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ORIGINAL ARTICLE

School climate assemblies: an educational tool for empowering pupils and youth to take climate and sustainability action

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Abstract

This paper presents *school climate assemblies*, conceived as an innovative educational tool for the co-creation of climate change and sustainability solutions in educational institutions and communities. It describes an intervention research project that builds on previous processes and experiences of climate citizen assemblies which have been organised in different countries across the world. School climate assemblies are conceived of as a tool that promotes the active engagement of pupils and their communities in co-creating climate change mitigation and adaptation strategies towards jointly defining innovative sustainability and climate change solutions. An intervention, piloted in five secondary schools in the Spanish region of Tarragona, is reported, presenting the main phases and steps followed. To test the effectiveness of the intervention, this paper outlines the policy climate change recommendations that emerged from the co-creation process to identify and agree on a set of actions to tackle climate change and sustainability challenges and the degree of student satisfaction with the intervention. A detailed methodology for organising school climate assemblies that can be replicated in other educational institutions, contexts and regions, is presented, enabling the widespread adoption of this innovative approach. The study emphasises the potential of co-creation methods in the educational context and underscores the critical role of education in fostering sustainability in citizens and empowering students to become active change agents in their local communities. The results lead to policy implications for integrating co-creation approaches into school curricula worldwide, aiming to empower students and drive sustainability action.

Keywords Climate assemblies · Schools · Education for sustainable development · Co-creation · Climate change · Youth

Introduction

Education is a key agent in tackling the current sustainability challenges that societies are facing, due to its key mission of knowledge generation through teaching and student learning processes (Boeve-de Pauw and Van Petegem 2018; UNESCO 2017). The Declaration of the United Nations Decade of Education for Sustainable Development (UNDESD, 2005–2014) was a catalyst for the integration of Education for Sustainable Development (ESD) into all education levels (UNESCO 2014). Also, the Global Action Programme, the UNDESD follow-up programme, focused on expanding ESD by acknowledging the relevance of schooling and educators' and students' sustainability competencies. The United Nations 2030 Agenda for Sustainable Development, adopted by world leaders in 2015, also ratified education as fundamental in promoting more sustainable lifestyles and in developing sustainability competencies among individuals (United Nations 2015; UNESCO 2017). In this context,

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the framework *Education for Sustainable Development: Towards achieving the Sustainable Development Goals* (*SDGs*) (*ESD for 2030*) has set up five priority action areas for the fruitful attainment of the 17 SDGs and the societal transformation required, including policy, learning environments, educators' competencies, youth, and local community action (UNESCO 2020).

Over the last years, national governments and supranational institutions have stressed the role of education in promoting a more just and inclusive transition of societies towards more sustainable patterns. In Europe, this has been reiterated in the European Green Deal communication, echoed in the 2020 Commission communication on achieving the European Education Area and in the 2020 Commission communication on a European Skills Agenda for sustainable competitiveness, social fairness, and resilience (European Commission 2019, 2022). Therefore, education (formal, non-formal, and informal) is increasingly seen as a principal agent for addressing present sustainability challenges (Rieckmann 2018; UNESCO 2014; United Nations 2012).

Individuals as part of society should be empowered to act sustainably in complex situations, which may require them to strike out in new directions, and to participate in socio-political processes, moving their societies towards sustainability (Sterling et al. 2017; Stibbe 2009). Thus ESD is conceived as a holistic and transformational education that addresses learning content and outcomes, pedagogy, and the learning environment. It requires whole institution approaches and the entire system, including the culture and ethos, operations, physical spaces, organisational structures, resource management and usage (i.e. energy, recycling, water and paper consumption), pedagogical approaches, curriculum delivery, stakeholder collaboration, and partnerships with the local community (Evans et al. 2012; Mogren et al. 2019; Symons 2008; Watson et al. 2013).

Transformative learning processes where innovative educational practices, critical thinking, and inter- and transdisciplinarity are promoted are fundamental (Barth 2015; Lotz-Sisitka et al. 2015). Existing literature in ESD asks for a pedagogy that focuses on action, participation, transformation and autonomous learning and that encourages collaboration and problem-solving through learner-centred approaches, inter- and trans-disciplinary approaches and the linkage of formal, non-formal and informal learning settings to promote sustainability competencies' development (Brundiers et al. 2021; Rieckmann 2018; Sipos et al. 2008; Tilbury 2011). Thus, the active involvement of citizens and communities in climate and sustainability action provides unique learning opportunities for personal well-being, fulfilment, and more sustainable lifestyles (Leicht et al. 2018). It enables citizens to be better informed, more autonomous and more active in addressing societal challenges such as climate change, sustainable development, and environmental protection to achieve the sustainable transformation of society (Ardoin et al. 2023).

The active involvement of students in community-based learning and action through initiatives like service-learning programmes, education community projects, and partnerships that engage different stakeholders (from inside and outside academia) in real sustainability projects is crucial if it is to offer diverse perspectives and insights and nurture learning for sustainability (Anderson and Jacobson 2018; Östman et al. 2019; Taylor et al. 2019; UNESCO 2017). Previous research has underscored the key role that families, communities, and local governments play in involving students and entire educational institutions in sustainability efforts (Duarte et al. 2017; Evans et al. 2012; Symons 2008). Empirical case studies from various countries have demonstrated the relevance of linking students' experiences to sustainability issues and decision-making processes as a fundamental aspect in fostering transformative learning, which in turn cultivates more pro-environmental behaviours and attitudes (Green and Somerville 2015; Jucker and Mathar 2015; Mogren et al. 2019). Creating joint collaborative and participatory initiatives and spaces between different community stakeholders can contribute to learning for sustainability, the belief in the ability to have a positive influence (self-efficacy) and the capacity to influence individuals' actions and external sustainability actions (sense of agency) (Baldwin et al. 2023; Gimenes et al. 2019). To develop students' action competence for sustainability, self-efficacy and confidence in their competence, students need to experience active participation throughout the learning process and active engagement in decision-making processes in schools (Olsson et al. 2022). This involves learning from real, relevant and local sustainability challenges, where students can contribute with solutions in cooperation with peers and other community stakeholders (Sinakou et al. 2019).

Existing research has documented examples and best practices in ESD, mainly related to the usage of student-centred teaching and learning methods such as service-learning and problem- and inquiry-based learning that contribute to the development of sustainability knowledge and competencies (Cebrián et al. 2020; Vesterinen and Ratinen 2023; Wiek et al. 2011). However, recent literature has stressed the need to develop more hybrid pedagogies that engage multiple voices and actors, thus enabling the creation of spaces that empower individuals in sustainability action and challenge existing values (Mulà et al. 2022; Lotz-Sisitka et al. 2015; Olsson et al. 2022).

While the literature underlines the relevance of linking sustainability learning to the local community, engaging people in climate change and sustainability action, and developing participatory and co-creation processes to develop climate change and sustainability solutions and actions, the contributions and influence of these processes

have not been systematically studied and documented (Green and Somerville 2015; Symons 2008; Van Poeck et al. 2017; Font et al. 2021).

This paper presents an intervention research project that developed and tested a methodological approach to implementing climate assemblies in schools. To test the effectiveness of the intervention, this paper presents the climate change policy recommendations that emerged from the co-creation process to identify and agree on a set of actions for tackling climate change and sustainability challenges and the degree of student satisfaction with the intervention. It is based on an empirical case implementing the designed school climate assembly methodology in five secondary schools in the Spanish region of Tarragona, in which 43 school members and 586 students participated.

