

Article

The Relationship Between University Students' Ecological Citizenship and Ecological Literacy: Examining the Mediating Role of Eco-Anxiety

Danyal Tekdal ^{1,*}, Erol Koçoğlu ¹, Cihat Yaşaroğlu ¹, Kübra Melis Avcu ¹ , Özcan Ekici ², Yunus Emre Avcı ³ , Yunus Yumak ⁴ and Rümeysa Zeynep Demir ⁵ 

¹ Department of Turkish and Social Sciences Education, Faculty of Education, Inonu University, 44000 Malatya, Turkey; erol.kocoglu@inonu.edu.tr (E.K.); cihat.yasaroglu@inonu.edu.tr (C.Y.); ayasmelis5858@gmail.com (K.M.A.)

² Department of Turkish and Social Sciences Education, Ziya Gökalp Faculty of Education, Dicle University, 21300 Diyarbakir, Turkey; ekiciozcan44@gmail.com

³ Department of Educational Science, Faculty of Education, Siirt University, 56100 Siirt, Turkey; yunusavci027@hotmail.com

⁴ Department of Mathematics and Science Education, Faculty of Education, Selcuk University, 42130 Konya, Turkey; yunusyumak@selcuk.edu.tr

⁵ Department of Turkish and Social Sciences Education, Faculty of Education, Van Yuzuncu Yil University, 65090 Van, Turkey; demirrumeysazeynep@gmail.com

* Correspondence: danyal.tekdal@inonu.edu.tr

Abstract

This study examined the relationships among ecological citizenship, ecological literacy, and eco-anxiety among university students and tested a theory-informed, non-causal statistical model in which ecological citizenship was specified as the predictor, eco-anxiety as the intervening variable, and ecological literacy as the outcome. A cross-sectional correlational design was used. Data were collected from 218 undergraduate students at one public university in Türkiye through convenience sampling. Participants completed a demographic information form, the Eco-Anxiety Scale, the Ecological Literacy Scale, and the Ecological Citizenship Scale. Analyses included descriptive statistics, reliability analysis, independent-samples *t*-tests, one-way analysis of variance, Pearson correlations, and a regression-based indirect-effect analysis using 5000 bootstrap resamples and 95% confidence intervals. The total scores did not differ significantly by age. Ecological literacy was higher among female students, ecological citizenship differed by year of study, and all three constructs differed across departments. Eco-anxiety was positively correlated with ecological literacy ($r = 0.304$) and ecological citizenship ($r = 0.344$), while ecological citizenship was strongly correlated with ecological literacy ($r = 0.675$). In the specified model, the direct association between ecological citizenship and ecological literacy remained significant after eco-anxiety was included ($B = 0.750$, 95% CI [0.628, 0.871], $p < 0.001$). The bootstrapped indirect association through eco-anxiety was not significant ($B = 0.032$, 95% CI [−0.009, 0.092]). Thus, eco-anxiety was associated with both focal constructs but did not statistically account for their relationship. Because the data were cross-sectional, the ordering should be interpreted as a theory-informed statistical specification rather than evidence of temporal or causal mediation.



Academic Editor: Tai-Yi Yu

Received: 22 June 2026

Revised: 26 July 2026

Accepted: 27 July 2026

Published: 5 August 2026

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Keywords: sustainability; eco-anxiety; ecological literacy; ecological citizenship; university student

1. Introduction

Growing ecological crises have made environmental responsibility one of the priority issues in education. Greta Thunberg's 2019 call for urgent action exemplifies the growing public concern about ecological crises [1]. Although contemporary sustainability policies have renewed interest in environmental responsibility, this responsibility is also informed by cultural, ethical, and philosophical understandings of the human–nature relationship [2–4]. Since the 1972 Stockholm Conference and the subsequent UNESCO and UNEP initiatives, environmental education has increasingly incorporated sustainability-related knowledge, skills, values, and responsibilities [5].

Ecological literacy concerns understanding the relationships among people, cultures, and natural systems and using that understanding to support sustainable ways of living [6]. Ecological citizenship emphasizes responsibility, participation, sustainability, and attention to environmental rights and justice [7,8]. The two constructs are therefore closely connected but not identical: literacy includes knowledge, affective orientations, and behavioural dispositions, whereas citizenship foregrounds responsibility and civic participation. Their relationship may also be reciprocal. Ecological understanding may support responsible action, while participation in ecological action may create opportunities for further learning.

Eco-anxiety may be important in this relationship because ecological engagement may increase individuals' exposure to information about ecological threats and prompt deeper reflection on their personal and collective responsibilities. When such anxiety remains at a manageable level, it may direct attention toward environmental problems and promote information-seeking behaviour and learning. However, when it becomes intense or functionally impairing, it may adversely affect well-being and constructive environmental action. Accordingly, the present study evaluates a theoretically plausible statistical ordering that does not imply causality: ecological citizenship → eco-anxiety → ecological literacy. This model does not suggest that the proposed ordering is the only possible or causally correct one. More specifically, the model examines whether eco-anxiety statistically accounts for part of the association between ecological citizenship and ecological literacy after ecological citizenship is entered into the analysis as the predictor variable. Alternative models in which ecological literacy precedes ecological citizenship, as well as reciprocal relationships among these constructs, are also theoretically plausible and should be examined through longitudinal research.

