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Environmental citizenship among Spanish pre-service teachers: sustainability awareness and online civic engagement at the University of Granada

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Background: Spain's green transition places education at the center of sustainability, but evidence on digitally mediated environmental citizenship among Spanish pre-service teachers remains limited.
Methods: An exploratory cross-sectional study was conducted with 275 pre-service teachers from the Faculty of Education Sciences at the University of Granada using a self-administered questionnaire assessing environmental motivation, environmental citizenship, and online civic engagement.
Results: Participants showed moderate to high environmental motivation, but low past participation in environmental activities, especially collective and digitally mediated actions. Future intentions were moderate, suggesting willingness to engage more actively under supportive conditions.
Discussion: The findings underline the need for stronger institutional support and curricular integration of sustainability and digital environmental citizenship in teacher education.

KEYWORDS
climate change, education for sustainability, environmental citizenship, higher education, sustainability

1 Introduction and background

Environmental education is increasingly understood not only as a matter of awareness, but also as preparation for civic participation in sustainability transitions. The environmental crisis and climate change have become critical challenges that require a global response. Human activities, such as deforestation, burning fossil fuels, and pollution, have significantly increased greenhouse gas emissions, leading to accelerated global warming and adverse climate changes (IPCC, 2018), (Intergovernmental Panel on Climate Change). This situation has increased interest in environmental issues at the international level, with diversity of views reinforcing the idea that importance should be given to education as a preparatory process to empower individuals and promote a generation of citizens competent to deal with environmental problems (Biesta, 2020).

In the Spanish context, this challenge has gained particular relevance due to recent educational and policy efforts to integrate sustainability into formal education. In recent

years, Spain has embarked on an ambitious green-transition strategy that is modernising its economy, generating sustainable employment, boosting competitiveness, and reducing energy dependence on external sources (European Environment Agency, 2025). Central to this transformation is a strong emphasis on education: the country has integrated sustainability and environmental awareness into its formal educational framework through its most recent educational reform (LOMLOE) (Ley Orgánica por la que se modifica la Ley Orgánica de Educación (2/2006), which for the first time embeds "Education for Sustainable Development" (ESD) and global citizenship education as structural components of the national curriculum across primary, secondary, and vocational education (Correa-González et al., 2023). According to recent empirical research, education plays a decisive role in moderating the environmental impacts of economic development: in a cross-national study of OECD countries (Organisation for Economic Co-operation and Development) (1998–2020), higher levels of education attenuated the link between industrialization, urbanization, foreign investment and increased carbon emissions suggesting that education contributes to decoupling development from environmental degradation (Sahu et al., 2024). Therefore, education, as a way of empowering young people to advocate for a new sustainable model, should foster active citizenship that promotes sustainable living among citizens (Pinheiro et al., 2024). Higher education institutions are key for the implementation of sustainability principles (Žalėnienė and Pereira, 2021). They are not only centers of research and innovation but also have the responsibility of shaping future leaders and professionals who will be capable of implementing sustainable solutions in various sectors of society (Žalėnienė and Pereira, 2021).

Moreover, within the Spanish context, schools and universities are gradually embedding sustainability not only in curricula but also in everyday practices such as energy-efficient buildings, resource-saving measures, promotion of circular economy principles, and fostering sustainable consumption habits among students (Bautista-Puig and Sanz-Casado, 2021). In higher-education institutions, sustainability practices have been progressively adopted, though significant challenges remain (Bautista-Puig and Sanz-Casado, 2021). Specifically, the analysis of perceptions and behaviors related to the ecological citizenship of future education professionals has been the subject of study in environmental research. Previous studies analyzed the degree of ecological citizenship among trainee teachers (Karatekin and Uysal, 2018; Uysal and Karatekin, 2022). In these works, it is evident that the level of environmental commitment of future education professionals is not sufficient to successfully educate their students as ecological citizens. Therefore, knowledge of the environmental positioning of trainee teachers is key to the development of their own environmental awareness and its further projection to students once they have started their professional career.

Despite these advances, important gaps remain. A recent study surveying Spanish teachers found that, although many express strong intrinsic and "transcendent" motivations (e.g., commitment to the common good) to support ESD, they also report barriers including insufficient training, lack of institutional support and resources, and a need for greater systemic integration of sustainability across educational institutions (Vergara-Arteaga et al., 2025).

Thus, while Spain appears well-positioned thanks to its renewable-resources potential, industrial and human capacity, and its evolving educational framework to lead the ecological transition, there remains a crucial challenge: to ensure that education is supported by sufficiently motivated, trained and institutionally empowered educators, and that sustainability becomes embedded not only in curricula but in the broader cultural and structural practices across all sectors of society. Only then can the green transition benefit from a socially-shared sense of responsibility, rather than rely on individual efforts in isolation.

1.1 Sustainability education in the post-COVID digital era in Spain

In the Spanish higher education context, digital technologies have become deeply embedded in the everyday practices of pre-service teachers, shaping not only how they learn but also how they participate socially and civically. The widespread use of virtual learning environments, and educational applications means that digital tools now function as essential infrastructures for academic engagement rather than optional pedagogical add-ons (Hajj-Hassan et al., 2024; Mogren et al., 2019). Evidence from recent analyses of teachers' digital competence in Spain further reinforces this trend: pre-service teachers demonstrate substantial proficiency in accessing and managing information online, creating digital content, using cloud storage, navigating the internet, and engaging in synchronous and asynchronous communication. These digital practices strengthened during the COVID-19 period highlight a professional culture in which educators are not merely familiar with ICT, but actively use it to support instruction, communication, and resource management.

Pre-service teachers, situated within this increasingly digital ecosystem, rely daily on online platforms to access information, coordinate group work, and engage in university initiatives, often in ways that intersect directly with sustainability education (UNESCO, 2018). This pervasive digital engagement creates a favourable environment for the cultivation of environmental citizenship, as digital tools offer flexible, networked spaces through which ecological knowledge, values, and participation can be enhanced alongside more traditional curriculum-based approaches (Gooding and Phillips, 2025; Leal Filho et al., 2016). The intensified digitalisation of teaching and learning following the COVID-19 pandemic further accelerated this shift, reinforcing the need for pre-service teacher education programmes to integrate sustainability as both an academic imperative and a societal responsibility. Sustainability education today demands transformative pedagogies that promote critical thinking, collaboration, and meaningful participation, enabling students to bridge theory and practice and to translate their ecological awareness into concrete action (Cano-Ortiz et al., 2025; UNESCO, 2014). Within this context, digital tools function not only as technical supports, but as mediating environments that can strengthen pre-service teachers' readiness for environmental citizenship and empower them to enact sustainability principles in their future professional practice.

Despite the rapid digitalisation of teaching and learning environments during and after the COVID-19 pandemic, there is a notable absence of empirical studies in Spain examining

how environmental citizenship or sustainability education has evolved in this new digital landscape. The available pre-pandemic literature has extensively documented students' environmental awareness, attitudes and behavioural limitations (e.g., González-Gaudiano and Meira-Cartea, 2009; Mediavilla et al., 2020), yet no published research has analysed how the post-COVID shift toward digitally mediated learning environments may have reshaped pre-service teachers' engagement with environmental education. This gap is particularly salient given the potential of digital tools to foster ecological literacy, participatory engagement and sustainability awareness, as highlighted by recent systematic reviews on digital technologies in environmental education (Hajj-Hassan et al., 2024). The emergence of digital platforms, online communities, and interactive applications has opened new pathways for accessing environmental information, mobilising collective action, and integrating sustainability into daily academic routines. Consequently, investigating environmental citizenship among Spanish pre-service teachers in the post-COVID digital context is both timely and necessary, offering valuable insights into how digital environments may be transforming not only supporting students' readiness to act as environmental citizens within and beyond the university.

1.2 Environmental citizenship in higher education in Spain

Environmental citizenship encompasses pro-environmental actions in both private and public spheres, grounded in values of justice, responsibility and participation (D'Arco and Marino, 2022; Lee and Khan, 2020; Powers and Trauntvein, 2024). It includes practices such as responsible consumption, recycling, energy efficiency and involvement in environmental initiatives, reflecting a commitment to building a fair and sustainable society (Vega, 2016). While ESD provides the knowledge and skills needed to understand environmental issues, environmental citizenship emphasises the mobilisation of these competencies into democratic and participatory action. Informal and non-formal learning opportunities such as campus campaigns, volunteering and community initiatives further reinforce these dispositions (UNESCO, 2018).

