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RESEARCH ARTICLE

REVISED Understanding climate engagement and open recognition in European higher education: A mixed-methods study across four countries

[version 2; peer review: 4 approved]

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Abstract

Background

This mixed-methods study investigates student engagement with climate issues and perceptions of open recognition systems across four European educational institutions in France, Italy, Portugal, and Spain as part of the OpenPass4Climate Erasmus+ project. Against the backdrop of the European Green Deal and UNESCO's call for transformative education, our research addresses the critical need for innovative climate education approaches that bridge knowledge and action.

Methods

Through a comprehensive approach combining surveys (*n*=630), individual interviews (*n*=69), national focus groups (*n*=45), and a transnational focus group (*n*=16), we examined students' climate attitudes, educational preferences, and views on digital badge systems for recognizing climate competencies.

Results

Results reveal a notable disconnect between strong climate concern

Open Peer Review

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(mean=4.0/5) and moderate personal responsibility (3.2/5), alongside significant cross-country variations in environmental engagement, with Portuguese students consistently demonstrating the highest climate awareness and Italian students the lowest. While respondents strongly endorsed formal climate curriculum integration (4.1/5) and valued informal learning pathways (3.8/5), they reported limited participation in eco-pedagogical activities (2.3/5), highlighting an implementation gap in environmental education. Students rated their informal climate change education (3.5/5) more highly than formal training (3.2/5), suggesting untapped potential for recognition of non-formal learning experiences. Gender differences emerged consistently, with female respondents showing significantly higher environmental concern and engagement across multiple dimensions. Analysis of open badge perceptions revealed moderate familiarity but substantial interest, particularly when aligned with institutional credentialing systems and employer recognition frameworks.

Conclusions

Key implementation challenges identified include the need for robust quality assurance mechanisms, institutional endorsement, and enhanced digital infrastructure accessibility. These findings inform strategic recommendations for developing the European Open Badges Passport, emphasizing the importance of balancing standardization with contextual flexibility while facilitating recognition of both formal and informal climate learning across diverse higher education settings.

Contexte

Cette étude à méthodes mixtes examine l'engagement des étudiants envers les questions climatiques et leurs perceptions des systèmes de reconnaissance ouverts dans quatre établissements d'enseignement européens en France, Italie, Portugal et Espagne, dans le cadre du projet Erasmus+ OpenPass4Climate. Dans le contexte du Pacte vert pour l'Europe et de l'appel de l'UNESCO à une éducation transformatrice, notre recherche répond au besoin crucial d'approches innovantes en matière d'éducation au climat qui établissent un pont entre les connaissances et l'action.

Méthodes

Grâce à une approche complète combinant des enquêtes (n=630), des entretiens individuels (n=69), des groupes de discussion nationaux (n=45) et un groupe de discussion transnational (n=16), nous avons examiné les attitudes des étudiants face au climat, leurs préférences éducatives et leurs opinions sur les systèmes de badges numériques

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pour la reconnaissance des compétences climatiques.

Résultats

Les résultats révèlent un décalage notable entre une forte préoccupation climatique (moyenne=4,0/5) et une responsabilité personnelle modérée (3,2/5), ainsi que des variations significatives entre les pays en matière d'engagement environnemental, les étudiants portugais démontrant systématiquement la plus grande sensibilisation au climat et les étudiants italiens la plus faible. Bien que les répondants aient fortement approuvé l'intégration formelle du climat dans les programmes d'études (4,1/5) et valorisé les parcours d'apprentissage informels (3,8/5), ils ont signalé une participation limitée aux activités éco-pédagogiques (2,3/5), mettant en évidence un écart de mise en œuvre dans l'éducation environnementale. Les étudiants ont évalué leur éducation informelle sur le changement climatique (3,5/5) plus favorablement que leur formation formelle (3,2/5), suggérant un potentiel inexploité pour la reconnaissance des expériences d'apprentissage non formelles. Des différences de genre ont émergé de façon constante, les répondantes montrant une préoccupation et un engagement environnementaux significativement plus élevés dans de multiples dimensions. L'analyse des perceptions des badges ouverts a révélé une familiarité modérée mais un intérêt substantiel, particulièrement lorsqu'ils sont alignés avec les systèmes d'accréditation institutionnels et les cadres de reconnaissance des employeurs.

Conclusions

Les principaux défis de mise en œuvre identifiés comprennent la nécessité de mécanismes d'assurance qualité robustes, d'approbation institutionnelle et d'amélioration de l'accessibilité des infrastructures numériques. Ces résultats éclairent les recommandations stratégiques pour le développement du Passeport Européen des Badges Ouverts, soulignant l'importance d'équilibrer la standardisation avec la flexibilité contextuelle tout en facilitant la reconnaissance des apprentissages climatiques formels et informels dans divers contextes d'enseignement supérieur.

Contesto

Questo studio a metodi misti indaga il coinvolgimento degli studenti nelle questioni climatiche e le percezioni dei sistemi di riconoscimento aperto in quattro istituzioni educative europee in Francia, Italia, Portogallo e Spagna come parte del progetto Erasmus+ OpenPass4Climate. Nel contesto del Green Deal europeo e dell'appello dell'UNESCO per un'educazione trasformativa, la nostra

ricerca affronta la necessità critica di approcci innovativi all'educazione climatica che colmino il divario tra conoscenza e azione.

Metodi

Attraverso un approccio completo che combina sondaggi (n=630), interviste individuali (n=69), focus group nazionali (n=45) e un focus group transnazionale (n=16), abbiamo esaminato gli atteggiamenti degli studenti verso il clima, le loro preferenze educative e le loro opinioni sui sistemi di badge digitali per il riconoscimento delle competenze climatiche.

Risultati

I risultati rivelano una notevole disconnessione tra una forte preoccupazione per il clima (media=4,0/5) e una moderata responsabilità personale (3,2/5), insieme a significative variazioni tra i paesi nell'impegno ambientale, con gli studenti portoghesi che dimostrano costantemente la più alta consapevolezza climatica e gli studenti italiani la più bassa. Mentre i rispondenti hanno fortemente sostenuto l'integrazione formale del clima nei programmi di studio (4,1/5) e hanno valorizzato i percorsi di apprendimento informale (3,8/5), hanno riportato una partecipazione limitata alle attività eco-pedagogiche (2,3/5), evidenziando un divario di implementazione nell'educazione ambientale. Gli studenti hanno valutato la loro educazione informale sul cambiamento climatico (3,5/5) più positivamente della formazione formale (3,2/5), suggerendo un potenziale non sfruttato per il riconoscimento delle esperienze di apprendimento non formale. Le differenze di genere sono emerse costantemente, con le rispondenti femmine che mostrano una preoccupazione e un impegno ambientale significativamente più elevati in più dimensioni. L'analisi delle percezioni dei badge aperti ha rivelato una familiarità moderata ma un interesse sostanziale, particolarmente quando allineati con i sistemi di accreditamento istituzionale e i quadri di riconoscimento dei datori di lavoro.

Conclusioni

Le principali sfide di implementazione identificate includono la necessità di solidi meccanismi di garanzia della qualità, supporto istituzionale e una migliore accessibilità dell'infrastruttura digitale. Questi risultati informano raccomandazioni strategiche per lo sviluppo del Passaporto Europeo dei Badge Aperti, sottolineando l'importanza di bilanciare la standardizzazione con la flessibilità contestuale, facilitando al contempo il riconoscimento dell'apprendimento climatico sia formale che informale in diversi contesti di istruzione superiore.

Hintergrund

Diese Mixed-Methods-Studie untersucht das Engagement von Studierenden für Klimafragen und ihre Wahrnehmung offener Anerkennungssysteme an vier europäischen Bildungseinrichtungen in Frankreich, Italien, Portugal und Spanien im Rahmen des Erasmus+-Projekts OpenPass4Climate. Vor dem Hintergrund des europäischen Green Deals und des UNESCO-Aufrufs zu transformativer Bildung befasst sich unsere Forschung mit dem kritischen Bedarf an innovativen Ansätzen zur Klimabildung, die Wissen und Handeln miteinander verbinden.

Methoden

Durch einen umfassenden Ansatz, der Umfragen (n=630), Einzelinterviews (n=69), nationale Fokusgruppen (n=45) und eine transnationale Fokusgruppe (n=16) kombiniert, untersuchten wir die Einstellungen der Studierenden zum Klima, ihre Bildungspräferenzen und ihre Ansichten zu digitalen Badge-Systemen zur Anerkennung von Klimakompetenzen.

Ergebnisse

Die Ergebnisse zeigen eine bemerkenswerte Diskrepanz zwischen starker Klimabesorgnis (Mittelwert=4,0/5) und mäßiger persönlicher Verantwortung (3,2/5) sowie signifikante länderübergreifende Unterschiede im Umweltengagement, wobei portugiesische Studierende durchweg das höchste Klimabewusstsein und italienische Studierende das niedrigste aufweisen. Während die Befragten die formale Integration des Klimas in die Lehrpläne (4,1/5) nachdrücklich befürworteten und informelle Lernwege schätzten (3,8/5), berichteten sie von einer begrenzten Teilnahme an ökopädagogischen Aktivitäten (2,3/5), was eine Umsetzungslücke in der Umweltbildung verdeutlicht. Die Studierenden bewerteten ihre informelle Klimawandelbildung (3,5/5) höher als ihre formale Ausbildung (3,2/5), was auf ein unausgeschöpftes Potenzial für die Anerkennung nicht-formaler Lernerfahrungen hindeutet. Geschlechterunterschiede traten konsequent zutage, wobei weibliche Befragte in mehreren Dimensionen ein signifikant höheres Umweltbewusstsein und Engagement zeigten. Die Analyse der Wahrnehmung offener Badges ergab eine moderate Vertrautheit, aber ein erhebliches Interesse, insbesondere wenn sie mit institutionellen Zertifizierungssystemen und Anerkennungsrahmen von Arbeitgebern in Einklang gebracht werden.

Schlussfolgerungen

Zu den identifizierten Hauptherausforderungen bei der Umsetzung gehören die Notwendigkeit robuster Qualitätssicherungsmechanismen, institutioneller Unterstützung und verbesserter Zugänglichkeit digitaler Infrastrukturen. Diese Erkenntnisse liefern strategische Empfehlungen für die Entwicklung des Europäischen Open Badges Passes, wobei die Bedeutung einer ausgewogenen Standardisierung mit kontextueller Flexibilität hervorgehoben wird, während gleichzeitig die Anerkennung von formalem und informellem Klimaelernen in verschiedenen Hochschulkontexten erleichtert wird.

Antecedentes

Este estudio de métodos mixtos investiga la implicación de los estudiantes con los problemas climáticos y las percepciones de los sistemas de reconocimiento abierto en cuatro instituciones educativas europeas en Francia, Italia, Portugal y España como parte del proyecto Erasmus+ OpenPass4Climate. En el contexto del Pacto Verde Europeo y el llamamiento de la UNESCO para una educación transformadora, nuestra investigación aborda la necesidad crítica de enfoques innovadores de educación climática que vinculen el conocimiento y la acción.

Métodos

A través de un enfoque integral que combina encuestas (n=630), entrevistas individuales (n=69), grupos de discusión nacionales (n=45) y un grupo de discusión transnacional (n=16), examinamos las actitudes de los estudiantes hacia el clima, sus preferencias educativas y sus opiniones sobre los sistemas de insignias digitales para el reconocimiento de competencias climáticas.

