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1.5. Acronyms

Acronym	Description
ACTION	Participatory science toolkit against pollution
AI	Artificial intelligence
BSC	Barcelona Supercomputing Center
CRA	Climate Risk Analysis
DBT	Danish Board of Technology Foundation
EA	Ellinogermaniki Agogi
ECCEL	European Certification for Climate and Environmental Literacy
ENG	Engineering Ingegneria Informatica S.P.A.
MICS	Measuring the Impact of Citizen Science
MLP	Multi-level perspective
RGSMART	Racunarska gimnazija SMART Novi Sad
RRI	Responsible research and innovation
RST	School for Europe Foundation – Royal School in Transylvania
STEM	Science, Technology, Engineering and Mathematics
UAB	Universitat Autònoma de Barcelona
UNSPMF	University of Novi Sad, Faculty of Science
YDA	Youth design assembly

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1.6. Executive Summary

The socio-economic impact assessment of the GreenSCENT project, detailed in this deliverable, employs a dual perspective. It quantifies the impact on stakeholders, public administrations, schools, and local authorities resulting from the adoption of GreenSCENT solutions. Additionally, it maps the impact of GreenSCENT activities to analyse how the solutions and activities developed by the project enhance users' conditions during the project's development and beyond.

The assessment methodology is both qualitative and quantitative, multi-stakeholder, and multidimensional, using the impact value chain method to analyse project inputs, activities, outputs, outcomes, and impacts. This approach supports the identification of the project's value proposition, its expected impacts, and potential obstacles to full achievement.

To respect the uniqueness of each project's pilot, the methodology is modular, adaptable to different settings of the demonstrations and pilots. Project partners were actively involved in the methodology development, with a dedicated workshop early in the project to assist partners in understanding the process and providing necessary information. The assessment was performed at the end of the project, with output and activities monitored throughout the project's development to provide a mid-term assessment for the partners to adjust their actions. The final impact assessment considers impacts on a larger scale and takes into account the upscaling potential of the project.

The GreenSCENT impact assessment framework draws inspiration from earlier projects related to citizen science, such as the ACTION project and the MOTION handbook, focusing on transformative system change. The assessment covers five basic elements: scientific, social, environmental, economic, and political impacts. The results of the assessment highlight the project's added value, transformative capability, and the most interesting outcomes.

The GreenSCENT project highlighted the crucial role of teachers and educational staff in implementing Demonstrators, emphasizing the need for pedagogical experts to create effective deployment strategies. The involvement of class teachers, who understand classroom dynamics and student motivation, was essential. The project also underscored the importance of discovery and tangible outputs for students, although digital tools sometimes posed challenges. The presence of experts in classrooms significantly boosted student enthusiasm and motivation.

Despite challenges, the Demonstrators positively impacted students by increasing interest in science-related topics and encouraging lifestyle changes. The engagement methods were designed to be fair and motivating, with flexibility and inclusivity being key considerations. The Open Innovation Challenge attracted significant participation and could inspire younger students in future projects. The exploration of AI's impact on sustainability education revealed its potential benefits and challenges, highlighting the need for responsible and balanced AI adoption.

2. Introduction

GreenSCENT – Smart Citizen Education for a Green Future – is a research and innovation project funded by the European Union's Horizon 2020 programme, under Grant Agreement N° 101036480.

GreenSCENT's objective is to develop a competence framework that encompasses all the Green Deal focus areas through an iterative, participatory, experience-based, and learning-by-doing design approach.

GreenSCENT activities actively involve experts, researchers, and relevant stakeholders from the education communities. These activities also encourage citizen participation and stakeholder engagement initiatives across different European regions and various educational levels—from primary schools to higher education. The initiatives range in levels of engagement, from observation to data collection and processing, contributing to both scientific and policy agendas.

The GreenSCENT legacy will comprise the Competence Framework, its methodology, use cases, and user guides. It will also include co-designed training kits for implementing the framework; the GreenSCENT box, which is a set of digital, physical, and hybrid demonstrators developed by the project; and ECCEL, a "European driving license" for climate and environmental competencies and skills, which will be tested during the project. This deliverable is produced as part of T6.4 Impact assessment.

2.1. Description of the task in the Grant Agreement

The impact assessment will be performed individually for each pilot and then at the project level, considering all the general outputs produced by the project. The impact assessment will employ a dual perspective. On one hand, it will quantify the impact on identified stakeholders, public administrations, schools, and local authorities resulting from the adoption of GreenSCENT solutions. On the other hand, it will map the impact of the GreenSCENT activities to quantify and analyse how the solutions and activities developed by the project enhance users' conditions during the project's development and beyond.

The methodology will be qualitative and quantitative, multi-stakeholder, and multidimensional. The impact assessment approach will use the impact value chain method, analysing project inputs, activities, outputs, outcomes, and impacts. This methodology will support the identification of the project's value proposition, its expected impacts, and potential obstacles to full achievement.

To respect the uniqueness of each of the pilots, the methodology will be modular, making it adaptable to different settings of the demonstrations and pilots. Project partners will be actively involved in the methodology development. A dedicated workshop early in the project will assist the partners involved in this activity in understanding the methodology development process and providing the necessary information/data.

The assessment will be performed at the end of the project (M36). However, output and activities will be monitored throughout the project's development to provide a mid-term assessment for the partners to adjust their actions (M18). The primary goal of the mid-term round is to provide useful inputs to the consortium to fine-tune the activities for maximising the project impacts.

The final impact assessment will consider impacts on a larger scale and will take into account the upscaling potential of the project. Both the preliminary and the final assessments will inform the dissemination activities by highlighting the project's added value, its transformative capability, and the most interesting results.

2.2. Objectives of the deliverable

This deliverable has the following objectives:

1. **Analysis of Individual Demonstrators:** This objective focuses on evaluating the Demonstrators from the perspectives of technical experts, class teachers, and supervisors who were actively involved in the testing and implementation of activities. The analysis was conducted through a combination of

interviews with both experts and class teachers, as well as online questionnaires administered using Questback software[1].

2. **Assessment of AI's Potential in Enhancing Sustainability Competences:** This objective aims to understand how Demonstrator leaders perceive the potential of AI to enhance sustainability competences. The assessment involved 10 interviews conducted between September and October 2024, each lasting approximately one hour. All interviews were recorded and transcribed.

[1] https://www.questback.com/

3. GreenSCENT impact assessment methodology

The impact assessment for the GreenSCENT project was conducted using a comprehensive and multi-dimensional approach, emphasizing both qualitative and quantitative methods to ensure a thorough evaluation of the project's impact. The assessment was carried out individually for each demonstrator.

The methodology employed the impact value chain method, a structured approach analysing project inputs, activities, outputs, outcomes, and impacts, to uncover key value propositions and potential barriers. This approach helped identify the project's value proposition, its expected impacts, and potential obstacles to full achievement. The assessment was modular, making it adaptable to different settings of the demonstrations. Project partners played an integral role in developing the methodology, participating in a dedicated early-stage workshop designed to enhance their understanding and contribute critical insights.

The impact assessment was performed at the project's conclusion, with continuous monitoring of outputs and activities throughout its duration to ensure alignment with objectives. A mid-term assessment was carried out. This mid-term assessment aimed to provide useful inputs to the consortium to fine-tune activities for maximizing project impacts. The final impact assessment considered impacts on a larger scale and took into account the upscaling potential of the project. Both the preliminary (mid-term) and final assessments informed the dissemination activities by highlighting the project's added value, its transformative capability, and the most interesting results.

The GreenSCENT impact assessment framework was inspired by the framework developed in the ACTION (Participatory science toolkit against pollution) -project and the MOTION handbook, which focused on transformative system change by combining the Theory of Change methodology with the Multi-Level Perspective (MLP) (Alvial-Palavicino, Matti and Witte, 2022; Passani *et al.*, 2022; Passani, Janssen and Hölscher, 2022). The impact was assessed through five basic elements: scientific, social, environmental, economic, and political impacts.

Earlier citizen science projects served as a foundation for GreenSCENT's impact assessment, offering replicable methodologies that ensured comprehensive coverage of relevant dimensions. This allowed replicability of the previously developed assessment methods and proved to be beneficial in making sure all relevant dimensions were covered.

MICS (Measuring the Impact of Citizen Science) developed a platform consisting of metrics and instruments to support measuring the costs and benefits of citizen science across four sites. The metrics are connected to six impact domains: society, economy, environment, science and technology and governance. The impact assessment includes over 200 questions, each with a predefined set of answers to choose from. The platform also provides citizen science projects with specific recommendations on improving impact. (*MICS.tools*, 2022).

ACTION aimed to combat major forms of pollution in the EU while working across 16 pilot sites. ACTION identified the needs of different stakeholders throughout the lifecycle of citizen science, and created methodologies, tools and guidelines to democratise the scientific process to support anyone to design and realise a citizen science project from the early stages of ideation to validating and publishing the results. ACTION applied five categories of assessment: scientific, social, economic, political and environmental. The assessment had approximately 138 questions with some questions aimed at Citizen Science managers while some were aimed at citizens. (Passani *et al.*, 2022; Passani, Janssen and Hölscher, 2022)

The Demonstrators in GreenSCENT were implemented on a much smaller scale as compared to MICS and ACTION and the total number of Demonstrators in GreenSCENT was also lower than those in the previous projects. For this purpose, not all questions in ACTION and MICS were relevant for our purpose, however, we were able to extract and combine the most applicable questions. GreenSCENT performed its impact assessment in two ways: 1. Individual interviews with the Demonstrator leaders and Class teachers and 2. Collecting feedback from the Demonstrator developers and Class teachers through brief online questionnaires using Questback that focused on three dimensions (social, governance and economic). All questionnaires are available in Annex 9.1 and 9.2.

Individual interviews with the Demonstrators were conducted between May and September 2024, focusing on their experiences, challenges, and key takeaways from the implementation process. The Class teachers were also interviewed separately to find out about their experience with each implemented activity in their schools. The online questionnaires (separate for both the Demonstrators and Class Teachers) were created using Questback and distributed via email after the detailed discussion.

The impact assessment also incorporated insights from the Responsible research and innovation (RRI) evaluations conducted during the project (see D2.1.), which emphasized responsible research practices and active citizen engagement and included thematic evaluation discussions during consortium meetings, an online survey in January 2024 to collect the key learnings and concerns related to RRI issues and two workshops to elaborate the findings of the surveys, one online in February 2024 and one as part of the consortium meeting in April 2024. These results were also used to formulate the policy recommendations to support environmental citizenship in education (D2.3.).

3.1. Overview of the Demonstrators

Table 1: Pilots and Demonstrators

	Demonstrators							
	Environment app	Citizen journalism	Interactive documentaries	Microplastics (activity could not continue)	Climathon	CleanAir	GreenAIR app	YDA (separate analysis)
EA			X		X	X	X	X
RGSMART		X			X	X		X
RST	X	X	X	X		X	X	X
UNINETTUNO	X	X	X			X		X
UNSPMF		X	X		X	X		X

Table 1 shows which of the Demonstrators were implemented at which GreenSCENT pilot site (i.e. schools & university). Seven Demonstrators completed the online questionnaires: Environment monitoring app, Citizen journalism, Interactive Documentaries, Climathon, CleanAir@School, GreenAIR app and Youth Design Assemblies. Microplastics has been exempted from the questionnaire as the activity could not be implemented as planned. The Open Innovation Challenge will be analysed in a separate chapter below.

4. Results

4.1. Social, governance and economic dimensions of the demonstrations

Social dimension: Demonstrators were asked about the amount of responsibility allocated to the students. "A lot of responsibility" might involve tasks such as collecting repeated observations, maintaining equipment or running workshops, while "not much responsibility" might involve analysing data as part of a group (MICS 2022). The responses revealed that most of the Demonstrators, such as Climathon or CleanAir@School, required students to work in groups and analyse data together. This placed students level of of responsibility somewhere in the middle.

Approximately 43% of the Demonstrators reported that student satisfaction with the participation process had been measured and found to be positive. The remaining 57% also claimed student satisfaction, but without formal measurement. Additionally, 86% of the Demonstrators reported that they had measured students' satisfaction with the project results and received positive feedback.

Most of the project outcomes where shared in the form of the scientific articles, grey literature and participation in events (Figure 1). Most of the Demonstrators worked with secondary school students, while some also worked with primary schools and university-level students (Figure 2). At the time of writing the deliverable, 12 peer reviewed journal articles and two peer reviewed book chapters had been published.

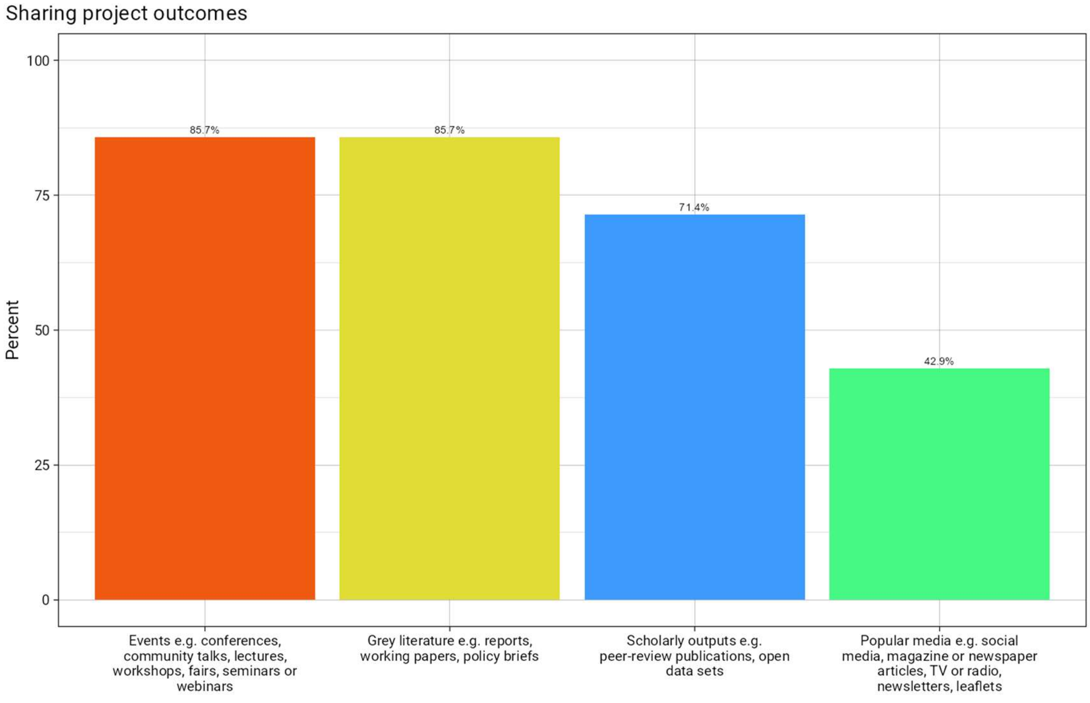

Figure 1: How were the project outcomes shared in GreenSCENT?