Despite the prominence of sustainability discourse in higher education, empirical research specifically examining pre-service teachers remains limited (Karatekin, 2019; Koca and Çobanoğlu, 2024; Sarbaini, 2021; Ünal, 2019). Given their future influence on school-aged students, understanding their environmental readiness and citizenship is essential.

1.3 Environmental citizenship among pre-service Spanish students and research questions

In Spain, environmental citizenship among university students is characterised by high awareness but relatively weak behavioural engagement. Many university initiatives remain fragmented or symbolic (Valderrama-Hernández et al., 2020). This is described as environmental hyperopia, a tendency to perceive environmental threats as distant and abstract, limiting the translation of concern into action (Mediavilla et al., 2020). Overreliance on knowledge-based strategies without adequate attention to motivation, agency and values further constrains behaviour change (Pelletier et al., 1998).

Motivation is a key determinant of sustainable behaviour. Intrinsic motivation, aligned with personal values and identity, is more likely to support sustained engagement than extrinsic pressures (Deci and Ryan, 2002; Kaida and Kaida, 2015), underscoring the importance of understanding motivational structures in environmental citizenship. Hence, theoretical perspectives such as the Value-Belief-Norm (VBN) theory (Stern, 2000) and eco-citizenship frameworks (Hadjichambis and Paraskeva-Hadjichambi, 2020; Powers and Trauntvein, 2024) help explain how values, norms and perceived responsibilities shape environmental action. Students' perceptions of their ecological role interact with behaviours such as recycling, advocacy or participation in sustainability initiatives, reinforcing or weakening their ecological identity (Ariza et al., 2021; Benzehaf et al. 2025). In point of matter, previous research consistently shows that both intrinsic and extrinsic motivational drivers play an important role in promoting pro-environmental behaviour among university students. Studies demonstrate that intrinsic motivation is strengthened when individuals perceive clear links between their behaviours, environmental consequences, and personal responsibility norms (D'Arco and Marino, 2022). Recent research in teacher education suggests a recurrent pattern: pre-service teachers often express favorable attitudes toward sustainability, but these attitudes do not always translate into sustained civic or environmental action (Di Giusto et al., 2018; Wachholz et al., 2014). Other work highlights the importance of psychological factors such as environmental attitudes, self-efficacy, perceived costs and perceived rewards in shaping pro-environmental choices (Shafiei and Maleksaeidi, 2020). Recent evidence from Lebanon further reinforces these dynamics. Hajj-Hassan et al. (2024b) found that digital engagement, environmental attitudes and perceived behavioural control jointly predicted environmental citizenship competencies, suggesting that motivation and ecological identity are strengthened when learners participate in digitally mediated sustainability experiences. Together, these findings underscore that environmental citizenship emerges from a complex interplay between knowledge, attitudes, efficacy beliefs, and motivational processes elements that are especially relevant for understanding pre-service teachers' readiness to enact and model sustainability in educational settings.

While ESD traditionally focuses on developing learners' knowledge, values, and competences related to sustainability, environmental citizenship extends this perspective by emphasizing the translation of these dispositions into active, participatory, and justice-oriented behaviors in both private and public spheres (Hadjichambis and Paraskeva-Hadjichambi, 2020; Powers and Trauntvein, 2024). In this sense, environmental citizenship is conceptualized not as redundant with ESD but as its behavioral and civic enactment, highlighting learners' agency and responsibility in addressing socio-ecological challenges. Within this framework, motivational processes play a central mediating role. Drawing on Self-Determination Theory (Deci and Ryan, 2002), intrinsic and extrinsic environmental motivations are understood as key drivers that influence whether sustainability

knowledge and values developed through ESD are translated into environmental citizenship practices. Complementarily, the Value-Belief-Norm (VBN) perspective (Stern, 2000) helps explain how internalized ecological values and moral obligations shape pro-environmental intentions and actions. Together, SDT and VBN provide a multi-layered explanation of how cognitive, affective, and normative factors support (or hinder) the emergence of environmental citizenship.

Importantly, the post-COVID digital context introduces an additional layer to this framework. Digital platforms increasingly function as spaces where environmental citizenship is expressed through online civic engagement, including participation in campaigns, forums, petitions, and networked advocacy. Therefore, digitally mediated participation is treated in this study as a contemporary manifestation of environmental citizenship rather than a separate construct. The present research adopts an integrated conceptual framework that connects Education for Sustainable Development (ESD), environmental citizenship, motivational processes, and digitally mediated civic engagement. By integrating ESD foundations, motivational mechanisms, and digital civic opportunities, the proposed framework allows for a more comprehensive understanding of Spanish pre-service teachers' readiness to act as environmental citizens in both offline and online contexts.

Within this context, pre-service teachers represent a strategic group because their future professional role may shape how sustainability is enacted in schools. Despite the strategic role of teachers and the rapid post-COVID digital transformation, no studies have examined environmental citizenship among Spanish pre-service teachers within this new context. Given that prior correlational studies conducted in other countries provide valuable insights yet remain limited in their generalisability, it is essential to investigate whether similar motivational and behavioural patterns hold true in Spain. With growing national interest in advancing the Spanish sustainability agenda, examining these dynamics in the local context becomes critical for assessing whether pre-service teacher education programmes are effectively preparing future educators to meet the sustainability expectations embedded in contemporary schooling.

Against this background, the purpose of this study is to examine how Spanish pre-service teachers express environmental motivation, ecological dispositions, and environmental citizenship behaviors within a post-COVID and increasingly digital educational context. More specifically, the study seeks to clarify how these dimensions are distributed within the sample, how they relate to one another, and how they extend to online forms of environmental civic engagement. In doing so, the study aims to provide an updated empirical account of environmental citizenship among future teachers in Spain.

Accordingly, this study is guided by three research objectives. First, it examines the extent to which Spanish pre-service teachers express environmental motivation (intrinsic and extrinsic), ecological dispositions (knowledge, skills, values, and attitudes), and environmental citizenship behaviors (past and intended). Second, it analyzes the interrelations among these dimensions of environmental citizenship. Third, it explores the extent to which Spanish pre-service teachers report current and future online environmental civic engagement in relation to their environmental motivation, ecological dispositions, and selected background factors.

The expected contributions of this study are threefold:

(RQ1) Theoretical: it strengthens the conceptual articulation between Education for Sustainable Development, environmental citizenship, motivational processes, and digitally mediated civic engagement in teacher education.

(RQ2) Methodological: it provides an integrated empirical approach that combines motivation, ecological dispositions, past and intended behavior, and online civic engagement within one analytical design.

(RQ3) Practical: it offers evidence that may help teacher education programs design more action-oriented and digitally relevant strategies for preparing future teachers as environmental citizens.

2 Materials and methods

2.1 Participants

The entire population targeted in this study consists of students from all academic years within the Faculty of Education Sciences at the University of Granada. A convenience sampling strategy was used, based on participant accessibility and availability within the Faculty of Education Sciences at the University of Granada. Consequently, the sample should not be considered statistically representative of all Spanish pre-service teachers. The demographic characteristics of the participants are summarized in Table 1. The sample comprised 275 students from the Faculty of Education Sciences at the University of Granada. Among the respondents, 34 were male (12.4%), 240 were female (87.3%), and 1 identified as non-binary (0.4%). The majority of students were in their first (34.2%) or second (61.5%) academic year, with a smaller proportion in the third (2.5%) and fourth (1.5%) years, and a minimal number in the sixth year or beyond (0.4%). The age distribution was predominantly between 18 and 21 years old, with the largest group being 19 years old (33.5%). Due to the need to

TABLE 1 Sample characteristics ($N = 275$).

Variable	Modality	Percent (%)	Frequency
Gender	Male	12.4	34
	Female	87.3	240
	Non-binary	0.4	1
Academic year	1st	34.2	94
	2nd	61.5	169
	3rd	2.5	7
	4th	1.5	4
	6th and beyond	0.4	1
Age	18–19	132	48.9
	20–21	85	31
	22 and more	53	19.6

consolidate categories to ensure adequate sample weight equilibrium and significance, academic-year groups were merged. Specifically, 169 students in the second academic year, 7 in the third year, 4 in the fourth year, and 1 in the sixth year and above were combined into a single category, resulting in two final academic-year groups 94 student in the first academic year, and 181 in the 2nd and above). Similarly, age categories were merged into two categories with students below 19 years (132:48.9%) (corresponding to students in the first academic year) and students that are older than 20 years (138:50.%).