Resultados

Los resultados revelan una notable desconexión entre una fuerte preocupación por el clima (media=4,0/5) y una responsabilidad personal moderada (3,2/5), junto con variaciones significativas entre países en el compromiso ambiental, mostrando los estudiantes portugueses sistemáticamente la mayor concienciación climática y los estudiantes italianos la menor. Aunque los encuestados respaldaron firmemente la integración formal del clima en el plan de estudios (4,1/5) y valoraron las vías de aprendizaje informal (3,8/5), informaron de una participación limitada en actividades eco-pedagógicas (2,3/5), lo que pone de manifiesto una brecha de implementación en la educación ambiental. Los estudiantes valoraron más su educación informal sobre el cambio climático (3,5/5) que su formación formal (3,2/5), lo que sugiere un potencial sin explotar para el

reconocimiento de experiencias de aprendizaje no formal. Las diferencias de género surgieron de manera consistente, mostrando las encuestadas una preocupación y compromiso ambiental significativamente mayores en múltiples dimensiones. El análisis de las percepciones sobre las insignias abiertas reveló una familiaridad moderada pero un interés sustancial, particularmente cuando están alineadas con los sistemas de acreditación institucional y los marcos de reconocimiento de los empleadores.

Conclusiones

Los principales desafíos de implementación identificados incluyen la necesidad de mecanismos sólidos de garantía de calidad, respaldo institucional y mejora de la accesibilidad a la infraestructura digital. Estos hallazgos informan recomendaciones estratégicas para el desarrollo del Pasaporte Europeo de Insignias Abiertas, enfatizando la importancia de equilibrar la estandarización con la flexibilidad contextual, facilitando al mismo tiempo el reconocimiento del aprendizaje climático tanto formal como informal en diversos entornos de educación superior.

Plain language summary

Our research investigated how university students across four European countries (France, Italy, Portugal, and Spain) think about and engage with climate change issues, and what they think about using digital badges to recognize climate-related learning. We collected information through an online survey of 630 students, individual interviews with 69 participants, group discussions in each country, and an international group discussion.

The study revealed important insights about students' perspectives on climate change and environmental education. While students expressed strong concern about climate change, they felt only moderately responsible for taking action themselves. We found notable differences across demographics and countries: female students and those in advanced degree programs showed higher environmental awareness, and Portuguese students consistently demonstrated the highest climate awareness, while Italian students showed the lowest. Although students valued both formal education and informal learning about climate issues, they reported low participation in actual environmental activities. When it came to recognition of climate-related learning through digital badges, students showed moderate interest but expressed concerns about how employers would view these credentials.

These findings are significant because they help us understand how to better engage students in climate education and action. The research provides valuable insights for developing the European Open Badges Passport, a system that will recognize both formal and informal climate learning achievements. Our results suggest that effective

climate education needs to bridge the gap between awareness and action, while recognition systems must balance standardization across Europe with flexibility for local needs. The findings emphasize the importance of ensuring digital badges are credible and valued by employers, while making climate education more accessible through both traditional and innovative learning approaches. These insights will directly inform how European universities approach climate education and recognize students' environmental competencies in the coming years.

Keywords
Digital credentials, Educational policy, Environmental competencies, European Green Deal, Informal learning, Micro-credentials, Sustainability literacy, Value-action gap

This article is included in the Erasmus+ gateway.

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REVISED **Amendments from Version 1**

This revised version incorporates substantial improvements following peer review. Major changes include:

(1) Enhanced Introduction with a paper structure outline for improved navigation and full spelling of acronyms at first use.

(2) Addition of a Literature Review section positioning our empirical study within existing research on climate education and digital credentialing, explicitly stating three unique contributions: empirical assessment across European contexts, examining the climate education-digital credentialing intersection from student perspectives, and identifying implementation barriers through mixed-methods evidence.

(3) Significant expansion of the Methods section with theoretical justification for our mixed-methods design, detailed theoretical frameworks underlying each survey construct, comprehensive data collection procedures including recruitment processes and sampling strategies, and a new subsection on "Methodological limitations and mitigation strategies" transparently addressing sampling constraints, translation challenges, and analytical decisions.

(4) Clarified quantitative analysis explanation regarding non-parametric methods and interpretation of mean ranks as effect indicators.

(5) Strengthened Discussion section with enhanced literature integration, clearer explanation of Likert-Eurobarometer comparisons, expanded analysis of educational effects on climate concern, and better contextualization of national variations.

(6) Explicit acknowledgment in Limitations of the absence of political engagement measures, recognizing the importance of collective action alongside individual behavioral changes in climate movements.

(7) Standardization of terminology throughout.

These revisions strengthen the manuscript's theoretical grounding, methodological transparency, and contribution to understanding how open recognition systems can support climate education in European higher education. The core findings and conclusions remain unchanged, but their presentation, contextualization, and scholarly positioning have been substantially enhanced to better serve readers and advance the field.

Any further responses from the reviewers can be found at the end of the article

Introduction

The fight against climate change is a cornerstone of the European Union (EU) Erasmus+ program, with education recognized as a vital tool in confronting this global challenge (European Commission, 2021a). The environmental crisis confronting humanity today transcends scientific boundaries, encompassing profound social and political dimensions (Vare & Scott, 2007). As we approach the mid-2020s, the urgency of climate change and the associated loss of biodiversity necessitate an educational response, yet many schools and systems grapple with effective strategies (UNESCO, 2021). Research consistently shows that merely imparting knowledge about environmental issues is insufficient to spur meaningful change; shifts in attitudes and perceptions of the natural world are essential to catalyzing behavioral transformation (Ajzen, 1991; Bamberg & Möser, 2007; Kollmuss & Agyeman, 2002).

The European Union has responded decisively through initiatives such as the European Green Deal, launched in 2019, which outlines a roadmap for sustainable development (European Commission, 2019). Moreover, its commitment has been further reinforced by policy recommendations that stress the importance of education for environmental sustainability and advocate for incorporating youth perspectives in tackling climate and biodiversity challenges—most notably, the Council Recommendation on Learning for the Green Transition and Sustainable Development (Council of the European Union, 2022a) and the Council of Europe Recommendation on Young People and Climate Action (Council of Europe, 2024). Complementing these efforts, the European Commission's sustainability competence (GreenComp) framework provides a structured approach to fostering sustainability competencies across educational contexts (Bianchi *et al.*, 2022).

Within this framework, the OpenPass4Climate project emerges as an innovative initiative under the Erasmus+ program, introducing an open recognition alliance system to enhance climate education. By leveraging Open Badges and the OpenPass4Climate platform, the project aims to elevate climate-related activities from awareness to actionable commitment and justice. It seeks to evaluate the tangible impacts of these efforts on advancing climate justice and to identify mechanisms that accelerate the adoption of positive behaviors. A core objective is the creation of a lifelong, portable OpenPass4Climate system, empowering individuals to engage actively in climate initiatives.

To ensure the system's efficacy, work package 3 (WP3) focused on understanding students' engagement with climate issues, assessing key climate commitments, and exploring perceptions of both implicit and explicit recognition mechanisms. This comprehensive study spanned four European countries (France, Italy, Portugal, and Spain) and employed multiple research methods: an online survey, one-to-one interviews, national focus groups, and a transnational focus group. These efforts provide insights into youth perceptions of climate change, educational preferences, and attitudes toward open recognition systems, informing the co-design of an effective Open Badge system.

This article details the research methodology, presents findings from all study components, analyzes results within the context of contemporary European environmental and educational frameworks, and offers recommendations for the OpenPass4Climate system's implementation. The findings aim to support the development of student-centered curricula and flexible learning pathways that bridge knowledge and action, fostering a generation of environmentally conscious citizens.

This paper is structured as follows: Section 2 reviews relevant literature on climate education and open recognition systems, identifying key gaps this study addresses. Section 3 details our mixed-methods methodology across four European countries. Section 4 presents quantitative survey results and qualitative findings from interviews and focus groups. Section 5 discusses these findings in relation to existing literature and policy

frameworks. Section 6 concludes with implications for implementing open recognition systems in climate education contexts.

Literature review

The intersection of climate education and digital recognition systems represents an emerging field with significant potential yet substantial implementation gaps. This section synthesizes current knowledge to contextualize our empirical investigation of student engagement and perceptions.

Climate education in higher education

Climate education in European higher education faces multiple challenges. Research indicates that while environmental awareness among university students generally exceeds that of the general population (Leal Filho *et al.*, 2021a), this awareness frequently fails to translate into action (Kollmuss & Agyeman, 2002; Uitto *et al.*, 2015). The European Commission's GreenComp framework (Bianchi *et al.*, 2022) provides structured competencies for sustainability education, yet implementation remains fragmented across institutions and disciplines.

Recent Eurobarometer surveys reveal concerning patterns: while 77% of EU citizens view climate change as very serious (European Commission, 2023), only 35% feel personally responsible for addressing it, and merely 24% identify education as an effective intervention (European Commission, 2020a). This suggests a critical gap between awareness and agency that educational interventions must address.

Open recognition systems in education

Digital credentials, including open badges and micro-credentials, offer promising mechanisms for recognizing diverse learning pathways essential for climate competency development. The companion scoping review from our project (Martín-Ramos *et al.*, 2025) analyzed 70 publications on digital credentials for environmental competencies, revealing three critical gaps: first, a definitional and standardization gap: inconsistent standards across institutions undermine credential portability and recognition. Second, a trust and awareness gap: employers and educational institutions show limited understanding of digital credentials' value, restricting their currency in professional contexts. Third, and most significantly for our study, an implementation gap in climate education: of 70 publications reviewed, only 8 (11.4%) addressed environmental or climate contexts, with a complete absence of frameworks for recognizing eco-pedagogical activities (the experiential, action-oriented learning central to climate education).

Research gap and study rationale

While theoretical frameworks exist for both climate education (UNESCO, 2021) and digital credentialing (Council of the European Union, 2022b), empirical evidence on student perceptions, needs, and engagement with these systems remains scarce. No studies have systematically examined how students across different European contexts perceive the intersection of climate learning and open recognition, nor how cultural and institutional variations influence these perceptions.

Our study addresses this gap through a cross-national empirical investigation, moving beyond theoretical frameworks to understand actual student attitudes, behaviors, and requirements for effective implementation of open recognition in climate education. This evidence is essential for bridging the identified implementation gap and developing student-centered approaches to climate competency recognition. Specifically, our study makes three distinct contributions: (1) provides an empirical assessment of student perceptions across multiple European contexts, (2) examines the intersection of climate education and digital credentialing from a student-centered perspective, and (3) identifies implementation barriers and facilitators through mixed-methods evidence rather than theoretical speculation.

Methods

This study employed a sequential explanatory mixed-methods design (Creswell & Plano Clark, 2018), integrating quantitative and qualitative approaches to comprehensively explore student perspectives on climate change and open recognition. This methodological choice was guided by pragmatist philosophy, which emphasizes using the most appropriate methods to answer research questions rather than adhering to single paradigmatic constraints (Morgan, 2007).

Research design and rationale

The sequential explanatory design was selected for three methodological reasons. First, the quantitative phase enables broad pattern identification across national contexts, essential given the diversity of European educational systems. Second, the qualitative phase provides explanatory depth, revealing the contextual factors and reasoning behind observed patterns, critical for understanding culturally-embedded attitudes toward climate action. Third, this approach aligns with mixed-methods best practices for exploring complex educational phenomena where neither quantitative nor qualitative data alone would suffice (Tashakkori & Teddlie, 2010).

The integration occurred at multiple points: survey results informed interview and focus group protocols, quantitative patterns guided qualitative sampling strategies, and both data types were synthesized during interpretation. This methodological triangulation enhances validity through convergent evidence while allowing divergent findings to reveal complexity (Denzin, 2012).

