling, pollution reduction, sustainable consumption, and environmental participation.

The model assumes that education can influence behavior by strengthening understanding, sensitivity, and practical capability; awareness can support responsible decision making by clarifying the consequences of environmental degradation; and environmental values can shape priorities, beliefs, and lifestyles. Environmental ethics may strengthen the translation of education, awareness, and values into action by transforming favorable attitudes into internal moral commitment.

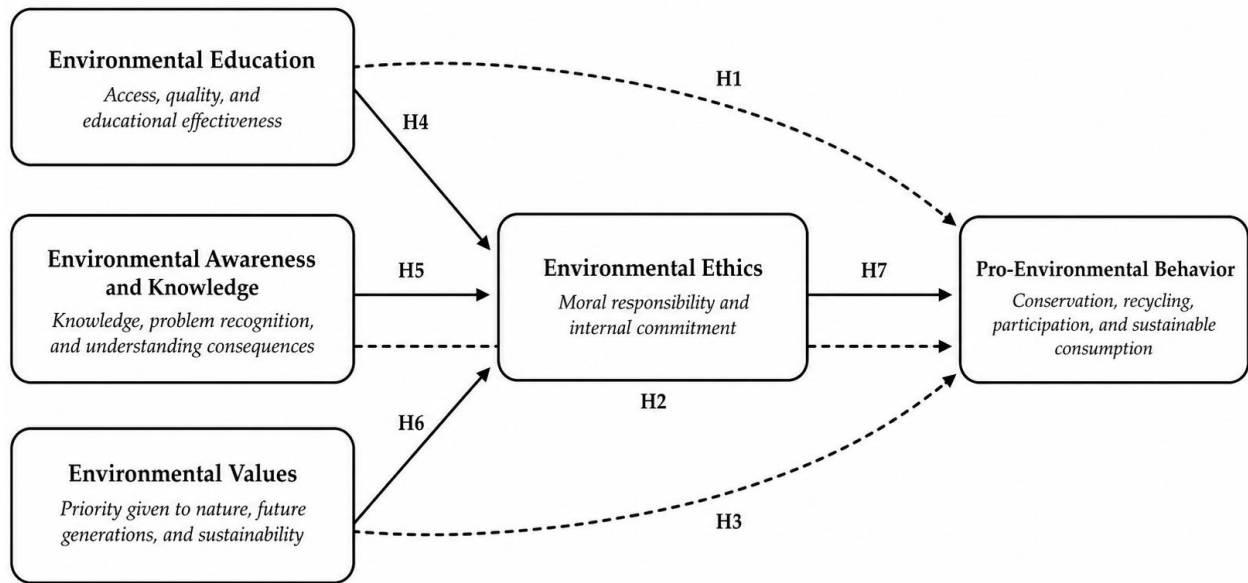


Figure 1. Proposed conceptual model of the study.

Environmental Education and Pro-Environmental Behavior

Environmental education can increase citizens' knowledge of ecological problems, sensitivity to the consequences of daily behavior, and practical skills for responsible action. It is most effective when it moves beyond information transfer and incorporates experience, participation, and responsibility (Ardoin et al., 2020; UNESCO, 2020; Zhao et al., 2024).

H1: Environmental education has a positive and significant effect on citizens' pro-environmental behavior.

Environmental Awareness and Knowledge and Pro-Environmental Behavior

Greater knowledge of air pollution, water scarcity, waste generation, energy consumption, and resource degradation may encourage citizens to reconsider routine conduct. Awareness is nevertheless more effective when accompanied by responsibility, environmental values, and practical opportunity (Miller & Rice, 2024; Tian & Liu, 2022).

H2: Environmental awareness and knowledge have a positive and significant effect on citizens' pro-environmental behavior.

Environmental Values and Pro-Environmental Behavior

Individuals with strong biospheric and altruistic values tend to regard environmental protection as part of personal and social responsibility. Environmental values may strengthen sustainable action through attitudes, environmental identity, and personal norms (Li et al., 2022; Piao & Managi, 2024; Tamar et al., 2021).

H3: Environmental values have a positive and significant effect on citizens' pro-environmental behavior.

Environmental Education and Environmental Ethics

Ethically oriented education can introduce citizens to the moral consequences of human action for nature, future generations, and other living beings. It may therefore move individuals from awareness toward responsibility and commitment.

H4: Environmental education has a positive and significant effect on citizens' environmental ethics.