2.2 Instruments

2.2.1 Environmental citizenship

To measure environmental citizenship of Spanish higher students, we used the framework used by the Hadjichambis and Paraskeva-Hadjichambi (2020)'s scale (ECQ), which was developed as a comprehensive and holistic instrument need based on the European Network for Environmental Citizenship (ENEC) (2018) definition of environmental citizenship. More precisely, we used the reduced version of the ECQ (rECQ), which was validated in separate research (authors, in press) and adapted to the Spanish higher education context. rECQ consists of 32 items respecting the original ECQ's 9 factor structure, distributed in three second-order dimensions: past activities, competences, and intentions. From the VBN perspective (Stern, 2000), environmental citizenship is understood as a function of internalized values, ecological worldviews, and perceived moral obligations, all of which are reflected in the ECQ's focus on environmental attitudes, personal responsibility, and action intentions. Likewise, the inclusion of competences and intentions in the ECQ aligns with self-determination theory's (SDT) emphasis on autonomy, competence, and relatedness (Deci and Ryan, 2002) as drivers of sustained motivation for prosocial behaviors. The ECQ captures both intrinsically regulated pro-environmental tendencies (e.g., acting based on values and identity) and externalized dimensions (e.g., civic participation), offering a multidimensional profile of environmental citizenship coherent with both motivational and norm-based models of behavior. The questionnaire uses 4-point Likert scales, with the wording depending on each group of items. The survey was originally constructed in Greek, with the English version kindly available from Hadjichambis and Paraskeva-Hadjichambi (2020). By following the transcultural validation methodology proposed by Vallerand (1989), we translated the original English version to Spanish. A back translation was applied, and two bilingual researchers compared the back translated English version with the original English version survey. The modifications needed were adjusted.

2.2.2 Environmental motivation

Regarding the motivational scale, Pelletier et al. (1998) have developed the Motivation Toward the Environment Scale (MTES) based on the self-determination continuum. Being considered the most autonomously regulated motivation factors, regulation extrinsic factors and intrinsic motivation were retained from the MTES. The survey included 8 items with a 7-point Likert scale (e.g., Taking care of myself and the environment are inseparable; For fun, mastering new ways to help the environment; I love the feeling when I do something useful towards the environment; Taking care of the environment has an impact on how I live). The use of this scale is grounded in SDT (Deci and Ryan, 2002), which distinguishes between intrinsic and extrinsic types of motivation and their role in predicting sustained, self-regulated pro-environmental behavior. The MTES is particularly suited to capturing these nuances, as it was specifically designed to assess environmental actions along this motivational spectrum.

2.3 Procedure

The questionnaire was designed for online dissemination, allowing completion on any electronic device. To ensure high response rates and the reliability of responses, students completed the questionnaire during regular class sessions at the University of Granada, in the presence of their teachers. Data was collected during the 2023–2024 academic year.

2.4 Data analysis

In line with the theoretical approaches described above, which structure environmental citizenship into different cognitive and behavioural dimensions, the data analysis focuses on validating this structure through the procedures outlined in the following points.

To ensure the validity of the factor structure, the dataset was randomly split in half. An exploratory factor analysis (EFA) was conducted on the first subsample to identify the underlying factor structure, and a confirmatory factor analysis (CFA) was performed on the second subsample to test the fitness of the model. This split-sample approach helps prevent overfitting and enhances the generalizability of the factor solution (Worthington and Whittaker, 2006). Data was analyzed using SPSS Version 26.0 and AMOS 22. The EFA of the rECQ yielded a Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy of 0.864 and a Bartlett's test of sphericity with $Chi^2 = 5297.471$, $df = 496$, $p < 0.001$. It yielded a 9-factor structure that aligned with the theoretical framework of the rECQ, preserving its original organization of nine components grouped into three overarching dimensions: past actions, competences, and intentions (see Table 2). The CFA showed good fit indices (CFI = 0.918, NNFI = 0.920, RMSEA = 0.058) of the 9-factor structure, indicating satisfactory indices of fit between the measurement model and the data.

To ensure the validity of the factorial structure, the total data set ($N = 275$) was randomly divided into two subsamples: one for Exploratory Factor Analysis ($n_{EFA} = 138$) and another for Confirmatory Factor Analysis (n_{CFA}=137), following the split-sample approach to prevent overfitting (Worthington and Whittaker, 2006). The sample size is considered adequate according to the guidelines of Hair et al. (2018) and Tabachnick and Fidell (2019), who validate samples of $N > 100$ when the factor structure is theoretically sound. Specifically, the 32-item,

TABLE 2 Descriptive statistics.

Dimension	Factor	Mean	SD	Min	Max	Cronbach α	Normality
Eco-citizenship activities	Past Actions as ECn	1.77	0.92	1	4	0.85	0.073*
Eco-citizenship competences	Knowledge for ECn	2.10	0.85	1	4	0.87	0.089*
	Conceptions for ECn	3.10	0.65	1	4	0.87	0.217*
	Skills of ECn	2.54	0.68	1	4	0.82	0.122*
	Attitudes of ECn	3.49	0.58	1	4	0.87	0.157*
	Values of ECn	3.62	0.49	1	4	0.87	0.131*
Eco-citizenship intentions	Future Actions Inside School	2.54	0.75	1	4	0.82	0.194*
	Future Actions Outside School	2.52	0.75	1	4	0.84	0.232*
	Agents of Change	3.21	0.66	1	4	0.76	0.107*
Environmental motivation	Extrinsic Motivation	4.88	1.39	1	7	0.94	0.092*
	Intrinsic Motivation	4.70	1.37	1	7	0.94	0.171*

*$p < 0.001$.

9-factor model has an item-factor ratio of 3.55, meeting the criterion of a minimum of 3 items for model identification (Raubenheimer, 2004). Likewise, the participant-parameter ratio (*n*:*p*) for the AFC was 4.28:1, calculated by dividing the subsample by the number of measurement parameters according to Jackson's rule (Jackson, 2003); although slightly lower than the ideal threshold of 5:1, this ratio is fully justified by the robust factor saturations and excellent goodness-of-fit indices obtained. The data were processed using SPSS 26.0 and AMOS 22, where the AFE yielded a KMO measure of.864 and a significant Bartlett's sphericity test $Chi^2 = 5{,}297.471$, $df = 496$, $p < .001$, confirming a 9-factor structure aligned with the original dimensions of the rECQ (past actions, competencies, and intentions). Finally, the CFA confirmed this structure with satisfactory fit indices (CFI = .918, NNFI = .920, RMSEA = .058), demonstrating the stability of the model despite the segmented sample size.

3 Results

3.1 Descriptive statistics

Descriptive statistics for each factor are presented in Table 2. The mean scores and standard deviations indicate the levels of engagement and competence in various aspects of environmental citizenship among the students. The results show satisfactory to excellent internal consistencies for all constructs, as Cronbach's alphas range from 0.76 to 0.94. The data distribution does not yield normal distributions for the factors according to the Kolmogorov–Smirnov normality test ($p < 0.001$). Thus, non-parametric statistical tests will be used.

Descriptive statistics for each factor are presented in Table 3 for all measured variables, including means, standard deviations, and reliability coefficients. Overall, the results indicate satisfactory internal consistency across all constructs. Detailed values for each dimension are reported in the table. The Kolmogorov–Smirnov test showed that the dimensions followed a univariate normal distribution ($p > 0.05$ in all cases). However, considering the sensitivity of structural equation models to multivariate normality, Confirmatory Factor Analysis (CFA) was performed in AMOS 22 using the Maximum Likelihood (ML) estimator. To ensure the robustness of the parameters and correct possible biases in the Chi^2 statistic derived from the multivariate structure, the Bollen-Stine bootstrapping procedure (2,000 resamples) was applied (Bollen and Stine, 1992). This approach provides a more accurate fit evaluation and robust standard errors for factor loadings.