Survey design and theoretical framework

A 20-question survey (Annex I in the Extended Data) was administered to students from four European countries (France, Italy, Portugal, and Spain). The survey, designed by consortium members and crafted in compliance with the European Union's General Data Protection Regulation, collected demographic information including age, gender, education level, and country of study. Gender was determined through self-identification, with

participants selecting from options including 'Male', 'Female', 'Non-binary', 'Prefer not to say', and an open text option for other gender identities. This approach aligns with best practices in gender-inclusive research design.

The survey instrument comprised 20 questions organized around seven theoretically-grounded constructs, each selected based on established environmental psychology and education research:

- *Climate change views* (Questions 1–4): Based on risk perception theory (Slovic, 2000) and climate change communication research (Moser, 2010), these items assessed cognitive and affective dimensions of climate awareness, including threat perception, causal attribution, efficacy beliefs, and governance expectations.
- *Environmental values and identity* (Questions 5–7): Drawing from Value-Belief-Norm theory (Stern, 2000) and the 2-MEV model (Bogner & Wiseman, 2006; Johnson & Manoli, 2010), these questions examined intrinsic environmental values, prioritization against competing values, and the values-action alignment gap documented in environmental psychology (Blake, 1999).
- *Personal responsibility and emotional responses* (Questions 8–9): Grounded in moral norm activation theory (Schwartz, 1977) and eco-anxiety research (Pihkala, 2020), these items explored responsibility attribution and emotional responses to environmental futures, recognizing emotions as action motivators or barriers.
- *Social norms* (Questions 10–11): Based on social cognitive theory (Bandura, 1986) and normative influence research (Cialdini & Goldstein, 2004), these questions assessed perceived descriptive and injunctive norms within peer groups and authority structures.
- *Eco-pedagogical activities* (Questions 12–14): Informed by experiential learning theory (Kolb, 1984) and environmental education effectiveness research (Ardoin *et al.*, 2018), these items evaluated exposure to and engagement with formal and informal climate education.
- *Learning interests and training preferences* (Questions 15–17): Drawing from self-determination theory (Deci & Ryan, 2000) and adult learning principles (Knowles *et al.*, 2020), these questions assessed intrinsic motivation for climate learning and preferences for pedagogical approaches.
- *Open badges system/awareness* (Questions 18–20): Based on digital credentialing research (Gibson *et al.*, 2015) and recognition theory (Honneth, 1995), these items explored familiarity with and perceived value of alternative credentialing systems.

Response options used a 5-point Likert scale with clearly defined anchors (1=strongly disagree/very low, 5=strongly agree/very high) to ensure consistent interpretation across respondents.

The survey instrument was initially pilot tested with a group of students from Consorzio Scuola Comunità Impresa (CSCI) to assess clarity, comprehensibility, and response patterns. Feedback from this pilot phase was incorporated into the final version of the questionnaire. Internal consistency and reliability were assessed using Cronbach's alpha coefficient.

Data collection procedures

Survey administration

The survey was administered online using Microsoft Forms (chosen for GDPR compliance and institutional accessibility) from March to May 2023. Distribution employed a multi-channel convenience sampling approach:

- *Institutional channels*: Survey invitations were sent through official institutional email lists to all registered students at each partner institution. An email reminder was sent at 14 days post-initial invitation.
- *Classroom promotion*: Faculty members announced the survey during lectures, providing QR codes for immediate access. This dual approach aimed to reach students who might overlook institutional emails.
- *Inclusion criteria*: Current enrollment at partner institutions; informed consent provided.

The final sample (n = 630) comprised: high school students (primarily from Italian technical institutes affiliated with CSCI), undergraduate students (from all four countries), and postgraduate students (Master's and PhD levels, predominantly from France and Portugal).

One-to-one interviews

Interview participants were recruited through a two-stage process:

Stage 1 - Expression of interest: The final survey question asked: "*Would you be willing to participate in a follow-up interview to discuss your views on climate commitments in more detail?*" Interested respondents provided email addresses after reviewing data protection information.

Stage 2 - Purposive selection: From volunteers (n = 147), we selected 69 participants using maximum variation sampling (Palinkas *et al.*, 2015) to ensure diversity in:

- Gender (targeting 50% female representation)
- Educational level (high school through PhD)
- Survey response patterns (high/medium/low climate concern scores)

Selected participants received detailed information sheets and consent forms. Interviews were scheduled at participants' convenience, conducted in native languages via video call or in-person based on participant preference.

Interview structure: A set of 12 questions (Annex III in the Extended Data), designed by consortium members based on

feedback from each partner institution's teaching staff and students, structured the interviews into four blocks: '*Climate change views*', '*Eco-pedagogical activities*', '*Learning interests and training preferences*', and '*Open badges system/awareness*'. Interviews were conducted in participants' native languages without time constraints, allowing respondents to elaborate as needed for each question.

National focus groups

Recruitment: national focus groups (n = 45 total participants) followed a stratified purposive approach:

- *Pool identification*: Interview participants were asked about focus group interest.
- *Selection criteria*: Educational level diversity, gender balance, availability for 90-minute sessions.
- *Final composition*: France (17 undergraduates), Italy (6 high school/vocational students), Portugal (12 mixed levels: 5 Bachelor's, 5 Master's, 2 PhD), Spain (10 undergraduate/Master's).

Sessions were conducted in-person at partner institutions (except 2 Spanish participants who joined virtually due to distance), moderated by native-speaking researchers using a semi-structured protocol.

Focus group protocol: The focus groups addressed 12 questions (Annex IV in the Extended Data) organized into four thematic blocks: '*Climate change views*', '*Personal responsibility and social norms*', '*Learning interests and training preferences*', and '*Open badges system/awareness*'. Each consortium member conducted the focus group in their country using the participants' native language.

Data protection: As in the case of the one-to-one interviews, to comply with General Data Protection Regulation (GDPR) requirements, personally identifiable information and full transcripts were only accessible to the educational institution to which students belonged, with anonymized reports shared among consortium members. This approach balanced research needs with privacy protection while enabling cross-national analysis.

Transnational focus groups

This culminating session required specific selection and procedures:

Participant selection (n = 16):

- *Eligibility*: Previous participation in national focus groups
- *Selection process*: Each country nominated 6–8 candidates based on English proficiency (self-assessed B2 level minimum), demonstrated engagement in climate discussions, and availability for synchronous online participation.
- *Final selection*: Four participants per country, ensuring educational level representation (Italian high school, French undergraduate, Portuguese Master's, Spanish PhD students) and gender balance (9 female, 7 male).

Session procedures: Participants were contacted by their institutions regarding the purpose, objectives, and expected outcomes, with informed consent obtained for participation and research data use. The session used Miro (a GDPR-compliant collaborative platform) with real-time interaction features. Rather than recording the session, Miro's notes feature captured relevant information and insights during discussions, facilitating free and open dialogue while maintaining participant privacy. This approach allowed participants to express views more freely while creating a permanent visual record of the discussion through collaborative board contributions. The session lasted 2 hours with structured activities including individual reflection, small group work, and plenary discussion.

Data analysis

The analysis followed a sequential mixed-methods approach. Quantitative survey data underwent statistical analysis using IBM SPSS Statistics v.27 (IBM Corp., Armonk, NY, USA). For reproducibility purposes, all statistical analyses conducted in this study can be replicated using R statistical software, an open-source alternative that provides equivalent statistical capabilities.

Given the ordinal nature of Likert scale data and non-normal distributions, non-parametric statistical methods were employed. The Kruskal-Wallis test was used for comparing three or more independent groups, with statistical significance set at $p < 0.05$. *Post-hoc* multiple pairwise comparisons used the Conover-Iman procedure with Bonferroni correction to control for Type I error.

Annex II (Extended Data) provides mean Likert scores for all survey items by demographic groups, p-values from Kruskal-Wallis tests, mean ranks indicating relative group positions, and Conover-Iman *post-hoc* comparisons shown through letter notation. For non-parametric analyses of ordinal data, the mean rank differences serve as indicators of effect magnitude, with larger rank separations indicating stronger practical effects. The complete dataset and analysis are available for researchers interested in alternative analytical approaches.

Qualitative data from interviews and focus groups were subjected to thematic analysis. The integration phase employed a convergent design, wherein quantitative and qualitative findings were compared and contrasted to identify areas of convergence and divergence.

Methodological limitations and mitigation strategies

To address potential methodological limitations, several measures were implemented throughout the study design and analysis phases. The sample composition, while diverse across four countries and multiple educational levels, showed inherent limitations that required careful analytical consideration.

Regarding sample size limitations, categories with insufficient representation were excluded from the survey analysis to

avoid spurious findings and maintain statistical validity. Specifically, we excluded respondents identifying as "Lifelong learner/Other" (n = 6, 1.0%), "Middle School/Junior High" students (n = 3, 0.5%), and PhD students (n = 8, 1.3%) from educational level comparisons due to their minimal representation. Similarly, for gender-based analyses, respondents selecting "Other" or "Prefer not to say" (n = 19, 3.0%) were excluded, as this heterogeneous category prevented meaningful interpretation. These exclusions, while necessary for analytical rigor, represent 5.7% of the total sample and may limit our understanding of these specific populations' perspectives.

The relationship between age and educational level presented another analytical challenge. Initial examination revealed substantial overlap between these demographic variables, with the 18–24 age group comprising primarily Bachelor's degree students (n = 194) and Master's degree students (n = 155), representing 80.8% of this age category. Similarly, the under-18 group consisted predominantly of high school students (n = 139 of 153 total). This overlap would have created multicollinearity issues in analyses including both variables. Consequently, we retained only educational level as the analytical variable, as it provided greater differentiation and more meaningful interpretation than age categories, particularly given our focus on educational contexts for climate learning.

Translation and cultural equivalence across four linguistic versions presented challenges at multiple stages. For the survey instruments, back-translation procedures (Brislin, 1970) were employed to ensure semantic equivalence, and each partner institution conducted cognitive interviews with three students before deployment to identify comprehension issues. However, subtle cultural differences in interpreting climate-related concepts may have introduced unmeasured variance. For the qualitative phases, while interviews and focus groups were conducted in participants' native languages to ensure authentic expression, subsequent translation of findings into English for cross-consortium analysis required careful attention. Review by multiple consortium members fluent in both the source language and English helped maintain accuracy and consistency, though some nuance may have been lost in translation. These linguistic considerations apply particularly to the interpretation of culturally-embedded concepts such as "personal responsibility" and "political action," which may carry different connotations across the four national contexts.

The convenience sampling approach, while pragmatic for accessing diverse student populations across four countries, limits generalizability beyond the participating institutions. Students who self-selected to participate may have stronger environmental interests than non-participants, potentially inflating engagement measures. This selection bias is partially addressed through our mixed-methods design, where qualitative data provides context for interpreting potentially inflated quantitative measures.

Finally, we acknowledge that convenience sampling may introduce selection bias toward environmentally engaged students, as those who self-selected to participate likely have stronger environmental interests than non-participants. While this potentially inflates engagement measures, our mixed-methods design partially addresses this limitation by providing qualitative context that helps interpret the quantitative findings.