2. Theoretical Framework

2.1. *Eco-Anxiety*

Anxiety is a response to perceived threat and can involve cognitive, emotional, physiological, and behavioral processes. Although excessive anxiety can impair functioning, anxiety can also heighten vigilance, motivate appraisal, and support preparation when it remains proportionate to the threat [9–12]. Eco-anxiety refers specifically to anxiety arising from current or anticipated ecological degradation, including climate change, pollution, deforestation, biodiversity loss, and resource depletion [13–19].

Eco-anxiety should not automatically be treated as a psychiatric diagnosis or an exclusively maladaptive outcome. Clayton [20] distinguishes adaptive concern, which may increase attention and preparation, from anxiety that disrupts well-being or daily functioning. Clayton and Karaszia [21] similarly differentiate cognitive-emotional and functional impairment from behavioural engagement. Hogg et al. [22] conceptualize eco-anxiety as a multidimensional response comprising affective symptoms, rumination, behavioral symptoms, and anxiety about one's negative impact on the planet. These dimensions exhibit characteristics that distinguish them from general stress, anxiety and

depression. In this respect, the intensity, context and functionality of eco-anxiety have the potential to either motivate or inhibit individuals.

Individuals who experience ecological anxiety to an extreme degree are constantly plagued by worry, fear of the future, guilt, helplessness and sleep problems. They also tend to conjure up doomsday scenarios that constantly occupy their minds [23,24]. The approach to environmental education, however, must be consistent and balanced. It is emphasised that it should not exaggerate fear-mongering scenarios, but rather adopt approaches that are emotionally sensitive, hope-focused and constructive [18,25,26].

2.2. Ecological Literacy

Literacy extends beyond basic reading and writing skills; it also encompasses the capacity to construct meaning, evaluate information, apply knowledge across different contexts, and engage in higher-order thinking processes [27–30]. Ecological literacy, in turn, is grounded in individuals' understanding of how natural systems function, how these systems support life, and the reciprocal relationships between human society and the natural environment [31,32]. In this respect, ecological literacy goes beyond possessing fragmented or superficial knowledge of environmental issues; it requires an understanding of the interconnections among ecological processes and the ability to use this knowledge when evaluating decisions related to sustainable living.

The development of ecological literacy may help individuals recognize environmental problems, assess their causes and consequences, and make sense of the effects of human activities on natural systems. It has been suggested that ecological literacy can be fostered through education from an early age and that digital learning environments can be used to promote environmental awareness [6]. In this context, an ecologically literate individual is expected not merely to know ecological concepts but also to interpret the connections between natural systems and human activities and to reflect this understanding in decisions concerning sustainable living [31,32].

Levels of ecological literacy may vary depending on the social and educational contexts in which individuals live. Pitman et al. [29] found that knowledge and understanding of ecological systems were associated with various sociodemographic characteristics, including age, gender, education, and upbringing [32]. Similarly, Ha and Dong [33] demonstrated that ecological literacy is not distributed uniformly across different sociodemographic groups and that contextual characteristics should be taken into account. These findings suggest that ecological literacy cannot be explained solely by an individual's body of knowledge; rather, it should be evaluated in conjunction with educational and social conditions.

2.3. Ecological Citizenship

Citizenship traditionally refers to the legal and political relationship between the individual and the state, as well as the rights, duties, and responsibilities arising from this relationship [34]. Ecological citizenship expands the traditional understanding of citizenship by recognizing that environmental problems transcend national and political boundaries. Because the effects of global environmental problems are not confined to a particular country or community, ecological citizenship encompasses individuals' responsibilities not only toward their own societies but also toward other societies, future generations, and the natural environment [35]. In this respect, ecological citizenship is closely associated with debates concerning globalization, cosmopolitan responsibility, and environmental sustainability.

Ecological citizenship encompasses individuals' public and collective responsibilities in addition to personal practices aimed at reducing their environmental impacts. While

the conscious use of resources, limitation of consumption, and reduction in environmental impacts are practices within the private sphere, participation in environmental decision-making, support for sustainable policies, and concern for environmental justice constitute the public dimension of this concept [7,35,36]. The findings of Wolf et al. indicate that, in the context of climate change, ecological citizenship manifests itself through perceptions of personal responsibility, actions undertaken as voters and consumers, and considerations of fairness in resource use [7]. Therefore, ecological citizenship consists not only of individual environmentally friendly behaviours but also of an awareness of the social and ethical consequences of such behaviours.

Ecological citizenship encompasses interconnected dimensions such as participation, sustainability, responsibility, rights, and justice [8,36]. Nevertheless, engaging in environmentally beneficial behaviour may not always indicate the adoption of a broader understanding of ecological citizenship. Martinsson and Lundqvist draw attention to the fact that behaviours that reduce environmental impacts do not necessarily coexist with more comprehensive environmental attitudes and values [37]. This distinction indicates that ecological citizenship should be evaluated not merely in terms of the frequency of particular environmentally friendly behaviours but also in conjunction with the underlying understanding of responsibility, justice, and civic participation.