3.2 Factors correlation

Significant correlations were found between several factors, indicating the interconnectedness of different dimensions of eco-citizenship (Table 4). Notably, environmental citizenship "competences" (conceptions, skills, attitudes, and values) were consistently and positively correlated with "future intentions" (both inside and outside the school and agents of change). However, several non-significant correlations are worth highlighting. "Past actions" showed no significant relationship with knowledge ($\rho = -0.021$), conceptions ($\rho = -0.068$), attitudes ($\rho = 0.046$), or values ($\rho = 0.041$), and were only weakly negatively correlated with skills ($\rho = -0.159$, $p < 0.01$). Similarly, "past actions" did not correlate with either intrinsic ($\rho = -0.007$) or extrinsic motivation ($\rho = 0.002$). Interestingly, knowledge for ECn did not correlate with attitudes ($\rho = -0.047$), values ($\rho = -0.005$), or past actions ($\rho = -0.021$), and showed only weak associations with other variables. Finally, both intrinsic and extrinsic motivation showed significant positive correlations with most of the competences and future intentions.

3.2.1 Research question 1: environmental citizenship expressions

Descriptive statistics revealed distinct patterns across the dimensions of environmental citizenship and motivation. Regarding ECn's "Activities", students reported low engagement in *past actions* associated with environmental citizenship

TABLE 3 Descriptive statistics.

Dimension	Factor	Mean	SD	Min	Max	Cronbach α	Normality
Eco-citizenship activities	Past Actions as ECn	1.77	0.92	1	4	0.85	0.073
Eco-citizenship competences	Knowledge for ECn	2.10	0.85	1	4	0.87	0.089
	Conceptions for ECn	3.10	0.65	1	4	0.87	0.217
	Skills of ECn	2.54	0.68	1	4	0.82	0.122
	Attitudes of ECn	3.49	0.58	1	4	0.87	0.157
	Values of ECn	3.62	0.49	1	4	0.87	0.131
Eco-citizenship intentions	Future Actions Inside School	2.54	0.75	1	4	0.82	0.194
	Future Actions Outside School	2.52	0.75	1	4	0.84	0.232
	Agents of Change	3.21	0.66	1	4	0.76	0.107
Environmental motivation	Extrinsic Motivation	4.88	1.39	1	7	0.94	0.092
	Intrinsic Motivation	4.70	1.37	1	7	0.94	0.171

Motivation factors were measured on a 7-point Likert scale, while other constructs used a 4-point scale.

TABLE 4 Intercorrelation table between environmental citizenship and environmental motivation factors.

Factor	1	2	3	4	5	6	7	8	9	10
1. Past Actions as ECn	–									
2. Knowledge for ECn	−0.021	–								
3. Conceptions for ECn	−0.068	0.216**	–							
4. Skills of ECn	−0.159**	0.175**	0.393**	–						
5. Attitudes of ECn	0.046	−0.047	0.274**	0.158**	–					
6. Values of ECn	0.041	−0.005	0.370**	0.234**	0.422**	–				
7. Future Actions Inside School	−0.166**	0.271**	0.393**	0.418**	0.213**	0.318**	–			
8. Future Actions Outside School	−0.125*	0.258**	0.352**	0.394**	0.209**	0.291**	0.682**	–		
9. Agents of Change	−0.089	0.111	0.360**	0.344**	0.391**	0.475**	0.477**	0.501**	–	
10. Intrinsic Motivation	−0.007	0.114	0.336**	0.209**	0.224**	0.377**	0.264**	0.310**	0.288**	–
11. Extrinsic Motivation	0.002	0.106	0.343**	0.204**	0.285**	0.365**	0.252**	0.321**	0.318**	0.858**

*Significant at the 0.05 level (one-tailed).
**Correlation is significant at the 0.01 level (two-tailed).

(M = 1.77, SD = 0.92), suggesting limited prior involvement in concrete sustainability-related actions. In terms of ECn's "Competences", students scored highest on *values* (M = 3.62, SD = 0.49), *attitudes* (M = 3.49, SD = 0.58), and *conceptions* (M = 3.10, SD = 0.65), reflecting strong internal agreement with the principles of environmental citizenship. These high scores indicate that students not only recognize the importance of sustainability but also align their personal convictions with ecological responsibility. Meanwhile, moderate scores were observed for *skills* (M = 2.54, SD = 0.68) and *knowledge* (M = 2.10, SD = 0.85), pointing to potential gaps between students' attitudes and their perceived ability to take informed action. Regarding ECn's future actions, students expressed moderate *intentions* to engage in environmental actions both *inside* (M = 2.54, SD = 0.75) and *outside* the university context (M = 2.52, SD = 0.75). Notably, the score of "Agents of Change" factor was relatively high (M = 3.21, SD = 0.66), suggesting that students see themselves as potential promoters of sustainability and social transformation. However, the intention to act could be more aspirational than realized, as seen in the gap between intentions and past behaviors. Lastly, the results for "Environmental Motivation" showed relatively high scores for both extrinsic (M = 4.88, SD = 1.39) and intrinsic motivation (M = 4.70, SD = 1.37). This suggests that students are motivated by both internalized values and external reinforcements when it comes to engaging in environmentally responsible behaviors.

Descriptive statistics revealed a marked discrepancy between students' psychological alignment and their practical engagement. The highest scores were concentrated in internal dimensions: *values* ($M = 3.62$, $SD = 0.49$), *attitudes* ($M = 3.49$, $SD = 0.58$), and *conceptions* ($M = 3.10$, $SD = 0.65$). This internal commitment is further supported by high levels of extrinsic ($M = 4.88$, $SD = 1.39$) and intrinsic motivation ($M = 4.70$, $SD = 1.37$), as well as a strong identification as "Agents of Change" ($M = 3.21$, $SD = 0.66$).

In contrast, a significant deficit was observed in practical and cognitive tools. Engagement in *past actions* was notably low ($M = 1.77$, $SD = 0.92$), and students reported limited *knowledge*

($M = 2.10$, $SD = 0.85$) and *skills* ($M = 2.54$, $SD = 0.68$). This suggests that while students possess the motivation and convictions to promote sustainability, they lack the perceived ability and experience to take informed action. Consequently, their intentions for future engagement remain moderate, both *inside* ($M = 2.54$, $SD = 0.75$) and *outside* the university context ($M = 2.52$, $SD = 0.75$), highlighting an "intention-action gap" where aspirations outpace realized behaviors.

3.2.2 Research question 2: comparisons between past actions, competences, and intentions

To address RQ2, we compared students' reported past actions, competences, and future intentions as three related dimensions of environmental citizenship. As shown in Table 5, past actions scored markedly lower than both competences and future intentions, while competences were slightly but significantly higher than intentions. This pattern suggests a clear gap between students' prior environmental practice and their self-perceived readiness or willingness to engage in future action. We used the Wilcoxon signed-rank test to compare between each factor. We first calculated the grand mean scores for *Competences* ($M = 2.97$; $SD = 0.41$) and *Intentions* ($M = 2.76$; $SD = 0.61$). Results show that pre-service students' environmental citizenship "*Past Actions*" ($M = 1.74$; $SD = 0.95$) scores are significantly lower from "*Competences*" score ($Z = -12.31$; $P = 0.000$) and "*Intentions*" score ($Z = -11.10$; $P = 0.000$; effect size = 0.27), with a mean difference of $M = 1.23$; $SD = 0.54$ and $M = 0.96$; $SD = 0.34$ respectively. We also found that students' "Competences" mean scores are significantly slightly higher than Intentions ($Z = -13.77$; $P = 0.000$), with a mean difference of ($M = 0.20$; $SD = 0.20$).

3.2.3 Research question 3: environmental citizenship and online civic engagement

Table 6 summarizes the descriptive profile of students' online environmental civic engagement. Overall, expressive and discussion-based actions showed moderate scores, whereas more demanding forms of collective digital participation remained comparatively weaker. This pattern suggests that students feel more prepared for individual communicative engagement than for sustained online mobilization.

As shown in Table 7, all seven online engagement items were positively associated, indicating that online environmental participation tends to cluster rather than occur in isolated forms. The strongest relationships appeared among explicitly collective digital actions, especially forum participation, organizing online groups, and campaign involvement, which points to a coherent sub-pattern of digitally mediated civic action.