Environmental Awareness and Knowledge and Environmental Ethics

Knowledge of the consequences of consumption, waste, energy use, and neglect of resources may activate moral responsibility. Awareness of consequences and ascription of responsibility are central to the development of personal moral norms (Niu et al., 2023).

H5: Environmental awareness and knowledge have a positive and significant effect on citizens' environmental ethics.

Environmental Values and Environmental Ethics

Values provide the foundation for moral judgment. When nature is regarded as intrinsically valuable and its protection as a public good, individuals are more likely to develop moral responsibility toward the environment (Li et al., 2022; Saracevic & Schlegelmilch, 2021).

H6: Environmental values have a positive and significant effect on citizens' environmental ethics.

3.7. Environmental Ethics and Pro-Environmental Behavior

Environmental ethics may sustain behavior that is costly or inconvenient because the behavior is understood as morally right rather than merely personally useful. Moral emotions such as guilt and pride have been associated with pro-environmental behavior (Shipley & van Riper, 2022).

H7: Environmental ethics has a positive and significant effect on citizens' pro-environmental behavior.

Mediating Role of Environmental Ethics

The model further proposes that education, awareness, and environmental values affect behavior indirectly through environmental ethics. Information and values may generate persistent action when they are internalized as moral commitment.

H8: Environmental ethics mediates the relationship between environmental education and pro-environmental behavior.

H9: Environmental ethics mediates the relationship between environmental awareness and knowledge and pro-environmental behavior.

H10: Environmental ethics mediates the relationship between environmental values and pro-environmental behavior.

Summary of the Research Model

The model conceptualizes citizens' pro-environmental behavior as a function of educational, cognitive, value-based, and ethical factors. Environmental education, environmental awareness and knowledge, and environmental values are expected to influence behavior directly and indirectly through environmental ethics. Environmental ethics occupies a central position because it may reduce the knowledge-action gap and elevate environmental behavior from temporary action to sustained commitment.

Methodology

Study Design

This was an applied, descriptive-correlational study. It examined relationships among environmental education, environmental awareness and knowledge, and environmental values as predictor variables; pro-environmental behavior as the dependent variable; and environmental ethics as a mediating variable within a causal structural model.

Population and Sampling

The population consisted of citizens residing in District 12 of Tehran. This district was selected because of its high population density, social diversity, and urban environmental challenges. Because the population size was treated as unknown, Cochran's formula for an unlimited population was used. At a 95% confidence level and a margin of error of .05, the required minimum sample was 384. A total of 390 valid questionnaires were ultimately analyzed. Simple random sampling was conducted in public settings, including shopping centers, parks, and public-transport stations.

Instrument

Data were collected using a researcher-developed questionnaire based on the theoretical framework and literature review. The first section assessed demographic characteristics, including age, sex, educational attainment, and duration of residence. The second section measured the study constructs using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The instrument contained 3 environmental-education items, 4 environmental-awareness and knowledge items, 3 environmental-value items, 5 environmental-ethics items, and 6 pro-environmental-behavior items.

Validity and Reliability

For content validation, the questionnaire was reviewed by 10 specialists in environmental studies and the social sciences, and revisions were made in response to their comments. Internal consistency was assessed using Cronbach's alpha. Composite reliability (CR) and average variance extracted (AVE) were also calculated to evaluate construct reliability and convergent validity. Discriminant validity was examined using the Fornell-Larcker criterion and the heterotrait-monotrait ratio (HTMT).

Data Analysis

Data were analyzed using partial least squares structural equation modeling (PLS-SEM), selected because of its suitability for complex models and its limited distributional assumptions (Hair et al., 2017). Analysis proceeded in two stages. The measurement model was evaluated using factor loadings, Cronbach's alpha, CR, AVE, the Fornell-Larcker criterion, and HTMT. The structural model was then assessed using variance inflation factors (VIF), standardized path coefficients (β), t statistics, p values, coefficients of determination (R^2), predictive relevance (Q^2), and model-fit indices. Statistical significance was evaluated using bootstrapping with 5,000 resamples.

Research Findings

The results are presented in terms of participant characteristics, descriptive statistics, the measurement model, and the structural model. Data from all 390 valid questionnaires were included in the analysis.