Ecological citizenship and ecological literacy are related insofar as both are oriented toward environmental responsibility. Knowledge of ecological systems and environmental problems may enable individuals to evaluate the consequences of their environmental choices and fulfil their responsibilities more consciously. Conversely, participation in environmental initiatives and decision-making processes may help individuals acquire new knowledge and develop a more comprehensive understanding of ecological problems. Nevertheless, the two constructs should not be used interchangeably. Whereas ecological literacy emphasizes the capacity to understand ecological systems and evaluate environmental information, ecological citizenship focuses on translating this understanding into the social sphere through responsibility, participation, sustainability, and environmental justice [7,8,31].

2.4. Rationale for the Specified Indirect-Effect Model

The specified ordering begins with ecological citizenship because participation, responsibility, and sustainable practice can increase individuals' contact with environmental information, consequences, and moral self-appraisal. People who monitor their ecological footprint, participate in environmental initiatives, or attend to environmental rights may become more aware of the scale and urgency of ecological threats. This increased salience can plausibly intensify affective symptoms, rumination, and concern about personal impact the dimensions identified by Hogg et al. [22]. In this sense, eco-anxiety can be considered a possible emotional response associated with ecological engagement rather than only an outcome of prior knowledge.

The second part of the proposed sequence is that eco-anxiety may focus attention on environmental threats and motivate efforts to understand them. Pihkala [18] and Clayton [20] both emphasize that environmentally grounded anxiety can have adaptive as well as maladaptive forms. When anxiety remains manageable, it may encourage information seeking, reflection, preparation, and learning; when it is overwhelming, it may instead produce avoidance or impaired functioning. This dual-process interpretation makes eco-anxiety theoretically plausible, but not inevitable, intervening variable between ecological citizenship and ecological literacy.

This rationale does not establish temporal precedence. The reverse ordering ecological literacy increasing both eco-anxiety and ecological citizenship is also credible, and

reciprocal relationships may unfold over time. In this regard, ecological literacy has been approached from the perspective of systems thinking. Because the present data are cross-sectional, the arrows in Figure 1 represent a prespecified regression ordering rather than causal pathways. The analysis therefore evaluates a conditional indirect association within one theory-informed model and does not adjudicate among competing temporal models (Figure 2).

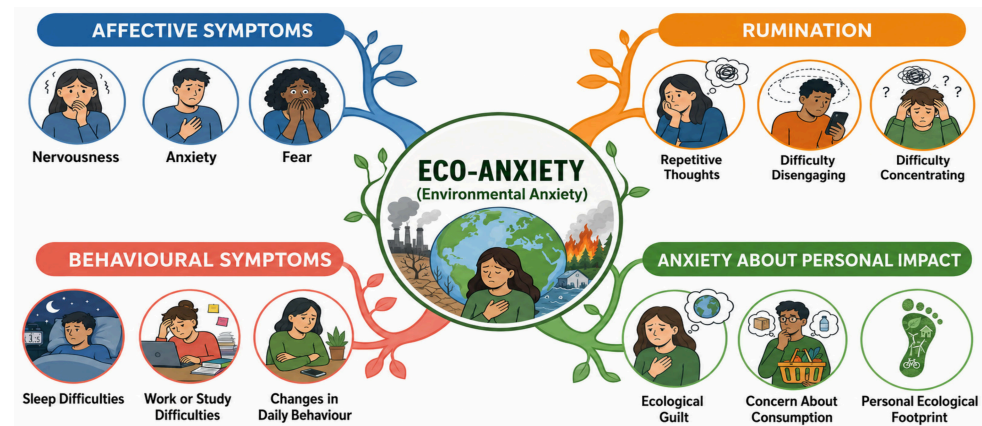


Figure 1. The conceptual framework of eco-anxiety generated by Gemini (Gemini 1.5 Flash).

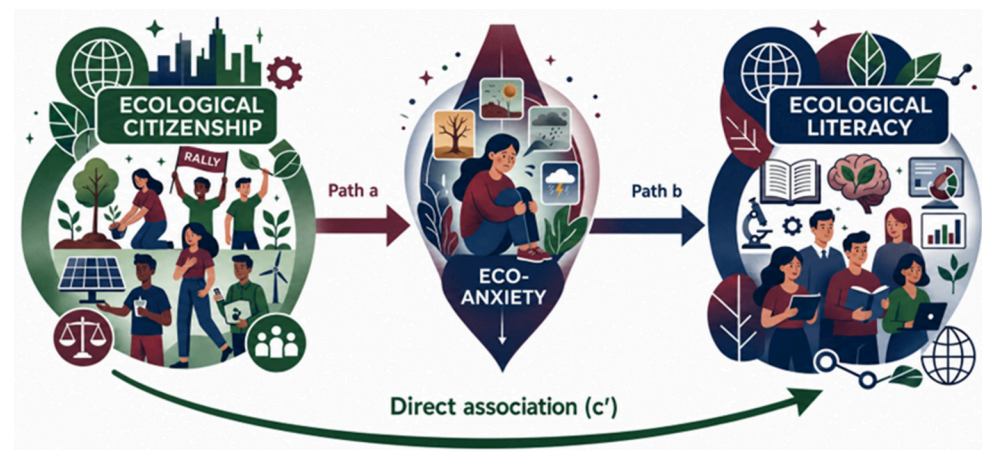


Figure 2. Conceptual indirect-effect model. The arrows indicate the statistical ordering tested and do not establish temporal or causal direction (generated by Gemini 1.5 Flash).