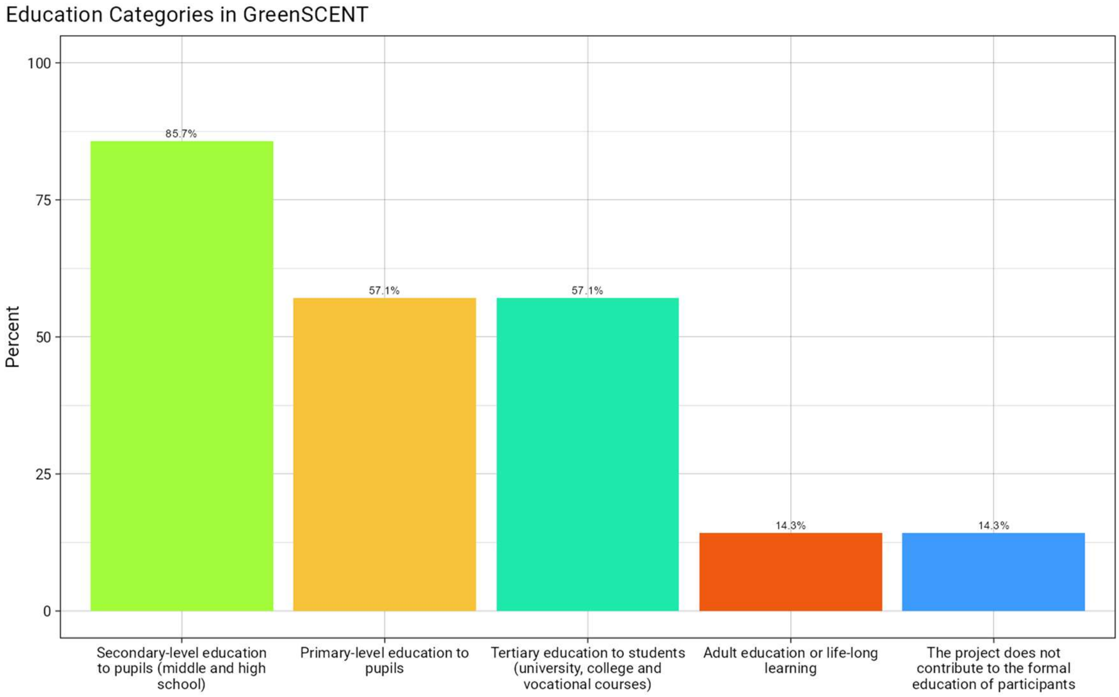

Figure 2: Education categories in GreenSCENT

Regarding personal change in behaviour, 29% of the Demonstrators claimed that their activity led to a positive change in behaviour, and that this had been measured by them (Figure 3). The remaining 57% of the Demonstrators also claimed a positive change in behaviour, but without measuring it. Additionally, 14% of the Demonstrators did not measure any behaviour change

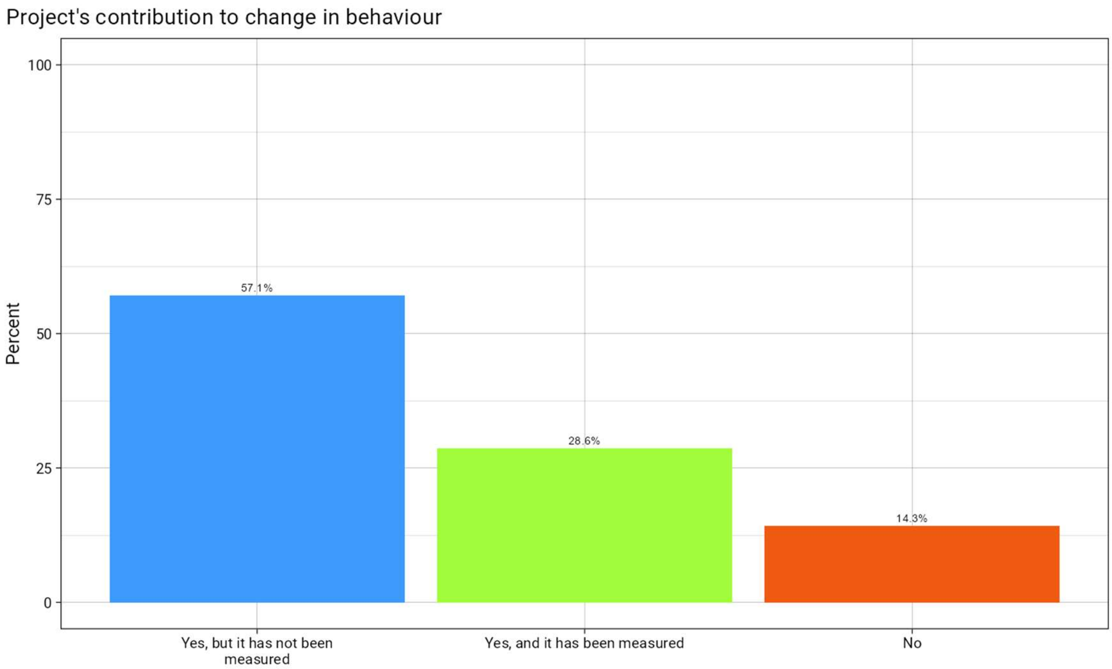

Figure 3: Project's contribution to change in behaviour

Governance dimension: In most cases (57%), the right to the collected data was given to both the school and the Demonstrators. In some cases, the data is open to the public (14%), and in other cases, the data is fully owned by the Demonstrator (14%). Nonetheless, most of the generated data (86%) is reusable for future project work. Regarding transparency, all Demonstrators explained the reason for engaging with the students and the need for data collection to both the schools and the students.

Figure 4 shows the Sustainable Development Goals (SDGs) that the Demonstrators related to the most, according to the Demonstrator leader. The SDGs covered by the most Demonstrators included Sustainable Cities and Communities and Climate action (both 86%) and Quality education (71%). Some Demonstrators were also linked to Good Health and Well-being and Responsible Consumption and Production (both 29%), Affordable and Clean Energy (14%), and Other (14%).

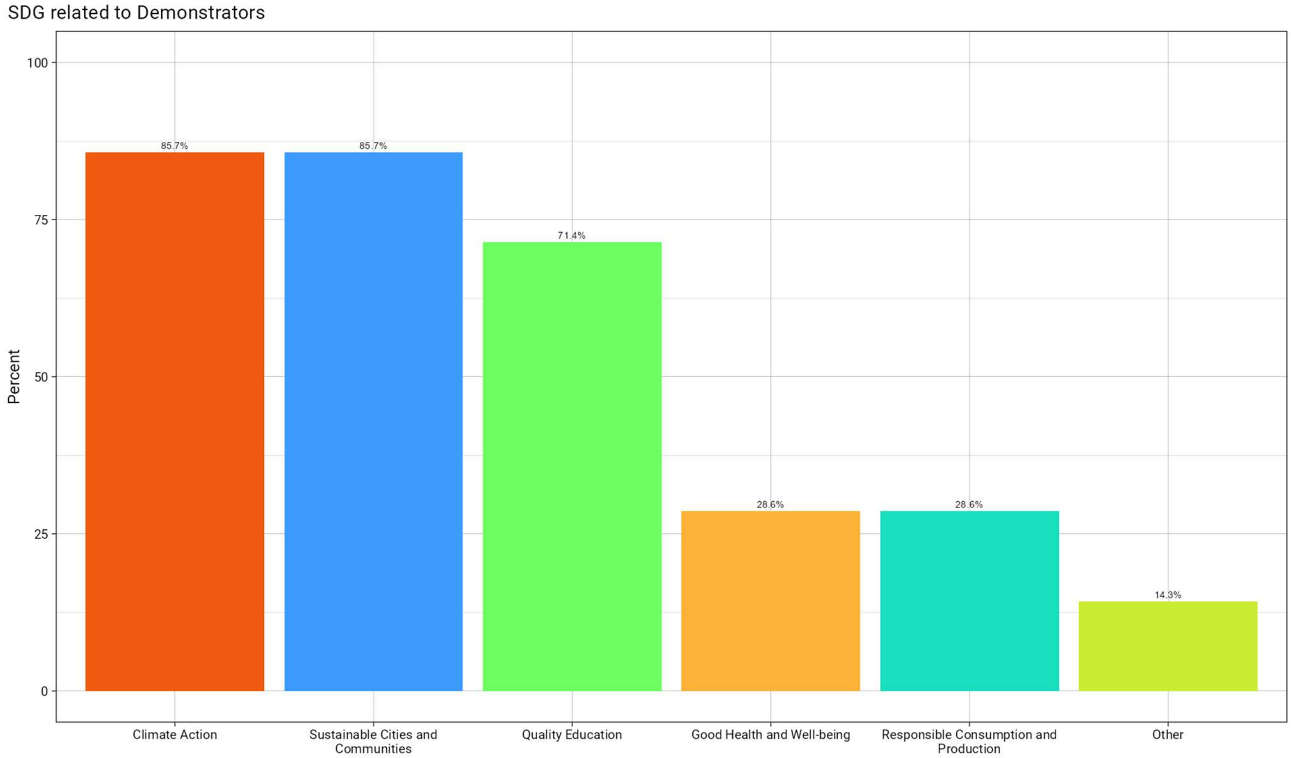

Figure 4: SDGs related to the Demonstrators

Economic dimensions: When discussing potential future projects, 29% of the Demonstrators claimed that GreenSCENT helped generate new projects for them while 14% stated that this is still under progress, such as by writing new proposals (see Figure 5). Additionally, more than half of the Demonstrators claimed there is sufficient economic potential to be exploited for future projects, for example, "new intellectual property with economic value, or new sensors with a clear market".

More than half of the Demonstrators (57%) stated that they require recurring investments in technology (for example, software licenses or app/platform maintenance) that affect the long-term sustainability of their respective activities (Figure 6). Furthermore, less than half of the Demonstrators have an intellectual property rights strategy in place and any explicit plans to sustain activities after the current funding ends.

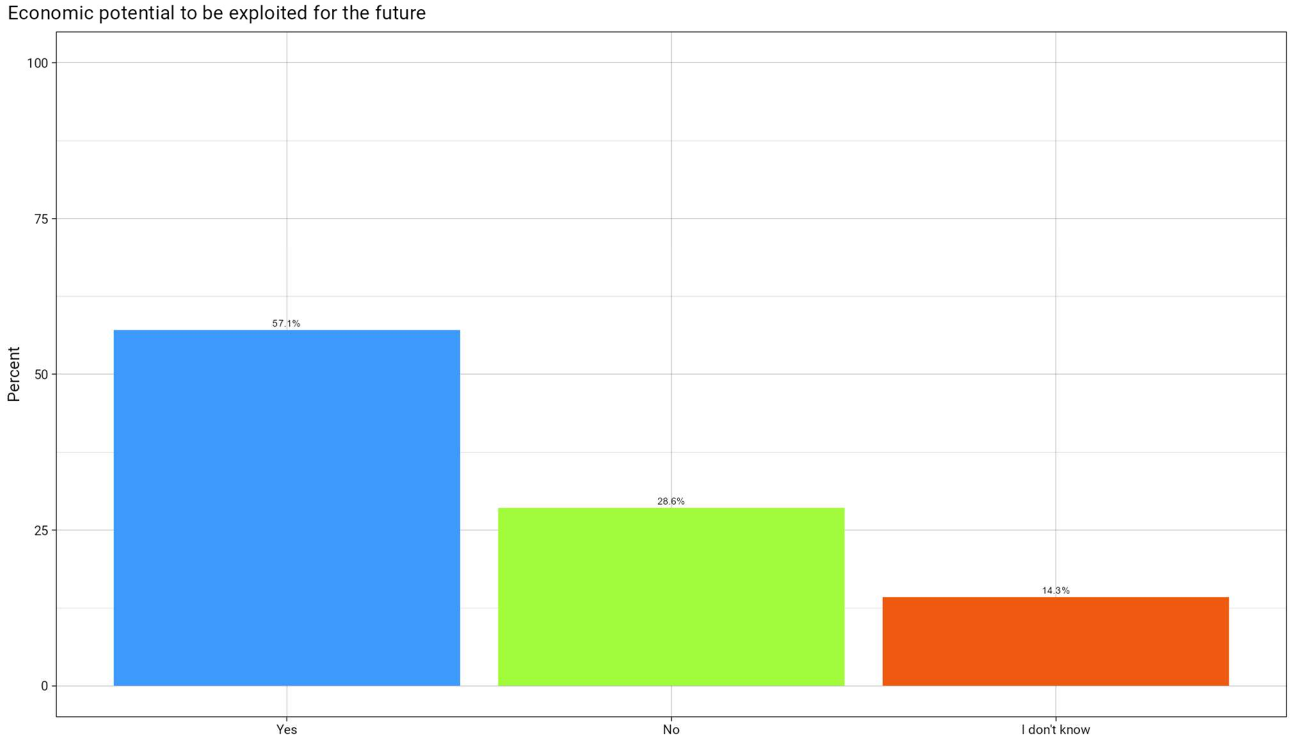

Figure 5: Economic potential to be exploited for the future

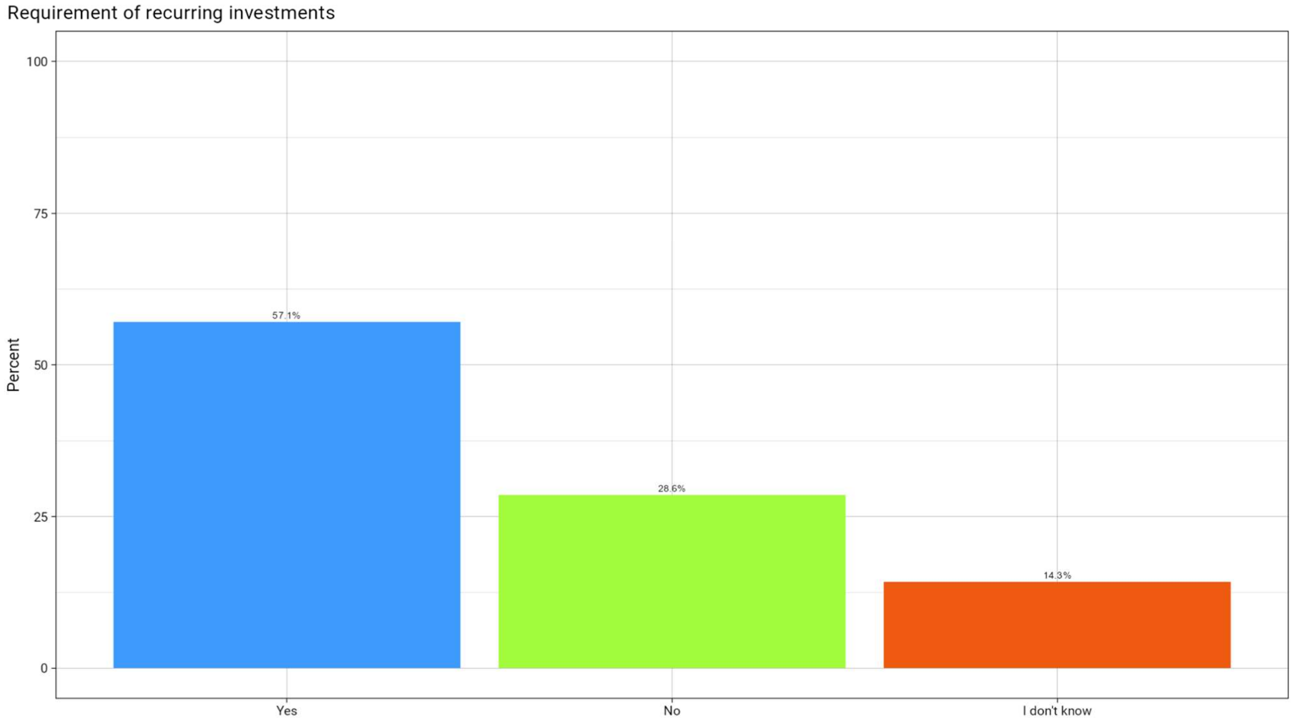

Figure 6: Requirement of recurring investments

Table 2 provides an overview of the number of students engaged through various GreenSCENT Demonstrators. It highlights the participation levels across different initiatives, such as the Environment monitoring app, Citizen journalism, and Interactive Documentaries. For instance, the Climathon at UNSPMF involved 27 participants, including 24 undergraduates, one master's student, and two PhD candidates. The CleanAir@School initiative engaged 1000 students across more than 60 schools in Europe. Additionally, the Youth Design Assemblies (YDAs) had 56 students participating, with some dropouts.