Participant Characteristics

Table 1. Demographic characteristics of the sample

Variable	Category	Frequency	Percent
Sex	Male	176	45.1
	Female	214	54.9
Age	<25 years	62	15.9
	25–35 years	156	40.0
	36–45 years	103	26.4
	≥46 years	69	17.7
Education	High-school diploma or lower	71	18.2
	Associate degree	85	21.8
	Bachelor's degree	148	37.9
	Master's degree or higher	86	22.1
Residence in the district	<5 years	112	28.7
	≥5 years	278	71.3

Women represented 54.9% of the sample, and the largest age group was 25–35 years (40.0%). Sixty percent of respondents held at least a bachelor's degree. Most participants (71.3%) had lived in the district for five years or longer, suggesting substantial familiarity with its environmental conditions.

Descriptive Statistics

All construct means exceeded the midpoint of the five-point scale. Environmental ethics had the highest mean (3.89), followed by environmental values (3.84). The mean for pro-environmental behavior was lower (3.56) than the means for the attitudinal and value-based constructs, a pattern consistent with a possible gap between favorable orientation and actual behavior.

Measurement Model

Descriptive Statistics, Reliability, and Convergent Validity

Table 2. Descriptive statistics and measurement-model assessment

Construct	Mean	SD	Cronbach's α	CR	AVE	Items and standardized loadings
Environmental education	3.61	0.74	0.81	0.88	0.70	A1=.81; A2=.86; A3=.84
Environmental awareness and knowledge	3.78	0.69	0.85	0.90	0.69	B1=.79; B2=.84; B3=.86; B4=.82
Environmental values	3.84	0.71	0.79	0.87	0.68	C1=.80; C2=.85; C3=.82
Environmental ethics	3.89	0.67	0.90	0.93	0.72	D1=.83; D2=.87; D3=.85; D4=.86; D5=.84
Pro-environmental behavior	3.56	0.73	0.88	0.91	0.63	E1=.77; E2=.82; E3=.80; E4=.81; E5=.79; E6=.78

Note. CR = composite reliability; AVE = average variance extracted. All indicator loadings exceeded .70.

Cronbach's alpha and composite reliability exceeded .70 for every construct, indicating satisfactory internal consistency. All AVE values were above .50, supporting convergent validity.

Standardized Indicator Loadings

Every indicator loading exceeded .70; therefore, all items demonstrated adequate measurement strength and none required removal.

Discriminant Validity

Table 3. Fornell-Larcker matrix

Construct	1	2	3	4	5
1. Environmental education	0.84				
2. Environmental awareness and knowledge	0.58	0.83			
3. Environmental values	0.52	0.61	0.82		
4. Environmental ethics	0.63	0.67	0.69	0.85	
5. Pro-environmental behavior	0.55	0.62	0.60	0.74	0.79

The diagonal values represent the square roots of AVE. Each exceeded the corresponding interconstruct correlations, supporting discriminant validity according to the Fornell-Larcker criterion.

Table 4. Heterotrait-monotrait ratios

Construct	1	2	3	4	5
1. Environmental education	—				
2. Environmental awareness and knowledge	0.71	—			
3. Environmental values	0.66	0.74	—		
4. Environmental ethics	0.78	0.81	0.83	—	
5. Pro-environmental behavior	0.69	0.76	0.73	0.87	—

All HTMT values were below .90, providing additional evidence of discriminant validity. The measurement model was therefore considered adequate for evaluation of the structural model.

Structural Model

Collinearity

All VIF values were below 3.0, indicating that collinearity among the predictors was not problematic.

Direct and Indirect Effects

Table 5. Structural-model path estimates and hypothesis tests

Hyp.	Path	VIF	Effect	t	p
H1	Environmental education → Pro-environmental behavior	1.86	.140	2.48	.013
H2	Environmental awareness and knowledge → Pro-environmental behavior	2.01	.190	3.12	.002
H3	Environmental values → Pro-environmental behavior	1.94	.160	2.87	.004
H4	Environmental education → Environmental ethics	1.73	.270	4.36	<.001
H5	Environmental awareness and knowledge → Environmental ethics	1.88	.310	4.98	<.001
H6	Environmental values → Environmental ethics	1.91	.340	5.41	<.001
H7	Environmental ethics → Pro-environmental behavior	2.27	.380	6.52	<.001
H8	Environmental education → Environmental ethics → Pro-environmental behavior	—	.103	3.61	<.001
H9	Environmental awareness and knowledge → Environmental ethics → Pro-environmental behavior	—	.118	4.02	<.001
H10	Environmental values → Environmental ethics → Pro-environmental behavior	—	.129	4.37	<.001

Note. "Effect" denotes the standardized direct effect for H1–H7 and the standardized indirect effect for H8–H10. All hypotheses were supported.