Mean significant differences (Wilcoxon):

Wilcoxon signed rank tests revealed significant differences between many item pairs ($p < 0.05$). According to significant mean differences, the online competence (Discuss a newspaper article about an environmental conflict ($M = 2.26$; $SD = 0.812$) is significantly lower than future civic online engagement (Collect signatures for a petition ($M = 2.75$; $SD = 0.891$) Contribute to an online discussion forum about environmental issues ($M = 2.45$; $SD = 0.863$) and Participate in an online campaign ($M = 2.56$; $SD = 0.939$). However, students scored higher on the second skill Argue your point of view about a controversial environmental issue ($M = 2.73$; $SD = 0.806$) than on their future online civic engagement (Contribute to an online discussion forum ($M = 2.45$; $SD = 0.863$), Organise an online group to take a stance on a controversial environmental issue ($M = 2.35$; $SD = 0.902$), Participate in an online campaign ($M = 2.56$; $SD = 0.939$). Students scored higher on the Write a letter or email to a newspaper skill than on both (Contribute to an online discussion forum ($M = 2.45$; $SD = 0.863$), Organise an online group to take a stance on a controversial environmental issue ($M = 2.35$; $SD = 0.902$) future online civic engagement.

To address the study's aim of examining differences in participants' engagement across various environmental action behaviors, a series of Wilcoxon signed-rank tests was conducted. This non-parametric technique was chosen because it allows for comparing paired ordinal ratings across multiple action types without assuming normal distribution. The table below presents the *Z*-values and significance levels for all pairwise comparisons between action items. The purpose of these analyses was to identify patterns in how participants differentiate between traditional actions (e.g., writing letters, signing petitions), discussion-based actions (e.g., talking with others), and online-oriented behaviors (e.g., sharing or posting environmental content online). By comparing these categories directly, the analysis sought to determine which forms of engagement are rated more favorably and whether a consistent hierarchy of preferred behaviors emerges.

TABLE 5 Aggregated values for ECn dimensions.

ECn dimensions	M	SD
Past actions	1.77	0.92
Competences	2.97	0.41
Future actions	2.76	0.61

TABLE 6 Descriptive results for the constructs conceptions for ECn and future actions outside school.

Construct	Item	Mean	SD
Conceptions for ECn	Discuss a newspaper article about an environmental conflict	2.26	0.812
	Argue your point of view about a controversial environmental issue	2.73	0.806
	Write a letter or email to a newspaper giving your view on a current environmental issue	2.65	0.881
Future actions outside school	Collect signatures for a petition	2.75	0.891
	Contribute to an online discussion forum about environmental issues	2.45	0.863
	Organise an online group to take a stance on a controversial environmental issue	2.35	0.902
	Participate in an online campaign	2.56	0.939

TABLE 7 Online civic engagement items intercorrelations.

Statistic	1	2	3	4	5
1-Discuss a newspaper article about an environmental conflict	–				
2-Argue your point of view about a controversial environmental issue	**0.595****	–			
3-Write a letter or email to a newspaper giving your view on a current environmental issue	**0.417****	0.457**	–		
4-Collect signatures for a petition	0.226**	0.248**			
5-Contribute to an online discussion forum about environmental issues	0.328**	**0.354****	0.233**	–	
6-Organise an online group to take a stance on a controversial environmental issue	0.370**	**0.394****	**0.246****	**0.748****	–
7-Participate in an online campaign	0.279**	0.350**	0.231**	**0.622****	**0.722****

Bold values indicate statistically significant pairwise differences ($p < .05$).

TABLE 8 Paired-comparisons between items.

Comparison group	1–4	1–5	1–6	1–7	2–4	2–5	2–6	2–7	3–4	3–5	3–6	3–7
Z	−7.074	−3.229	−1.729	−4.443	−.280	−4.623	−6.093	−2.733	−1.455	−2.968	−4.406	−1.299
Sig.	0.000	0.001	0.084	0.000	0.780	0.000	0.000	0.006	0.146	0.003	0.000	0.194

Although no general mean difference is identified between skills and future actions means ($Z = -0.266$; $P = 0.790$). Overall, online-oriented behaviors (items 5–7) received significantly higher ratings than traditional actions such as writing letters or collecting signatures (items 3–4). Traditional engagement behaviors were consistently rated lower, whereas discussion-based actions (items 1–2) tended to fall in the mid-range. The pattern suggests that participants were more inclined toward online environmental activism compared to traditional or formal methods.

3.3 Individual difference and online civic engagement

In order to explore whether patterns of environmental engagement differed by gender, academic year or age Mann–Whitney *U*-tests were conducted. This non-parametric test was selected because it is appropriate for comparing two independent groups on ordinal or non-normally distributed data. The analysis examined gender differences across all measured online, communicative, and collective environmental actions, with the goal of identifying whether students demonstrate distinct engagement profiles. Detailed Mann–Whitney U results for individual differences in online civic engagement are presented in Tables 8 and 9.

3.3.1 Gender differences

Mann–Whitney *U*-tests revealed no significant gender differences across any of the Online environmental actions measured (all $p > 0.05$). Although mean scores showed modest tendencies, women scored slightly higher for communicative and collective actions (Discussing articles, Writing letters/emails and Collecting signatures) and men slightly higher for debate-oriented actions (Arguing their point of view, Contributing in online forums) these differences were not statistically reliable. Overall, male and female participants reported similar levels of environmental engagement across the measured behaviors.

According to the bar graph, the error bars (95% CI) for males and females overlap in almost every category. This means that while there are differences in means, they may not be statistically significant and the groups do not truly differ in the population. The nonbinary category has too few data points to compare meaningfully. Gender differences can be seen in Figure 1.

3.3.2 Academic year

Academic year was not a significant factor in online environmental civic engagement. Mann–Whitney *U*-tests showed no significant differences between first- and second-year pre-service teachers across any item (all $p > 0.05$). Although Figure 2 suggests small descriptive variations—with first-year students scoring slightly higher in traditional communicative actions and second-year students in some collective online actions—these patterns were weak and accompanied by overlapping confidence intervals. Overall, the findings indicate that academic progression did not substantially modify students' online environmental engagement.

3.3.3 Age differences

Age was also not a significant factor in online environmental civic engagement. Mann–Whitney *U*-tests showed no significant differences between younger and older students across all items (all $p > 0.05$). Figure 3 suggests only minor descriptive variation, with younger students tending to score slightly higher on expressive actions and older students on collective digital participation; however, the overlapping confidence intervals indicate that these differences are not meaningful. Taken together, these results suggest that online environmental engagement is relatively stable across age groups within this sample.

TABLE 9 Individual difference and online civic engagement.

Comparison group	Discuss a newspaper article about an environmental conflict	Argue your point of view about a controversial environmental issue	Write a letter or email to a newspaper giving your view on a current environmental issue	Collect signatures for a petition	Contribute to an online discussion forum about environmental issues	Organise an online group to take a stance on a controversial environmental issue	Participate in online campaign	Skills	Future intentions outside school
Gender difference	U = 3,423, Z = −1.62, P = 0.104	U = 3,605, Z = −1.98, P = 0.231	U = 3,655, Z = −1.04, P = 0.297	U = 3,948, Z = −0.324, P = 0.746	U = 3,373, Z = −1.72, P = 0.085	U = 3,760, Z = −0.778, P = 0.437	U = 3,760, Z = −0.778, P = 0.437	U = 3,370, Z = −1.66, P = 0.096	U = 3,743, Z = −0.783, P = 0.434
Academic year	U = 7,941, Z = −0.969, P = 0.333	U = 8,465, Z = −0.072, P = 0.942	U = 7,495, Z = −1,71, P = 0.086	U = 8,268, Z = −0.406, P = 0.685	U = 7,636, Z = −1.477, P = 0.140	U = 8,303, Z = −0.343, P = 0.732	U = 8,351, Z = 0.262, P = 0.793	U = 7,873, Z = −1.028, P = 0.304	U = 8,163, Z = −.552, P = 0.581
Age plage	U = 8,784, Z = −0.541, P = 0.589	U = 8,334, Z = −1.316, P = 0.188	U = 8,552, Z = −0.921, P = 0.357	U = 8,966, Z = −0.235, P = 0.814	U = 8,025, Z = −1.788, P = 0.074	U = 8,116, Z = −1,627, P = 0.104	U = 8,891, Z = −0.354, P = 0.723	U = 8,915, Z = −0.305, P = 0.760	U = 8,265, Z = −1.322, P = 0.186

4 Discussion

The purpose of this study was to examine the environmental motivation, ecological dispositions, and environmental citizenship behaviours of Spanish pre-service teachers, and to explore the interrelations among these dimensions in the context of a rapidly digitalising post-COVID educational landscape. Understanding how pre-service teachers position themselves as environmental citizens is particularly important given their future role in shaping sustainability competencies in schools. Our findings contribute to the emerging evidence on how environmental motivation and behavioural readiness manifest among university students, while also addressing the lack of post-COVID empirical data on environmental citizenship in Spain. The results provide insights not only into motivational patterns but also into how these may interact with digital learning environments that increasingly mediate sustainability education.