Results

Survey findings

Reliability and sample characteristics

The survey garnered responses from 630 participants, with demographic analysis (Figure 1) revealing that 69% fell within the 18–24 age bracket. Gender distribution showed 60% female respondents compared to 37% male respondents. The sample's educational composition included Bachelor's

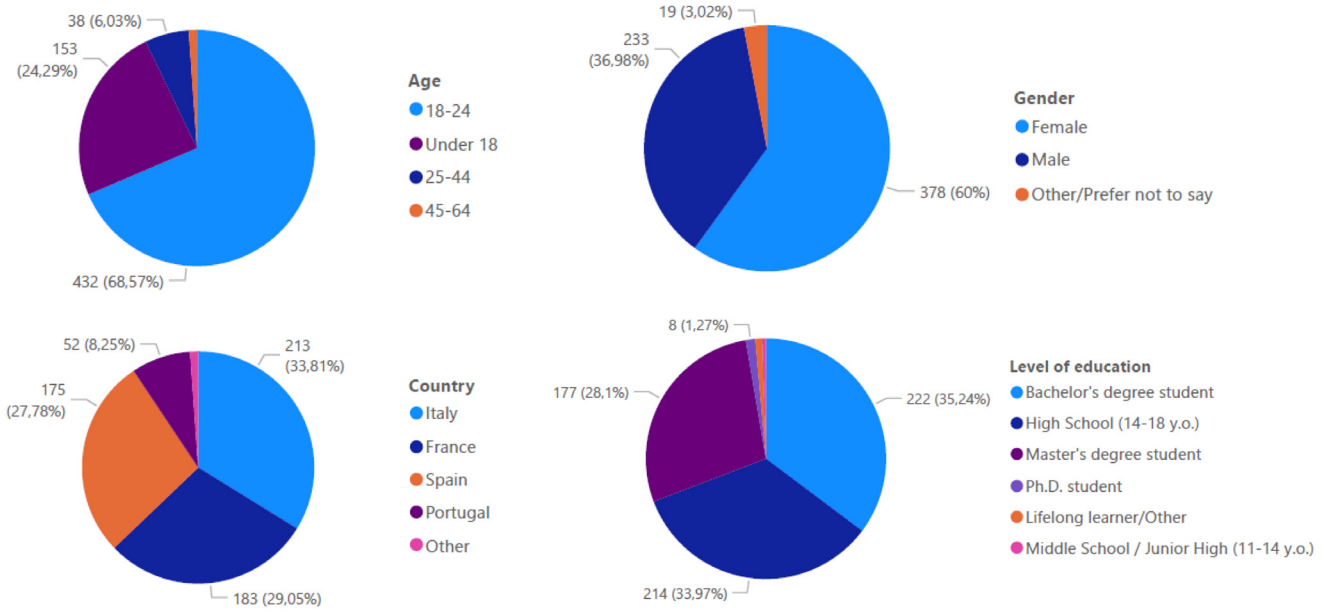

Figure 1. Profile of the survey respondents.

degree students (35%, with 150 from Spain, 43 from France, and 27 from Portugal), A-level students (34%, predominantly from Italy), and Master's degree students (28%, with 134 from France, 19 from Portugal, and 18 from Spain).

The survey's internal consistency, assessed through Cronbach's alpha coefficient (0.847) and standardized Cronbach's alpha (0.848), demonstrated strong reliability in measuring latent factors among subjects.

Climate attitudes and values

Climate change views (questions 1–4; Annex II in the Extended Data, Tables S1 and S2)

Respondents expressed significant concern about climate change (mean=4.0/5), with strong consensus acknowledging human activities as major contributors (4.4/5). Participants generally believed in an individual capacity to impact climate change (3.7/5) and strongly endorsed government intervention (4.4/5). Statistical analysis revealed:

- Significantly higher scores among female students across all four questions
- Higher concern levels among university students compared to other educational levels
- Country-level variations, with Italian students showing the lowest scores and Portuguese students consistently the highest

Environmental values and identity (questions 5–7; Annex II in the Extended Data, Tables S1 and S2)

Environmental protection received high importance ratings (4.5/5), though prioritizing it over economic growth garnered less support (3.8/5). Respondents reported medium-high alignment between actions and environmental values (3.6/5), with notable variations:

- Female students showed the highest scores for environmental values items
- No significant gender differences in action alignment
- Master's students and French students reported the lowest alignment
- Portuguese students demonstrated the highest alignment scores

Personal responsibility and emotional responses (questions 8–9; Annex II in the Extended Data, Tables S1 and S2)

Results showed a moderate sense of responsibility for reducing climate change effects (3.2/5), with:

- Significantly higher scores among female respondents
- Lowest scores among French students
- Highest scores among Portuguese students
- General lack of hope about the environmental future (2.6/5)
- Greater optimism among the youngest respondents and Portuguese/Italian students

Social norms (questions 10–11; Annex II in the Extended Data, Tables S1 and S2)

Participants reported medium levels of environmental concern in their social circles (2.9/5), with:

- Highest scores among Master's students
- Lower perceptions (2.4/5) of environmental care by authority figures
- Lowest scores in France
- Highest scores in Italy and Portugal

Educational engagement

Eco-pedagogical activities (questions 12–14; Annex II in the Extended Data, Tables S3 and S4)

Formal climate change training was rated as moderate (3.2/5), while informal education scored slightly higher (3.5/5). Key findings included:

- Higher scores among female and Master's students
- Higher participation rates in France and Portugal
- Low overall participation in eco-pedagogical activities (2.3/5)

Learning interests and training preferences (questions 15–17; Annex II in the Extended Data, Tables S3 and S4)

Students showed moderate-to-high interest in climate-related learning (3.8/5), with:

- Strong support for formal curriculum integration (4.1/5)
- High endorsement of informal learning effectiveness (4.1/5)
- Higher scores among female and Master's level students
- Particularly strong interest in France and Portugal

Open recognition systems

Open badges system/awareness (questions 18–20; Annex II in the Extended Data, Tables S3 and S4)

Results indicated:

- Moderate valuation of climate-related learning recognition (3.5/5)
- Limited motivation for earning open badges (3.2/5)
- Neutral stance on employability impact (3.0/5)
- Higher optimism among Portuguese students (3.5/5)

Statistical analysis revealed significant country-level differences for 12 out of 20 items, emphasizing the importance of considering national contexts in implementation strategies.

Interview and focus group findings

One-to-one interviews

Participant profiles

The interviews involved 69 participants across four countries:

- France: 17 respondents (14 females, 3 males), primarily second-year Environmental Engineering and Agri-Food degree students
- Italy: 23 respondents (14 males, 9 females) aged 17–18, representing diverse educational fields including Administration, Finance, Marketing, Agriculture, and others
- Portugal: 10 Master's level students (5 females, 5 males) from the School of Business and Economics
- Spain: 19 respondents (11 females, 8 males) across undergraduate (11), Master's level (3), and PhD-level (5) programs

Common themes across countries

Pressing environmental issues emerged as a primary concern, with climate change universally recognized as the most critical issue. Participants specifically highlighted global warming, CO_2 emissions, pollution across multiple domains (air, water, soil), deforestation, biodiversity loss, and waste management challenges.

Individual actions were emphasized across all interviews, with participants identifying key behavioral changes such as reducing meat consumption, using public transportation, practicing recycling, raising awareness through education, and adopting responsible consumption habits.

Participants across countries supported regulatory measures and environmental taxes to drive change, emphasizing the role of politicians, governments, and corporations. Most respondents reported receiving climate-related training through both formal university courses and informal methods such as workshops and documentaries.

Country-specific insights

Italian participants provided detailed insights into local waste management practices and emphasized the need for improved energy efficiency systems. French students demonstrated a strong interest in innovative sustainability solutions and emphasized the importance of robust government policies. Portuguese respondents highlighted community-driven initiatives and advocated for comprehensive educational reforms. Spanish participants showed clear preferences for experiential and practical learning methods, with a strong dislike for purely online learning formats.

National focus groups

Participant distribution

The national focus groups comprised:

- France: 17 undergraduate students (14 females, 3 males)
- Italy: 6 vocational and high-school students (3 females, 3 males)
- Portugal: 12 students (7 females, 5 males) across Bachelor's (5), Master's (5), and PhD (2) levels
- Spain: 10 undergraduate and Master's level students (8 females, 2 males)

Key findings

Participants across all countries acknowledged the severity and urgency of climate change, citing issues such as global warming, extreme weather events, pollution, and biodiversity loss. There was strong consensus regarding climate change's impact on future generations, particularly concerning food security, health issues, economic instability, and increased migration.

Education emerged as crucial in fostering environmental awareness and promoting sustainable practices. Participants advocated for integrating environmental education into school curricula from an early age, ensuring comprehensive approaches beyond superficial treatment of topics.

Country-specific variations revealed:

- Italian participants emphasized economic consequences, particularly agricultural impacts
- French participants discussed eco-anxiety and psychological effects
- Portuguese participants focused on greenwashing issues and corporate transparency
- Spanish participants provided detailed insights into local climate impacts

International focus group

The transnational focus group involved 16 students (4 per country) representing different educational levels. Discussions focused on badge design, implementation preferences, and potential concerns.

Badge design and comprehension

Participants critiqued the badge design, noting readability challenges with white text on light backgrounds. They suggested green and orange hues to reflect nature and confidence, respectively, alongside clearer classification descriptions and refined graphics and logo sizes for visual clarity.

Implementation recommendations

For implementation, they advocated user-friendly features, such as progress-tracking tools and detailed tutorials, as well as highlighting training hours in metadata for EU-wide recognition. They also proposed gamification (e.g., weekly challenges) and integration with LinkedIn and university transcripts to enhance utility.

Potential concerns

Participants raised concerns about employer preferences for traditional certificates, uncertainty about badge value in job applications, and risks of superficial learning focused on badge acquisition rather than genuine knowledge gain. They emphasized the need for technical support and guidance for organizations implementing the badge system.

These findings provided insights for developing the badge system's design and implementation strategy while highlighting important considerations for ensuring its effectiveness and credibility.

Discussion

The multi-method approach of this study provides robust insights into youth climate attitudes, educational preferences, and perceptions of open recognition systems. Building on prior European research, such as the Special Eurobarometer 501 (European Commission, 2020a) and 538 (European Commission, 2023), the findings reveal both encouraging trends and persistent challenges in climate education and competency development, particularly within educational contexts and among younger populations.

When comparing our Likert scale means (1–5) with Eurobarometer percentage data, we interpret scores above 4.0 as indicating that approximately 80% of respondents lean toward agreement (since 4.0 represents the "agree" point on our scale), while scores around 3.0 suggest neutral or mixed responses. This interpretation allows approximate comparison with Eurobarometer's binary percentage findings, though we acknowledge these are different measurement approaches. Furthermore, our student sample represents a specific subpopulation (younger, currently engaged in education) and comparisons with general population surveys should be understood as exploratory rather than definitive.

The methodological approach of interpreting Likert means as probability distributions follows established psychometric conventions (Norman, 2010). This enables meaningful comparison with binary response formats while acknowledging inherent measurement differences. Our approach aligns with recommendations for cross-survey comparisons in environmental attitude research (Dunlap *et al.,* 2000).

Environmental attitudes and climate awareness

Concerning the first construct on '*Climate change views*', a comparison of our survey results with the Eurobarometer findings reveals important insights into youth climate attitudes within the broader European context. Our student respondents demonstrated high climate concern (Q1, mean=4.0/5), which aligns with but intensifies the general public sentiment captured in Eurobarometer 538 (QC2, *'How serious a problem do you think climate change is at this moment?*'), where 77% of EU citizens view climate change as a very serious problem. Country-specific trends (Portugal, 4.48 > France, 4.11 > Spain, 3.91 > Italy, 3.76) were quite consistent with those obtained in the Eurobarometer 538 (Portugal, 89% > Spain, 86% > France, 85% > Italy, 83%), with Portugal and Italy ranking first and last, respectively.

This pattern of heightened concern among students compared to the general population aligns with literature documenting the relationship between educational attainment and environmental awareness. Meyer (2015) found that each additional year of education increases climate concern, while Poortinga *et al.* (2019) identified longer formal education as a strong predictor of climate action readiness. Our findings extend this work by demonstrating that this educational effect persists even within student populations, with Master's students showing significantly higher engagement than undergraduate peers.

The OpenPass4Climate survey (Q2) provided unique insight into students' strong belief in human responsibility for climate change (4.4/5 overall, with Portugal's highest at 4.8/5), a perspective not directly measured in the Eurobarometer surveys.