All seven direct hypotheses were supported. Environmental ethics had the strongest direct effect on pro-environmental behavior ($\beta = .38$). It was followed by environmental awareness and knowledge ($\beta = .19$), environmental values ($\beta = .16$), and environmental education ($\beta = .14$). Environmental values had the largest effect on environmental ethics ($\beta = .34$), followed by awareness and knowledge ($\beta = .31$) and education ($\beta = .27$).

Environmental ethics significantly mediated the relationships of environmental education, environmental awareness and knowledge, and environmental values with pro-environmental behavior. Thus, part of the influence of each antecedent was transmitted through moral responsibility and internal commitment toward nature.

Explanatory, Predictive, and Model-Fit Assessment

Table 6. Explanatory, predictive, and model-fit indices

Category	Metric or construct	Value	Interpretation
Explanatory and predictive power	Environmental ethics	$R^2 = .62$; $Q^2 = .41$	Satisfactory
Explanatory and predictive power	Pro-environmental behavior	$R^2 = .71$; $Q^2 = .48$	Strong
Model fit	SRMR	.067	Satisfactory
Model fit	NFI	.91	Satisfactory
Model fit	RMS_theta	.081	Acceptable

Environmental education, awareness and knowledge, and values explained 62% of the variance in environmental ethics. The full model explained 71% of the variance in pro-environmental behavior. Positive Q^2 values of .41 and .48 indicated satisfactory predictive relevance for both endogenous constructs.

The SRMR was below .08, the NFI exceeded .90, and RMS_theta was within an acceptable range. Taken together, these indices indicated satisfactory fit between the proposed model and the observed data.

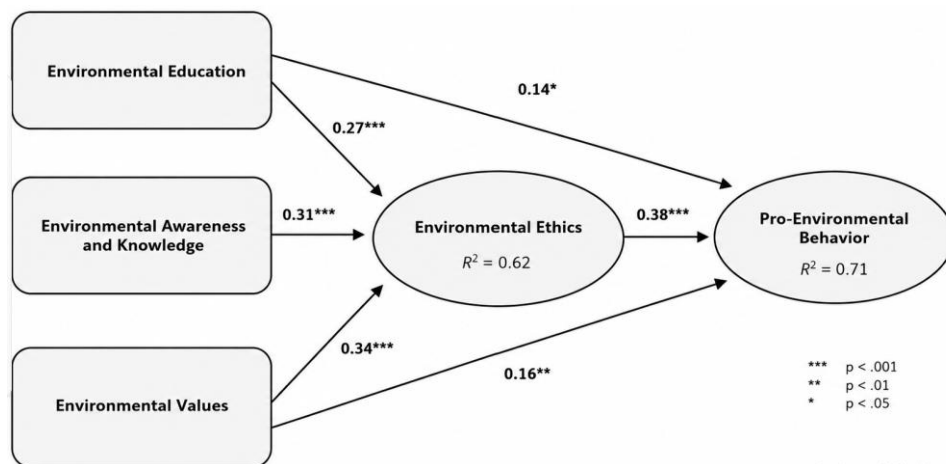


Figure 2. Final structural model with standardized path coefficients.

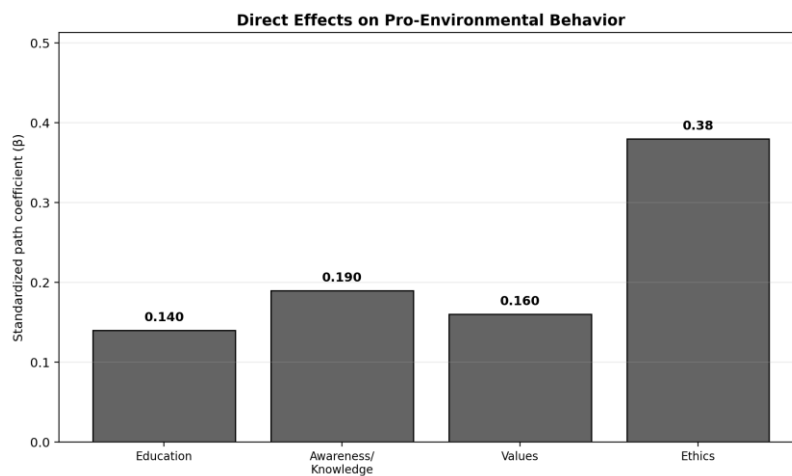


Figure 3. Comparison of direct effects on pro-environmental behavior.