Climate assemblies

Citizen assemblies bring together a diverse group of people to reflect, discuss, and learn about an issue and reach a consensus about actions and priorities (Grewin 2018). Citizen assemblies have been used in the United Kingdom (UK) and other countries, including Australia, Canada, and the USA, to tackle a range of complex issues and are often described in the literature as "mini-publics" (Stack and Griessler 2022). This term implies that these assemblies are framed by a deliberative approach, with a diverse representation of the general public, providing information to its members on the political issue covered, in which members' ideas and reasoning are taken seriously (Fung 2003).

In recent years, citizen assemblies focused on climate have gained momentum as participatory processes to promote broader democratic engagement in the search for solutions to climate change driven by ordinary citizens (Capstick et al. 2020). Since 2016, governments have promoted numerous climate citizen assemblies, conceived as an innovative form of deliberative democracy for learning, deliberating, and making informed decisions to address climate change and promote sustainability (Stack and Griessler 2022; Torney 2021). Between 20 and 150 people are brought together to deliberate and make informed decisions about local, regional, or national climate change and sustainability actions and priorities. Members are randomly selected based on a profile that reflects the diversity of the population, including demographic and attitudinal criteria (Boswell et al. 2022). After sharing ideas and opinions and listening to a series of experts and external speakers, the participants agree on a set of recommendations (Capstick et al. 2020).

Climate citizen assemblies have emerged as powerful instruments to promote broader democratic engagement in the search for innovative solutions for sustainability. In Europe, national citizen assemblies for climate have been organised in Ireland (2016–2018), France (2019–2020), the UK (2020), Scotland (2020–2021), Denmark (2020–2021), Germany (2021), Finland (2021), Austria (2022), and Spain (2022) (Elstub et al. 2021; Stack and Griessler 2022). France, Ireland, and the UK were pioneers in organising climate citizen assemblies to give voice to and involve a wide representation of citizens in proposing measures and recommendations for addressing climate change at a national scale (Climate Assembly UK 2020; Torney 2021). In 2021, the Spanish Government also initiated its first climate assembly with the participation of 100 citizens representing the diversity of Spanish society. The citizen assembly for the climate is one of the priority lines of action of the Declaration on Climate and Environmental Emergency in Spain, enshrined in the Law on Climate Change and Energy Transition, and it opens a new path to reinforce public participation. It allows for sharing knowledge and identifying and debating proposals to advance urgent responses to climate change.

Climate assemblies held to date have been primarily organised by governments or municipalities. In the EMPOCLIM project "Empowering the educational community to adapt to climate change" and in the EDUCLIMAD project "School climate assemblies: co-creation of climate change mitigation and adaptation strategies and sustainability competencies' development", we conducted and implemented an intervention research project aimed at testing the effectiveness of school climate assemblies in practice in secondary education (EMPOCLIM) and the fifth and sixth grades of primary education (EDUCLIMAD). We analysed the policy climate change recommendations that emerge from the actions proposed by students during the assemblies, and determined the degree of student satisfaction with different aspects of the school climate assemblies. In this paper, we present the intervention and methodological approach for both projects and provide the main outcomes of the pilot intervention in the EMPOCLIM project.

Materials and methods

The intervention research project

In this section, we outline the programme that was designed and implemented based on an intervention research design approach (Fraser and Galinsky 2010). We outline the school climate assembly programme developed and provide evidence from the pilot project conducted with five secondary schools, according to the steps in intervention research, namely: (1) problem and programme theories, (2) programme structures and processes, (3) research method, data collection, and analysis, (4) outcomes and effectiveness of the programme, and (5) dissemination actions and materials.

Step 1: Problem and programme theories

To promote new ways of living and sustainable social practices, individuals and communities must be able to engage in transformative and community-based learning processes that promote environmental awareness and action and the acquisition of new knowledge and skills in sustainability (Brundiers et al. 2021). Evidence of the potential of children and youth as change agents in their societies is evident through the emergence of youth-led social movements related to sustainability and climate change, such as Fridays for Future (Biasutti 2015; Deisenrieder et al. 2020). In this context, citizen science and community learning have gained recognition in recent years as strategies to advance scientific research in sustainability and increase citizens' understanding and awareness of climate change while fostering new knowledge and skills in sustainability (Cebrián et al. 2020; Fritz et al. 2019; Hsu et al. 2014).

Building on the processes and experiences of climate assemblies previously organised worldwide with citizens from the general public (Elstub et al. 2021; Torney 2021; Stack and Griessler 2022), this programme develops the steps and processes to organise school climate assemblies, conceived as an innovative educational activity that promotes the active engagement of pupils and their communities in co-creating climate change mitigation and adaptation strategies towards jointly defining innovative sustainability and climate change solutions. The paper provides evidence of its effectiveness and programme dissemination actions.

Methodological approach to implement school climate assemblies

School climate assemblies aim to offer educational communities a greater involvement and active participation in learning, deliberation, decision-making, and the search for solutions to deal with climate change and promote local and regional sustainability (Boqué Ciurana et al. 2023). The main goals of the school climate assembly are to:

- increase the knowledge and environmental awareness of the educational community (students, teachers, management team, and families) and
- train and involve citizens in the achievement of SDG 13 Climate Action and the development of action plans and political recommendations to address the SDGs at local and regional levels.

Based on existing climate citizen assemblies' experiences, school climate assemblies adopt a three-stage process of learning, deliberation, and decision-making, supported by a team of facilitators who guide participants throughout the process, ensuring that all voices are heard and everyone actively participates (Grewin 2018; Ferejohn 2008). School climate assemblies are designed so that participants can respond in their own words to reach an understanding or consensus about a topic (Eisenahuer and Nicholson, 2005; Newig et al. 2008). The phases typically involved in a school climate assembly are as follows.

- The *learning phase* includes preparatory materials and activities and the participation of experts in topics related to climate change and sustainability through presentations, group dynamics, and exercises, facilitated group debates, and expert panels or interactive conferences that provide different perspectives on the topic to help participants share, discuss, and debate ideas.
- The *deliberation phase* focuses on facilitating dialogue and debate among participants to share, co-create, and further develop their opinions and understandings with other members of the assembly. In this phase, experts become critical friends and facilitators of the process (Kember et al. 1997). Techniques that can be used in this phase include open plenary sessions, small group work, active learning, role-playing, or workshops for visualising different scenarios (Shared Future 2020).
- The *decision-making phase* involves engaging participants in developing joint and agreed-upon conclusions based on their learning, reflections, and discussions throughout the assembly to produce action plans with policy recommendations.

The tools and techniques used during the school climate assemblies should focus on participatory approaches, including tools such as participatory mapping, visualisation of alternative futures, use of the arts, active learning, role playing, or problem trees (Shared Future 2020).

Step 2: Programme structures and processes

This section presents the programme structures and processes to implement school climate assemblies, providing evidence from a pilot project conducted with five secondary schools. This intervention research was developed under the EMPOCLIM project "Empowering the educational community to adapt to climate change", an initiative supported by the Provincial Council of Tarragona and Universitat Rovira i Virgili. The project took place between June 2021 and March 2022 and was conducted as a pilot in one of the areas considered to have the most significant environmental and climate problems in the province of Tarragona (Spain): Camp de Tarragona. The city of Tarragona and its surroundings have a unique air quality situation as it is a dynamic region with the largest petrochemical industry in southern Europe and the second largest agglomeration of inhabitants in Catalonia (482,000 inhabitants), coexisting with important tourist

and agricultural activities (Rovira et al. 2021; Peñuelas et al. 2021). Its geographical location on the Mediterranean coast implies the recurring and increasingly frequent presence of extreme weather phenomena, such as heat waves, droughts and torrential rains, in some cases related to storms such as Gloria (Sanuy et al. 2021).