4.1 Interpretation of findings

The main contribution of the findings lies in the contrast between strong environmental motivation and comparatively weaker records of enacted environmental participation. This pattern suggests that, within this sample of Spanish pre-service teachers, sustainability is already present as a meaningful value orientation, but not yet consistently translated into regular civic or environmental action. Rather than indicating indifference, the findings point to a participation gap between disposition and practice.

This interpretation is consistent with previous research in the Spanish context. Studies in Spanish universities consistently show that pre-service teachers display strong pro-environmental attitudes and high motivation, yet only moderate environmental knowledge and limited participation in organisations or sustained ecological actions (Álvarez-García et al., 2018; Estrada-Vidal et al., 2020; Solís-Espallargas et al., 2019). Similar to our results, Spanish students often value sustainability and recognise its importance for their future teaching roles, but their engagement remains mostly individual rather than collective, mirroring the persistent intention-behaviour gap described in Spanish youth and university populations (Ibáñez et al., 2020; Leiva-Brondo et al., 2022). Moreover, recent evidence from Andalusia reports that future teachers exhibit strong environmental priorities but only partial environmental literacy and limited opportunities for meaningful participation (Rivero García et al., 2024). Consequently, our results do not contradict existing Spanish findings; instead, they reinforce the national pattern of motivated but under-engaged pre-service teachers, suggesting that environmental education in Spain continues to foster positive dispositions while struggling to translate them into systematic knowledge acquisition and active citizenship.

The findings on motivation are particularly revealing. Students displayed high intrinsic and extrinsic environmental motivation, suggesting that they significantly internalise the importance of ecological actions in everyday life. This aligns with literature emphasising the role of higher education not only in transmitting sustainability knowledge but also in shaping attitudes, skills, and dispositions that underpin pro-environmental behaviour (Ásványi

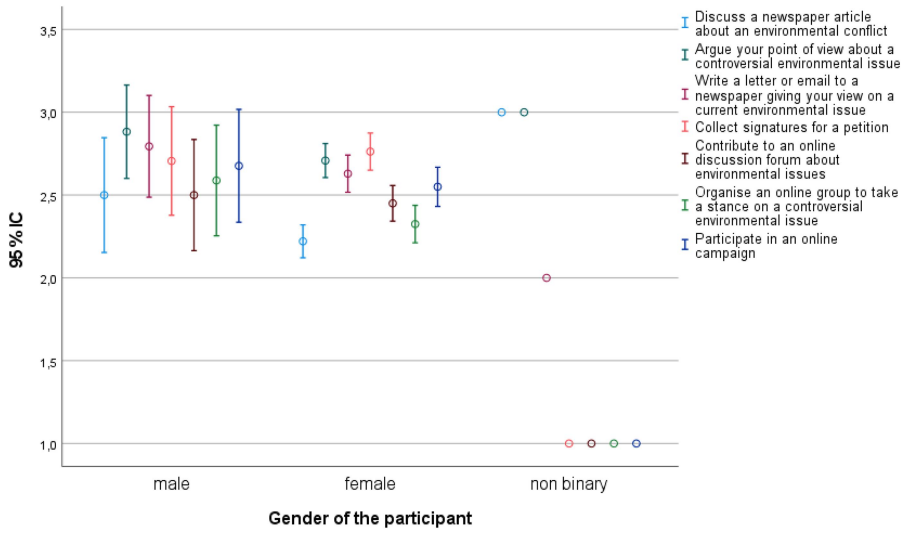

FIGURE 1
Gender of the participants by item.

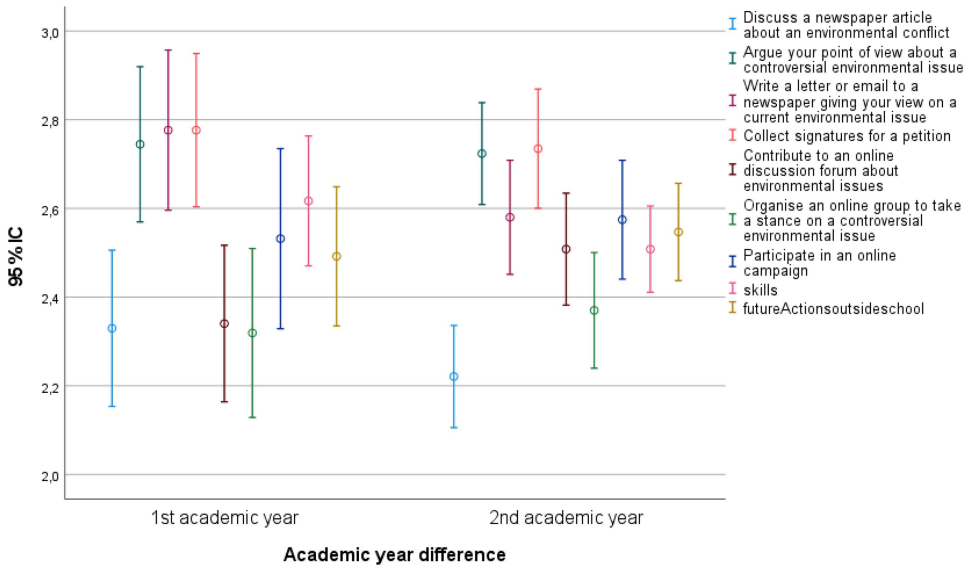

FIGURE 2
Academic year difference by item.

and Gedeon 2025; Tilbury, 2011). At the same time, the results confirm a common challenge in environmental education research: strong awareness and motivation do not necessarily translate into active participation. Similar findings in Spanish youth research point to a persistent gap between ecological intention and concrete action (Ayay-Arista et al., 2025). This suggests that while students value sustainability, teacher education still needs to provide practical avenues through which motivation can become behaviour.

This tension also becomes visible in the domain of past and intended action. Despite reporting strong intrinsic and extrinsic motivation, many students showed limited engagement in environmental or human-rights organisations. This confirms the persistent gap between intention and action widely documented in environmental education research (Ayay-Arista et al., 2025). Our findings echo broader literature showing that knowledge, while necessary, does not automatically translate into pro-environmental behaviour (Liu et al., 2020). Motivation rooted in values, empathy, and identity is often more decisive, as noted by Van der Linden (2015), yet extrinsic influences such as social norms or incentives may also shape engagement (Ejelöv et al., 2022). The moderate level of future intentions therefore reveals both a challenge and an opportunity: without institutional reinforcement, students' awareness risks remaining abstract, but their relatively higher sense of agency as future educators suggests strong developmental potential.

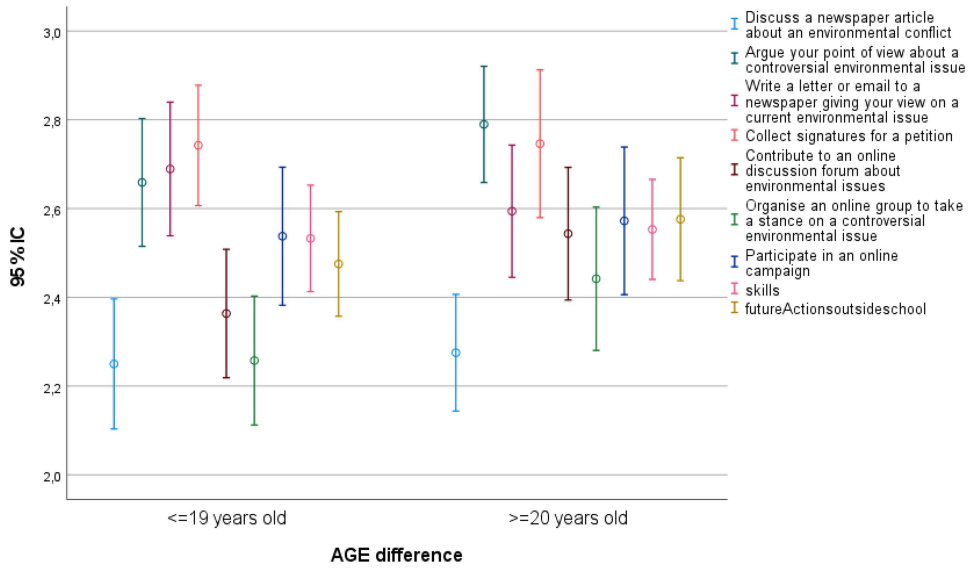

FIGURE 3
Age differences by item.