Accordingly, the study addressed the following hypotheses:

- H1: Ecological citizenship is positively associated with ecological literacy.
- H2: Ecological citizenship is positively associated with eco-anxiety.
- H3: Eco-anxiety is positively associated with ecological literacy.
- H4: In the specified statistical ordering, ecological citizenship has a positive indirect association with ecological literacy through eco-anxiety.
- H5: Ecological citizenship remains directly and positively associated with ecological literacy after eco-anxiety is included in the model.

3. Materials and Methods

3.1. Research Method

The study used a quantitative, cross-sectional correlational design to examine relationships among university students' ecological citizenship, eco-anxiety, and ecological literacy. Ecological citizenship was specified as the predictor (X), eco-anxiety as the intervening variable (M), and ecological literacy as the outcome (Y). These labels describe the regression

ordering only; they do not establish temporal precedence or causal effects. The term indirect effect is used in its statistical sense throughout the article.

In this study, ecological citizenship was specified as the predictor variable, eco-anxiety as the mediator, and ecological literacy as the outcome variable. These labels describe the statistical ordering of the model and do not establish temporal or causal priority. As the study employed a cross-sectional design, the findings were interpreted as predictive and correlational patterns rather than causal effects.

The mediation model tested in the study was structured as follows: ecological citizenship was included in the model as the predictor variable, ecological literacy as the outcome variable, and eco-anxiety as the mediating variable. This model was preferred because the study aimed to determine whether students' ecological citizenship levels were associated with their ecological literacy levels directly or indirectly through eco-anxiety.

Participation in the study was on a voluntary basis. Participants were informed of the purpose of the study, that the data would be used solely for scientific purposes, that their personal information would be kept confidential, and that they could withdraw from the study at any time. The research process was conducted in accordance with ethical principles, and ethical committee approval was obtained via Decision No. 8/1 dated 8 May 2026 of the Inonu University Research Ethics Committee for Social and Human Sciences.

In this study, the Gemini image editing tool was used to prepare Figures 1 and 2. Gemini provided detailed prompts for the color and content of the visuals. The resulting visuals were then edited by the authors in Canva Pro. Inappropriate parts were removed using the magic eraser, and text was edited. In addition, the criticisms of the reviewers and editor were taken into account, and the figures were restructured accordingly.

3.2. Population, Sample, and Participants

The study was conducted at one public university in Türkiye. Undergraduate students in the participating departments were recruited through convenience sampling. A Google Forms link was circulated online to eligible students together with an invitation explaining the study purpose, voluntary participation, confidentiality, and the right to withdraw. Students who chose to participate opened the link, provided informed consent, and completed the measures. A total of 218 undergraduate students participated. The single-institution, non-probability sampling procedure limits the representativeness and generalisability of the findings.

When examined Table 1 by year group, 10 participants were first-year students (4.59 per cent), 61 were second-year students (27.98 per cent), 84 were third-year students (38.53 per cent) and 63 were fourth-year students (28.90 per cent). In terms of distribution by department, the highest number of participants came from the Primary School Teaching department ($n = 63$, 28.90 per cent). This is followed, in order, by Social Studies Education ($n = 33$, 15.14 per cent), Turkish Language Education ($n = 29$, 13.30 per cent), English Language Education ($n = 27$, 12.39 per cent), Primary School Mathematics Education ($n = 22$, 10.09 per cent), Islamic Studies ($n = 19$, 8.72 per cent), special needs education ($n = 15$, 6.88 per cent) and other programmes ($n = 10$, 4.59 per cent). This distribution demonstrates that the sample comprises students from various academic fields and enables the comparison of variables in terms of department, year group and gender.

Table 1. Demographic characteristics of the sample.

Variable	Category	(<i>n</i>)	(%)
Gender	Female	164	75.23
	Male	54	24.77

Table 1. *Cont.*

Variable	Category	(n)	(%)
Year of Study	1st Year	10	4.59
	2nd Year	61	27.98
	3rd Year	84	38.53
	4th Year	63	28.90
Department	Other	10	4.59
	Theology	19	8.72
	Primary Mathematics Education	22	10.09
	English Language Teaching	27	12.39
	Special Education	15	6.88
	Primary School Teaching	63	28.90
	Social Studies Education	33	15.14
	Turkish Language Teaching	29	13.30

3.3. Data Collection Tools and Procedure

Data were collected through Google Forms using a demographic information form and three standardized measures. The demographic form assessed age, gender, year of study, and department. In response to the study's focus and to avoid giving disproportionate analytical weight to overlapping subdimensions, the inferential analyses used only the total scores of the three scales. Higher total scores indicate higher levels of the corresponding construct.

3.3.1. Eco-Anxiety Scale

The Eco-Anxiety Scale was originally developed by Hogg et al. [22] and adapted into Turkish by Uzun et al. [38]. It contains 13 items rated on a four-category scale from 0 to 3 and assesses affective symptoms, rumination, behavioural symptoms, and anxiety about one's negative impact on the planet. Total scores range from 0 to 39, with higher scores indicating more frequent eco-anxiety experiences. In the present sample, the total scale demonstrated good internal consistency (Cronbach's $\alpha = 0.89$).