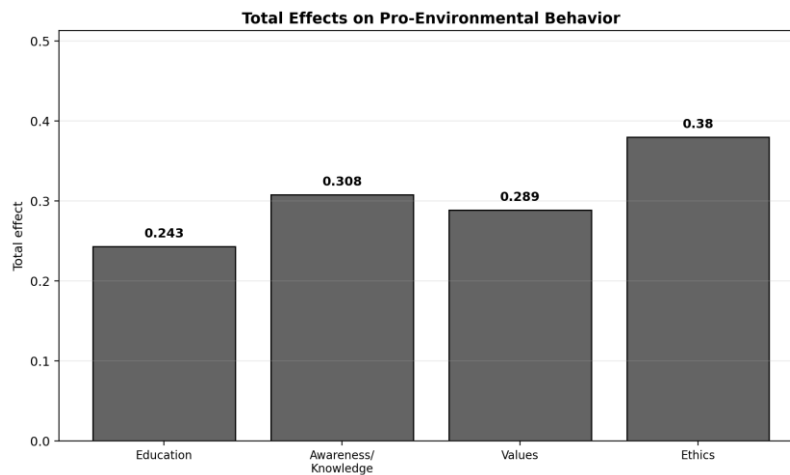


Figure 4. Comparison of total effects on pro-environmental behavior.

The total effects were .243 for environmental education, .308 for environmental awareness and knowledge, .289 for environmental values, and .380 for environmental ethics. When direct and indirect effects were considered together, awareness and knowledge and environmental values also made substantial contributions to behavior.

The proposed model demonstrated satisfactory explanatory power and fit, and all hypothesized relationships were supported. Environmental education, environmental awareness and knowledge, and environmental values affected behavior both directly and indirectly through environmental ethics. Environmental ethics was the strongest determinant of pro-environmental behavior. The findings indicate that increasing information alone is unlikely to produce sufficient change unless education and cultural interventions also strengthen environmental values and internal moral responsibility.

Discussion

The study examined an integrated model of pro-environmental behavior and found support for all direct and mediated relationships. The measurement model demonstrated adequate reliability and validity, and the structural model explained a substantial proportion of variance in environmental ethics and behavior. The results are discussed below in relation to the theoretical framework and previous evidence.

Environmental Education

Environmental education had a positive and significant direct effect on pro-environmental behavior. This finding is consistent with evidence that education can promote conservation and other forms of sustainable action ([Ardoin et al., 2020](#); [UNESCO, 2020](#)). Education can increase knowledge, practical skills, and sensitivity to environmental issues. Its comparatively modest direct coefficient, however, indicates that education alone is unlikely to be sufficient. Programs may achieve greater behavioral impact when they incorporate value formation, moral reasoning, participation, and opportunities for practical action.

Environmental Awareness and Knowledge

Environmental awareness and knowledge also positively predicted pro-environmental behavior. This finding agrees with research identifying awareness as an important precursor of sustainable action ([Miller & Rice, 2024](#); [Tian & Liu, 2022](#)).

Nevertheless, the knowledge-action literature shows that informed citizens do not necessarily change established behavior. In the present model, awareness exerted a stronger total effect when its indirect pathway through environmental ethics was included, suggesting that knowledge becomes more influential when connected with moral responsibility and internal values.

Environmental Values

Environmental values had significant effects on both environmental ethics and pro-environmental behavior. This result is consistent with Li et al. (2022) and Piao and Managi (2024) (Li et al., 2022; Piao & Managi, 2024). Values orient priorities and daily decisions; individuals who attribute intrinsic value to nature are more likely to accept personal responsibility for its protection. The relatively strong effect of values on environmental ethics suggests that value formation is an important foundation for internal moral commitment. Cultural policy should therefore address how nature, future generations, and sustainability are represented in education, media, and public discourse.

Environmental Ethics

The strongest direct predictor of pro-environmental behavior was environmental ethics ($\beta = .38$). This pattern accords with Norm-Activation Theory and Value-Belief-Norm theory, which propose that awareness of consequences, responsibility, and personal norms can activate behavior that benefits others and the environment. When individuals view environmental protection as a moral duty, they may act sustainably even when doing so is inconvenient or costly. The finding implies that environmental action in the study population was shaped more strongly by internalized moral commitment than by knowledge or education alone.