Table 2: Number of students engaged within the GreenSCENT pilots only (excludes user testing)

Demonstrator	#Participants engaged
Environment monitoring app	**RST**: 36 **UNINETTUNO**: 7
Citizen journalism	**RGSMART:** 200 students, 25 teachers **RST:** 25 **UNINETTUNO:** 7 **UNSPMF:** 10
Interactive Documentaries	**EA:** 12 participants (pupils from Grade 7, 12 years old) **RST:** 25 **UNINETTUNO:** 4 **UNSPMF: 10**
Climathon	**EA:** 5 **RGSMART:** 20 students, 1 teacher **UNSPMF:** 27 participants (24 undergraduates, one master's student, two PhD candidates)
CleanAir@School	**EA**: 308 participants (150 pupils + 6 teachers in primary education and 150 pupils + 2 teachers in secondary education) **RGSMART:** 53 students, 2 teachers, 1 school principal **RST:** 50 **UNINETTUNO:** 253 **UNSPMF:** 15
GreenAIR app	**EA:** 152 participants (150 pupils + 2 teachers in primary education) **RST**: 171 (age group: 10 – 15 years old)
YDAs	**EA:** 16 participants (14 pupils+2 teachers in secondary education) **RGSMART:** 9 students, 1 teacher **RST:** 8 **UNSPMF:** 1 56 students, plus dropouts

4.1.1. Accessibility

To ensure inclusivity in participation, UAB supported with testing all the project solutions for user-friendliness and accessibility starting from the design phase up until the final implementation. The team based their work on the principles of Universal Design and combined it with two accessibility standards: the Web Content Accessibility Guidelines (WCAG 2.2) and the EU standard EN301 549. (McDonagh, Hagan et al. 2024).

The principles were applied to the following technological tools, activities and materials:

- GreenSCENT website developed by UNINETTUNO
- GreenSCENT platform (GreenVerse) developed by Engineering (ENG)
- Four technological tools:
  - Interactive documentaries (GreenVerse) developed by ENG
  - Citizen journalism (GreenVerse) developed by ENG
  - Augmented reality (AR) app on air quality developed by Barcelona Supercomputing Center by BSC
  - Air quality app and platform for CleanAir@Schools developed by 4sfera
- Farm to Fork innovation challenge platform developed by Agorize
- Teacher training kits developed by UNINETTUNO

4.1.2. Responsible citizen engagement

To ensure that the engagement methods of the GreenSCENT pilots and demonstrators were fair and motivating for the engaged students and teachers, we collected feedback and exchanged experiences within the project team on the topics identified in the GreenSCENT RRI framework. According to these reflections, following issues were identified important in defining the ability of the piloted methods to enhance active environmental citizenship in education:

Flexibility and adjustability of methods offered resources for different educational contexts and different learners:

- Methods that did not require high-end technological solutions (e.g., the microplastics demonstrator that can be done with readily available tools) or provided flexibility in adjusting for different contexts (CleanAir@Scool) supported a more inclusive approach to environmental education.
- Hands-on learning experiences and practical exercises in the field offered by several GreenSCENT pilots established a meaningful connection between practical and academic knowledge for the students, even in areas where schools do not have regular collaboration with resource organizations.

Involvement of young people in sustainability discussions and curriculum design improved students' agency

- Youth assemblies reached out to a diverse group of public to listen to their perspective on environmental issues and solutions.
- Co-creation of educational resources engaged students in the development of educational resources that are relevant and meaningful for them and their peers. This method allows students to co-design the curriculum and learning outcomes, using their creativity and skills to produce the resources. It can help reach hard-to-reach students, who may feel more motivated and empowered by the co-creation process.
- The participatory co-creation approach also allowed researchers to understand the specific needs of the students involved in the educational experience.

In addition to clear benefits, following exclusion risks were identified:

Exclusion of students with disabilities in physical hands-on exercises

- Several piloted methods were based on visual tools, and some methods, including the microplastics demonstrator and CleanAir@School, required physical activities. These methods pose risks of excluding students with disabilities or different physical capacities.
    - For instance, individuals with mobility disabilities may face challenges navigating uneven terrain or accessing remote beach locations in the microplastics demonstrator. In the CleanAir@School monitoring, the placement of sensors outdoors at a height of 2 meters posed a challenge for younger children, students with a fear of heights, and those with physical disabilities. Ensuring a safe location for sensor placement became a complex task.

Risks related to uneven participatory settings in co-creation methods

- Youth Design Assemblies needed to carefully consider the diversity of the students involved. For example, a risk of biased interaction was related to the age difference among participants. Additionally, participants had different capabilities in communicating in an online environment with strangers in English.

- To overcome these challenges, particular attention was put on establishing norms for interaction and creating a safe space for everyone to participate. The GreenSCENT project has collected these learnings and published guidelines for establishing Youth Assemblies in a fair and inclusive way in D2.3.

4.2. Environment monitoring mobile app (ENG)

The mobile application empowers registered users to generate comprehensive environmental reports. Each report includes a title, a thorough description of the issue, and visual evidence in the form of images or videos. All reports are georeferenced and categorized based on predefined criticality types, such as Risk, Emergency, Pollution, and Solution. The application also provides a map-based display of all reports within the territory using their respective coordinates. Figure 7 explains how the mobile app differs from the Citizen journalism and Interactive documentaries. The mobile app can be used independently, and it is not connected to the GreenVerse platform. It has the general functions of the platform as compared to Citizen Journalism. (Mudelsee 2023)

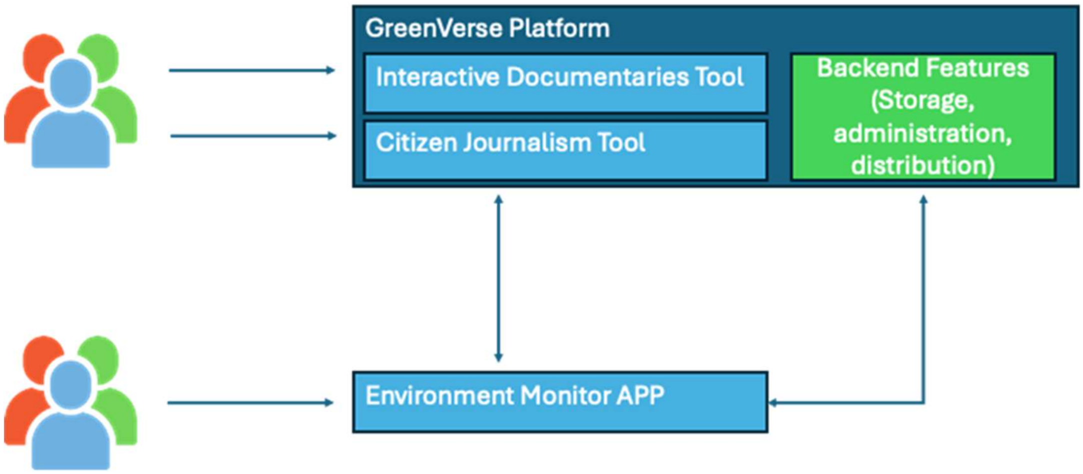

Figure 7: Differentiating between the three activities and the use of the GreenVerse platform (Source: ENG)

Any report must be approved (or rejected) by the administrator of the institution (school) to avoid duplicates or inconsistent or irrelevant reports. The mobile is available through Safari for iOS and Chrome for Android users. Reports can be enriched by other users, who can add their own comments, updates and new photo/video documentation as well; This process, called “Social Enrichment", aims to allow continuous monitoring of the report and the collection of data from different users to confirm the report, update its status, or enrich the attached documentation. The owner of a report or the administrator may mar it as ‘Solved’ if the issue has been resolved (more details by Mudelsee (2023) in D5.2).

To use the app, participants must agree to share their geographical position with the app. If users are under 18 years old, the consent process is handled by the schools (more details in D5.2) (Figure 8).

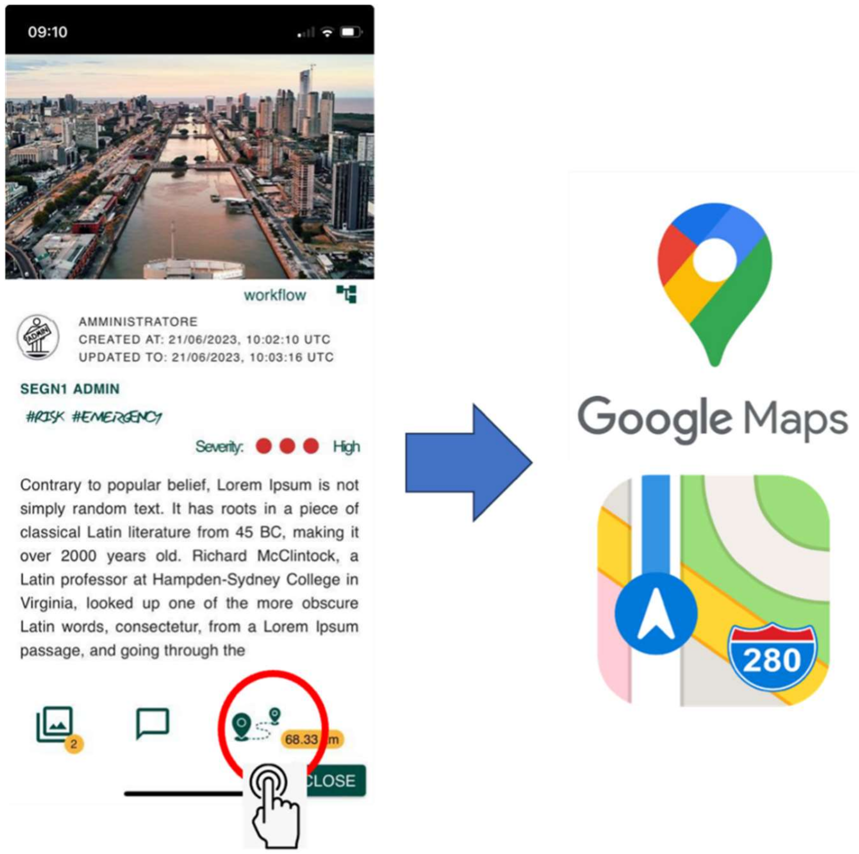

Figure 8: Environment Monitoring app view

4.2.1. User perspectives

The mobile app was piloted for the first time by ENG and it was officially used by two schools: RST and UNINETTUNO. The student age group for this activity was 15 – 22 years. The results were polarized, with one school fully agreeing that the activity positively influenced the students' attitude toward science, while the other school disagreed due to technical difficulties. Other categories received similar scores, with the two schools having opposing views (Figure 9).

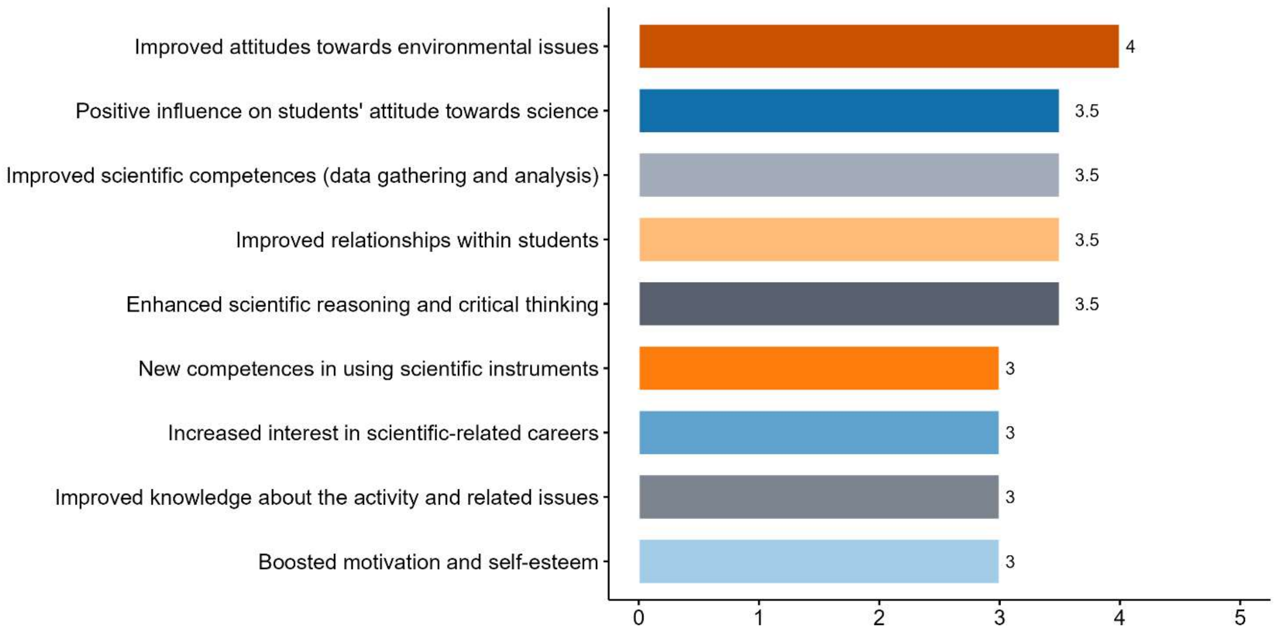

Figure 9: Class teacher's feedback on Environment Monitoring app (displays the average of responses, n = 2)

As the mobile app was not available through the App Store, the students' motivation and interest were very low. This can be attributed to the fact that many students were Apple users and the app's unavailability on the App Store was not well-received by the group. Additionally, if students wished to upload something, they had to wait for approvals, which further decreased their motivation. ENG improved the approval system in updated versions, and for RST and Youth Design Assemblies (YDAs) in particular, the approval process was removed completely. The purpose of the approval system was to avoid duplication of material, but it affected student engagement.

Nonetheless, the app was received much better by the students compared to the Interactive Documentaries, as the mobile app could be retrieved using a QR code, ensuring better student engagement. For future projects, the app will only be made available through the App Store for iOS and Google Play Store for Android.

4.3. Citizen journalism (GreenVerse) (ENG)

Citizen journalism tool provides access to the multimedia content uploaded by the registered users of the mobile app (Figure 10). Users (students) can choose whether to make their media public or private. The purpose of citizen journalism is to allow users to interact with the content and become aware of their territory, encouraging a sense of ownership of the territory. The tool offers additional features, such as downloading media and sharing encouraging the reuse on the internet, for instance in social, messaging apps, blogs, web articles, to support visualization of the territory. It can be used individually on its (Mudelsee 2023).