To address this complexity and find a balanced relationship between social, environmental, and economic development, we must promote citizen science and participatory processes that raise awareness and promote a deeper understanding while fostering new knowledge and skills in sustainability (Cebrián et al. 2020; Fritz et al. 2019; Hsu et al. 2014). For this reason, the EMPOCLIM project sought to offer educational communities a greater involvement and active participation in climate change challenges through the creation and piloting of school climate assemblies in five secondary schools in Camp de Tarragona. Schools were recruited through formal invitations sent via email and participated voluntarily. The selection of schools was based on their geographical location and their willingness to participate in the project. Table 1 presents the location, number of teachers, school principals, and students involved in the assemblies and the student age, number of class groups, and grade per secondary school.

The school climate assemblies were organised per class group within each school, due to post-COVID-19 pandemic restrictions and organisational and logistic factors, and to allow the creation of fruitful discussions and deliberations amongst students. In this intervention research project, school climate assemblies were organised, facilitated, and guided by a group of experts in climate change and sustainability from the university, with each class group inviting members of the educational community, social and environmental entities and families and teachers to participate. Figure 1 presents a graphical representation of the phases, processes, and outcomes of the school climate assemblies implemented.

School climate assemblies included different phases according to the programme designed (see "Step 1: Problem and programme theories"). The assembly started with a presentation by the expert facilitation group focused on sharing aims, the main environmental challenges in the region, and images that served as inspiration. In each class group, four working groups of between six and eight students were formed to work on a specific environmental challenge. Each working group focused on four critical themes: air, water, energy, and tourism. These environmental themes were identified as significant domains for action due to their direct relevance to climate change mitigation and adaptation efforts in the study area.

Learning phase

In the learning and reflection phase, a concept map was co-created on these environmental themes in small working groups with the support of experts, aiming to identify environmental challenges and issues the students thought existed at the neighbourhood, municipal, regional, or provincial level, positive and negative aspects, and possible opportunities or actions to address them. Concept maps were used to develop the full potential of people and teams (de Reis et al. 2022) through collaborative thinking with hands and creativity, specifically using manual thinking material. This material facilitates the group's creative work in the formation and organisation of ideas to co-create a concept map with socio-environmental challenges and problems and possible actions that youngsters perceive as priorities in their local environment, at an individual level, in their school, in the neighbourhood, town or city, and at a regional level. In this phase, participants engaged in group discussions, shared insights and jointly created a concept map, each focused on a specific environmental theme. Figure 2 shows illustrative images of this phase and the concept maps created by the students.

Deliberation phase

The deliberation phase focused on fostering a group discussion and reaching a consensus within the working group on priority actions to finally list the ten actions chosen. In this

Table 1 Schools participating in the school climate assembly pilot

Secondary school	Location	Number of teachers and principals	Number of students	Student age, class groups, and grade
1	Cambrils	10	95	15 years old, three class groups of third-grade compulsory secondary education
2	Tarragona	8	125	15–16 years old, four class groups, two of third-grade and two of fourth-grade compulsory secondary education
3	Tarragona	7	93	16 years old, three class groups of fourth-grade compulsory secondary education
4	Tarragona	8	123	16 years old, three class groups of fourth-grade compulsory secondary education 18 years old, two class groups of upper secondary education
5	Vila-seca	10	150	16 years old, six class groups of fourth-grade compulsory secondary education
	Total	43	586	

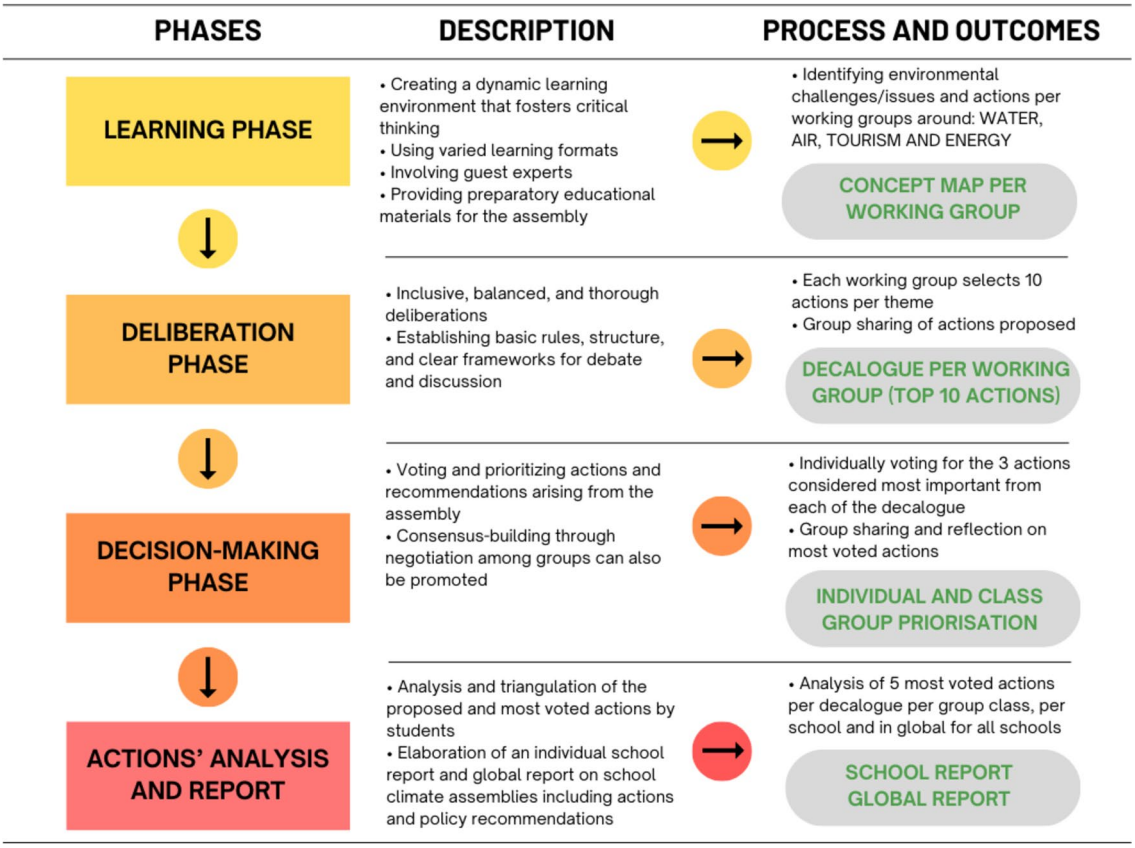

Fig. 1 Diagram of phases, processes, and outcomes in school climate assemblies implemented

Fig. 2 Illustrative images of the learning phase and concept maps created by students

phase, the four working groups deliberated to collectively develop a decalogue of action measures aimed at addressing climate change impacts. Once group agreement was reached on the ten actions proposed, each group presented the work done and their action proposals to the rest of the class. Figure 3 shows examples of this phase and the process of reaching consensus, group sharing and presentation.

Decision-making phase

In the decision-making phase, individual prioritisation of the most relevant actions was reached through voting. Each student was given 12 stickers with which they voted for the three actions that were most relevant to them in each of the decalogues. Figure 4 shows examples of individual prioritisation and voting. Finally, to promote reflection on the actions that emerged and were most often voted for, the group class evaluated, reflected on and reached a consensus among the actions that emerged.

Step 3: Research method and data collection and analysis

To gather the outcomes from the school climate assemblies, a systematic process was followed to identify policy climate change recommendations that emerged from the

Fig. 3 Illustrative images of deliberation and group consensus phase

Fig. 4 Illustrative images of the decision-making phase

intervention, based on the school climate assemblies and the students' perceptions of them.