Mediating Role of Environmental Ethics

Environmental ethics significantly mediated the effects of education, awareness, and values on pro-environmental behavior. Education and knowledge may provide information and capability, while environmental values define what is important; ethics appears to convert these resources into a felt obligation to act. The indirect effects were statistically significant for all three antecedents, supporting the proposition that moral internalization is a mechanism through which knowledge and values become sustained behavior. Environmental ethics can therefore be interpreted as a bridge between knowing, valuing, and acting.

Theoretical and Governance Implications

The findings reinforce a multidimensional explanation of pro-environmental behavior. Cognitive and educational factors remain important, but behavior cannot be explained adequately without values and ethics. The model also has governance implications. Policy makers should not treat citizens as passive recipients of information; they should create institutional conditions that make sustainable action feasible and socially supported. Education should be coordinated with reliable municipal services, accessible recycling and transport infrastructure, transparent environmental governance, and public communication that emphasizes shared responsibility rather than individual blame.

The gap between the relatively high means for environmental ethics and values and the lower mean for reported behavior also indicates that favorable orientation may be constrained by practical conditions. Moral commitment cannot substitute for infrastructure. Effective governance must combine internal motivation with opportunities for action, consistent

incentives, institutional trust, and visible accountability. The empirical model focuses on individual-level determinants, but the broader literature and the Iranian urban context suggest that structural support remains necessary for sustained change.

Conclusion, Practical Recommendations, and Limitations

Conclusion

The study analyzed environmental education, environmental awareness and knowledge, environmental values, and environmental ethics as determinants of citizens' pro-environmental behavior. All proposed direct relationships were positive and significant, and the model demonstrated satisfactory fit. Environmental ethics had the strongest direct effect on behavior and significantly mediated the effects of education, awareness, and values. The findings therefore indicate that pro-environmental behavior becomes more durable when knowledge and positive values are internalized as moral commitment.

The model explained 71% of the variance in pro-environmental behavior, suggesting that the selected educational, cognitive, value-based, and ethical factors provide a strong account of differences in behavior within the study sample. At the same time, the lower behavioral mean relative to ethics and values points to an attitude-action gap and highlights the importance of institutional opportunity. A comprehensive strategy should strengthen motivation and moral commitment while also improving the conditions under which citizens can act.

Practical Recommendations

1. Develop targeted environmental education.

Programs should move beyond information transfer and use skill-based, participatory, and problem-centered methods. Field experience, school projects, and community learning may strengthen application.

2. Improve public understanding of behavioral consequences.

Media, municipal organizations, and educational institutions should communicate the environmental effects of everyday water, energy, transport, and waste choices.

3. Strengthen environmental values.

Cultural and social programs should institutionalize respect for nature and future generations as shared social values and public norms.

4. Integrate environmental ethics into education and media.

Curricula and public communication should address intergenerational responsibility, environmental justice, moral accountability, and respect for nature.

5. Improve urban and institutional infrastructure.

Recycling services, waste-management systems, and public transportation should be strengthened so that citizens have realistic opportunities to perform sustainable behavior.

Limitations

Geographical scope.

The study was conducted only in District 12 of Tehran; generalization to other urban and rural populations should therefore be cautious.

Self-report measurement.

Questionnaire responses may have been influenced by recall error or socially desirable responding.

Cross-sectional design.

The design did not assess change in environmental behavior over time and cannot establish temporal causality.

Restricted set of variables.

The model focused on four principal antecedents. Institutional trust, government policy, cultural norms, household economic conditions, and access to infrastructure may also affect behavior.

Directions for Future Research

- Test the model in other Iranian cities, rural areas, and other countries.
- Use longitudinal designs to examine behavioral change and causal ordering over time.
- Examine institutional trust, social media, perceived policy effectiveness, social pressure, and economic constraints.
- Use mixed quantitative and qualitative methods to investigate the mechanisms through which values and ethics become behavior.
- Include objective or behavioral measures alongside self-reported environmental action.

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Authors' Contributions

Authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

AI use statement

Artificial intelligence tools were used only to support language editing, translation refinement, formatting, and consistency checks. The authors take full responsibility for the accuracy of the data, analyses, interpretations, citations, and final content of the manuscript.

Ethical Considerations

This study was conducted using interview and questionnaire data. Participation was voluntary, and the confidentiality of participants' responses was preserved. The research procedure was designed to avoid harm to participants and to respect the principles of informed participation and academic integrity.

Transparency of Data

Reasonable requests for research materials should be directed to the corresponding author, subject to university policies and participant confidentiality.

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