When examining individual roles in tackling climate change (Q3), student respondents showed a stronger belief in individual impact (3.7/5) compared to the relatively low percentages in Eurobarometer 538 (QC3, '*In your opinion, who within the EU is responsible for tackling climate change?*'), in which only 35% of respondents (EU27-average) felt personally responsible for tackling climate change. This suggests that students may feel more empowered than the general population. Interestingly, Portugal showed the highest belief in our survey (3.98/5), and lower than the EU27 average (28%) in the Eurobarometer, while Italy showed the lowest belief in both surveys (3.57/5 and 20%, respectively).

Our students' strong endorsement of government intervention (4.4/5) substantially exceeds Eurobarometer 538's (QC3) finding that only 56% of EU citizens primarily assign responsibility to governments. This generational difference aligns with Han and Ahn's (2020) analysis of youth climate movements, which identified a fundamental shift from individual responsibility narratives toward demands for systemic change. The Fridays for Future movement exemplifies this transition, with young people explicitly rejecting individualized solutions in favor of structural transformation. This also connects with strong support for coordinated intervention, with Eurobarometer 501 (QA8) showing that 70% of the respondents favor joint EU decision-making on environmental issues. As for country differences, Portuguese students' strong support in our survey (4.63/5) contrasts with the lower support in Eurobarometer 538's QC3 (47% and 52% for national governments and the EU, respectively), while Italy's lowest scores in both surveys are consistent.

With regard to the '*Environmental values and identity*' construct, the relationship between environmental values and actions revealed interesting patterns across surveys. Younger populations demonstrated heightened endorsement of environmental protection (Q5, 4.5/5) compared to national averages: in Eurobarometer 501 (QA1, '*How important is protecting the environment to you personally?*'), only 53% (EU-27 average value) of the respondents chose 'very important'. The highest score among Portuguese students (4.75/5) aligns with the results from the Trends in International Mathematics and Science Study (TIMSS) 2023 survey, where Portugal ranked better (522±2.6) than Italy (517±3.7) and France (511±4.3) in terms of 'Students Value Environmental Preservation' (von Davier *et al.*, 2024).

However, despite strong endorsement of environmental protection, alignment between values and actions was moderate

(Q7, 3.6/5), highlighting a 'value-action gap' (Uitto *et al.*, 2015). This phenomenon is well-documented, with Kollmuss and Agyeman (2002) identifying its roots in psychological barriers (e.g., perceived lack of efficacy), structural constraints (limited sustainable options), and social factors (conflicting norms). Our qualitative data enrich this framework: students explicitly articulated feeling "overwhelmed" by the magnitude of climate change while questioning whether "small actions even matter", classic symptoms of psychological distance and efficacy doubts (Gifford, 2011).

This disconnect finds parallels in broader European data. For instance, in Eurobarometer 538 (QC5, '*Have you personally taken any action to fight climate change over the past six months?*'), only 63% of the respondents said 'yes', with concrete actions varying significantly (QC6). Similarly, in Eurobarometer 501 (QA9), 67% of the respondents recognized that they were not doing enough as citizens to protect the environment. Interestingly, Italy's highest action-value alignment in our survey (3.71/5) contrasts with its lowest value in Eurobarometer 538 (52%), suggesting that this gap may be narrowing among the country's more environmentally aware youth populations.

For the '*Personal responsibility and emotional responses*' construct, a dimension not covered in the Eurobarometer surveys, our survey shows students felt only moderately responsible for reducing the negative effects of climate change (Q8, 3.2/5), with a lower value than the one indicated above for Q3 on how much individuals can make a difference in addressing climate change (3.7/5). This further supports that they predominantly place the onus for climate action on governments while underestimating potential individual responsibility and contributions. Regarding the hopefulness about the future of the environment (Q9), they were mostly pessimistic (2.6/5). This prevailing sense of hopelessness about the environment's future is consistent with their perception of those in leadership positions within their countries, who they consider can make a difference, as indifferent to environmental issues (see below).

Analysis of the '*Social norms*' construct reveals that respondents in our survey considered that people in their social circle cared less than them about the environment and climate change (Q10, 2.9/10 vs. Q5, 4.5/5), which does not align with the actual perception in their countries according to Eurobarometer 538 QC2 (83 to 89% of respondents considered climate change a very serious problem). Their view on how much people in positions of responsibility (national government, regional government) in their country care and take action to protect the environment and climate change yielded a very low value (Q11, 2.3/5). This aligns with Eurobarometer 538 (QC7), in which 67% (EU27-average) of the respondents believed their governments are not doing enough, and with Eurobarometer 501 (QA9), in which 72% and 68% of the respondents considered that their national governments and the EU were not doing enough to protect the environment.

As for other aspects not analyzed in the Eurobarometer surveys, gender differences emerged in our survey, with female respondents consistently scoring higher on environmental values, aligning with established research (McCright, 2010; McCright & Xiao, 2014; Zelezny *et al.*, 2000), though Portugal's uniformly high scores suggest cultural and educational contexts may mitigate such disparities.

The educational level also emerged as a significant factor in environmental engagement. Master's students showed the highest rates of climate awareness and advocacy, which aligns with the United Nations Educational, Scientific and Cultural Organization's (UNESCO) analysis of how specialized education enhances pro-environmental behavior, particularly among Science, Technology, Engineering, and Mathematics (STEM) graduates (Nair-Bedouelle, 2021).

Eco-pedagogical activities, learning interests, and training preferences

Results from the '*Eco-pedagogical activities*' construct indicate that students rated their informal climate change education (Q13, 3.5/5) more highly than their formal training (Q12, 3.2/5). This preference for informal learning sources mirrors Eurobarometer 501's QA4 findings, where respondents primarily relied on television news (66%) and the internet (38%) for environmental information rather than formal educational channels. The higher scores for perceived climate change training in France (Q12, 3.51/5; Q13, 3.66/5), with Portugal ranking second, do not align with the results from the TIMSS 2023 survey where Portugal ranked better (520±2.9) than Italy (504±3.8) and France (492±3.6) in terms of 'Average Environmental Knowledge' score (von Davier *et al.*, 2024).

Despite high interest in climate-related learning (Q15, 3.8/5), participation in eco-pedagogical activities was low (Q14, 2.3/5). This participation gap mirrors the findings from Eurobarometer 501, in which eco-pedagogical activities (e.g., attending a workshop about environmental issues or a collective beach or park cleanup) showed consistently low engagement rates across member states (7% EU-27 average). Moreover, in Eurobarometer 501's QA10, providing more information and education was only chosen as an effective way of tackling environmental issues by 24% of the respondents.

This dramatic difference between our students' valuation of educational interventions, particularly their strong support for formal curriculum integration (Q16, 4.1/5) and informal pathways (Q17, 3.8/5), and the general population's skepticism reveals a critical perception gap. Monroe *et al.* (2019) suggest this reflects experiential differences: those currently in education systems better understand pedagogical potential, while older generations may view education through outdated transmissive models that indeed show limited effectiveness for behavior change. This interpretation is supported by research showing that effective climate change education relies on active, participatory, and personally relevant strategies rather than traditional information transmission approaches.

National focus groups underscored these preferences, with students advocating for hybrid learning models that combine theoretical knowledge with practical, community-based activities.

This aligns with the European Commission's emphasis on flexible learning pathways (European Commission, 2021a) and the GreenComp framework's call for holistic sustainability education that fosters critical thinking, problem-solving, and collaboration (Bianchi *et al.*, 2022).

Open recognition systems: bridging theory and practice

The identified value-action gap suggests that recognition systems could incentivize action, even though the initial survey showed that students only moderately valued recognition for completing climate-related learning activities (Q18, 3.5/5) and showed even less interest in open badges as a motivation tool to learn about climate-related topics (Q19, 3.2/5). As subsequently evidenced during the one-to-one interviews and national focus groups, this was partly due to the students' limited understanding of the open badges system and its value for recognizing and showcasing climate-related learning achievements (underscoring the need for targeted awareness campaigns and educational initiatives regarding its purpose and applications) and partly due to real-world applicability concerns, a notion supported by the transnational focus group's emphasis on quality assurance, institutional credibility, and alignment with existing qualification frameworks. Participants expressed concerns about employer recognition of badges, technological barriers (e.g., lack of access to digital platforms in rural areas), and the risk of superficial learning if badges are awarded without rigorous assessment. These challenges resonate with broader EU competency framework efforts (European Commission: Joint Research Centre, 2025) and UNESCO's call for transformative education that fosters deep, meaningful engagement (UNESCO, 2021).

On the question of employability (Q20, 3/5), the survey's neutral perception contrasts with evidence from the World Economic Forum's 2023 Future of Jobs Report, which indicates growing employer recognition of sustainability-focused credentials (Di Battista *et al.*, 2023). This discrepancy aligns with critiques of poor institutional communication about credential portability (Oliver, 2022). However, Portuguese students were more optimistic (3.5/5), which may be tentatively attributed to Portugal's comprehensive digital education strategy, particularly the Digital Transition Action Plan (PDE) adopted in 2020, which the European Schoolnet highlighted as a transformative System Change Case Study (Wastiau *et al.*, 2024). This initiative, complemented by the National Digital Skills Initiative e.2030 (INCoDe.2030) and the Portuguese government's strategic funding of Universidade Aberta, has created an integrated approach to digital micro-credentials and open education for certifying competencies (Griffiths *et al.*, 2024). Such coordinated national efforts align with and advance broader EU initiatives to embed Open Badges in educational frameworks (Council of the European Union, 2022b; EQAR, 2023).

Addressing these concerns will require careful design, ensuring that badges are credible, user-friendly, and integrated with existing educational and professional frameworks. For example, badges could be aligned with the European Qualifications Framework (European Commission, 2018) to enhance their recognition across borders. The European Council's emphasis on whole-institution approaches (Council of the European Union, 2022a) provides a supportive context for such developments, encouraging universities to adopt open recognition systems as part of their sustainability strategies.

Policy implications

The research findings advocate for coordinated policy interventions across European, national, and institutional levels to advance climate education and open recognition systems. Each level presents distinct challenges and opportunities that must be addressed through carefully crafted policy frameworks.

At the European level, the European Union must establish comprehensive frameworks that balance standardization with national adaptability. This requires developing quality assurance mechanisms for open badge systems that set minimum standards while allowing flexibility for national and regional adaptation (Council of the European Union, 2022b). These mechanisms should ensure alignment with existing European qualification frameworks (European Commission, 2018) while supporting accessibility through multilingual resources and platforms. The EU must also provide funding for digital infrastructure, particularly in underserved regions, and establish standardized protocols for badge portability across member states. Integration with broader EU initiatives is crucial, including alignment with European Green Deal educational objectives (European Commission, 2019) and coordination with the Digital Education Action Plan implementation to support cross-border recognition of climate-related credentials.

National-level policy development should focus on the systemic integration of climate education and recognition within existing educational frameworks. Curriculum development requires thoughtful integration of climate competencies into national frameworks, with consideration given to increasing mandatory climate education hours (UNESCO, 2022). Additionally, assessment frameworks must evolve to recognize both formal and informal learning pathways. Teacher preparation represents another crucial area for national policy intervention, as highlighted by Redman *et al.* (2018). Countries should establish systematic professional development programs and create support networks for teaching staff, providing necessary resources for eco-pedagogical activities. Recognition systems at the national level must create clear pathways for validating informal learning and establish mechanisms for incorporating open badges into national qualification systems, with quality assurance processes aligned with EU standards (European Commission: Joint Research Centre, 2025).