The tool is available as a web application and is accessible through Chrome, Mozilla Firefox, and other browsers that support the HTML 5 standard and WebGL. The app is available in five languages: Catalan, Spanish, English, Italian and Greek. Students at UAB evaluated both the functional requirements (app's operation) and non-functional requirements (performance, reliability and usability) (Mudelsee 2023). UAB ensured sufficient colour contrast, options for accessibility at login, and Alt text for images. The app underwent initial testing during the Youth Assemblies in Copenhagen (1-3 September 2023), Barcelona (8-10 September 2023), Rome (22-24 September 2023) and Novi Sad (8-10 October 2023). A feedback workshop was arranged afterward, during which 14 students participated and provided feedback to the developers. Further information is provided in D3.7 (McDonagh, Hagan et al. 2024).

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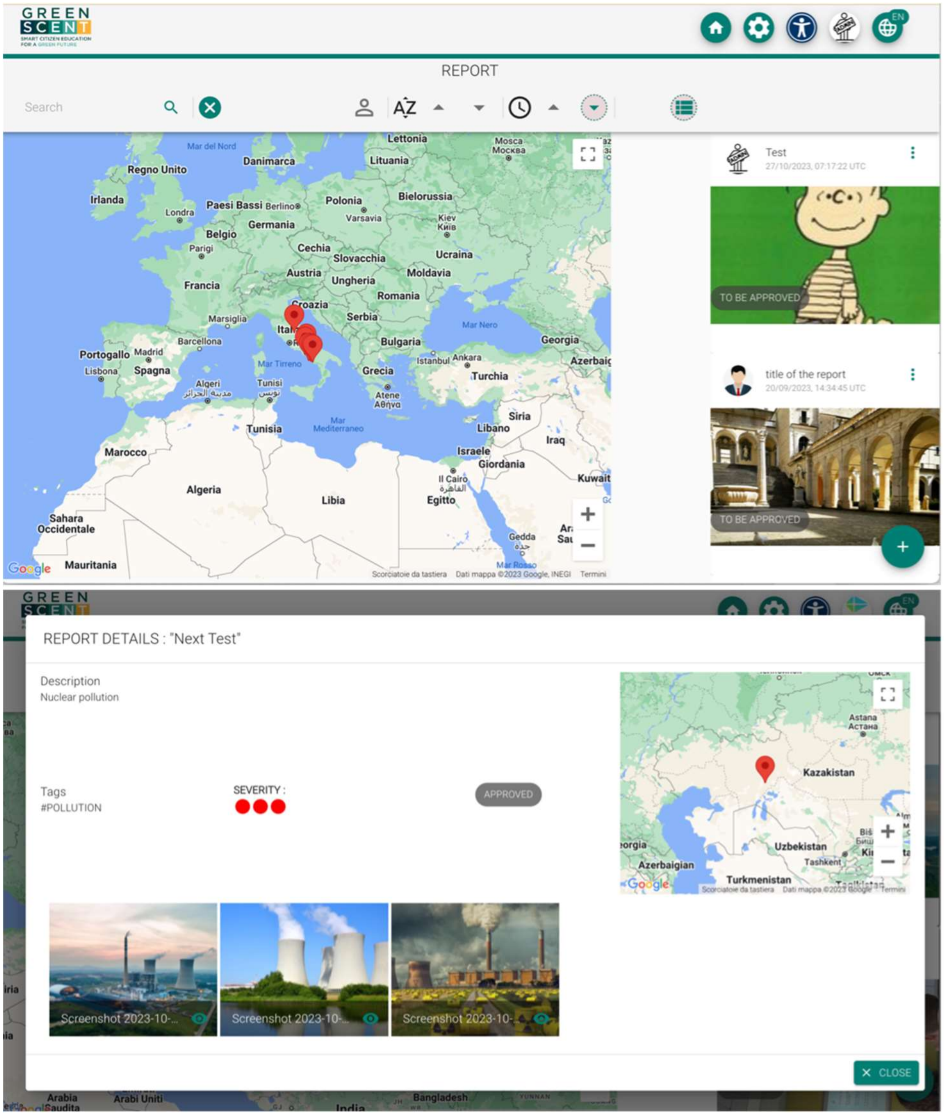


Figure 10: Citizen Journalism example

4.3.1. User perspectives

This demonstrator was piloted for the first time by ENG and implemented in four schools (RGSMART, RST, UNSPMF and UNINETTUNO). The student age group for the activity was 15 – 22 years old. Approximately 50% of the class teachers believed the activity positively influenced the students' attitude towards science and 25% believed the activity provided students with new competence in using scientific instruments (Figure 11). Feedback on whether the activity influenced the students' data gathering and data analysis was agreed upon by half of the schools. In terms of improving the students' scientific reasoning and critical thinking, three of the schools agreed the activity was very beneficial. However, whether the activity helped in developing the students' interest in scientific-related careers was not clear.

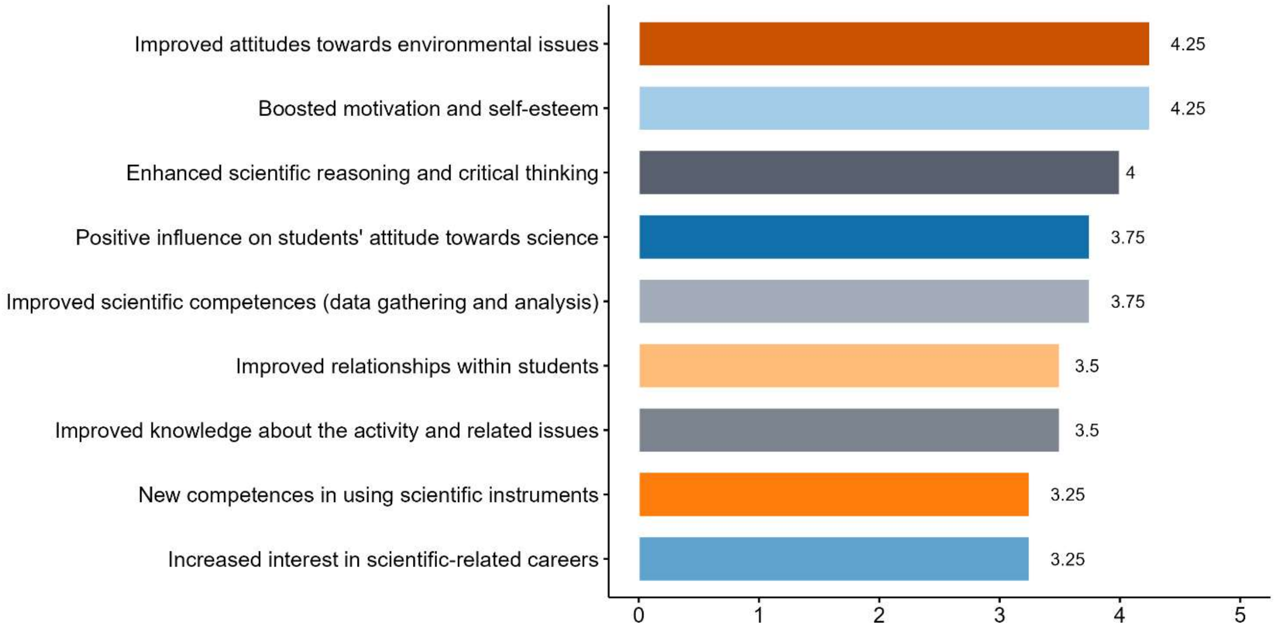


Figure 11: Class teacher's feedback on Citizen Journalism (displays the average of responses, n = 4)

If the students wished to upload something, they needed to go through an approval process. However, this proved to be quite time-consuming for both ENG and the schools. Eventually, it was decided that each school could independently manage the approval process if they wished, or the approval process could be removed completely.

According to the teachers, one difficulty with the app was that it was not available through the App Store. There were sometimes issues with the login, which demotivated the students as it required them to spend extra time before being able to upload their observations. A potential solution could be enabling Google Account login. For one school, this activity was very creative as it could be combined with the school's course on entrepreneurship to develop business ideas for environmental protection.

An additional concern raised by the school was about the incentive to use the app. This may prove to be quite difficult unless someone is naturally inclined towards journalism. Additionally, students asked about the final output of the app and the purpose of the data collection. The teachers also noticed that some students did not feel it was their responsibility to identify issues within the neighbourhood. However, if the app is linked to a local authority, students and the community might be more interested in creating posts. This may lead to local political issues as the authorities would need to be convinced about the need for such an app.

Nonetheless, citizen journalism has much potential to improve students' knowledge about the issues at hand, as students often do not observe their surroundings. This tool encouraged them to look at what is happening around them.

4.4. Interactive documentaries (GreenVerse) (ENG)

Interactive documentaries allow the creation of immersive experiences using web or mobile browsers (Figure 12). The first step is defining a background which can be an immersive multimedia element (360° video or photography) or a traditional one (standard film or photography). Additional multimedia content can be superimposed on this background, either visible by default or activated by specific user behaviours (click/tap hotspots).

Each setting/background is called a "bubble". The tool allows for setting changes (actual jumps between the bubbles) based on specific events (e.g. at a certain point in a video, when an icon is clicked, etc.)

The tool does not require any installation. Users registered on GreenVerse can log in via the web, upload their material (background and content) to the platform, and edit it through the browser (Google Chrome, Mozilla Firefox, and others that support the HTML 5 standard and WebGL). The results can be shared via links on social networks, portals, messaging apps, and it is also possible to generate QR codes (more details by Mudelsee (2023) in D5.2).

The immersive storytelling platform GreenVerse underwent usability and accessibility testing in Spain (M6 and M18) as part of the ITACA Summer School at UAB and in Italy (M7). A total of 63 participants evaluated the platform's usability, including aspects such as audio, font adjustments, photo uploading and editing. Further details are provided in D3.7 (McDonagh, Hagan et al. 2024).

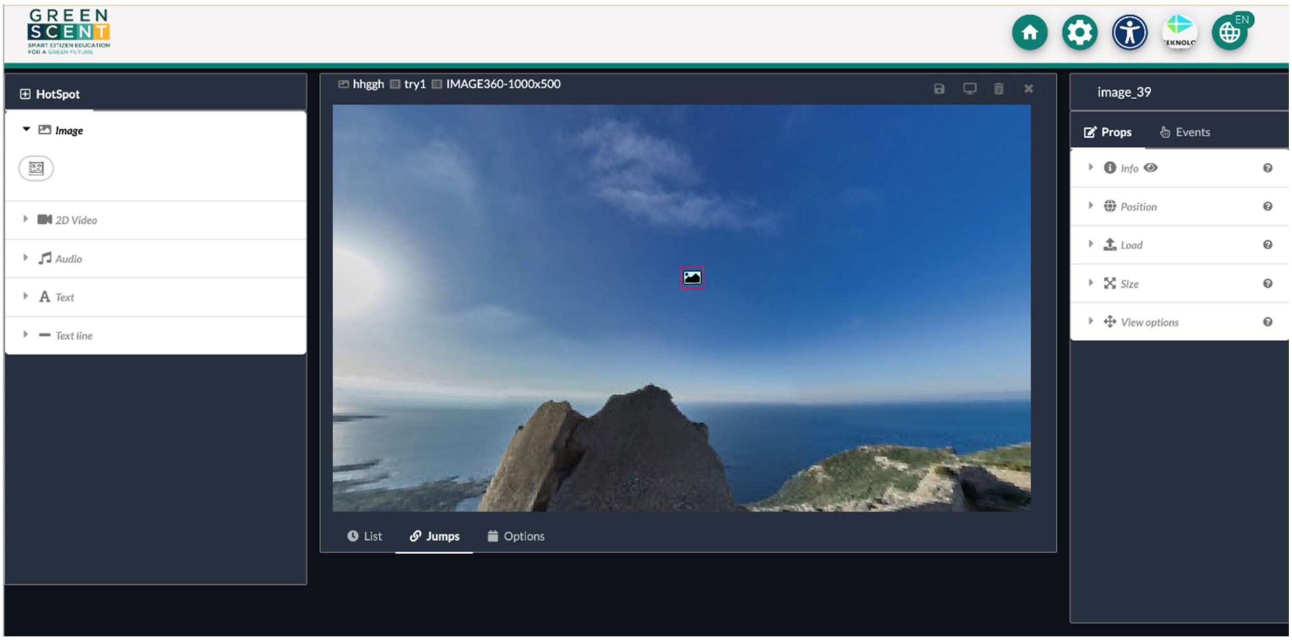


Figure 12: Interactive Documentaries view

4.4.1. User perspectives

This Demonstrator was piloted for the first time by ENG. While the technical aspect was familiar to ENG, ensuring and guaranteeing student engagement was challenging due to the target group's nature. Both usability and accessibility for a young audience were new considerations for ENG. The student age group for this activity was 15–22 years old. A brief online tutorial (1 hour) was provided to the teachers and partners who would be implementing the activity with their students.

The tool was experimented with across four schools (EA, UNSPMF, UNINETTUNO, RST). All four schools agreed the activity had a somewhat positive outcome for the students (Figure 13). However, there was a significant difference in opinions regarding the activity's influence on students' attitudes towards science, with scores ranging from 2/5 to 5/5. Two schools strongly agreed that Interactive Documentaries provided students with new competencies related to scientific instruments, while the other two schools only somewhat agreed. Feedback on whether Interactive Documentaries influenced competencies related to data gathering and analysis also showed large differences in opinion, with scores ranging from 2/5 to 5/5.

Interestingly, three schools strongly agreed that the activity positively influenced students' critical thinking, encouraged them to consider scientific careers, and improved their attitudes towards the environment. However, one school believed the activity did not significantly impact these aspects. As observed previously, all four class teachers had varying opinions on whether Interactive Documentaries effectively improved students' knowledge and self-esteem. Additionally, only two schools agreed that the activity improved the relationship between students.