The profile of ecological dispositions also reflects this unevenness. Competences linked to attitudes and environmental priorities appeared stronger than those related to knowledge and communication. This confirms previous findings of knowledge deficits among Spanish pre-service teachers (Estrada-Vidal et al., 2020) and suggests that sustainability content, though present in curricula, still requires greater emphasis and continuity (Ásványi and Gedeon, 2025). Students seem normatively aligned with ecological responsibility and supportive of stronger environmental protection, reduced disposable consumption, and greater institutional accountability, echoing Barry's (2006) argument that transformation requires shifts in both individual and structural practices. However, more demanding competences, especially those involving communication, public articulation, or sustained participation, remain less developed. This indicates that ecological commitment may be stronger at the level of value orientation than at the level of confident public action.

A similar tension appears in the digital domain. Online environmental civic engagement emerged as an important but still developing dimension of environmental citizenship. The overall pattern suggests that students are relatively open to digitally mediated participation, especially in low-barrier or campaign-style actions, but that this readiness does not necessarily mean they are fully prepared for deeper, more sustained forms of digital civic involvement. This aligns with broader trends in youth participation, where online spaces provide accessible, immediate, and socially connected environments for action (Goldman et al., 2020; Hoffmann et al., 2024). Yet the findings also suggest that foundational communication competences do not always transfer automatically into the digital public sphere, where much contemporary civic engagement now takes place.

Importantly, the relative stability of online environmental engagement across gender, age, and academic subgroups suggests that these forms of participation may be shaped less by demographic variation than by shared digital learning conditions. This contrasts with findings from the Swedish context, where older students showed stronger eco-citizenship profiles and greater willingness to act as agents of change (Cederqvist et al., 2025). In our case, the lack of marked subgroup differences suggests that digital civic participation may function as a common mode of engagement across this teacher education population, likely facilitated by the pervasive role of digital tools in contemporary university life.

Taken together, these findings portray environmental citizenship as an uneven process: students appear motivated and normatively aligned with sustainability, yet they do not always experience the institutional, practical, or participatory conditions needed to transform these orientations into repeated action. The findings therefore support an interpretation of environmental citizenship not as a stable trait, but as a developmental process shaped by opportunities for practice, reflection, and agency.

4.2 Theoretical implications

From a theoretical perspective, the findings reinforce the need to distinguish between sustainability-oriented dispositions and enacted environmental citizenship. While Education for Sustainable Development has often focused on awareness, values, and competence formation, the present findings suggest that these dimensions do not automatically produce sustained participation. In this respect, environmental citizenship remains a useful extension of ESD because it foregrounds action, responsibility, and public engagement rather than stopping at attitudinal endorsement.

This distinction is especially useful for clarifying the relationship between motivation, competence, and action. The results suggest that environmental motivation is an important precondition for engagement, but not a sufficient one. High levels of intrinsic and extrinsic motivation indicate that students recognise the importance of sustainability and place value on

ecological responsibility, yet this motivational readiness does not necessarily become behaviourally visible. This supports the relevance of motivational perspectives such as Self-Determination Theory, which help explain why valuing sustainability may prepare the ground for action, while still depending on supportive contexts in which such motivation can be enacted. In this sense, higher education should not be understood merely as a site for transmitting sustainability knowledge, but as a social environment in which values, identities, and action possibilities are shaped (Ásványi and Gedeon, 2025; Tilbury, 2011).

The findings also support broader theoretical work on environmental citizenship as the active fulfilment of environmental rights and responsibilities across both private and public spheres (Goldman et al., 2020; Powers and Trauntvein, 2024). The gap observed between awareness and participation suggests that environmental citizenship cannot be inferred solely from positive attitudes or strong priorities. Rather, it must be understood as a more demanding form of civic enactment that requires repeated opportunities for participation and a sense of agency in relation to collective problems. In this respect, our results are consistent with literature showing that values, empathy, and identity are central to environmental engagement (Van der Linden, 2015), but also that social norms, institutional incentives, and contextual conditions shape whether such dispositions are translated into practice (Ejelöv et al., 2022).

The competence-related findings also carry important theoretical implications. The coexistence of moderate knowledge with stronger attitudes and priorities suggests that different dimensions of ecological competence do not necessarily develop in parallel. Research by Kaiser and Fuhrer (2003) helps illuminate this point by showing that different forms of knowledge play distinct roles in shaping behaviour. Declarative knowledge provides foundational understanding of environmental systems and reduces uncertainty. Procedural knowledge and practical competence enable individuals to act effectively, generating the mastery experiences that Bandura (1997) identifies as central to self-efficacy. Effectiveness knowledge helps prioritise behaviours with the greatest ecological impact. From this perspective, environmental citizenship requires more than general concern: it depends on the coordinated development of differentiated forms of knowledge, competence, and confidence. Our findings suggest that this integration remains partial in the teacher education context examined here.

The study also highlights the importance of incorporating digitally mediated civic engagement into contemporary conceptualisations of environmental citizenship. In post-COVID educational contexts, civic participation increasingly unfolds through online discussion, coordination, advocacy, and collective visibility. This means that environmental citizenship theory must now account not only for offline practices, but also for the igital spaces in which ecological identities and actions are increasingly negotiated. The growing familiarity of students with digital tools may partly reinforce environmental motivation by making learning more accessible, interactive, and socially connected, as suggested by recent research (Hajj-Hassan et al., 2024; Selvarajan and Mahmud, 2025). Similarly, Xia (2024) and Ricoy and Sánchez-Martínez (2022) show that digital learning environments can draw students more dynamically into sustainability content and increase its perceived relevance. Although digital competence was not measured directly in this study, the findings suggest that digital environments are not merely a pedagogical backdrop, but part of the contemporary ecology through which environmental citizenship is imagined and practised.

Finally, these results support a more integrated theoretical view of environmental citizenship in teacher education. Such a view should connect sustainability awareness, motivational orientation, ecological competence, civic practice, and digital participation within a single developmental framework. Rather than treating these dimensions as interchangeable, the study suggests that they are interrelated but non-equivalent. Their alignment is dynamic rather than automatic, and their educational significance depends on the extent to which universities create conditions for them to converge in meaningful forms of public and professional action.

4.3 Practical implications for teacher education

From a practical standpoint, the findings suggest that teacher education programs should move beyond awareness-based sustainability instruction and create structured pathways for action-oriented participation. If future teachers are expected to foster sustainability in schools, it is not enough for them to support environmental values in abstract terms; they must also experience what it means to participate, deliberate, collaborate, and act as environmental citizens during their own training.

First, pre-service teachers need repeated opportunities to engage in environmental citizenship through authentic tasks, such as participation in campus sustainability initiatives, collaboration with local communities, reflective projects linked to environmental justice, and pedagogical experiences that connect ecological concerns with civic responsibility. These opportunities may help reduce the gap between environmental intention and enacted behaviour by allowing students to move from endorsement to practice. Universities must therefore do more than transmit environmental knowledge: they must create meaningful and repeated opportunities, both physical and digital, for students to practise ecological citizenship and experience success in action.

Second, teacher education should explicitly strengthen the differentiated competences that underpin environmental action. The findings suggest that attitudes and environmental priorities may be relatively strong, while knowledge, communication, and action-oriented competences remain more fragile. This means that curricula should support a better balance between declarative, procedural, and effectiveness knowledge, while also strengthening public communication skills and opportunities for participation. Sustainability education must therefore move beyond sporadic exposure and adopt a more comprehensive approach that prepares well-rounded environmental citizens capable of articulating, defending, and enacting sustainability principles in both educational and civic spaces.