At the institutional level, educational organizations require policy support for implementing comprehensive approaches to climate education and recognition (Breiting *et al.*, 2005; Higgs & McMillan, 2006; Leal-Filho *et al.*, 2021b; Mathar, 2015). Organizational strategy should embrace whole-institution approaches to climate education while establishing partnerships with environmental organizations (UNESCO, 2021). Institutions must develop clear policies for recognizing external learning and integrating sustainability across academic

programs. Infrastructure development demands significant attention, with investments needed in digital platforms for badge issuance and verification, alongside technical support systems for users. Quality assurance at the institutional level requires robust assessment criteria and verification processes for badge issuance, supported by careful documentation of learning outcomes.

These policy recommendations align with key EU frameworks, including the European Skills Agenda's emphasis on transversal skills recognition (European Commission, 2020b), the Digital Education Action Plan's promotion of innovative learning tools (European Commission, 2021b), and the European Green Deal's focus on environmental sustainability education (European Commission, 2019). Successful implementation requires careful attention to several critical factors. Policymakers must maintain a delicate balance between standardization and contextual flexibility while ensuring equitable access to recognition systems. Support for technological infrastructure development must be coupled with building credibility through robust quality assurance, such as the European Blockchain Service Infrastructure (EBSI). Furthermore, policies should foster collaboration between educational institutions and industry to enhance the value and recognition of climate-related credentials.

Implementation should follow an evidence-based approach while remaining adaptable to emerging needs and technological developments in digital credentialing. The findings from this study suggest that effective policy frameworks must address both the technical aspects of open badge systems and the broader educational and social contexts in which they operate (Bianchi *et al.*, 2022). As climate education evolves and digital recognition systems mature, policies must remain responsive to changing needs while maintaining high standards for quality and accessibility.

Limitations and future research directions

This study has several limitations that future research should address. As detailed in the 'Methodological limitations and mitigation strategies' subsection, several methodological constraints, including convenience sampling and excluding small categories, should be considered when interpreting these findings. The sample's skew toward higher education students may limit generalizability to other educational contexts.

Furthermore, a significant limitation of our survey design is the absence of systematic measures for political engagement and collective action. While we assessed individual behavioral changes and perceptions of government responsibility, we did not explicitly measure participation in climate protests, petition signing, contacting elected officials, or other forms of political activism. This omission is particularly notable given that our target demographic (18–24-year-olds) has been central to global climate movements like Fridays for Future. Although our qualitative data captured some political dimensions (including voting preferences, activism strategies, and collective pressure tactics), the lack of quantitative measures prevents us from fully understanding how educational engagement relates to political mobilization. This omission is particularly consequential given our finding of a substantial value-action gap. The absence of political action measures may partially explain this gap, as collective political engagement represents a critical pathway between environmental values and systemic change that our study design failed to capture.

Additionally, the rapid evolution of digital credentialing systems means that attitudes toward open badges may shift as these tools become more widespread.

Future research should therefore explore:

- Longitudinal impacts of open recognition systems on learning outcomes.
- Comparative effectiveness of different badge implementation strategies.
- Intersection of climate competencies with other key EU competency frameworks.
- The relationship between climate education and political mobilization, including how recognition systems might validate and encourage collective action alongside individual behavioral changes.
- Role of emerging technologies, like blockchain, in credential verification to enhance security and trust.

Another critical avenue for future inquiry stems from our findings on national context variations. We observed that Portugal consistently showed the highest climate engagement and Italy the lowest—patterns consistent with Eurobarometer data. Future research should move beyond this observation to investigate the underlying causes of these differences. Institutional theory (Scott, 2014) offers a valuable lens for this work, suggesting an exploration of distinct national "climate cultures." For instance, comparative case studies could analyze how the interplay of regulatory frameworks, normative expectations, and cultural-cognitive schemas shapes environmental engagement in different countries. Investigating whether Portugal's success in renewable energy has created positive feedback loops between policy and public perception would be a valuable line of inquiry within this theoretical framework.

Our findings underscore the complex interplay between environmental attitudes, educational preferences, and recognition systems in supporting climate competency development. Success will require carefully coordinated efforts across policy domains and stakeholder groups, with particular attention to maintaining a balance between standardization and contextual flexibility.

Conclusions

The OpenPass4Climate research reveals critical insights for developing effective climate education and open recognition systems in European higher education. The study across four

countries demonstrates that while students show strong climate awareness, there remains a significant gap between knowledge and action. This gap presents both a challenge and an opportunity for the development of open badge systems.

The findings suggest three key areas requiring immediate attention for the successful implementation of the OpenPass4Climate initiative:

First, educational systems must bridge formal and informal learning pathways. Our research demonstrates that students value both structured academic approaches and experiential learning opportunities, suggesting that open badge systems should recognize and validate both forms of learning.

Second, badge system design must prioritize credibility and usability. The focus group findings emphasize that successful implementation requires clear institutional backing, robust quality assurance mechanisms, and user-friendly interfaces. These elements are essential for ensuring that badges hold value for both academic progression and professional development.

Third, implementation strategies must account for national and cultural contexts while maintaining European-wide standards. The significant variations in climate attitudes and educational preferences across countries indicate the need for flexible frameworks that can adapt to local contexts while ensuring consistent quality and recognition.

Looking ahead, the OpenPass4Climate initiative must work within existing European educational frameworks while pushing boundaries to create innovative recognition systems. The focus should be on developing badges that not only acknowledge learning but actively encourage engagement with climate issues through practical action.

The path forward requires a coordinated effort from educational institutions, policymakers, and stakeholders to create meaningful change in climate education. Success will depend on maintaining the delicate balance between standardization and flexibility, ensuring that open badges serve as effective tools for recognizing and promoting climate competency development across Europe.

Ethics and consent

This research was conducted in accordance with the ethical principles of the Declaration of Helsinki. The study was approved by the Technical Directorate for Privacy Matters, with approval from the Data Protection Officer of the University of Valladolid (Reference Number: UVA/26/2023) on September 21, 2023. The study was conducted in accordance with the University of Valladolid's Ethical Code, approved by the Governing Council on July 22, 2022.

Informed consent was obtained from all participants through the online survey platform, where participants were informed that, by taking the survey, they indicated they had read and understood the data protection and consent statement and agreed to participate. For focus groups and interviews, participants provided verbal consent after reviewing data protection information. All participants were informed of data confidentiality measures and their rights under GDPR requirements, including the right to withdraw from the study at any time without penalty. Data were anonymized during analysis and reporting to protect participant identities.

Data availability statement

UVaDOC Documentary Repository of the University of Valladolid: Understanding climate engagement and open recognition in European higher education: A mixed-methods study across four countries. https://doi.org/10.35376/10324/75208

This project contains the following underlying data:

– OpenPass4Climate_survey_results.ods (Complete dataset of survey responses from 630 participants across four European countries).

Extended data

UVaDOC Documentary Repository of the University of Valladolid: Understanding climate engagement and open recognition in European higher education: A mixed-methods study across four countries. https://uvadoc.uva.es/handle/10324/75250

This project contains the following extended data:

– Annex I: Survey questionnaire

– Annex II: Statistical analysis tables including mean Likert scale scores, Kruskal-Wallis test results (mean of ranks), and Conover-Iman multiple pairwise comparisons

– Annex III: One-to-one interview questionnaire

– Annex IV: National focus group questionnaire

All data are available under the terms of the Creative Commons Zero "No rights reserved" data waiver (CC0 Public domain dedication).

Reporting guidelines

This study follows the Standards for Reporting Qualitative Research (SRQR) guidelines for the qualitative components and the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for the survey component. Additionally, the study adheres to the Sex and Gender Equity in Research (SAGER) guidelines for reporting sex and gender information.

Author contributions

Conceptualization, P.M.-R.; methodology, P.M.-R. and F.F.; formal analysis, P.M.-R., F.F., L.A.L.G., and F.O.P.; investigation, P.M.-R., A.C.-G., F.F., K.C., L.A.L.G., B.T., F.O.P., L.V.M., and L.M.N.-G.; validation, A.C.-G.; writing—original draft preparation, P.M.-R. and F.F.; writing—review and editing, P.M.-R.; supervision, P.M.-R.; project administration, P.M.-R., K.C., B.T., L.V.M., and L.M.N.-G. All authors have read and agreed to the published version of the manuscript.

References

Ajzen I: **The theory of planned behavior.** *Organ Behav Hum Decis Process.* 1991; **50**(2): 179–211.
Publisher Full Text

Ardoin NM, Bowers AW, Roth NW, *et al.*: **Environmental education and K-12 student outcomes: a review and analysis of research.** *J Environ Educ.* 2018; **49**(1): 1–17.
Publisher Full Text

Bamberg S, Möser G: **Twenty years after Hines, Hungerford, and Tomera: a new meta-analysis of psycho-social determinants of pro-environmental behaviour.** *J Environ Psychol.* 2007; **27**(1): 14–25.
Publisher Full Text

Bandura A: **Social foundations of thought and action: a social cognitive theory**. Prentice-Hall, Englewood Cliffs, NJ USA, 1986.
Publisher Full Text

Bianchi G, Pisiotis U, Cabrera Giraldez M: **GreenComp: the European sustainability competence framework.** Punie, Y. and Bacigalupo, M. editor(s), EUR 30955 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-46485-3, JRC128040, 2022.
Publisher Full Text

Blake J: **Overcoming the 'value-action gap' in environmental policy: tensions between national policy and local experience.** *Local Environ.* 1999; **4**(3): 257–278.
Publisher Full Text

Breiting S, Mayer M, Mogensen F: **Quality criteria for ESD-schools.** Austrian Federal Ministry of Education, Science and Culture, 2005.
Reference Source

Brislin RW: **Back-translation for cross-cultural research.** *J Cross Cult Psychol.* 1970; **1**(3): 185–216.
Publisher Full Text

Bogner FX, Wiseman M: **Adolescents' attitudes towards nature and environment: quantifying the 2-MEV model.** *Environmentalist.* 2006; **26**: 247–254.
Publisher Full Text

Cialdini RB, Goldstein NJ: **Social influence: compliance and conformity.** *Annu Rev Psychol.* 2004; **55**: 591–621.
PubMed Abstract | **Publisher Full Text**

Council of Europe: **Recommendation CM/Rec(2024)6 of the Committee of Ministers to member States on young people and climate action.** 2024.
Reference Source

Council of the European Union: **Council Recommendation of 16 June 2022 on learning for the green transition and sustainable development 2022/C 243/01.** 2022a.
Reference Source

Council of the European Union: **Council Recommendation of 16 June 2022 on a European approach to micro-credentials for lifelong learning and employability 2022/C 243/02.** 2022b.
Reference Source

Creswell JW, Plano Clark VL: **Designing and conducting mixed methods research**. 3rd ed. SAGE Publications, Thousand Oaks, CA USA, 2018.
Reference Source

Deci EL, Ryan RM: **The "what" and "why" of goal pursuits: human needs and the self-determination of behavior.** *Psychol Inq.* 2000; **11**(4): 227–268.
Publisher Full Text

Denzin NK: **Triangulation 2.0.** *J Mix Methods Res.* 2012; **6**(2): 80–88.
Publisher Full Text

Di Battista A, Grayling S, Hasselaar E, *et al.*: **Future of jobs report 2023.** World Economic Forum, Geneva, Switzerland, 2023.
Reference Source

Dunlap RE, Van Liere KD, Mertig AG, *et al.*: **New trends in measuring environmental attitudes: measuring endorsement of the new ecological paradigm: a revised NEP scale.** *J Soc Issues.* 2000; **56**: 425–442.
Publisher Full Text

European Commission: Directorate-General for Employment, Social Affairs and Inclusion: **The European qualifications framework – supporting learning, work, and cross-border mobility – 10th anniversary.** Publications Office of the European Union, 2018.
Publisher Full Text