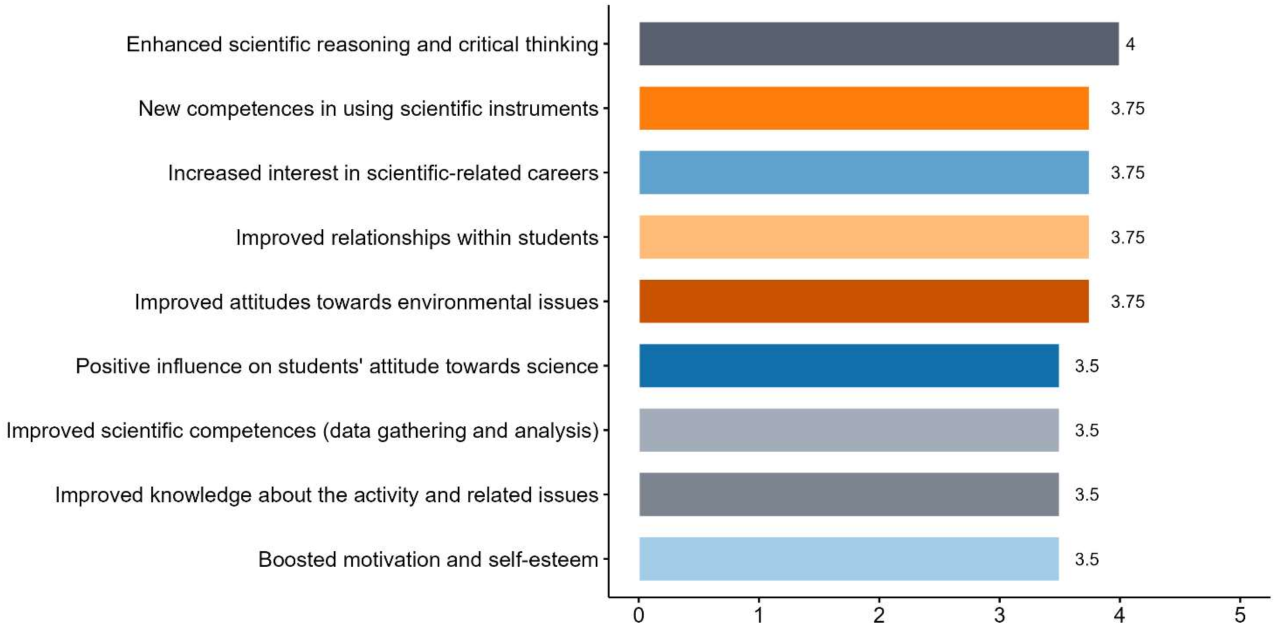


Figure 13: Class teacher's feedback on Interactive Documentaries (displays the average of responses, n = 4)

The feedback can be attributed to the fact that the app interface was considered partially satisfactory by the students, as it was only accessible through the web browser. Like the Environmental Monitoring mobile app, students wished for the Interactive Documentaries app to also be available through the App Store. Despite this, the tool provided students with the opportunity to map the school and find alternative ways to address environmental issues. The interactive documentary allowed them to create unconventional, reflective, and engaging storytelling that raised awareness about protecting their local environments. Future versions can simplify the tool further and enhance its material-sharing capabilities.

4.5. Climathon (CRA)

This Demonstrator was implemented as an online course for the first time and consisted of three sections: (a) climate, (b) climate data, and (c) climate data analysis (Figure 14 and Figure 15). The themes remained the same for both the secondary school and university students, but the content was simplified for secondary school students. The estimated time to complete the course was roughly three days. (Mudelsee, Stankov et al. 2025)

For secondary schools (RGSMART, EA), the content delivery started with basic concepts based on a recent textbook by the lecturer (Mudelsee 2020). Topics included: What is climate? What are the most important climate variables? How is the data for these variables obtained? The exercises included questions such as, "How many days are between 1 January 1893 and 31 December 2018?" The final exercise involved obtaining data from the students' hometowns (via the Internet and with the help of local teachers), plotting the series, and starting a simple linear trend analysis using open-source software (Pearson T3) (Ólafsdóttir KB and Mudelsee M 2014). More details are provided in Mudelsee, Stankov et al. (2025).

For university students (UNSPMF), the content for the Climathon consisted of the "standard" Climate Risk Analysis course, but due to time constraints the lecture focused on correlation. The first day covered the basics (introduction, persistence, and confidence intervals), while the second day included the main topic and some tasks. Students were provided with data and an open-source software (Pearson T3) to complete the tasks. More details about the task and software are provided in Mudelsee, Stankov et al. (2025).

This course did not require any user testing. Information about the course was disseminated by the schools themselves and for UNSPMF, the course information was shared through respective departments. Interested participants completed a registration form and sent it to CRA. The gender balance was approximately 50:50.

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101036480

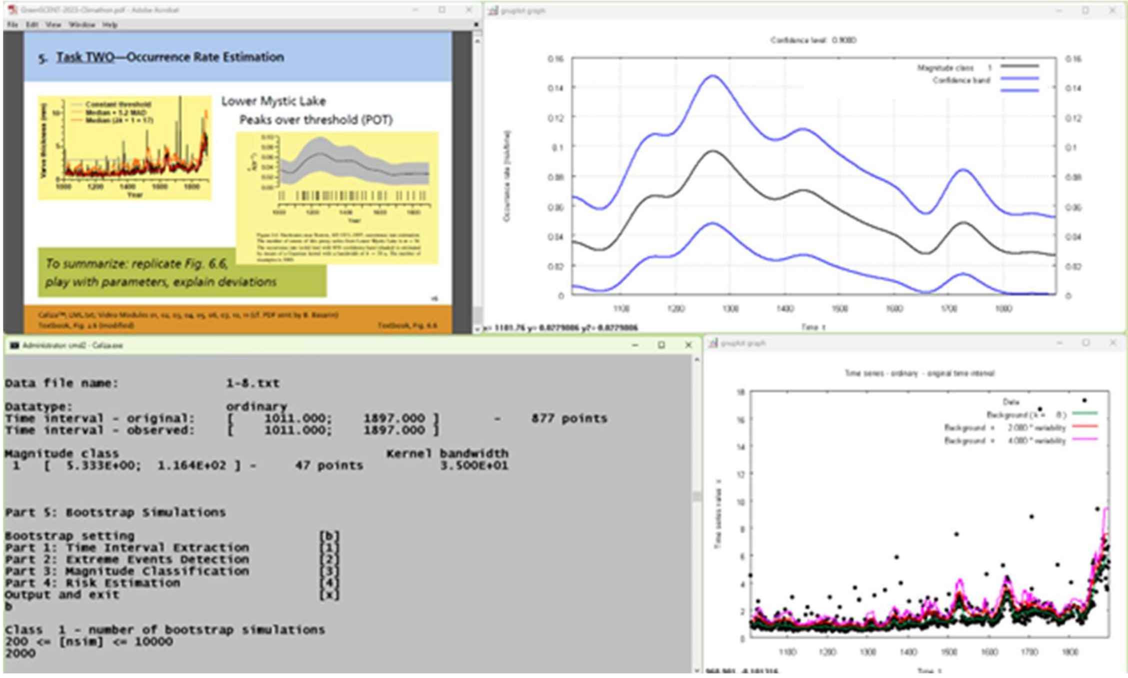


Figure 14: Example of Climathon lectures

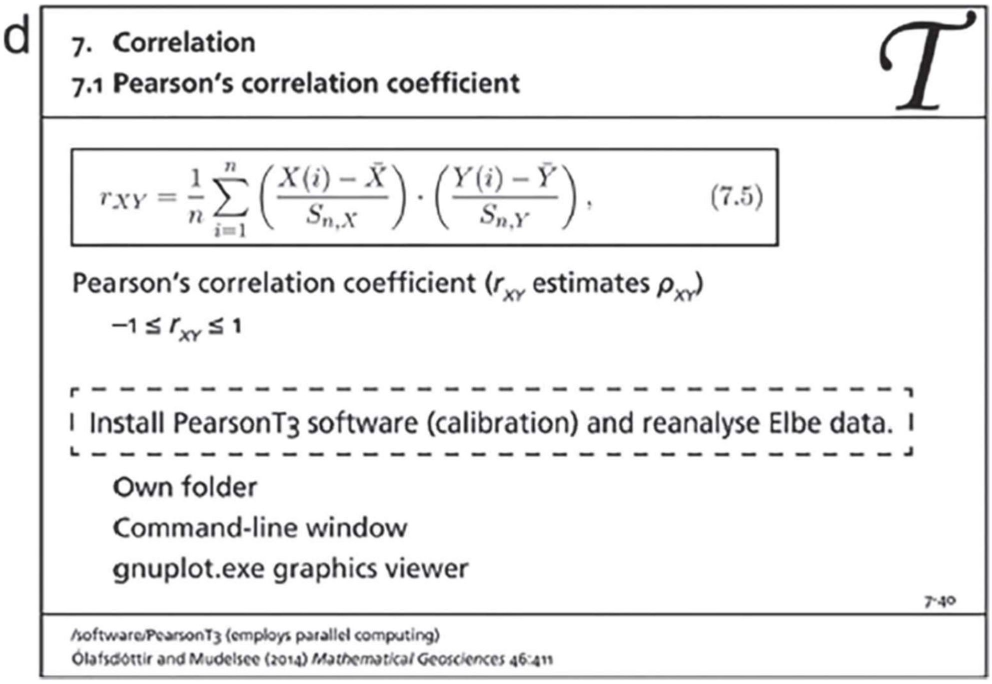


Figure 15: Climathon task for students at UNSPMF

4.5.1. User perspectives

Figure 16 shows the class teachers perspectives regarding Climathon. Despite the varied lecture content and different target age groups, the class teachers at the secondary school still believed the lecture was beneficial for the students, even though the course was difficult for them.

Climathon was implemented in two schools (RGSMART, EA) and one university (UNSPMF). The student age group for this activity varied between the two schools that implemented the course: EA, RGSMART (16 – 18 years old); UNSPMF (>18 years old; staff and PhD students). A total of 20 participants from RGSMART and 5 participants from EA attended the course. At UNSPMF, a total of 27 students participated in Climathon.

All three schools strongly believed that the Climathon positively influenced the students' attitude towards science, with an average score of 4.67. One secondary school felt that the activity only slightly supported the use of new scientific instruments, competencies, and scientific reasoning skills, while the other secondary school had a strong positive opinion about the outcome. Regarding interest in scientific careers, the activity received an average score of 4.33, although one secondary school believed the activity only somewhat influenced this aspect. A similar result was obtained regarding whether the Climathon improved the students' knowledge about the activity and related issues.

Additionally, according to the class teachers/supervisors, the activity only somewhat improved the students' motivation and self-esteem. For secondary school pupils, this might be connected to the fact that the course was still difficult for them. For university students, perhaps many of them did not have extensive knowledge of statistical analysis. Whether this was also the reason for the activity only somewhat affecting the students' relationships with other students is unclear. Nonetheless, the teachers/supervisors gave an average score of 4.00, which may be explained by students asking for help and support from their peers on more than one occasion due to the complexity of the tasks.

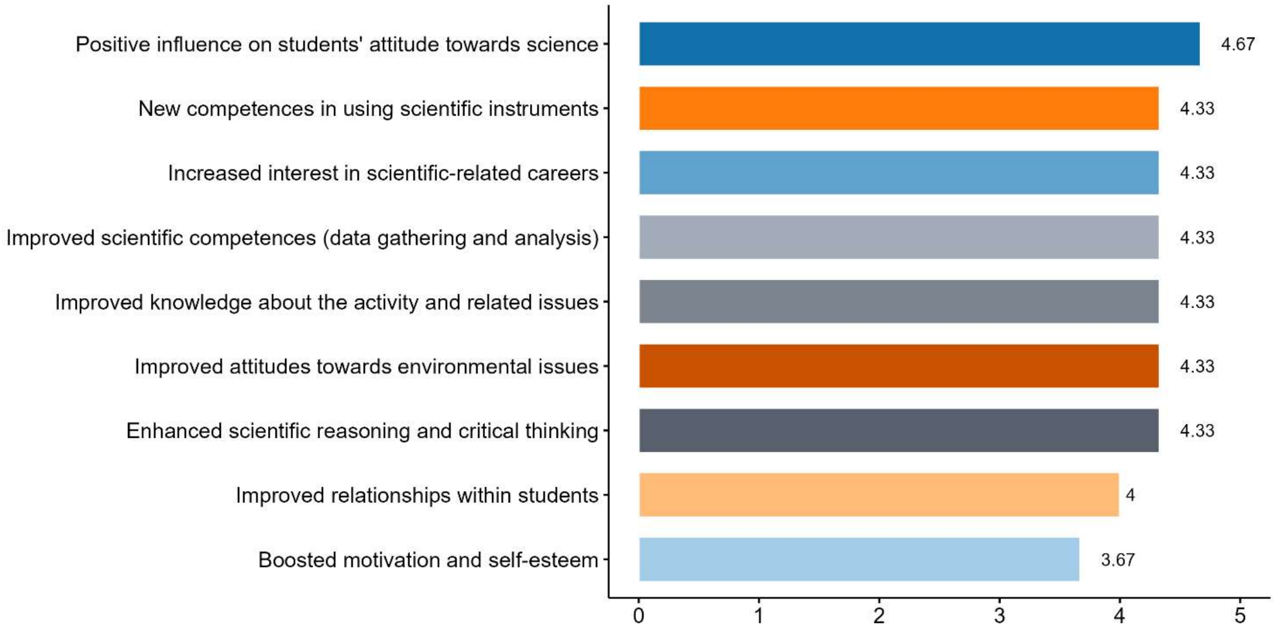


Figure 16: Class teacher's feedback on Climathon (displays the average of responses, n = 3)

Through the course, students had the opportunity to study statistical data at a scientific level. However, the course was quite advanced for high school students. To simplify the content for the high school students at RGSMART, the university (UNSPMF) provided a staff member who was always present in class to further explain the content in the local language. For university participants, the course demanded more advanced data analysis skills. After completing the course, all students received certificates from CRA.

4.6. GreenAir Augmented Reality (BSC)

GreenAir is an educational application designed to help students and citizens learn about air quality in a fun and interactive manner. The app consists of a series of lessons on air quality, covering topics such as pollutants and their sources, as well as challenges that test the knowledge gained from the lessons. Some lessons include augmented reality (AR) features, allowing users to view maps of the air quality index across Europe and the city of Barcelona (Figure 17 and Figure 18).

The concept for this app was based on the needs of students and teachers identified during the project, so there was no pre-existing system. Although BSC has expertise in climate research topics, this expertise had not been implemented in a school setting before. The content of the app was decided after conducting user experience research, which included co-creation workshops, interviews with 12 teachers, and BSC's own desk research.

Through teacher interviews, it became evident that air quality topics are rarely a standard part of the curriculum. When addressed, they tend to be covered within environmental science or geography classes, often with varied approaches. A recurring finding was that many participants confused air quality with other environmental issues, such as carbon dioxide emissions. This highlights a strong need to establish the fundamental basics of air quality and distinguish between different topics. These insights guided the design of the GreenAIR app, which explains air quality in a friendly and interactive manner.

The co-creation workshops offered valuable insights by engaging diverse participants in Athens (Greece), Novi Sad (Serbia), and Barcelona (Spain). Each city held at least three sessions with students aged between 8–15 years, along with their parents and teachers (about 30 participants in total), as well as researchers from GreenSCENT and external researchers (8 participants in total). These workshops allowed participants to share personal stories and daily experiences regarding air quality, helping to collect individual perspectives on the environment and identify knowledge gaps.

The GreenAir app was tested in different settings, including Barcelona with 120 students and Youth Design Assemblies (YDAs) with approximately 15 students. These tests helped improve the user experience and app content. The app was tested during the online Youth Assemblies in February and June 2023. During a 3-hour workshop, participants were asked to generate ideas for improving the app and discuss these ideas directly with the app developers from BSC and UNINETTUNO. Suggestions included adding interactive elements, a reward system, better accessibility, and school-based campaigns.

The Youth Design Assemblies focused on testing the initial lessons and gathering feedback not only on the content but also on the overall concept of the app. The feedback was highly positive, and one particularly interesting insight was related to the app's bird character. Initially, this character was included sporadically as an extra element, but students suggested that it should play a more central role as the app's official avatar. They felt it would resemble other popular apps such as Duolingo, Mentimeter, and Kahoot, enhancing engagement. Based on this insight, BSC iterated the design and made the bird a consistent companion throughout the app. Additionally, students expressed interest in having access to links and resources to explore the topics further.

In 2024, the app was further tested in several schools within the consortium, including RST and EA as well as in schools outside the consortium. The student age group for this activity was 10 – 15-year-old.