Concerning policy climate change recommendations, the decalogues from each class group in each school were collected and analysed. The five actions most frequently voted for from each decalogue (four in each class group working on water, energy, tourism, and air) were selected and analysed in conjunction per school and grouped into policy climate change recommendations. Class group actions were triangulated and merged with the actions from the other class groups in the school. The actions were grouped per main topics or areas of action, which allowed us to draw on key policy climate change recommendations to produce an individual school report for each participating school. Individual school policy climate change recommendations were then merged, and a global report was produced and disseminated through various communication channels and shared with the local community, policymakers, and relevant stakeholders (see "Step 5: Dissemination actions and materials").

To determine the efficacy of the intervention and the degree of satisfaction with school climate assemblies, an ad hoc questionnaire with two main sections was designed and administered to 180 secondary education students after the intervention. In the first section, the students rated their level of agreement or disagreement regarding various aspects of the assemblies based on a five-point Likert scale where 1 is 'totally disagree' and 5 is 'totally agree'. The first section included 11 items assessing the aspects of achievement of assembly objectives (i1), meeting of expectations regarding assembly content (i2), positive evaluation of facilitators' role and activity (i3), appropriateness of assembly duration for objectives and content (i4), appropriateness of the methodology and session dynamics (i5), facilitation of active participation through the methodology used (i6), usefulness of the assembly in practice (i7), quality of the learning environment (i8), perceived usefulness of the assembly for education and learning (i9), motivation and interest generated by teachers and experts (i10), and encouragement and facilitation of attendee participation (i11). These items provide valuable insights into the students' overall satisfaction with the school climate assemblies and their perception of the assemblies' effectiveness in achieving their objectives. An overall final item asked students to rate and globally evaluate the school climate assembly as excellent, good,

average, deficient, or very poor. The second section of the questionnaire included three open-ended questions where students could express their opinions and improvement suggestions, covering both positive and negative aspects of the intervention according to their perspective: (1) What was the best part of the school climate assembly? (2) What do you think could be improved? (3) What has the assembly brought you? Non-parametric descriptive statistics were used for the quantitative data analysis to determine overall satisfaction levels, while content analysis was used for qualitative data to identify recurring categories and patterns amongst participants' responses, which were then quantified according to the frequency of occurrence. The integration of quantitative and qualitative data provided a comprehensive understanding of student perceptions.

Results

Step 4: Outcomes and effectiveness of the programme

This step includes the main results of the intervention concerning policy climate change recommendations that emerged from school climate assemblies and student satisfaction and perception of the assembly process, which aimed at testing the effectiveness of school climate assemblies in real practice in five secondary schools.

First, the policy climate change recommendations and actions resulting from the contributions made and prioritised by students during the school climate assemblies are outlined. The main results related to the efficacy of the intervention according to the degree of satisfaction of participating students with the school climate assemblies are then presented.

Policy climate change recommendations that emerged from the school climate assemblies

The policy recommendations that emerged from the analysis of the actions and proposals the students made are presented and conceptualised, including the actions that emerged and their frequency, and the number of times that the action was prioritised or voted for. The degree of concreteness of the contributions has been respected; for this reason, some policy recommendations or proposals may have a higher level of concreteness of action than others.

Policy Recommendation 1. Promote energy efficiency and the use of renewable energies This field of action refers to the use of renewable energies such as wind, solar, and tidal energy. It highlights the importance of making good use of the energies we have and actions aimed at reducing consumption and energy expenditure and avoiding excess consumption. It includes the installation of solar panels, support for renewable energy companies, increased investment in renewable energy, use of rechargeable batteries, natural light, and LED lights, and turning off household appliances when not in use. Table 2 presents the actions proposed by the students forming this policy recommendation.

Policy Recommendation 2. Improve the environmental management of industries and establish more mechanisms to control atmospheric pollution, enhance research, and promote sustainability in the industrial sector. This area includes actions aimed at improving the environmental

Table 2 Actions proposed and frequency: Policy Recommendation 1

Action	Frequency number
Self-supply solar energy (e.g. solar panels)	305
Use renewable energies	260
Make good use of energy and reduce the consumption of electricity and heating (e.g. turn off household appliances not being used, reduce the use and consumption of light and electricity, use LED lights)	118
Use natural light	43
Put in more wind turbines	25
Support renewable energy companies	15
Buy rechargeable batteries	15
Invest in products that can make the house more sustainable	14
Reduce the use of nuclear power plants	14
Use tidal energy	14
Try not to make excessive use of non-renewable energies	14
Use less energy for technology	11
Invest more in renewable energy	10
Run factories with renewable energy	10

Table 3 Actions proposed and frequency: Policy Recommendation 2

Action	Frequency number
Penalise industries that exceed pollution limits Fine the most polluting industries	52
Pass stricter laws (e.g. use of polluting energies, use of water resources, coastal construction)	49
Control factory pollution Increase control measures in factories	33
Reduce the burning and consumption of fossil fuels	17
Reduce waste from factories	16
Make the use of renewable energy mandatory in factories	14
Develop agricultural technologies	13
Improve factory filters	11
Reduce intensive livestock locations and move them away from the population	6
Increase the variety of production systems	5

management of industry. The actions proposed relate to the reduction of waste from industry, the establishment of more demanding legislation about sustainability, control measures and sanctions for the most polluting industries, and the promotion of the mandatory use of energy renewables in factories. Proposals include the improvement of filters, the manufacture of biodegradable and reusable materials, and research on the elimination of microplastics. A further proposal is reducing the use of fossil fuels and reducing and distancing intensive livestock farming from the population. Table 3 presents the actions proposed by the students forming this policy recommendation.

Policy Recommendation 3. Promote sustainable mobility The students proposed actions aimed at promoting and enhancing sustainable mobility through the use of non-polluting means of transport such as cycling or walking. They also emphasised the need to promote the use of public transport and electric cars to reduce the use of polluting fuels, create bike lanes, and control transport associated with ships. Table 4 presents the actions proposed by the students forming this policy recommendation.

Policy Recommendation 4. Preserve, improve, and expand green areas and natural spaces This area of action refers to the need to develop measures to preserve and protect natural spaces and the creation and expansion of green areas, the planting of vegetation, ending deforestation, and improving the management of ecosystems. Table 5 presents the actions proposed by the students forming this policy recommendation.

Policy Recommendation 5. Reduce, recycle, and reuse and promote conscious and sustainable consumption The actions proposed by the students in this area refer to the 3Rs (reduce, recycle, and reuse): the need to reduce the use and manufacture of plastic packaging, waste management and the use of non-polluting products, the promotion of selective collection and reducing consumption and opting for local, natural and ecological products. A further proposal is the establishment of penalties to encourage recycling. Table 6 presents the actions proposed by the students forming this policy recommendation.