3.3.2. Ecological Literacy Scale

The Ecological Literacy Scale was developed by Koçoğlu et al. [39]. The 34-item measure includes cognitive (7 items), affective (13 items), and behavioural (14 items) components rated on a five-point Likert-type scale. Total scores can range from 34 to 170; higher scores indicate higher perceived ecological literacy. In the present sample, the total scale demonstrated excellent internal consistency (Cronbach's $\alpha = 0.95$).

3.3.3. Ecological Citizenship Scale

The Ecological Citizenship Scale was developed by Karatekin and Uysal [40]. It contains 24 items across four dimensions: participation (8 items), sustainability (7 items), responsibility (6 items), and rights and justice (3 items). Items are rated on a five-point Likert-type scale, producing total scores from 24 to 120; higher scores indicate higher ecological citizenship. In the present sample, the total scale demonstrated high internal consistency (Cronbach's $\alpha = 0.92$).

3.4. Data Analysis

Data were analysed using IBM SPSS Statistics 27.0. The data set was examined for missing values, outliers, distributional shape, and reliability before the primary analyses. Descriptive statistics and Cronbach's alpha coefficients were calculated for the total scale scores. Skewness and kurtosis values for all three totals were within -1 and $+1$.

Independent-samples *t*-tests and one-way analyses of variance were used for demographic comparisons, with post hoc pairwise comparisons following significant omnibus tests. Pearson correlation coefficients were calculated among the three total scores.

The prespecified indirect association was estimated within a regression-based framework using 5000 bootstrap resamples and a 95% confidence interval [41]. An indirect association was considered statistically significant when its bootstrap confidence interval did not include zero. Cross-sectional indirect-effect analysis cannot establish temporal mediation and can misrepresent processes that unfold longitudinally [42]; the results were therefore interpreted as conditional associations within the specified model.

A sample-size sensitivity assessment was also conducted using the simulation benchmarks reported by Fritz and MacKinnon [43]. Their results indicate that bootstrap tests may require approximately 462 participants when both component paths are small and approximately 391 when one path is medium and the other is small. In the present standardized model, the ecological citizenship–eco-anxiety path was $a = 0.344$, whereas the adjusted eco-anxiety–ecological literacy path was $b = 0.081$, yielding a standardized indirect association of approximately 0.028. Because the *b* path was even smaller than the conventional small-path benchmark, $n = 218$ should be regarded as having limited sensitivity for detecting a very small indirect association. Accordingly, the nonsignificant indirect result is not interpreted as proof that no indirect process exists.

Structural equation modelling (SEM) was considered. SEM could explicitly model measurement error and test the discriminant validity of ecological literacy and ecological citizenship. However, the present study was designed to estimate an observed-score indirect association rather than validate a latent measurement model, and an item-level model containing all 71 items would be comparatively parameter intensive for $n = 218$. More importantly, SEM would not by itself establish temporal ordering in cross-sectional data. Regression-based bootstrapping was therefore retained for the prespecified analysis, while latent-variable SEM and comparisons of alternative directional models are recommended for larger longitudinal samples.

Table 2 presents the descriptive statistics, distributional indices, and internal consistency coefficients for the total scale scores. The mean scores were 14.05 (SD = 6.45) for eco-anxiety, 103.80 (SD = 18.86) for ecological literacy, and 74.21 (SD = 16.28) for ecological citizenship. Skewness values ranged from 0.06 to 0.74, while kurtosis values ranged from 0.20 to 0.60. Based on these distributional indices, no marked departures from univariate normality were observed. Eco-anxiety scores showed a modest positive skew, whereas ecological literacy and ecological citizenship scores were more symmetrically distributed. Internal consistency was high across all three scales, with Cronbach's alpha coefficients of 0.89 for eco-anxiety, 0.95 for ecological literacy, and 0.92 for ecological citizenship.

Table 2. Descriptive statistics, distributional indices, and internal consistency for total scale scores.

Variable	M	Min.	Max.	SD	Skew	Kurt	α
Eco-Anxiety	14.05	0	39	6.45	0.74	0.30	0.89
Ecological Literacy	103.80	48	167	18.86	0.06	0.60	0.95
Ecological Citizenship	74.21	30	119	16.28	0.14	0.20	0.92

α = Cronbach's Alpha.

4. Findings

When we look at Table 3, total eco-anxiety scores did not differ significantly by age, gender, or year of study, but differed by department ($F = 4.257$, $p = 0.001$). Post hoc comparisons indicated higher eco-anxiety among Special Education students than among students in the Other and Primary School Teaching categories. Ecological literacy did not

differ by age or year of study. Female students reported higher ecological literacy than male students ($t = 2.453$, $p = 0.017$), and ecological literacy differed by department ($F = 4.518$, $p = 0.001$). Ecological citizenship did not differ by age or gender but differed by year of study ($F = 5.481$, $p = 0.001$) and department ($F = 4.348$, $p = 0.001$). Third-year students scored lower than first- and fourth-year students. Special Education students scored higher than students in the Other and Primary School Teaching categories.

Table 3. Comparisons of total scale scores across demographic groups.