The app was developed as a web-based application that can be used on any device through an internet browser, including older devices. However, it should be noted that the AR feature is currently only available on Android devices due to software incompatibility. It is possible to explore the 3D maps on iPhones and other devices, but without the AR feature.

Additionally, the app's use can be adapted according to the teachers' and students' preferences (e.g., the app can be used in the classroom, as part of homework, or both). BSC is currently preparing a guidance document for teachers, including case studies on how the app can be used, depending on the age of students, teacher preference, and class schedule.

The app lessons cover the following topics:

1. The air we breathe
2. Air pollution
3. What we can't see
4. A matter of habits
5. Air pollution has no boundaries

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101036480

6. The air quality index
7. The colours of air quality
8. Comparing air quality
9. A risk to our health
10. Actions we can take
11. Cleaner air for all

All lessons have information boxes that students can click on to learn more, in addition to multiple-choice or True/False questions

The application will remain live and free to use after the project ends. It will be available through the resources page of CALIOPE, the air quality forecasting system developed by the Barcelona Supercomputing Center (link).

A joint meeting between BSC and UAB in October 2023 focused on evaluating the accessibility of the BSC app prototype, including improvements to colours, Alt text, and ease of navigation. Subsequently, UAB produced an accessibility report outlining recommendations to enhance the usability and accessibility of the app before its beta version release in December 2023.

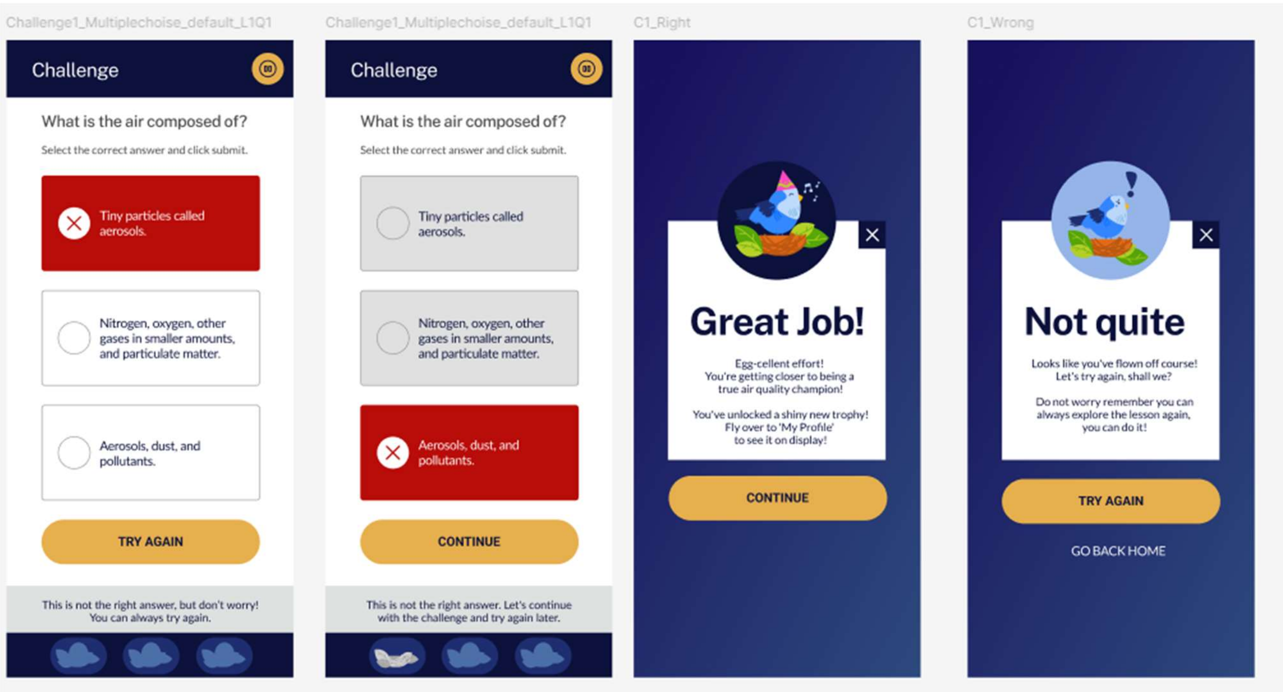


Figure 17: Example view of a Challenge. Source: BSC.

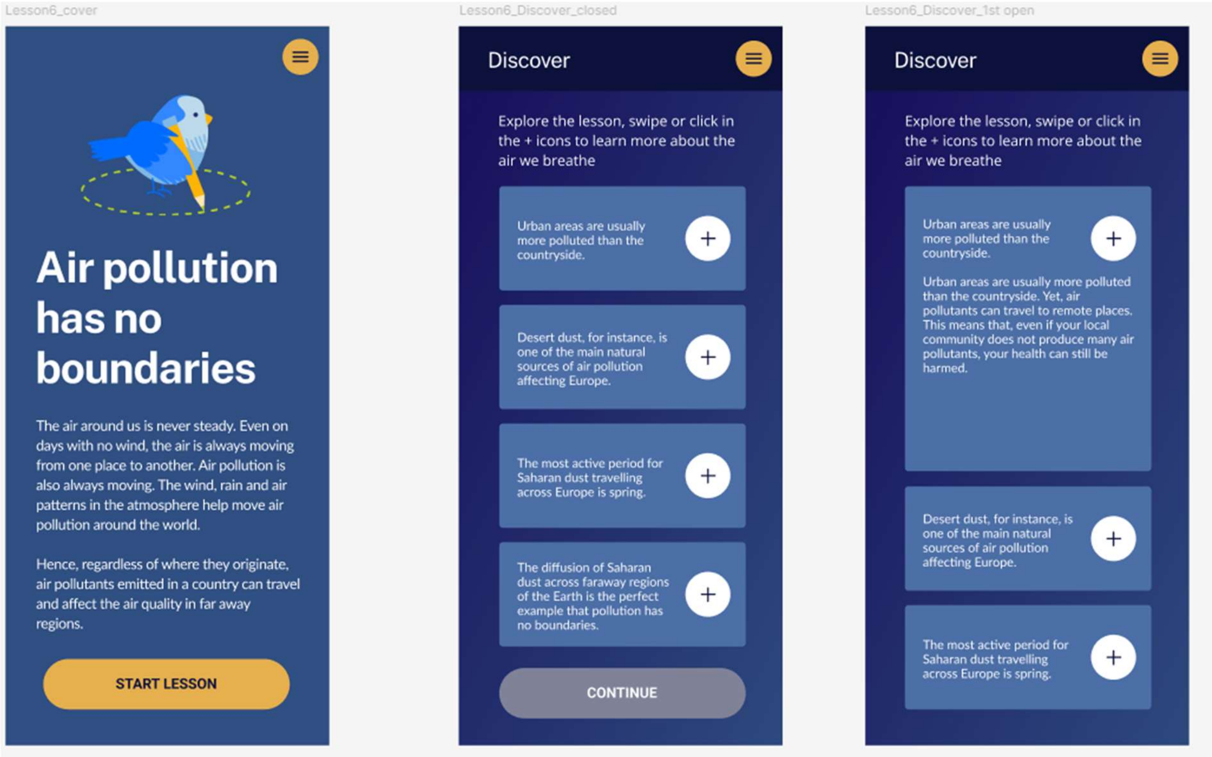
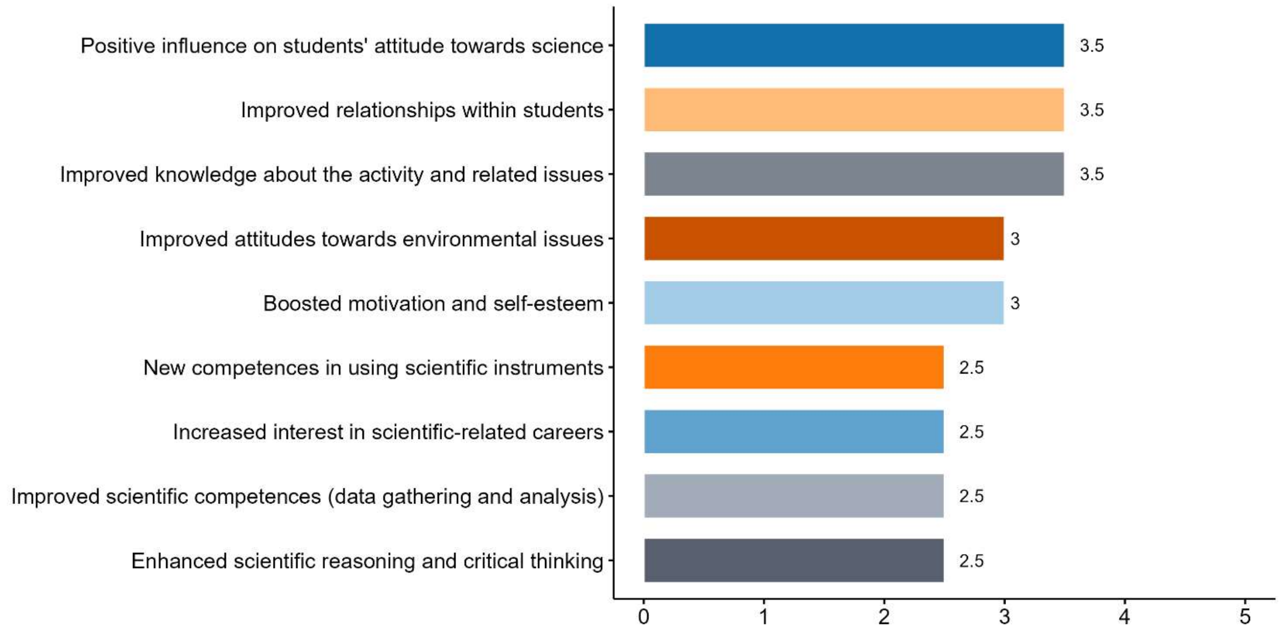


Figure 18: Example of a lesson and the information boxes

4.6.1. User perspectives

After the launch of the app, it was tested by the students in RST and EA (Figure 19). The student age group for this activity was 10–15 years old. Based on feedback from the 2023 school year, both schools only partially agreed (3.5/5) that the app positively influenced the students' attitude towards science. This could be related to the observation that the app can still be rather simple for 15-year-olds but a little difficult to use for 10-year-olds.

Although the app helped increase knowledge about air quality, teachers were only partially satisfied (2.5/5) with the app's contribution to new competencies such as the use of sensors, data analysis skills, scientific reasoning, and initiating student interest in scientific careers. The app has the potential to play a pivotal role in raising awareness among youngsters, as evident from the feedback received (3.5/5). However, there was only slight agreement among teachers regarding whether the activity improved students' motivation and self-esteem (3/5) and consequently their relationships with other students (3.5/5).



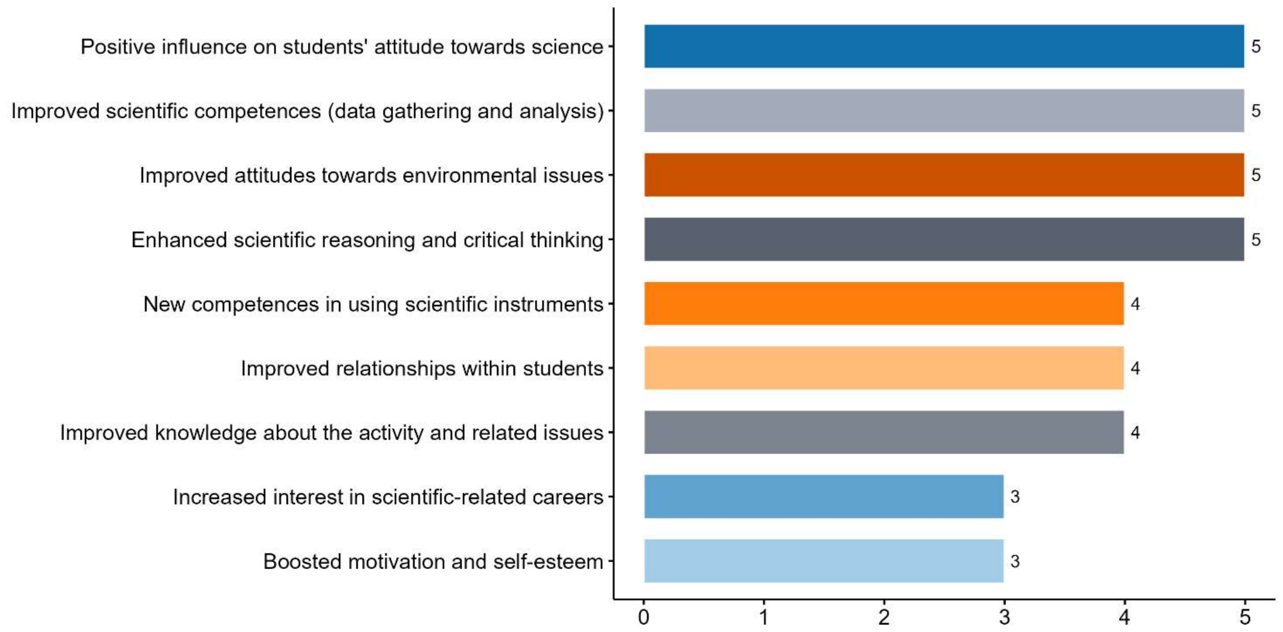


Figure 19: Top: Class teacher's feedback on the GreenAIR app during the school year 2023 (EA, RST; displays average of responses, n = 2). Bottom: Feedback from the school year 2024 (only RST; displays the average of responses, n = 1)

Based on feedback from the co-creation workshops and Youth Design Assemblies, an avatar (bird) was added to the Homepage to help with navigation and make the app interactive (explained in the earlier section). BSC also added trophies for challenge completions to further enhance the experience.

The app was implemented for the second time at RST once the new school year started (2024–2025). During this second round, a BSC staff member visited the school in person, which may have contributed to students promptly asking questions from the expert, thus better understanding the purpose of the app and connecting with it more effectively than the previous group. The feedback from this second round was extremely positive, and the class teacher firmly believed the app contributed to the students' new competencies, scientific reasoning, and improved attitudes towards science and environmental issues.

Since the concept for the app was developed after the project began, it required significant time and effort to create a viable prototype. This is also why the app's testing phase differed from that of the other Demonstrators. The two schools were generally satisfied with the app. One school noted that younger students became more familiar with the environment and learned ways to address environmental issues in their surroundings. More importantly, the teachers observed that students continued discussing the science behind the app even after the activities were completed. The presence of the BCS staff member significantly contributed to the students' active involvement and curiosity about specific air-pollution matters, connecting them to the concepts they had already studied.

4.7. CleanAir@School (4sfera)

CleanAir@School is focused on improving the air quality around schools, providing schools with both the necessary tools to carry it out and the instructive material to analyse problems related to air pollution and promote a healthier school environment. Pollution levels are measured by passive dosimeters placed at strategic points around the school (Figure 20 and Figure 21). The sampling duration can be between 2 and 4 weeks, after which the tubes are collected and sent to the laboratory for analysis. (4sfera 2023)

Any school can participate in this activity and is free to organize it as they wish. The activity is mainly aimed at Grades 5–6 (primary school), but other age groups can also be involved. The aim of the study is to involve citizens in carrying out air quality measurements around schools, designing campaigns, and analyzing the results. This helps students, teachers, and parents become aware of environmental problems and how they are influenced by our habits, mainly mobility, and encourages them to make changes based on the study's results1.