Table 4 Actions proposed and frequency: Policy Recommendation 3

Action	Frequency number
Use sustainable and non-polluting means of transport (bicycles, walking) more	227
Use public transportation more	168
Manufacture and use hybrid or electric cars	107
Reduce the use of polluting vehicles such as cars	39
Use electric and public vehicles	19
Build more parking lots	18
Expand public transport lines	12
Control the movements of ships	10
Enforce traffic regulations in the city	8
Build more bicycle paths	5

Table 5 Actions proposed and frequency: Policy Recommendation 4

Action	Frequency number
Create more green areas	44
Protect and seed natural spaces	35
End deforestation	15
Create more nature in urban areas	13
Manage ecosystems better	10
Avoid use of fertilisers at home	5
Reduce the number of controlled fires	4

Table 6 Actions proposed and frequency: Policy Recommendation 5

Action	Frequency number
Reduce, recycle, and reuse	153
Reduce the consumption of animal products	88
Reduce the manufacture and consumption of plastics Investigate how to eliminate microplastics	81
Reduce unnecessary consumption	33
Penalise not recycling	29
Reduce the waste thrown into the sea	25
Manufacture and use biodegradable materials	24
Establish facilities for recycling (selective collection)	23
Provide more trash cans	20
Buy and consume local products (Km0)	9
Reduce the consumption of single-use products	7

Policy Recommendation 6. Manage and use water better This area refers to actions aimed at making good use of water and reducing its consumption through saving measures such as reducing shower time, turning off taps to use only the necessary amount of water, showering instead of bathing, putting regulators or reducers on taps, reusing rainwater for irrigation, creating tanks to use rainwater, and making communal use of water facilities.

Another proposal is the storage and use of water by constructing rainwater collection points and actions to ensure the preservation and non-pollution of rivers. Further proposals are to ensure the preservation and inhibit the pollution of waters, rivers, and seas, avoid waste dumping, reduce sea pollution, control ship accidents, avoid altering the courses of rivers, increase the sewerage system, improve infrastructure to avoid floods and overflows, use desalination plants, protect marine species, and regulate prices according to consumption. Table 7 presents the actions proposed by the students forming this policy recommendation.

Policy Recommendation 7. Increase environmental education and support for initiatives that promote environmental awareness In this area, mechanisms should be established to raise awareness in society and promote environmental education both inside and outside schools, promoting awareness campaigns and environmental awareness and sensitisation actions on issues such as the use of public transport, good use of energy, environmental volunteering and specific educational activities and programmes, informative talks, and guided tours and outings aimed at promoting action towards environmental sustainability. Also, mechanisms are needed to support NGOs or entities that work on environmental issues and promote care for the environment. A further need is subsidies for ecological projects that promote sustainability and actions related to promoting changes in behaviours or habits concerning the collection of rubbish from the sea and the management of rubbish and the waste humans generate. Table 8 presents the actions proposed by the students forming this policy recommendation.

Policy Recommendation 8. Create sustainable cities and communities This area refers to actions related to providing better accessibility to work, working conditions and control of illegal work, promoting the establishment of stricter rules and regulations in the field of sustainability, increasing investment in sustainability, and ensuring the creation of sustainable cities and communities. A further proposal is to promote sustainable and local tourism and establish cleaning teams to improve people's quality of life. Other actions proposed relate to increasing containers on the beaches, imposing sanctions or fines on people who leave waste on the beaches, increasing bins and prohibiting

Table 7 Actions proposed and frequency: Policy Recommendation 6

Action	Frequency number
Make good use of water (e.g. shower instead of bathing, turn off the taps, install regulators)	277
Reduce sea pollution Do not dump waste or chemical products into the sea or other waters	79
Take advantage of rainwater Construct wells for the collection of rainwater	57
Improve water channelling infrastructure to avoid floods or overflows	24
Drink tap water	18
Do not alter the course of rivers	13
Control ship accidents	11
Do not throw waste into the toilet	11
Make use of desalination plants	9
Use water facilities communally (for example, swimming pools)	9
Maximise the use of non-potable water in productive activities	7
Establish exponential water usage prices	6

Table 8 Actions proposed and frequency: Policy Recommendation 7

Action	Frequency number
Raise awareness in society	56
Increase environmental education	38
Create environmental awareness campaigns (e.g. activities, outings, informative talks, guided tours, advertising campaigns)	32
Organise volunteering waste collection campaigns	38
Support NGOs	16
Encourage the use of public transport	13
Develop educational programmes based on equality, respect and diversity	4

construction projects with high environmental impact. Concerning tourism, proposals are to promote cultural leisure and proximity tourism that makes use of local commerce, increase winter activities and family activities, spread interesting tourist spaces, correctly size public services, improve the cleanliness of tourist sites, establish greater vigilance and control in nature and tourist areas, control noise pollution, and develop other sectors in addition to the tertiary sector. A final proposal is to increase the budget for cultural activities, diversify and promote different tourist destinations and rehabilitate historical spaces. Table 9 presents the actions proposed by the students forming this policy recommendation.

Student satisfaction and perception with school climate assemblies

Regarding the efficacy of the intervention and participants' degree of satisfaction, the results reveal favourable feedback from students on school climate assemblies, with a mean score of 4 out of 5 for all questionnaire items (see Fig. 5), which corresponds to agreeing with the statements for the 11 evaluated items.

According to the results (Fig. 5), most students (64%) agreed or totally agreed that the assembly's objectives were achieved (i1). Regarding content satisfaction, 68% agreed or totally agreed that the assembly content met their expectations (i2). Additionally, 78% positively evaluated the facilitators' role and activity, rating this item as agree or totally agree (i3). Three-quarters (75%) considered the assembly duration adequate (i4) and 74% found the methodology and session dynamics used appropriate (i5). Concerning the facilitation of active participation due to the methodology used, 73% agreed or totally agreed (i6). The figure was 74% for the usefulness of the assembly in practice (i7) and 75% for the quality of the learning environment created (i8). Likewise, 73% agreed or totally agreed with the usefulness of the assemblies for their education and learning (i9), 70% felt the teachers and experts motivated and generated interest (i10), and 76% agreed with the encouragement and

Table 9 Actions proposed and frequency: Policy Recommendation 8

Action	Frequency number
Increase family activities	82
Provide more containers on the beaches	58
Improve working conditions in the tourism sector	56
Provide more control and surveillance of tourist and natural sites	47
Establish penalties or fines for throwing waste on the ground and beaches	46
Further sustainable tourism	39
Promote local tourism	34
Create more cultural activities	26
Take care of local beaches and provide more cleaning in tourist places	22
Develop other sectors beyond the tertiary sector	12
Prohibit construction that alters the environment too much	11
Advertise interesting places to visit for tourists	10
Sell tourist cards for events (fewer tickets)	10
Consider the sizing of public services	7
Increase winter activities	7