Variable	Category	Eco-Anxiety M	SD/ <i>p</i>	Ecological Literacy M	SD/ <i>p</i>	Ecological Citizenship M	SD/ <i>p</i>
Age	18–19 (1)	15.71	9.74	104.96	21.26	73.04	16.72
	20–21 (2)	13.78	5.52	100.27	18.52	70.94	15.80
	22–23 (3)	13.17	5.30	107.50	18.17	76.44	16.36
	24+ (4)	15.23	7.57	103.77	18.62	77.77	16.07
	<i>F/p</i>	1.471	0.223	1.952	0.122	2.271	0.081
Gender	Female	14.16	6.36	105.83	17.08	74.85	16.12
	Male	13.72	6.77	97.63	22.52	72.26	16.75
	<i>t/p</i>	0.430	0.667	2.453	0.017	1.016	0.311
Year	First (1)	14.80	5.49	105.30	17.00	84.50	13.79
	Second (2)	14.25	6.85	100.36	19.62	72.36	15.27
	Third (3)	13.05	5.90	103.44	16.38	70.48	14.69
	Fourth (4)	15.08	6.83	107.37	21.11	79.35	17.87
	<i>F/p</i>	1.279	0.282	1.468	0.224	5.481	0.001
	Post hoc	—	—	—	—	3 < 1; 3 < 4	
Department	Other (1)	14.20	6.00	96.60	20.27	76.00	10.01
	Theology (2)	13.05	3.03	101.37	16.00	71.95	14.68
	Primary Mathematics (3)	14.32	4.98	106.82	13.97	77.55	11.63
	English Language (4)	14.15	8.07	100.81	22.07	72.89	16.38
	Special Education (5)	18.33	9.46	114.87	13.37	79.33	12.22
	Primary School (6)	12.24	5.25	100.11	16.90	67.65	15.98
	Social Studies (7)	15.09	6.29	107.79	20.15	79.58	18.68
	Turkish Language (8)	14.90	7.42	106.10	22.71	79.28	17.52
	<i>F/p</i>	4.257	0.001	4.518	0.001	4.348	0.001
	Post hoc	5 > 1; 5 > 6		5 > 1; 5 > 6		5 > 1; 5 > 6	

Note. For rows labelled *F/p* or *t/p*, the first cell within each outcome pair reports the test statistic and the second reports *p*. $p < 0.05$ indicates statistical significance.

When we look at Table 4 eco-anxiety was positively associated with ecological literacy ($r = 0.304$, $p < 0.01$) and ecological citizenship ($r = 0.344$, $p < 0.01$). These coefficients indicate moderate positive associations, suggesting that students with higher eco-anxiety scores also tended to report higher levels of ecological literacy and ecological citizenship. Eco-anxiety shared approximately 9.2% of its variance with ecological literacy and 11.8% with ecological citizenship. A comparatively stronger positive association was found between ecological citizenship and ecological literacy ($r = 0.675$, $p < 0.01$), corresponding to approximately 45.6% shared variance. All three correlations remained statistically significant under the Bonferroni-adjusted alpha level of 0.0167. These findings indicate that students with higher ecological citizenship tended to report higher ecological literacy and eco-anxiety, while those with higher eco-anxiety also tended to report higher ecological literacy.

Table 4. Pearson correlations among total scale scores.

Variable	1	2	3
1. Eco-anxiety	1		
2. Ecological literacy	0.304 **	1	
3. Ecological citizenship	0.344 **	0.675 **	1

Note. ** $p < 0.01$ (two-tailed). A Bonferroni-adjusted alpha of 0.0167 was applied to the three prespecified correlations. Only total scale scores are reported.

When we look at Table 5 the indirect association between ecological citizenship and ecological literacy through eco-anxiety was positive but not statistically significant because the bootstrap confidence interval included zero ($B = 0.032$, 95% CI $[-0.009, 0.092]$). Therefore, H4 was not supported. In contrast, ecological citizenship remained directly and positively associated with ecological literacy after eco-anxiety was included in the model ($B = 0.750$, 95% CI $[0.628, 0.871]$, $p < 0.001$), supporting H5. Thus, although H1–H3 were supported at the bivariate level, the results did not indicate that eco-anxiety statistically carried the association between ecological citizenship and ecological literacy.

Table 5. Direct, indirect, and total associations in the specified model.

Association	Label	B	SE	Lower 95% CI	Upper 95% CI	<i>p</i>
Indirect	$a \times b$	0.032	0.026	−0.009	0.092	—
Direct	c'	0.750	0.062	0.628	0.871	<0.001
Total	c	0.782	—	—	—	<0.001

Note. B = unstandardized regression coefficient; $a \times b$ = indirect association through eco-anxiety; c' = direct association between ecological citizenship and ecological literacy after eco-anxiety is included; c = total association.

When we look Figure 3 The direct association between ecological citizenship and ecological literacy remained positive and statistically significant after eco-anxiety was included ($B = 0.750$, 95% CI $[0.628, 0.871]$, $p < 0.001$), supporting H5. The indirect association through eco-anxiety was not significant because its bootstrap confidence interval included zero ($B = 0.032$, 95% CI $[-0.009, 0.092]$); H4 was therefore not supported. In this sample and model, the citizenship–literacy association was primarily direct rather than statistically carried through eco-anxiety.