Third, sustainability should be embedded across teacher education curricula not only as content, but as a participatory pedagogy. This requires integrating ecological issues into coursework, practicum experiences, interdisciplinary projects, and institutional culture, so that future teachers encounter sustainability as something to be practised collectively rather

than merely endorsed conceptually. A whole-program approach may be especially important in contexts such as Andalusia, where ecological richness coexists with pressing environmental challenges such as biodiversity loss, water scarcity, and desertification. While national frameworks such as the Spanish Strategy for Environmental Education (2020) provide guidelines for embedding sustainability into higher education, the present findings suggest that implementation has not yet fully permeated daily academic practices. More consistent institutionalisation is therefore needed.

Fourth, teacher education should explicitly develop digital civic competences related to sustainability. Given that sustainability debates increasingly unfold through online petitions, social media debates, digital campaigns, collaborative platforms, and networked communities, future teachers need to learn not only how to use digital tools pedagogically, but also how to participate critically and responsibly in digitally mediated forms of civic life. Training in online deliberation, digital advocacy, collaborative participation, critical engagement with media, and environmentally oriented online communities may better prepare them to enact and model citizenship under contemporary communicative conditions. The growing centrality of digital platforms in post-COVID education reinforces the urgency of this shift.

Fifth, universities should create more visible and continuous participation pathways that connect campus life with broader social and environmental challenges. Year-round campaigns, student-led sustainability projects, service-learning experiences, environmental leadership programmes, and collaboration with government agencies, NGOs, schools, and community organisations can help students experience environmental citizenship as a lived and socially meaningful practice (Brundiers et al., 2010; Leal Filho et al., 2016; Lozano et al., 2013). Digital tools and public forums, as highlighted by Mogren et al. (2019), provide additional spaces for participation and dialogue. Formal recognition for active participation may also encourage broader and more sustained involvement.

These implications are particularly relevant for pre-service teachers, who will shape the environmental awareness of future generations. Updating teacher education curricula with interdisciplinary training in sustainability is therefore essential, not only to inform but also to transform beliefs, attitudes, and professional identities. Evidence from Spanish higher education supports this direction: educational gardens have been shown to promote climate action (Corrochano et al., 2022), and flipped classrooms have increased awareness of climate change (Jeong et al., 2021). More broadly, immersive digital tools have proven effective in fostering sustainability awareness. From the perspective of Value-Belief-Norm theory, long-term ecological engagement depends not only on knowledge but also on the internalisation of values, ecological worldviews, and moral obligation (Echegoyen-Sanz and Martín-Ezpeleta, 2021; Stern, 2000). Educational strategies must therefore go beyond cognitive knowledge, incorporating emotional, ethical, and social dimensions that activate deeper motivational pathways and support sustained ecological identity and long-term pro-environmental behaviour.

Overall, this study contributes to the understanding of environmental citizenship in teacher education by showing that motivation, ecological dispositions, and civic engagement do not necessarily develop in parallel. Its practical implication is clear: if universities aim to prepare teachers who can foster sustainability in future generations, they must design learning environments that connect environmental commitment with repeated opportunities for both offline and digitally mediated action. These findings should therefore be interpreted as exploratory, since they derive from a convenience sample recruited from a single faculty within one university context.

5 Conclusion

The research conducted at the Faculty of Education Sciences of the University of Granada has revealed positive dispositions among pre-service teachers toward ecological citizenship. These inclinations are primarily motivated by self-care and a genuine commitment to environmental conservation. However, there is a notable gap between environmental awareness and effective action, as student participation in environmental organizations is limited. The significant environmental motivation in Andalusia, driven by its rich biodiversity and natural resources, contrasts with rather low concrete environmental activism. This underscores the critical need for a holistic approach, entailed in both formal and informal educational situations, that not only construct knowledge but also foster the skills, attitudes and behavior aligned with sustainability principles.

In terms of limitations, this study should be interpreted in light of several limitations related to sampling and generalizability. First, the research relied on a convenience sample drawn from a single institutional context, the Faculty of Education Sciences at the University of Granada. While this approach is appropriate for exploratory research and provides valuable insight into pre-service teachers' environmental citizenship within this setting, it necessarily limits the extent to which the findings can be generalized to the broader population of Spanish pre-service teachers. Institutional culture, regional environmental priorities, curriculum implementation, and student demographics may vary substantially across Spanish universities and autonomous communities. Consequently, the patterns of motivation, competences, and civic engagement observed here should be viewed as context-sensitive rather than nationally representative. Future research would benefit from multi-site sampling strategies involving diverse universities, teacher education programs, and regional contexts across Spain. Employing stratified or probability-based sampling designs, as well as longitudinal approaches, would further strengthen external validity and allow researchers to examine how environmental citizenship develops over time and across institutional environments. Additionally, the use of self-administered questionnaires may introduce self-report biases influenced by cultural or regional factors. Therefore, it is recommended to expand the research to various universities and faculties across Spain to capture a broader range of perceptions and behaviors towards eco-citizenship. Longitudinal research evaluating the evolution of these behaviors in response to educational reforms or environmental policies would also be of great value. An additional limitation concerns the gender distribution of the sample, which was highly skewed toward female participants (87.3%). This imbalance largely reflects the demographic composition of pre-service teacher education

programs in Spain, particularly in early childhood and primary education degrees, where women are substantially overrepresented. Nevertheless, the predominance of female respondents may have influenced the overall pattern of results. Previous research has frequently reported that women tend to express stronger pro-environmental attitudes, higher environmental concern, and greater willingness to engage in certain forms of civic and sustainability-related behaviors. Consequently, the relatively high levels of environmental values, attitudes, and motivation observed in this study should be interpreted with caution, as they may partially reflect gender composition effects rather than purely program-level characteristics.This institutional concentration limits the broader generalizability of the results. Future studies should replicate the research across multiple faculties and universities in order to test the consistency of these patterns in other educational settings.

At the same time, the present analyses did not reveal statistically significant gender differences in online environmental civic engagement within this sample. However, the unequal group sizes reduce statistical power for between-gender comparisons, particularly for the small male and non-binary subsamples. Future research should aim for more gender-balanced or stratified samples across different teacher education specializations to better disentangle gender effects and to determine whether the observed motivational and behavioral patterns hold across more demographically diverse cohorts.

Globally, while students highly value competencies related to participation in pro-environmental activities, they express less confidence in their abilities to debate and communicate environmental issues in public spaces. This finding highlights the urgent need to strengthen these competencies through continuous and practical training, maybe through fieldtrip learning settings fostering embodied learning (Wang et al., 2023), which should be an essential component of university curricula to prepare students to be effective advocates for sustainability. Importantly, this research also illustrates the continuity between higher education and K-12 education, particularly through the environmental training of pre-service teachers. By equipping future educators with the knowledge, values, and motivation necessary to act as environmental citizens, universities play a critical role in ensuring that these competences are transferred to future generations of pupils, who themselves will become the environmental citizens of tomorrow.

Although the results indicate that students display rather moderate intentions to act as environmental citizens in the future, particularly within the educational field, their willingness to engage in activities outside the university setting is less evident. In this perspective, a complementary line of reflection could be explored through the concept of quasi-communities (Emad and Roth, 2016), which may provide a relevant framework for enhancing student engagement beyond the university setting. As highlighted by Impedovo et al. (2024), quasi-communities represent an interdisciplinary approach that structures sociotechnical interactions and mobilizes diverse actors in sustainability initiatives. Using the case of a lake regeneration project in Rome, the study illustrates how heterogeneous groups, united around a common challenge, can develop sustainable practices and engage in collective learning. In the university context, quasi-communities could serve as a mechanism to bridge the gap between environmental awareness and concrete action, facilitating continuity between academic learning and real-world applications.

In conclusion, this study highlights the pressing need for enhanced regulatory frameworks to support the development of environmental citizenship among university pre-service teachers students.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Antonio Miñan Espigares, Javier de la Hoz-Ruíz, Javier Sanchez Mendías, University of Granada. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

RC: Writing – original draft, Writing – review & editing. JH-R: Writing – original draft, Writing – review & editing. AM: Writing – original draft, Writing – review & editing. JS: Writing – original draft, Writing – review & editing. MH-H: Writing – original draft, Writing – review & editing.

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The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The author(s) declared that generative AI was not used in the creation of this manuscript.

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