European Commission: **The European Green Deal. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee, and the Committee of the Regions (COM(2019) 640 final).** 2019.
Reference Source

European Commission: Directorate-General for Environment: **Special Eurobarometer 501: attitudes of European citizens towards the environment – Report.** 2020a.
Publisher Full Text

European Commission: **European skills Agenda for sustainable competitiveness, social fairness and resilience.** 2020b.
Reference Source

European Commission: **Erasmus+ programme guide 2021–2027.** 2021a.
Reference Source

European Commission: **Digital education action plan (2021–2027)**. 2021b.
Reference Source

European Commission: Directorate-General for Communication: **Special Eurobarometer 538: climate change**. 2023.
Reference Source

European Commission: Joint Research Centre, Napoli V, Pisiotis U, *et al.*: **The GreenComp community - accountability report 2023/2024**. Publications Office of the European Union, Luxembourg, 2025.
Publisher Full Text

EQAR: **European Digital credentials for learning**. 2023.
Reference Source

Gibson D, Ostashewski N, Flintoff K, *et al.*: **Digital badges in education.** *Educ Inf Technol.* 2015; **20**(2): 403–410.
Publisher Full Text

Gifford R: **The dragons of inaction: psychological barriers that limit climate change mitigation and adaptation.** *Am Psychol.* 2011; **66**(4): 290–302.
PubMed Abstract | **Publisher Full Text**

Griffiths D, Burgos D, Aceto S: **Open education and alternative digital credentials in Europe.** *Int Rev Res Open Dis Learn.* 2024; **25**(1): 89–108.
Publisher Full Text

Han H, Ahn SW: **Youth mobilization to stop global climate change: narratives and impact.** *Sustainability.* 2020; **12**(10): 4127.
Publisher Full Text

Higgs AL, McMillan VM: **Teaching through modeling: four schools' experiences in sustainability education.** *J Environ Educ.* 2006; **38**(1): 39–53.
Publisher Full Text

Honneth A: **The struggle for recognition: the moral grammar of social conflicts**. MIT Press, Cambridge, MA USA, 1995.
Reference Source

Johnson B, Manoli CC: **The 2–MEV scale in the United States: a measure of children's environmental attitudes based on the theory of ecological attitude.** *J Environ Educ.* 2010; **42**(2): 84–97.
Publisher Full Text

Knowles MS, Holton EF III, Swanson RA: **The adult learner: the definitive classic in adult education and human resource development**. 9th ed. Routledge, London, UK, 2020.
Publisher Full Text

Kolb DA: **Experiential learning: experience as the source of learning and development**. Prentice-Hall, Englewood Cliffs, NJ USA, 1984.
Reference Source

Kollmuss A, Agyeman J: **Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior?** *Environ Educ Res.* 2002; **8**(3): 239–260.
Publisher Full Text

Leal Filho W, Salvia AL, Pretorius RW, *et al.*: **Universities as living labs for sustainable development: supporting the implementation of the Sustainable Development Goals**. Springer, Cham, Switzerland, 2021a.
Publisher Full Text

Leal-Filho W, Sima M, Sharifi A, *et al.*: **Handling climate change education at universities: an overview.** *Environ Sci Eur.* 2021b; **33**(1): 109.
PubMed Abstract | **Publisher Full Text** | **Free Full Text**

Mathar R: **A whole school approach to sustainable development: elements of education for sustainable development and students' competencies for sustainable development.** In: R. Jucker & R. Mathar (Eds.), *Schooling for Sustainable Development in Europe*. Springer, Cham, 2015; **6**: 15–30.
Publisher Full Text

Martín-Ramos P, Diaz-De-Oleo D, Fourati-Jamoussi F, *et al.*: **Digital credentials for environmental competencies: A scoping review of open recognition systems in climate education [version 3; peer review: 2 approved].** *Open Res Eur.* 2025; **5**: 138.
PubMed Abstract | **Publisher Full Text** | **Free Full Text**

McCright AM: **The effects of gender on climate change knowledge and concern in the American public.** *Popul Environ.* 2010; **32**: 66–87.
Publisher Full Text

McCright AM, Xiao C: **Gender and environmental concern: insights from recent work and for future research.** *Soc Nat Resour.* 2014; **27**(10): 1109–1113.
Publisher Full Text

Meyer A: **Does education increase pro-environmental behavior? Evidence from Europe.** *Ecol Econ.* 2015; **116**: 108–121.
Publisher Full Text

Monroe MC, Plate RR, Oxarart A, *et al.*: **Identifying effective climate change**

education strategies: a systematic review of the research. *Environ Educ Res.* 2019; **25**(6): 791–812.
Publisher Full Text

Morgan DL: **Paradigms lost and pragmatism regained: methodological implications of combining qualitative and quantitative methods.** *J Mix Methods Res.* 2007; **1**(1): 48–76.
Publisher Full Text

Moser SC: **Communicating climate change: history, challenges, process and future directions.** *Wiley Interdiscip Rev Clim Change.* 2010; **1**(1): 31–53.
Publisher Full Text

Nair-Bedouelle S (Ed.): **Engineering for sustainable development: delivering on the sustainable development goals**. UNESCO - International Centre for Engineering Education, 2021.
Reference Source

Norman G: **Likert scales, levels of measurement and the "laws" of statistics.** *Adv Health Sci Educ Theory Pract.* 2010; **15**(5): 625–632.
PubMed Abstract | **Publisher Full Text**

Oliver B: **Towards a common definition of micro-credentials**. UNESCO, 2022.
Reference Source

Palinkas LA, Horwitz SM, Green CA, *et al.*: **Purposeful sampling for qualitative data collection and analysis in mixed method implementation research.** *Adm Policy Ment Health.* 2015; **42**(5): 533–544.
PubMed Abstract | **Publisher Full Text** | **Free Full Text**

Pihkala P: **Anxiety and the ecological crisis: an analysis of eco-anxiety and climate anxiety.** *Sustainability.* 2020; **12**(19): 7836.
Publisher Full Text

Poortinga W, Whitmarsh L, Steg L, *et al.*: **Climate change perceptions and their individual-level determinants: a cross-European analysis.** *Glob Environ Change.* 2019; **55**: 25–35.
Publisher Full Text

Redman E, Wiek A, Redman A: **Continuing professional development in sustainability education for K-12 teachers: principles, programme, applications, outlook.** *J Educ Sustain Dev.* 2018; **12**(1): 59–80.
Publisher Full Text

Schwartz SH: **Normative influences on altruism.** *Adv Exp Soc Psychol.* 1977; **10**: 221–279.
Publisher Full Text

Scott WR: **Institutions and organizations: ideas, interests, and identities (4th ed.)**. Sage Publishing, Thousand Oaks, CA, 2014.
Reference Source

Slovic P: **The perception of risk**. Earthscan Publications, London, UK, 2000.
Reference Source

Stern PC: **New environmental theories: toward a coherent theory of environmentally significant behavior.** *J Soc Issues.* 2000; **56**(3): 407–424.
Publisher Full Text

Tashakkori A, Teddlie C: **SAGE handbook of mixed methods in social & behavioral research**. 2nd ed. SAGE Publications, Thousand Oaks, CA USA, 2010.
Publisher Full Text

Uitto A, Boeve-de Pauw J, Saloranta S: **Participatory school experiences as facilitators for adolescents' ecological behavior.** *J Environ Psychol.* 2015; **43**: 55–65.
Publisher Full Text

UNESCO: International Commission on the Futures of Education: **Reimagining our futures together: a new social contract for education**. UNESCO Publishing, 2021.
Publisher Full Text

UNESCO: **Education for sustainable development: a roadmap**. UNESCO Publishing, 2022.
Publisher Full Text

Vare P, Scott W: **Learning for a change: exploring the relationship between Education and Sustainable Development.** *J Educ Sustain Dev.* 2007; **1**(2): 191–198.
Publisher Full Text

von Davier M, Kennedy A, Reynolds K, *et al.*: **TIMSS 2023 International Results in Mathematics and Science.** Boston College, TIMSS & PIRLS International Study Center, 2024.
Publisher Full Text

Wastiau P, Looney J, Laanpere M: **Portugal's digital transition strategy for education.** System change case studies series. Brussels, European Schoolnet, 2024.
Reference Source

Zelezny LC, Chua PP, Aldrich C: **New ways of thinking about environmentalism: elaborating on gender differences in environmentalism.** *J Soc Issues.* 2000; **56**(3): 443–457.
Publisher Full Text

Open Peer Review

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Version 2

Reviewer Report 08 November 2025

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✔ **Jennie Stephens**
National University of Ireland Maynooth, Co. Kildare, Ireland

The literature review section entitled "climate education in higher education" is insufficient and does not adequately reflect the breadth of prior research on climate education in higher education" including for example:

Kinol, A., et al. (2023). "Climate justice in higher education: a proposed paradigm shift towards a transformative role for colleges and universities." Climatic Change 176(2): 15.

In addition, this section should at least make a nod to acknowledging the broader sustainability education literature that also include climate education. By narrowly focusing only on climate education the authors risk perpetuating climate isolationism which is the phenomenon when people focus narrowly on climate without acknowledging how the climate crisis is intricately connected with larger problems of ecological destruction and growing vulnerabilities of human well-being

Is the work clearly and accurately presented and does it engage with the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

Are all the source data and materials underlying the results available?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?

I cannot comment. A qualified statistician is required.

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Climate justice in higher education.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 15 October 2025

https://doi.org/10.21956/openreseurope.22908.r60483

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Ihtsham Ul Haq Padda
Federal Urdu University of Arts, Science and Technology, Islamabad, Pakistan

The introduction of the article is well written and provides a clear overview of the research context. However, the significance of the study is not sufficiently articulated in connection with the contemporary global challenges of climate change and the urgent need to build resilience within higher education systems. Strengthening this linkage would enhance the relevance and impact of the study.
The literature review is adequate and provides a general background to the topic. Nonetheless, it appears somewhat limited, particularly concerning the dimension of climate change awareness and engagement practices within educational institutions. Expanding this section to include more recent and diverse sources would enrich the theoretical foundation.
The methodology is sound, following standard research procedures, and has been implemented in a well-organized manner. The management of the study is commendable, and the results are clearly presented with robust empirical evidence. However, the discussion section could be improved by incorporating more analytical depth—interpreting the findings beyond numerical presentation to offer stronger insights and implications.
In conclusion, this is a well-conducted and valuable study that contributes meaningfully to the growing body of literature on climate change and education. With minor revisions—particularly in highlighting the study's significance and enhancing the analytical discussion—it can make an important scholarly contribution to the field.

Is the work clearly and accurately presented and does it engage with the current literature?
Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

Are all the source data and materials underlying the results available?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Development Economics | Public Sector Economics | Environmental Economics | Food Security | Climate Change

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 15 October 2025

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Gaye Defne Ceyhan
Bogazici University, Istanbul, Turkey

This study investigates climate engagement and open recognition systems across four European countries. The findings present a valuable contribution to the field of climate education and digital credentialing. The revised manuscript successfully addresses reviewer concerns through substantial enhancements to the introduction, literature review, methods section, and discussion. The addition of the literature review section and enhanced theoretical justification for survey constructs strengthens the manuscript's scholarly positioning. The cross-national design with multiple data collection methods offers valuable comparative insights into climate education needs and cultural variations.
The revised manuscript includes detailed methodological explanations, explicit acknowledgment of limitations, and full data availability, supporting reproducibility and further research. The findings provide actionable recommendations for implementing open badge systems in climate education contexts. The authors have appropriately acknowledged the limitations of the study and proposed future research directions.

The revised manuscript is clearly written, methodologically sound, and provides valuable insights for researchers, educators, and policymakers working on climate education and recognition systems in European higher education. After reviewing the revised manuscript, I am pleased to recommend its acceptance.