For the CleanAir@School Demonstrator, an existing app was adapted by 4sfera to meet the project requirements. The responsible partner, 4sfera, has worked with schools since 2017 and has extensive expertise in student engagement. In addition to the project partner schools, 4sfera also implemented the activity in five additional schools in the region of Dâmbovița in Romania and over 60 schools in various areas of Spain, including Girona, Barcelona, Terrassa, Basque Country, Madrid, and Galicia (altogether 1000 students).

In GreenSCENT, the engaged age group was 10 – 15 years old. A pilot was conducted in 2022 to test the existing app. The students tested the web interface between 2022 and 2024. As part of bug fixing, the testing helped simplify the web interface and modified text within the app to make navigation easier.

To implement the activity, 4sfera was in direct contact with the teachers to provide them with basic training and an understanding of the Demonstrator. However, this process did not go as expected in some schools. While some teachers were able to carry out the tasks independently by following the guide documents, others required additional support1. As part of the information package, 4sfera presented three topics:

1. Air pollution and its effects on health
2. How to measure air pollution
3. Specific discussion on how to carry out the activity

This was designed to encourage the schools to sign up.

Based on the challenges encountered during the piloting phase, 4sfera identified areas for improvement in the provided materials and teacher support system. As a result, 4sfera improved the resources and developed a comprehensive training kit. This training kit aims to streamline the preparation process for schools, offering clearer guidance, structured training modules, and tailored support.

For the real-life implementation of the Demonstrator, it was crucial for 4sfera to know the day, time, and location when the sensor was installed and collected to perform data analysis. Some teachers recorded these details on paper, but ideally, this should have been done using the application. Additionally, there was a heavy reliance on teachers to add the information to the Excel file or 4sfera's platform.

Another challenge encountered during the activity was related to reading the QR codes on the sensors, which are used to uniquely identify each sensor (Figure 22). In some cases, this proved difficult due to issues with phone cameras not being able to scan the codes properly or poor visibility in certain locations.

To provide more support to teachers, 4sfera informed them that training was readily available for anyone needing extra assistance. However, this did not materialize as expected because teachers often did not communicate with 4sfera. In some cases, teachers did not follow the guide document, which created further difficulties.

Regarding the air quality platform used to track the installed sensors, it was improved to have better colour contrast, Alt text images, and provide help in local languages in addition to English. Users could also change accessibility settings according to their preferences. Additional features included making the platform compatible with a screen reader, the ability to navigate using a keyboard, and being usable on both Android and iOS devices.

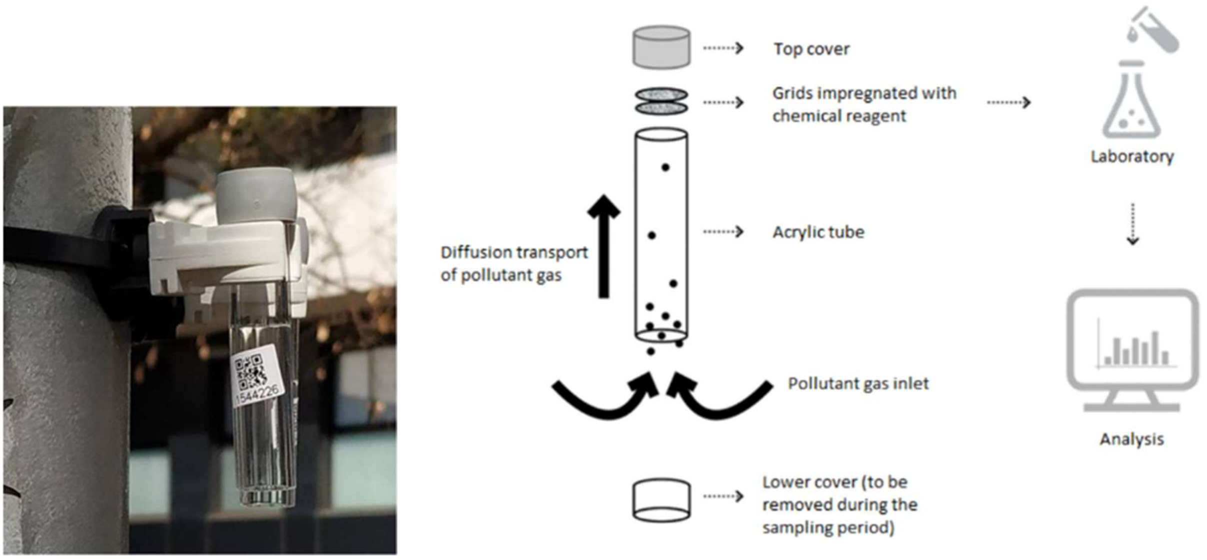


Figure 20: Left: Passive dosimeter; Right: Tube's operation. Source: 4sfera

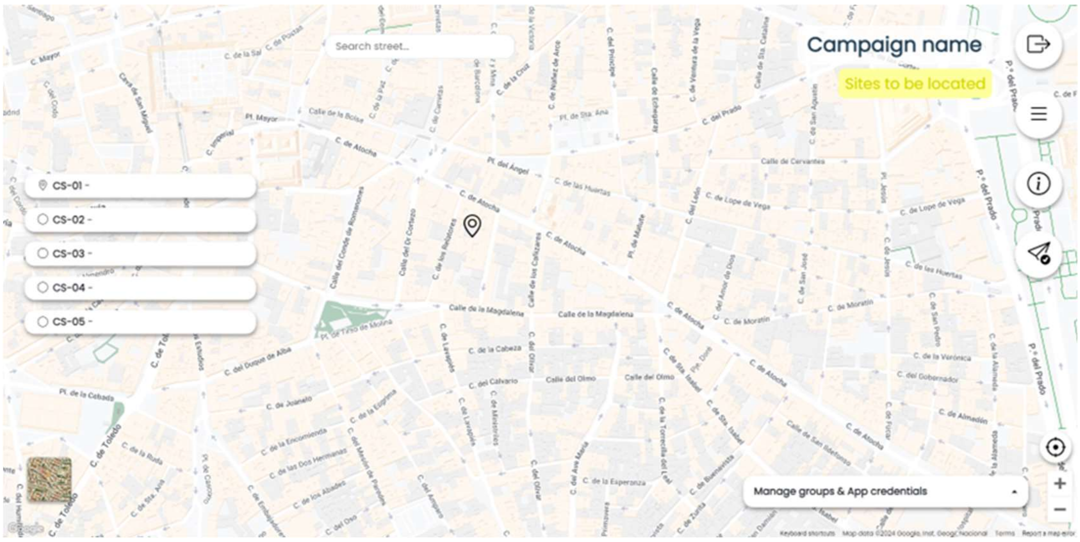


Figure 21: Placing the tubes and marking their location. All tubes for the school are assigned a code. Source: 4sfera

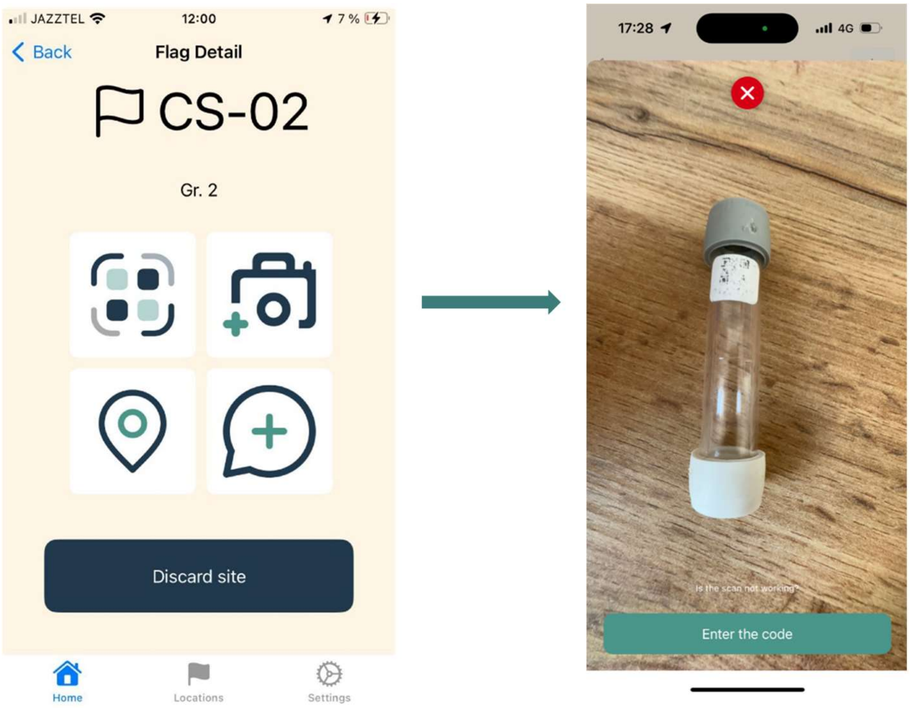


Figure 22: Additional information including QR code, location's picture, location on the map and comments are added for each tube before placing it on site. Source: 4sfera

4.7.1. User perspectives

CleanAir@School was conducted across five schools: RGSMART, RST, EA, UNSPMF, and a local school in Rome. All interviewees gave positive feedback on student engagement and expressed their desire to include the activity in the curriculum again (Figure 23). However, for university-level students, the activity could benefit from more data analysis tasks, as the simple installation of sensors was not suitable for this age group. Nonetheless, the majority of secondary and high-school teachers (60%) believed the activity improved students' interest in science and science-related careers.

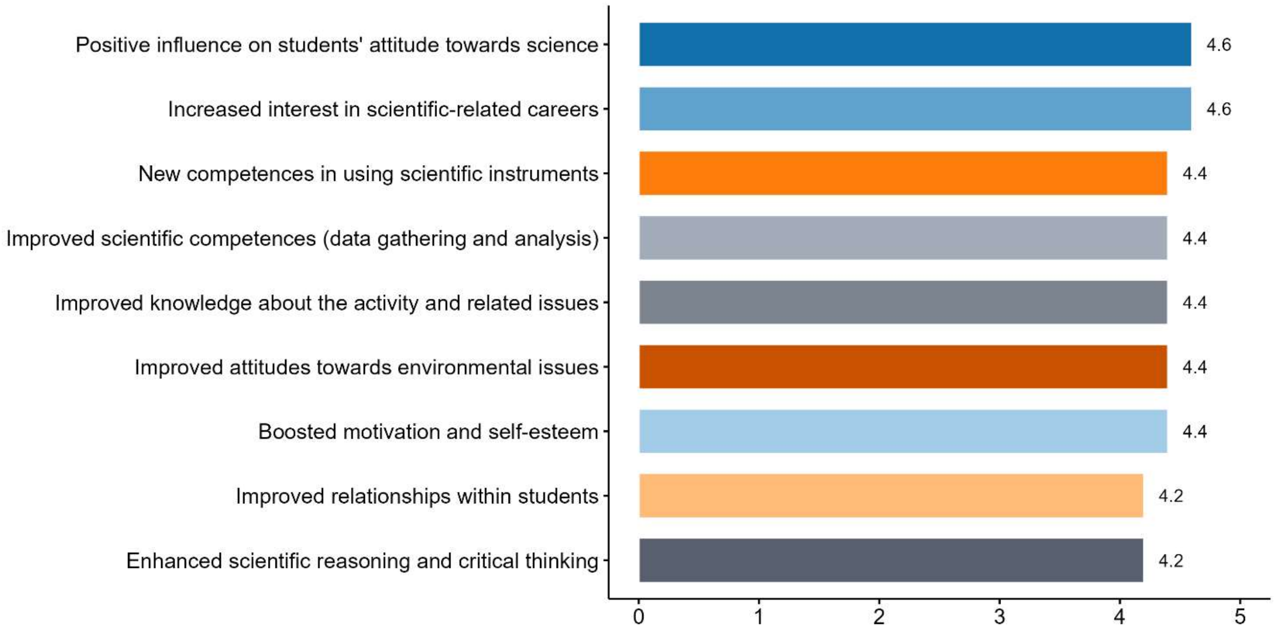


Figure 23: Class Teacher's assessment of CleanAir@School where 1 is: "not at all" and 5 is "in a very significant way (displays the average of responses, n = 5)

The results also indicate that a majority of the teachers (60%) believed CleanAir@School provided students with new competencies in using scientific instruments (use of sensors) and data gathering and analysis. However, 40% believed that students' scientific reasoning skills and attitudes towards environmental issues improved considerably. The activity also encouraged students to work in groups, and according to 80% of the teachers, CleanAir@School helped improve relationships between students.

Feedback from teachers states that CleanAir@School helped engage the entire school community, and for this reason, the timeline for data collection could be extended to gather more data. The experiment attracted a lot of student attention and motivation. Some school students are already using electric scooters to come to school every day as they are aware of the issue. For most teachers, CleanAir@School was user-friendly, and the instructions were clear, motivating them to implement it despite limited time flexibility during the school day.

As maintaining direct contact with teachers is difficult in many situations, having a local support person to communicate between the school and the Demonstrator team would be helpful. For example, the 4sfera team visited five schools in Greece with the help of a local support person at EA school. Another solution could be to have a dedicated teacher for the activity. If the activity is enforced by the principal or local authority, it may not produce the desired results. The success of the solution and student response also depend on the teacher's viewpoint. In the case of CleanAir@School, several schools carried out the activity without difficulty.

The 4sfera air quality platform was improved to have better colour contrast, Alt text images, and support for other local languages in addition to English. Users can also change accessibility settings according to their preferences. Further features included making the platform compatible with a screen reader, the ability to navigate using a keyboard, and usability on both Android and iOS devices. An accessibility concern exists during the installation of the sensors, as a ladder might be required to place the sensor at the correct height. Currently, the installation was not easy for students, and teachers were required to install and remove the sensors. Another concern raised by teachers was that the sensors were used during cold weather, which may affect particle concentration. To ensure inclusive participation, alternative strategies could be employed. For instance, those unable to reach the required height might be assigned different roles, such as quality control of the installation process, ensuring everyone can contribute meaningfully to the activity. Future improvements could include better documentation and more videos. Further information on accessibility is available in D3.7 (McDonagh, Hagan et al. 2024).

4.8. Youth Design Assemblies (YDAs) (DBT)

The objective of the Youth Design Assemblies (YDAs) was to engage young citizens in inspiring the development and improvement of the content and curriculum in GreenSCENT. The YDAs maintained continuous communication with technical experts, allowing participants to actively share and receive feedback on how their thoughts, questions, wishes, and ideas influenced the work in GreenSCENT. The 56 participants in the YDA were divided into four groups: YDA 1 (Clean Energy), YDA 2 (Farm to Fork), YDA 3 (Zero Pollution), and YDA 4 (Circular Economy). Each partner country recruited 12 participants from Italy, Spain, Serbia, Finland, Romania, Greece, and Denmark. (Mudelsee 2023). Participants were placed into different groups based on their age and preferences indicated in the application form (Table 3).

To maintain diversity in recruitment, DBT considered the following (Mudelsee 2023):

- Striving for diversity in gender, type of studies, urban/rural background, income, etc.
- Including minorities and vulnerable groups (persons with disabilities, ethnic minorities, persons with refugee backgrounds, etc.).
- Recruiting young people aged 17 to 25 years.
- Welcoming participants of all language backgrounds and ethnicities, provided they could speak and read English.
- Ensuring participants were students or had an interest in climate change, environmental issues, sustainability, or design/co-design.