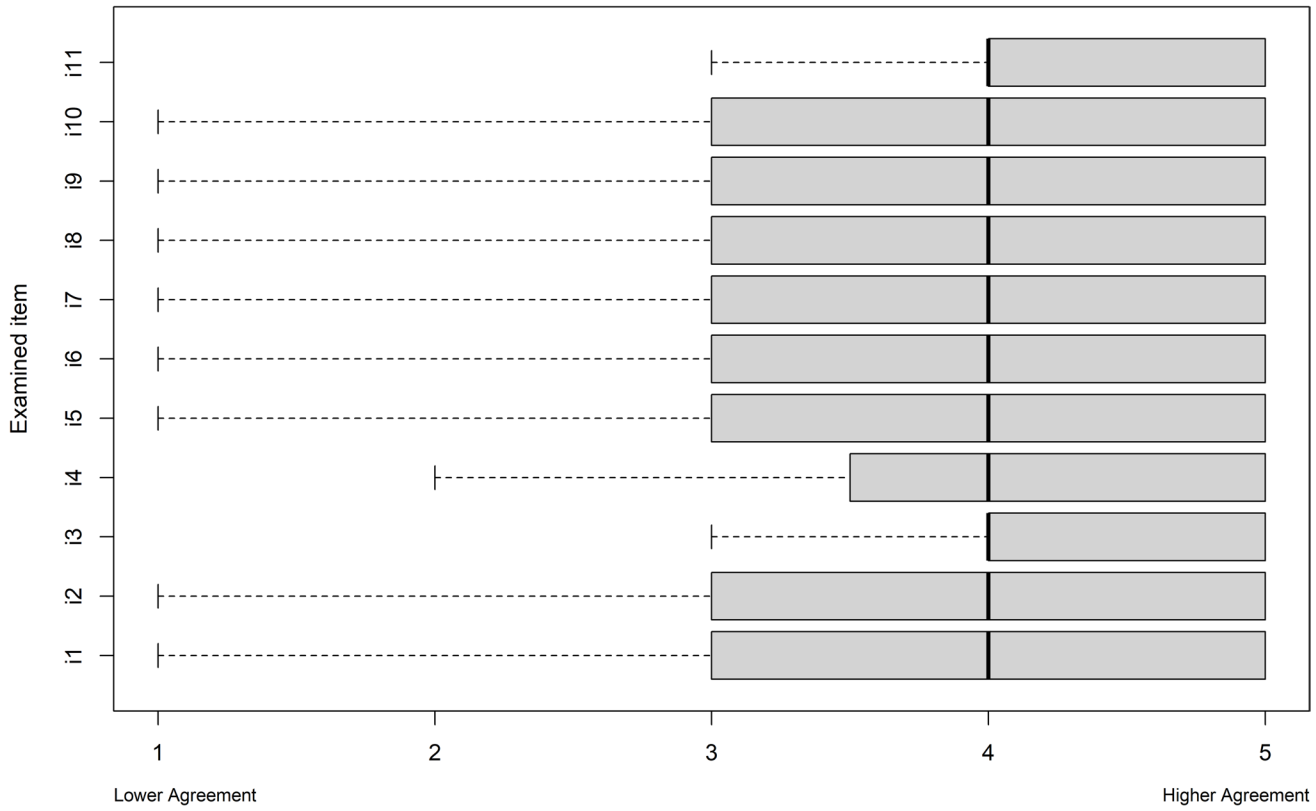

Fig. 5 Student satisfaction concerning questionnaire items

facilitation of attendee participation (i11). The most highly evaluated items relied on the positivity of the facilitator's role and activity (i3) and the facilitation of attendee participation (i11). Aspects that could be improved referred to the perception of achievement of the assembly's objectives (i1) and meeting content expectations (i2).

Students also answered three open-ended questions: What was the best part of the school climate assembly?, What do you think could be improved? What has the assembly brought you?. Collaboration and teamwork (27.6%) and dynamic methodology (23.6%) were identified by students as the best parts of the climate assembly (see Fig. 6). Other relevant aspects that were highly valued by the students were recreational and dynamic activity (10.6%), reflection and learning (10.6%), active participation, giving opinions and debate (9.8%), and all the activity (8.9%). Other interesting features but with less weight were the positive assessment of the facilitators' role (4.9%) and the creativity and originality of the activities (4.1%).

Students also highlighted what they thought could be improved in the climate assembly (see Fig. 7). Over one-third (37.5%) found nothing to improve. While 17.6% replied that it was aspects linked to the dynamic of the activities and 11.9% considered time management. Some students (8.8%) wanted an extended initial explanation of the activity (8.8%) and others (8.1%) wanted more time to participate and debate. The group dynamics and organisation (5.1%) and the methodology used (5.1%) could be improved in the opinions of some students. Participants also said changes might be made to the environmental action (2.9%) and activity materials (2.9%).

Regarding the aspects that the assembly brought them (see Fig. 8), 46.6% of the students reported new knowledge and learning and 36.3% said it was greater climate awareness. Other important aspects, but with fewer answers were that students now had more information about the topic (4.8%), had learned creative ways of working (4.1%), had gained more interest in the topic (2.1%), and had improved their capacity for teamwork (1.4%).

Concerning the general evaluation of the school climate assembly by participating students, most participants gave an overall rating of good (44%) or excellent (30%). Only 3% rated the assembly as very poor, 4% as deficient, and 19% as average. Thus, 74% of the students participating in the assemblies provided a positive evaluation.

Step 5: Dissemination actions and materials

For dissemination of the programme findings and materials, several actions during and after the project

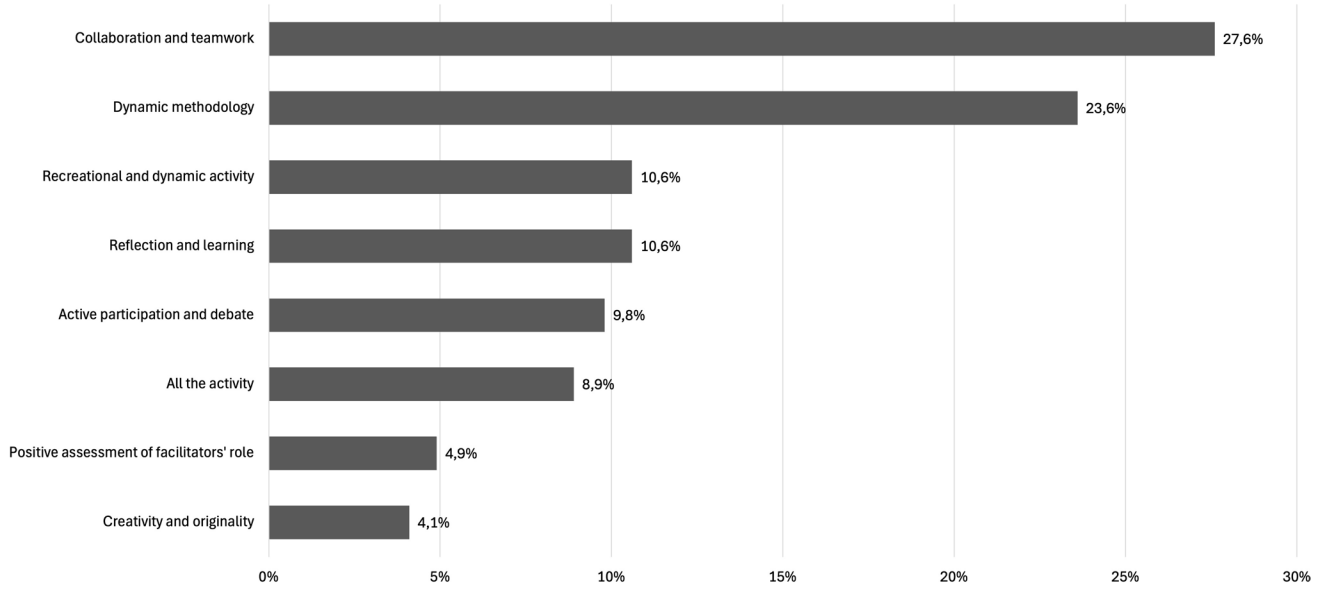

Fig. 6 Categories and percentages concerning students' opinions of the best part of the assembly