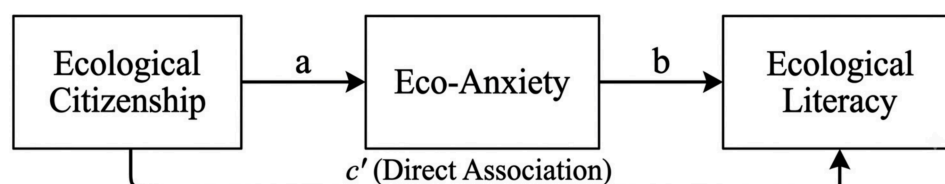


Figure 3. Estimated associations in the prespecified model. The direct association was significant; the indirect association through eco-anxiety was not.

5. Discussion

This study examined the relationships among university students' levels of ecological citizenship, ecological literacy, and eco-anxiety. It also tested the indirect role of eco-anxiety in the relationship between ecological citizenship and ecological literacy. The most prominent finding was the strong and positive relationship between ecological citizenship and ecological literacy. Eco-anxiety was also positively associated with both ecological citizenship and ecological literacy, although these relationships were weaker. In contrast, the indirect effect through eco-anxiety was not statistically significant. Therefore, the present findings do not support the assumption that eco-anxiety is a primary mediating mechanism explaining the relationship between ecological citizenship and ecological literacy.

No significant differences were found in the total scores of the three scales according to age. This result is consistent with the finding of Zehiroğlu and Dineri [44] that university students' levels of environmental awareness did not differ by age. The relatively narrow age range of university students and their similar educational and social experiences may have limited the emergence of age-related differences. Regarding gender, a significant difference was found only in ecological literacy scores, with female students obtaining higher scores. However, because 75.23% of the sample consisted of female students, this finding should not be interpreted as evidence of a general difference between female and male university

students. The absence of gender differences in eco-anxiety and ecological citizenship scores suggests that environmental concern and responsibility-based environmental participation cannot be explained solely by gender.

Department was associated with significant differences in all three variables, whereas year of study was associated only with ecological citizenship. The finding that students in the Special Education Department obtained higher scores than some of the comparison groups is noteworthy. The fact that special education teachers work with individuals with special needs may have fostered a more sensitive and tolerant nature in them and increased their engagement with social responsibility; the diverse demographic backgrounds associated with different programs may also have played a role. These factors can be considered when evaluating the potential outcomes. Although research in environmental education suggests that educational experiences may contribute to the development of environmental knowledge, attitudes, intentions, and behaviours, the extent of this contribution varies according to programme content and implementation context [45]. However, the present study did not assess whether students had taken environment-related courses, their curricular experiences, their connectedness to nature, their previous environmental activities, or their voluntary participation experiences. Therefore, it is not possible to claim that the higher scores of Special Education students directly resulted from the characteristics of their department. Rather than demonstrating a definite advantage specific to Special Education, this finding points to a difference that warrants further investigation.

The strong positive relationship between ecological citizenship and ecological literacy ($r = 0.675$, $p < 0.01$) indicates that these two constructs theoretically complement one another. Ecological literacy encompasses the knowledge and skills required to understand environmental systems, evaluate the causes and consequences of environmental problems, and develop sustainable solutions. Ecological citizenship refers to participating in social life with a sense of responsibility, involvement, and sustainability based on knowledge and awareness. In this regard, the concept of environmental knowledge supports awareness and the skills to be a responsible citizen, while participation in environmental activities helps gain new knowledge and turns that knowledge into action, leading to a better understanding of ecological systems. Thus, the relationship between these two constructs may reflect a reciprocal process of learning and participation rather than a unidirectional relationship.

The correlation between ecological citizenship and ecological literacy corresponds to approximately 45.6% shared variance. Although this proportion indicates that the constructs are closely related, it does not mean that they measure the same construct. Ecological citizenship encompasses participation, responsibility, sustainability, and environmental justice, whereas ecological literacy includes knowledge, affective orientations, and environmental behaviour. Nevertheless, the inclusion of items concerning environmentally responsible behaviours in both measurement instruments and the collection of data using self-report scales administered at the same time suggest that the observed relationship may have been influenced to some extent by common method variance or overlap in measurement content. Future confirmatory factor analyses and latent variable modelling could contribute to a more detailed assessment of the discriminant validity of these two constructs.

The positive relationships of eco-anxiety with ecological citizenship ($r = 0.344$) and ecological literacy ($r = 0.304$) suggest that concern about environmental problems may coexist with environmental awareness and participation. This finding is consistent with approaches arguing that eco-anxiety should not be regarded solely as a dysfunctional or adverse psychological outcome [18,20–22]. A manageable level of concern about environmental threats may encourage individuals to pay attention to environmental problems, seek information, and engage in solution-oriented behaviours. In contrast, intense and

debilitating eco-anxiety may lead to helplessness, avoidance, and impairment in daily functioning. Therefore, the relationship of eco-anxiety with environmental knowledge and behaviour may vary depending on the intensity of anxiety and individuals' self-efficacy, hope, and coping resources.