Is the work clearly and accurately presented and does it engage with the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

Are all the source data and materials underlying the results available?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Climate change education, sustainability education, systems thinking

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 01 October 2025

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Anh Thu Nguyen
Mount Royal University, Calgary, Canada

After reviewing the revised manuscript, we are pleased to recommend its acceptance. We appreciate the thoroughness with which the authors addressed our constructive comments, particularly their treatment of the limitation concerning the lack of collective political actions. The manuscript is now highly accessible, with a clear and logical flow. As a result, the revisions have successfully strengthened the introduction and the literature review, clarified the methodology,

and enhanced both the discussion and conclusions.
We commend the authors for their careful and thoughtful revisions, which have substantially improved the clarity and overall quality of the manuscript.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Sustainable consumption, sustainability education, climate change education

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 24 July 2025

https://doi.org/10.21956/openreseurope.21536.r53980

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Anh Thu Nguyen
[1] Mount Royal University, Calgary, Canada
[2] Mount Royal University, Calgary, Canada
Paul Berger
[1] Lakehead University, Thunder Bay,, Canada
[2] Lakehead University, Thunder Bay,, Canada

Thank you for the opportunity to review the manuscript. It touches a very important topic relating to climate change education with a study across four countries in Europe.

1. The introduction clearly sets a context for the research. We strongly recommend adding a literature review section to provide a current landscape of research on the topics and to identify research gaps that justify this research. Also, an outline of the paper structure could be provided at the end of the introduction for clarity. Please write acronyms out in full on their first usage.
2. Methods: The research design is appropriate; however, we suggest stronger justifications as to why this research design was used. The authors could explain more clearly the choice of research methods with support from theories on research methodologies. Additionally, the authors could elaborate on the choice of seven key constructs used in the survey design.
3. More details need to be provided about data collection methods for replication by others and to understand potential biases. For instance, how the authors conducted surveys in four countries (online, email, paper-based, etc), how they recruited students (university and high-school students), and how they recruited participants for the transnational focus group (what were the selection criteria?)
4. The analysis is good, with results reported clearly. However, we strongly recommend the

authors to clearly explain the measures used to overcome methodological limitations; for example, what are some inherent limitations in the sample's composition and how they were accounted for in the analysis. What categories had limited sample sizes? Please specify them. Quantitative results are typically reported with more detail, such as the effect size and confidence level; is there a reason why your results omitted details? Perhaps these are in Annex II.

5. The discussion could be improved by providing a more robust synthesis with the existing literature. As a literature review is not provided, it is difficult for the reader to see 'significant' findings, in comparison with what is known in literature. Some discussion is needed to help readers understand how Likert averages can be compared to percentages in the Eurobarometer findings and to speculate on comparisons between student and general population results.

References to the Eurobarometer findings are needed.

1. It is unclear why political action is not highlighted in this study; why emphasise individual actions such as eating less meat and asking about government responsibility, without asking whether participants have taken part in climate protests, signed petitions or contacted elected officials?

Thank you again for the opportunity to review the manuscript. We hope our comments help improve the work. We wish the authors the best of luck with the research!

Is the work clearly and accurately presented and does it engage with the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

Are all the source data and materials underlying the results available?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Sustainable consumption, sustainability education, climate change education

We confirm that we have read this submission and believe that we have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however we have significant reservations, as outlined above.

Author Response 09 Aug 2025

Pablo Martín-Ramos

Thank you for the opportunity to review the manuscript. It touches a very important topic relating to climate change education with a study across four countries in Europe.

***Response**: Thank you for your thorough and constructive review of our manuscript. We appreciate the interdisciplinary perspectives you bring from sustainability education and climate change pedagogy. We have carefully addressed each of your comments with substantial revisions to strengthen the manuscript. Below, we provide a detailed point-by-point response with specific changes made.*

Reviewer comment 1: The introduction clearly sets a context for the research. We strongly recommend adding a literature review section to provide a current landscape of research on the topics and to identify research gaps that justify this research. Also, an outline of the paper structure could be provided at the end of the introduction for clarity. Please write acronyms out in full on their first usage.

***Response**: We appreciate this suggestion and have added a new Literature Review section following the Introduction. As this manuscript is part of the OpenPass4Climate project, which includes a comprehensive scoping review published separately, we provide a focused synthesis that highlights key gaps our empirical study addresses while directing readers to the full review for detailed analysis.*
Changes made:
(1) A new paragraph providing an outline of the paper structure has been added at the end of the Introduction.
(2) A new section 2 (Literature review) has been added after the Introduction.
(3) "European Union (EU)", "United Nations Educational, Scientific and Cultural Organization (UNESCO)", "Science, Technology, Engineering, and Mathematics (STEM)", "General Data Protection Regulation (GDPR)", and "Trends in International Mathematics and Science Study (TIMSS)" are now written in full at first use.

Reviewer comment 2: Methods: The research design is appropriate; however, we suggest stronger justifications as to why this research design was used. The authors could explain more clearly the choice of research methods with support from theories on research methodologies. Additionally,the authors could elaborate on the choice of seven key constructs used in the survey design.

***Response**: We have substantially expanded the Methods section to provide theoretical justification for our methodological choices and elaborate on the survey constructs' theoretical foundations.*
Changes made:
(1) The first paragraph of the Methods section has been rewritten, and a new subsection on "Research design and rationale" has been added.
(2) The original "Survey design and implementation" subsection has been divided into two subsections. The survey design has been expanded to a new "Survey design and theoretical framework" subsection.

Reviewer comment 3: More details need to be provided about data collection methods for replication by others and to understand potential biases. For instance, how the authors conducted surveys in four countries (online, email, paper-based, etc), how they recruited students (university and high-school students), and how they recruited participants for the transnational focus group (what were the selection criteria?)

***Response**: We have comprehensively revised the data collection section to provide full operational details, enabling replication and bias assessment.*
Changes made: The original "Survey design and implementation" subsection has been divided into two subsections. The survey implementation has been expanded to a new "Data collection procedures" section, with "Survey administration, Interview recruitment and selection", and Focus group recruitment" subsection.

Reviewer comment 4: The analysis is good, with results reported clearly. However, we strongly recommend the authors to clearly explain the measures used to overcome methodological limitations; for example, what are some inherent limitations in the sample's composition and how they were accounted for in the analysis. What categories had limited sample sizes? Please specify them. Quantitative results are typically reported with more detail, such as the effect size and confidence level; is there a reason why your results omitted details? Perhaps these are in Annex II.

***Response**: We appreciate the reviewers' attention to methodological rigor and statistical reporting. We have expanded our discussion of limitations and clarified our statistical approach. Regarding effect sizes and confidence intervals: We acknowledge that these measures are not included in Annex II. Our analytical approach employed non-parametric methods (Kruskal-Wallis tests with Conover-Iman post-hoc comparisons) appropriate for ordinal Likert data that violated normality assumptions. For such non-parametric analyses, effect size measures are less standardized than for parametric tests. The mean ranks and rank differences provided in Tables S2 and S4 serve an analogous interpretive function: larger rank separations indicate stronger practical effects. For example, the 145.6-point rank difference between Italy and Portugal on climate concern (mean ranks: 260.0 vs. 405.6, $p<.0001$) clearly indicates a substantial effect beyond mere statistical significance.*
Confidence intervals, typically calculated assuming interval data properties, would be inappropriate for our rank-based analyses of ordinal data. However, recognizing that some researchers may wish to apply parametric interpretations, we have made our complete dataset available in the repository, enabling alternative analytical approaches, including effect size calculations or confidence interval estimation, for those who consider Likert data to possess interval properties.
Changes made:
(1) The "Data analysis" subsection has been updated (second paragraph).
(2) A new subsection on "Methodological limitations and mitigation strategies" has been added as a separate subsection after "Data analysis".
(3) A new sentence has been added to the existing "Limitations and future research directions" section to briefly acknowledge the technical details of limitations detailed in the methods subsection while keeping the focus on broader implications and future research needs.

Reviewer comment 5: The discussion could be improved by providing a more robust

synthesis with the existing literature. As a literature review is not provided, it is difficult for the reader to see 'significant' findings, in comparison with what is known in literature. Some discussion is needed to help readers understand how Likert averages can be compared to percentages in the Eurobarometer findings and to speculate on comparisons between student and general population results.

***Response**: We appreciate the reviewers' suggestion to strengthen literature integration in the Discussion. As noted in response to Comment 1, we have added a Literature Review section that establishes the theoretical context. We have now enhanced the Discussion with additional literature synthesis and methodological clarifications about our comparisons.*
Regarding the comparison of Likert scale means with Eurobarometer percentages, we acknowledge this methodological challenge and have added explicit clarification of our interpretive approach. We interpret scores above 4.0 as indicating that approximately 80% of respondents lean toward agreement (since 4.0 represents the "agree" point on our scale), while scores around 3.0 suggest neutral or mixed responses. This interpretation allows approximate comparison with Eurobarometer's binary percentage findings, though we explicitly acknowledge these are different measurement approaches. We have also clarified that our student sample represents a specific subpopulation (younger, currently engaged in education) and comparisons with general population surveys should be understood as exploratory rather than definitive.
Furthermore, we have integrated additional literature throughout the Discussion to contextualize our findings within established research on environmental attitudes, educational effects on climate concern, and motivational dynamics in recognition systems.
Changes made:
(1) Added clarification paragraph in Discussion section (after first paragraph)
(2) Added methodological justification paragraph (after the above)
(3) Enhanced literature integration throughout the Discussion, including: discussion of educational effects on climate concern, analysis of generational differences, education perception gap, and cross-national variations.

Reviewer comment 6: References to the Eurobarometer findings are needed.

***Response**: We thank the reviewers for noting this. The Eurobarometer references are provided in the manuscript at first mention ('Building on prior European research, such as the Special Eurobarometer 501 (European Commission, 2020a) and 538 (European Commission, 2023)...'). Throughout the Discussion, specific findings are attributed to their source surveys with question numbers (e.g., 'Eurobarometer 538, QC2') to ensure precision while maintaining readability. We believe this approach (full citation followed by abbreviated references with question identifiers) follows standard academic practice while providing complete traceability to specific data points.*

Reviewer comment 7: It is unclear why political action is not highlighted in this study; why emphasize individual actions such as eating less meat and asking about government responsibility, without asking whether participants have taken part in climate protests, signed petitions or contacted elected officials?

***Response**: We thank the reviewers for this important observation about political action. This represents a significant limitation of our study design that we now explicitly acknowledge. The OpenPass4Climate survey instrument was developed collaboratively by the project consortium*

with a primary focus on individual behavioral changes and educational preferences rather than political engagement. This reflects both the project's educational focus and, admittedly, an oversight in not adequately capturing the full spectrum of climate action, particularly collective political engagement that has become increasingly prominent through youth movements like Fridays for Future.
While our qualitative data (interviews and focus groups) did capture some political dimensions spontaneously raised by participants—such as the importance of voting for climate-conscious politicians (Portuguese focus group), activism approaches (French focus group), and the role of collective pressure in driving policy change (Spanish focus group)—we acknowledge that the absence of systematic data collection on political action represents a significant gap. This is particularly relevant given that our target demographic (18-24 year-olds) has been at the forefront of climate activism globally.
We have added this limitation to our Discussion section and recommend that future research on climate education and recognition systems should explicitly incorporate measures of political engagement, including participation in protests, petition signing, contacting elected officials, and involvement in climate justice movements. This would provide a more complete picture of how educational interventions relate to both individual and collective forms of climate action.

Changes made: A new paragraph has been added to the "Limitations and future research directions" subsection to clearly acknowledge the limitation, and a new future research bullet point has been included.

Competing Interests: No competing interests were disclosed.