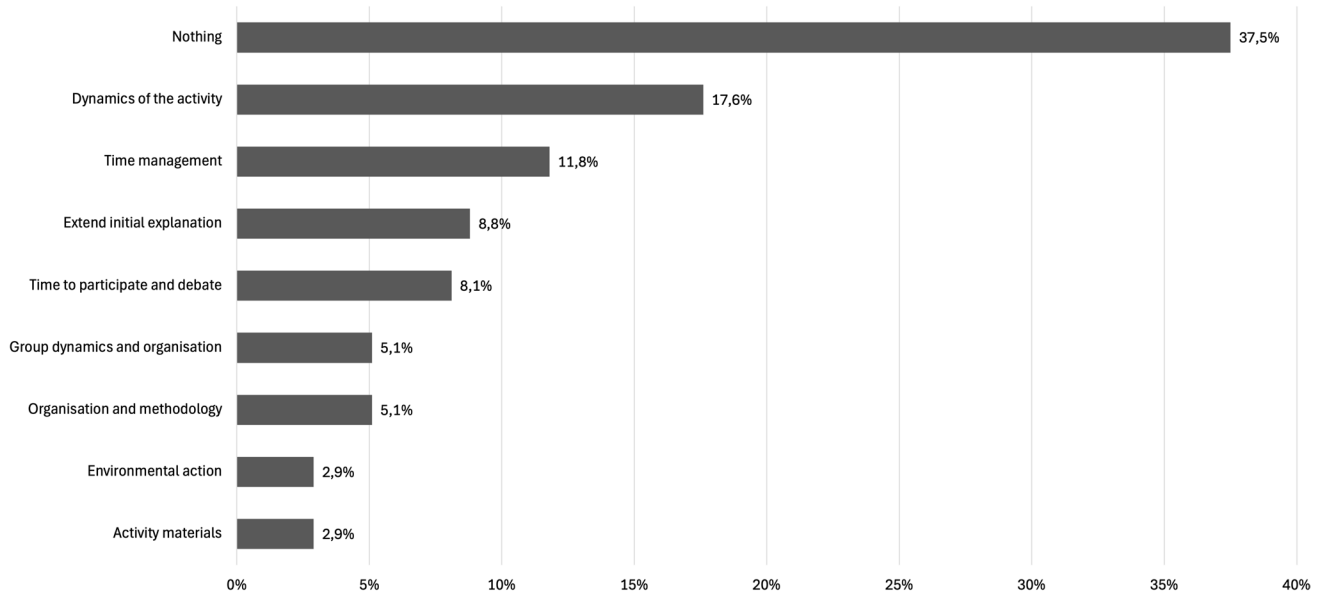

Fig. 7 Categories and percentages concerning students' opinions about aspects of the assemblies that could be improved

implementation were developed addressed to schools, educators, policymakers, the local community, and society in general:

- Individual school reports were sent to each school and education community.
- A global report on school climate assemblies, including the policy climate change recommendations that emerged from the climate assemblies' intervention, was sent to 94 policymakers and organisations, including policy representatives from the municipalities and regional and governmental administrations.
- Educational resources and school climate assembly implementation guidelines were shared with all 1267 secondary schools in Catalonia via email and accessible on the project website.
- A school climate assembly press release through the university communication unit was sent to 62 media. Information about the project appeared in 12 local, regional, and Catalan media and in interviews on three local and

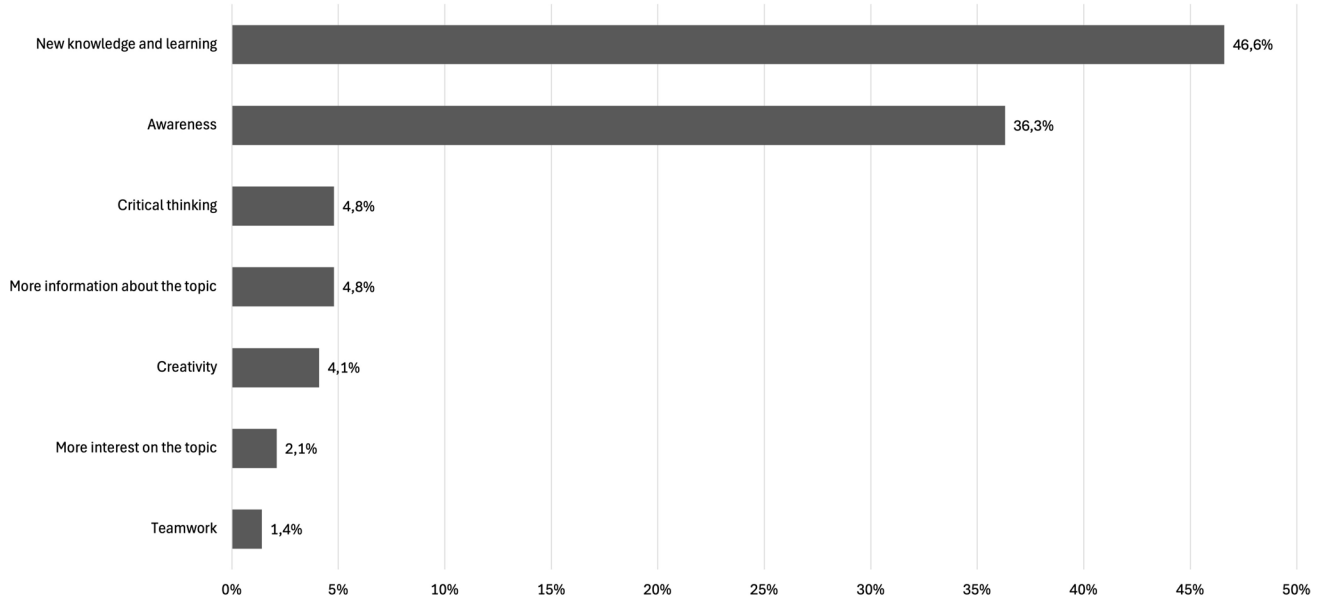

Fig. 8 Categories and percentages concerning what the assemblies brought to students

regional radio channels to present the project and its outcomes.

- In the final project outreach session, the process and results of the school climate assembly intervention were presented to policymakers, stakeholders, and the wider community.
- A session with one City Council was organised, in which a group of representative students from one participating secondary school shared and discussed the actions proposed and the policy climate change recommendations with the mayor and councillors.

Discussion

The policy climate change recommendations emerging from the assemblies cover a diverse range of areas, from promoting energy efficiency and sustainable mobility to improving environmental management in industries and advocating for sustainable cities and communities. The frequency analysis of proposed actions provides a quantitative dimension to the qualitative insights gathered during the assemblies. The detailed breakdown of policy recommendations, such as promoting energy efficiency and the use of renewable energies, improving industrial environmental management, promoting sustainable mobility, preserving green areas, adopting the principles of 'reduce, recycle, and reuse', managing water efficiently, and enhancing environmental education, showcases the breadth of perspectives and priorities among the students.

The main contribution of this paper is the description of an intervention research project proposing a methodological approach to implementing school climate assemblies in schools, adapted from deliberative democratic processes and previously organised climate assemblies with the general public and adult citizens (Elstub et al. 2021; Torney 2021; Stack and Griessler 2022). It outlines the phases and steps for applying school climate assemblies, also informed by co-creation methodologies and materials previously used in other fields, such as climate services (Font et al. 2021). The methodology employed in the project, involving the creation of concept maps and a structured process of deliberation and consensus-building, reflects a thoughtful and inclusive approach. The visual representation of concept maps provides a clear overview of the collaborative efforts and the identified areas of concern by students. The assembly phases, including group deliberation, individual prioritisation through voting, and the analysis of the most popular actions, contribute to a well-rounded exploration of potential solutions. The emphasis on actionable items, translated into policy climate change recommendations, reflects a practical and outcome-oriented approach.

Innovative forms of deliberative democracy are gaining traction in governing responses to climate change in Europe and beyond (Torney 2021). With this study, we wanted to expand this fact, so our methodology, based on qualitative information, builds on co-creation, deliberation, and reaching consensus amongst students to jointly define the main sustainability challenges in their local environment, school, municipality and region, and co-create and prioritise possible solutions. By using a qualitative method, we engage

students in a participatory process that allows them to express their perspectives and insights on sustainability and climate change challenges. This approach acknowledges the value of incorporating diverse voices and opinions, ensuring a more comprehensive and inclusive understanding of the issues at hand. The consensus-building aspect of our methodology is vital in identifying the key sustainability challenges. By engaging students in discussions and collaborative activities, we encourage them to find common ground and develop shared goals. This process helps foster a sense of ownership and collective responsibility for addressing sustainability issues and contributes to the implementation of ESD processes such as collaboration and dialogue, systems thinking, value clarification, and active and participatory learning (Tilbury 2011). It can also contribute to the development of sustainability competencies such as values-thinking, collective action, interpersonal competence, problem-solving, and strategic thinking (Bianchi et al. 2022; Brundiers, et al. 2021; Wiek et al. 2011).