Although eco-anxiety was associated with both principal variables, the nonsignificant indirect effect ($B = 0.032$, 95% CI $[-0.009, 0.092]$) indicates that the relationship between ecological citizenship and ecological literacy was not explained through eco-anxiety. The relationship between ecological citizenship and ecological literacy remained strong and significant after eco-anxiety was included in the model ($B = 0.750$, 95% CI $[0.628, 0.871]$, $p < 0.001$). This result suggests that the connection between ecological citizenship and ecological literacy may be established through environmental responsibility, the application of environmental knowledge, participatory experiences, and sustainable behaviours rather than through emotional concern. Eco-anxiety may therefore be a parallel emotional variable accompanying environmental awareness and participation rather than the explanatory mechanism underlying their relationship.

Nevertheless, the nonsignificant indirect effect does not mean that eco-anxiety has no role in environmental learning and behavioural processes. Its role may be nonlinear or may vary according to factors such as self-efficacy, hope, coping skills, and connectedness to nature. Future studies could therefore investigate the moderating role of eco-anxiety as a separate hypothesis. For example, researchers could test whether the relationship between ecological citizenship and ecological literacy differs at low, moderate, and high levels of eco-anxiety. However, such a moderation model is conceptually distinct from the mediation model tested in the present study and cannot be evaluated solely on the basis of bivariate correlations.

The ecological citizenship, eco-anxiety, ecological literacy, sequence tested in this study should not be interpreted as a causal or temporal process. Because the data were collected at a single point in time, it was not possible to determine which variable preceded the others. An alternative model in which ecological literacy increases awareness of environmental threats and thereby contributes to both eco-anxiety and ecological citizenship is also theoretically plausible. Similarly, ecological knowledge and environmental participation may mutually reinforce one another over time.

6. Conclusions, Limitations, and Future Recommendations

This study revealed a strong and positive relationship between university students' ecological citizenship and ecological literacy. Eco-anxiety was also positively associated with both variables, although these relationships were weaker. However, the indirect relationship through eco-anxiety was not statistically significant, whereas the direct relationship between ecological citizenship and ecological literacy remained strong after eco-anxiety was included in the model. Thus, eco-anxiety did not statistically explain the relationship between ecological citizenship and ecological literacy in the present sample. Instead, it may be regarded as an emotional response accompanying environmental awareness and engagement. The findings further indicate that ecological literacy and ecological citizenship are closely related yet distinct constructs. Ecological understanding may support responsible participation, while engagement in environmental activities may also create new learning opportunities.

The study has several limitations. Its cross-sectional design does not allow temporal ordering or causal direction to be established among the variables. Therefore, the proposed sequence of ecological citizenship, eco-anxiety, and ecological literacy should be interpreted as a theoretically specified statistical model rather than a causal process. The recruitment of participants from a single public university through convenience sampling

limits the generalizability of the findings. Measuring all variables at the same time using self-report instruments may have introduced social desirability and common method bias. Accordingly, ecological literacy should be interpreted as students' self-reported ecological literacy rather than an objectively demonstrated competence. Furthermore, the inclusion of similar environment-related behavioural content in the ecological literacy and ecological citizenship scales may have contributed to the strong relationship between these two constructs. The sample size also provided limited sensitivity for detecting a very small indirect relationship. Therefore, the non-significant indirect relationship should not be interpreted as conclusive evidence that such a process does not exist in the broader population. In addition, the use of total scale scores may have obscured differences between the adaptive and functionally impairing dimensions of eco-anxiety.

Future research should employ larger and more diverse samples drawn from different universities and academic departments. Longitudinal studies are needed to determine the temporal and reciprocal relationships among ecological citizenship, ecological literacy, and eco-anxiety. Latent-variable structural equation models could be used to examine measurement error, discriminant validity, and alternative directional models. Future studies could also investigate the nonlinear or moderating effects of eco-anxiety, as well as the roles of hope, environmental self-efficacy, coping skills, collective efficacy, connectedness to nature, and experiences with environment-related courses. Supplementing self-report scales with objective knowledge tests, behavioural indicators, and qualitative interviews may provide a more comprehensive understanding of these relationships. In practice, environmental education at universities may benefit from integrating ecological knowledge with participatory experiences, sustainability-oriented actions, realistic hope, and emotional coping support.

Author Contributions: Conceptualization, D.T.; methodology, E.K.; validation, K.M.A. and C.Y.; formal analysis, Ö.E.; investigation, Y.E.A.; data curation Y.Y.; writing—original draft preparation, R.Z.D.; writing—review and editing, R.Z.D. and K.M.A.; supervision, E.K. and D.T. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: All of the rules in the 'Directive on Scientific Research and Publication Ethics of Higher Education Institutions of Turkey' and the 'Declaration of Helsinki' were complied with. This study was approved by the Inonu University Human and Social Sciences Research Ethics Committee with the document date 8 May 2026 and number 8/1.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Acknowledgments: The AI tool called 'Gemini' was used to create the figures included in this study. This has been approved by all authors. While preparing this paper, the authors used the generative AI tool Google Gemini 1.5 Flash as an initial design assistant for the layout and color scheme of Figures 1 and 2. After generating the visuals with the correct prompts, the authors made adjustments using Canva (Canva Pro) to ensure the visuals were suitable for the style of the study.

Conflicts of Interest: The authors declare no conflict of interest.

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