Ghadiri et al. (2022) found that repeated participation in authentic scientific research in community citizen science contexts fosters youth development of new roles and environmental science identities. We could evidence this by the different sustainability actions the students identified during the school climate assemblies in our project. This aligns with the findings of Ghadiri et al. (2022), reinforcing the notion that involving young individuals in authentic scientific research and co-creation processes can inspire them to take on new environmental perspectives, roles, and identities.

In recent years, climate assemblies have emerged as popular tools for deliberating on climate adaptation options among citizens (Elstub et al. 2021; Stack and Griessler 2022; Wells et al. 2021). However, climate assemblies specifically designed for schools were not previously designed or implemented. While climate assemblies have been successful in engaging adult citizens, to date, the specific needs and perspectives of young individuals in the school context have not been fully addressed. Recognising this gap, EMPOCLIM and EDUCLIMAD projects focus on designing climate assemblies specifically tailored for schools, early adolescents, and youngsters. These school-based climate assemblies aim to involve students in the decision-making process regarding climate mitigation and adaptation options. By adapting the format and content of traditional climate assemblies (Torney 2021; Stack and Griessler 2022), school climate assemblies provide a platform for students to voice their opinions, contribute their ideas, and deliberate on climate-related issues that directly impact their lives.

The findings concerning student satisfaction with the school climate assemblies, the aspects the students highlighted as positive, and aspects that the process brought to them are mainly active participation, new knowledge and learning, awareness, reflection, collaboration and teamwork, and the dynamism of the process. These findings show that school climate assemblies are a suitable tool and intervention to promote the active engagement of pupils and their communities towards finding innovative sustainability and climate change solutions, which can lead to the development and operationalisation of sustainability competencies, providing a clear and validated pedagogical tool that can be replicated in other regions and contexts, which is currently lacking (Mulà et al. 2022). It can therefore contribute to the development of sustainability competencies in students, associated with interpersonal competence and collective action, which focus on acting for change in collaboration with others and promoting learners' abilities and wills to engage in democratic processes to achieve more sustainable societies (Bianchi et al. 2022; Brundiers et al. 2021).

Nowadays, as we collectively come to terms with the irreversible nature of a portion of the environmental damage and its long-term consequences, it is critical to examine the role of education and educational leadership in addressing the climate emergency (Cebrián et al. 2022; Lengthorn and Asbury 2021). In this context, our research provides a valuable tool that aligns with the purpose of education related to the need to help develop sustainability-competent citizens able to contribute to a positive social transformation towards sustainability (Bianchi et al. 2022; Brundiers et al. 2021). Through the methodology developed, students are empowered not only to identify the significant challenges in various environmental areas such as air quality, tourism, energy, and water, but also to propose solutions to address these challenges that can then be shared with the local community, social organisations, and policymakers. Learner empowerment is associated with psychological empowerment and refers to learner knowledge, competence and self-efficacy, impact, motivation to act and meaningfulness (Han et al. 2023). Self-efficacy refers to the belief in one's ability to make a difference and have a positive impact and is related to a sense of agency, having ownership of one's actions and the capacity to influence the external environment (Baldwin et al. 2023). The creation of participatory spaces is a way to foster empowerment to contribute to sustainability, leading to new knowledge and perspectives, acquisition of competencies, self-efficacy, and a sense of agency among students to influence sustainability in their local community (Gimenes et al. 2019).

Conclusions

The empirical results derived from the school climate assemblies provide valuable insights into the environmental perspectives, concerns, and priorities of youngsters in Camp de Tarragona. The geographical context of Camp de Tarragona, characterised by a dynamic interplay of factors such as a

significant population, a major petrochemical industry, tourism, and agriculture, underscores the importance of addressing climate change through participatory approaches and multi-faceted lenses. The actionable policy recommendations derived from these empirical findings can contribute significantly to local and regional efforts in sustainability and climate change adaptation.

Also, the study findings demonstrate the effectiveness of participatory processes in fostering a deeper understanding of climate change challenges, promoting active participation, developing new knowledge and learning, and building awareness and interpersonal competencies through collaboration and teamwork. Therefore, school climate assemblies, with their focus on empowering the educational community to adapt to climate change, present a comprehensive and participatory approach to address environmental challenges that in turn can promote sustainability learning and help develop sustainability competencies. School climate assemblies are in line with ESD processes such as collaboration, action, and participatory learning. They effectively promote the co-creation of climate change mitigation and adaptation strategies through the active participation and empowerment of pupils and youngsters. They offer an innovative and democratic platform for learning, deliberation, and decision-making, enabling students and communities to address climate change at local and regional levels.

School climate assemblies are envisioned as an innovative educational activity in which sustainability competencies can be operationalised and developed, especially regarding competencies related to values thinking, future thinking, and collective action, which focuses on acting for change in collaboration with others and promoting learners' ability and their will to engage in democratic processes to achieve more sustainable societies. This approach may also inform and influence policymaking through the identification of policy recommendations, actionable priorities and indicators of where community learning and action can make a significant contribution and drive meaningful action to address climate change and sustainability challenges.

This paper presents the methodological conceptualisation for implementing climate assemblies in schools based on previous experiences with the general public and citizens and the outcomes of a pilot with secondary school students, establishing a replicable framework that offers valuable learning from climate change deliberative processes for other educational institutions. Moreover, this approach can be applied in different contexts and educational levels and contexts, making it adaptable and scalable. In summary, the study underscores that school climate assemblies significantly contribute to the co-creation of climate change and mitigation strategies.

The creation and development of such innovative educational tools that promote transformative and community-based learning involving the school community in climate action are essential for achieving the SDGs and promoting environmental awareness and empowerment among young people through education.

This study provides valuable insights into the potential impact of sustainability-focused interventions within educational settings; however, several limitations should be acknowledged. Firstly, time constraints concerning the length of the intervention may have affected students' ability to reflect and internalise the learning gained concerning sustainability. Additionally, conducting the intervention during post-pandemic times may have influenced the dynamics of collaboration, interaction, and participation among participants. We could not collect evidence of the development of sustainability competencies, self-efficacy or empowerment amongst students due to the intervention, which is a remaining research question that requires further exploration. Moving forward, further intervention-based research focused on sustainability within educational settings is necessary to gain a deeper understanding of the impact this type of intervention has on student learning.

Further research on operationalising student sustainability learning and competency frameworks and defining clear assessment paths and tools is needed to move from self-perception to studies that provide evidence of student learning, empowerment, and competency development. Also, school climate assemblies could be replicated with greater populations and in different environmental, socio-cultural, socio-economic, and educational settings to conduct comparative studies that explore the differences and similarities according to specific contexts. Furthermore, longitudinal studies could be developed to evaluate the long-term social impact of participating in a school climate assembly by using different assessment tools at different levels, including individual, institutional, policy-making, and community. Additional research could assess how school climate assemblies influence political action, particularly in terms of implementing actions derived from students' proposals. This evaluation could shed light on the efficacy of student-driven initiatives in shaping policy decisions and driving tangible change at the governmental level.

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Data availability Data are available from the authors upon request.

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