Although some participants dropped out in the initial months, the overall dropout rate remained within expectations. The recruitment period during summer slowed the process. To avoid further dropouts, DBT focused on relationship building, designing more engaging meetings, contacting supplementary participants, and accepting slight imbalances in nationality (with participants per country ranging from 7 in Italy to 10 in Serbia). The desired age span was also extended due to recruitment challenges in some countries.

Despite the age differences (14 to 26 years old), the YDAs remained popular among all schools. Over a year and a half (2022-2024), the four YDAs convened digitally once a month initially and then once every two months after being properly established. During the meetings, participants got to know each other and worked together to collect and share feedback on content, such as testing the Environmental monitoring app and concept planning of the GreenAIR app (Mudelsee 2023). Each YDA group held seven online meetings (3 hours each) and one final in-person meeting (a weekend). The in-person meetings were arranged so participants could meet their co-participants physically in dedicated events organized in Italy, Denmark, Spain, and Serbia (Table 3).

YDA participants received short introductory lectures on the apps being developed in the project and the purpose of the Green Deal. However, the DBT team encountered difficulties with participants' proficiency in English. Some participants did not have a sufficient level of language, leading to the refusal of some interested students. It was not possible to organize translations during the sessions. Despite efforts to welcome young people with special needs, such as visual or hearing impairments, there were no individuals with special needs among the participants, and none were refused during the selection process. The organizers also maintained a gender balance in the YDAs.

Table 3: Participants in YDAs

YDA Group	#Participants[23]
Clean Energy	Age: 15 – 20 years old Number of participants: 13
Farm to Fork	Age: 15 – 23 years old Number of participants: 15
Zero Pollution	Age: 15 – 25 years old Number of participants: 15
Circular Economy	Age: 21 – 26 years old Number of participants: 13

4.8.1. User perspectives

Recruitment for YDAs was conducted in Italy, Spain, Serbia, Finland, Romania, Greece and Denmark with a special emphasis on the project's educational institution partners (see Table 1). However, the illustrated results only include feedback from four partner schools in GreenSCENT, as one school believed they did not have sufficient feedback. The survey includes feedback received from RST, EA, UNINETTUNO, and RGSMART (Figure 24).

All four schools fully agreed that YDAs positively influenced students' attitudes towards science. There was partial agreement (25%) on YDAs improving competence in the use of scientific instruments, data analysis, and interest in scientific careers. Nonetheless, there was a strong consensus on YDAs improving scientific reasoning and critical thinking skills, as well as directing students towards environmental issues. The schools agreed that YDAs sufficiently improved students' knowledge on different topics (4.25/5) and enhanced their motivation to participate (4.5/5). YDAs also included group activities, and all four schools fully agreed that group work had a strong influence on improving relationships among students (4.75/5).

[2] Age based on the participants' age in the end of the YDA.
[3] Numbers of participants in each group are approximate due to variation over the span of the 1,5 years.

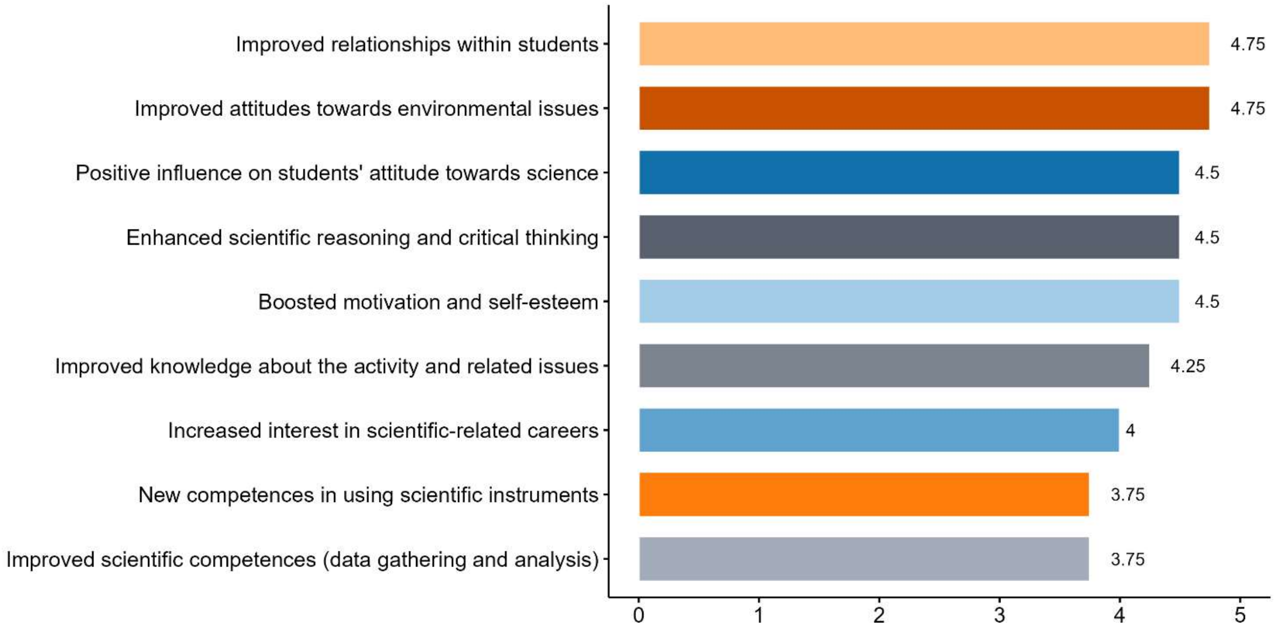


Figure 24: Class teacher feedback on YDAs (displays the average of responses, n = 4)

For future YDAs, the timeline can be shortened, as 1.5 years was too long for the students. Ideally, it could last for one year, as students sometimes move away. One school suggested recruiting students from Grades 7 to 9 instead of older high school students, so participation is continuous and the same students can continue with YDAs in the following years. The findings from the YDAs can also be shared with local authorities, which could be a way to make student voices heard. Additionally, there could be one school that leads the YDAs and connects to other local schools within the region. This can encourage non-English speaking schools to join the network and be active citizens of their community.

Future YDAs will also focus on the recruitment period and minimizing dropouts. Most importantly, there could be an in-person meeting at the start, instead of only at the end, to allow students to get to know one another better and work together more effectively.

The following four subsections explain the student feedback on each of the four YDAs. The full questionnaire is available in Annex 9.5.

4.8.2. Clean Energy

The following are direct claims by the students based on an online questionnaire created for the YDA focused on Clean Energy. The survey was filled in by 7 participants.

Q. What did you like about participating in the Youth Assemblies?

"I liked that we were able to talk freely and express our opinions among smaller groups and also among bigger groups. I also liked that it wasn't very stiff and formal and that we were able to be comfortable and communicate freely the way we wanted to".

"In general, there is nothing I didn't like about the experience, but what I liked the most was the activities we've done in the trip to Copenhagen (also meeting the other participants) and the privilege to attend the meetings of professionals"

"It brought different kind of people in groups, from different parts of Europe. That really helped realise the difference between the living conditions in the countries and what can and can't be implemented in them".

Getting to know the dilemmas of youth in other EU countries. It gave me a feeling of urgency and being heard, ex our feedback on the core material/descriptions proved that our opinion and ideas mattered".

More than half of the seven respondents (71,4%) claimed that they will change their habits as a result of the YDAs.

"Caring about wastes and consumptions"

"When throwing out the trash, I will try to be more mindful of the specific bins that everything has to be put in. Also, try not to waste food and things in general to be honest. To be more mindful of consumption".

"For example, I will reduce my consumerism and I will be, even more, conscious about my waste of water in my daily day, which I've already done".

"Try and reduce the amount of waste I produce, while also trying to influence other people to change as well".

They survey also revealed that for more than half of the seven respondents, the YDA did not change their interest in science-related topics and activities while a few of the respondents felt the YDA increased their interest. Most of the respondents agreed they learnt something new, such as figuring out how the waste plant operates in real life, being more respectful to the planet's resources and realizing how some countries do not have sufficient resources to make sustainable changes and also how sometimes they do not even care. Regarding improvements, the respondents suggested having more interaction with the experts, deciding on an easier meeting time that suits all participants, and raising the minimum age of the participants to have a more fluent discussion.

4.8.3. Farm to Fork

The following are direct claims by the students based on an online questionnaire created for the YDA focused on Farm to Fork. The survey was filled in by 7 participants.

Q. What did you like about participating in the Youth Assemblies?

"I loved our topic, the people and the meaningful goal that brought us together".

"It was a new experience that didn't only educate us through theory and books but has also demonstrated and taught us through real life examples".

"Communicating with peers, traveling and some of the experiences chosen".

"I liked to meet the other people and listen to their point of views".

"I liked that everybody was passionate about the project and wanted other to teach or learn something new. Everyone was eager to help out and we saw alot of new places and things. Meeting new friends who enjoyed learning was the best part".

"New friendships and learning about ecology".

"I learned a lot about other opinions, and of what is being done about the climate crisis"

Most of the respondents (85,7%) claimed that they will change their habits as a result of the YDAs.

"I will talk more about environmentally friendly habits with my friend and family so we can expand circle of good practice"

"Olive oil purchases when possible"

"How I discuss environmental related things with others"

"Eating more sustainable foods, the organic food from farms, markets and such places where you can always find sustainable and healthy foods that don't pollute the environment"

"I'll try to reduce my carbon footprint as much as possible, I will try to do a little garden in my house to grow tomatoes and more things if I'm able".

All seven respondents agreed that they learnt something new as part of the YDAs and 85,7% stated that they YDAs increased their interest in science-related topics.

"I learn a lot about app development, safe food, strategies healthy food can be delivered in different institutions and about olive growing and tasting".

"I wasn't aware of how meat production and freezing meat worked and how polluting it is. Another thing was the school lunch workshop, it helped me realise how complex it is and how many people are involved".

"Learned more about olive oil and its' production".

"About olive oil, about the systems which already exist to improve our world, and I learnt many things about myself".

"The process of farm to fork and how eating sustainable foods is important to the environment and how unsustainable food can slowly kill the environment".

"How important is to reduce waste".

"I learned a lot from the process which food undergoes and which types of food are better and which are worse from an environmental point of view".

For future improvements, respondents suggested dedicating more days to physical meetings to allow for more in-person discussions. They also recommended reducing the length of the meetings to better fit participants' schedules. Other suggestions included having more sessions with experts and possibly holding sessions on weekends to avoid extending the weekdays.

4.8.4. Zero Pollution

The following are direct claims by the students based on an online questionnaire created for the YDA focused on Zero Pollution. The survey was filled in by 7 participants.

Q. What did you like about participating in the Youth Assemblies?

"I liked people and the energy the most. This concept of youth assemblies is a great think that should be more often in other projects. All of us got a chance to learn something new and be part of something big and important. Including youths is great".

"I liked that i got to speak and share experiences with people from around the world".

"I loved to get to know other young people from other parts of the world and to walk across Barcelona. The food was also amazing!"

"what I really liked about being in the Youth Assemblies was that I had the opportunity to learn more about climate change and more importantly, what is required to stop climate change. I also had fun and enjoyable experiences with my fellow peers"

"I liked been heard and collaborating ideas through activities and meetings, since sometimes being young it is difficult to be taken "seriously" by older generations"

"Insight into international collaboration, inspiring to see how you can work together and communicate across borders and competencies. In relation to us participants, but also the professionals who have participated along the way and presented their work"

"Enrich myself by listening to interesting conferences, arguing with my teammates and giving feedback to those applications that will be used for educate people"

All seven respondents claimed that after participating in the YDAs, they became more interested in science-related activities and topics. Additionally, 85.7% said they would change their habits as a result of the experience. For example, a student from Serbia mentioned being more cautious when throwing garbage, even though there is no concept of recycling waste in Serbia. Others reported being more careful about consumption and gaining the ability to interact with international students. One respondent noted that the YDAs helped them change their diet and consume less meat, while others became aware of health problems due to air pollution and expressed a desire to encourage people around them to make small life changes for more sustainable living.

All respondents acknowledged that they learned a lot through the YDAs. For example, they learned about what is measured in air pollution, the efficient public transportation in Barcelona and the rule that no cars are allowed in the city centre, the many aspects of climate change, the ability to express their thoughts clearly, and how the EU works on climate change and encourages residents to be active citizens.

Regarding improvements, respondents indicated that they spent a lot of time indoors due to the sessions and suggested that some sessions could have been conducted outdoors, even though everything was digital. The length of the sessions was also a concern, as they often lasted longer than planned, contributing to a feeling of being overwhelmed. This could be improved by adding more breaks during sessions. Some participants also found that the output of the group work depended a lot on who the participants were. One suggestion was to improve group work by assigning the groups in advance.

4.8.5. Circular Economy

The following are direct claims by the students based on an online questionnaire created for the YDA focused on Circular Economy. The survey was filled in by 3 participants.

Q. What did you like about participating in the YDAs?

"I liked meeting all the new people, experiencing new cultures and practical information. I also appreciated the personal presentations and the encouragement for feedback".

"I liked the opportunity to learn and connect with likeminded people. It was great to see the hope for future generations and that there are people working and investing to improve the current situation".

"Participating in the Youth Assemblies was an incredible experience that enriched my perspective. The collaborative environment, diverse discussions, and shared passion for positive change were inspiring…"

All three participants claimed that they will change their habits as a result of the YDAs.

"I am interested in community projects. But it will not immediately change probably".

"More mindful personal waste management and advocating for improved systematic implementations for all waste management and agriculture".

"I integrate circular economy principles into my daily life. Though full implementation faces challenges, I prioritize waste sorting, support local businesses, and repurpose items. These personal choices reflect a circular mindset…"

In addition, two participants mentioned that after participating in the YDA, they felt more interested in learning about the areas in the Green Deal, while a third participant stated that their interest in the topic did not change. When asked about improvements, participants suggested having a separate session at the start of the YDA to better explain the background, such as EU legislation and the current state of affairs. Some participants also found the online agenda to be very intense, even though the discussions were inspiring. Future experiences could be further enhanced by incorporating more breaks, as continuous online discussions can potentially increase fatigue.

4.9. Assessing the Socioeconomic Impact of GreenSCENT Demonstrators

The GreenSCENT project has demonstrated potential in delivering socioeconomic impact through its educational initiatives, active community engagement, and technological development.

Educational Benefits: The GreenSCENT Demonstrators have played a role in promoting environmental awareness and sustainability skills among students. Tools such as the Environment Monitoring Mobile App, Citizen Journalism, and Interactive Documentaries offered experiential learning opportunities, enabling students to observe, document, and analyse environmental issues in practical and engaging ways. These activities encouraged the development of critical thinking and problem-solving skills, which are valuable for active participation in future sustainability efforts.

Community Engagement: The project's focus on participatory education has promoted community interaction and shared responsibility for addressing local environmental issues. Demonstrators like CleanAir@School, Citizen Journalism and Interactive Documentaries involved students in documenting their surroundings, which may contribute to greater community awareness and discussions. This engagement promotes social cohesion and inspire proactive, community-led environmental actions.

Reducing Educational Gaps: Demonstrators such as Climathon and the GreenAir Augmented Reality App brought complex topics, including climatology and air quality monitoring, into the classroom in an accessible format. These initiatives expanded the reach of environmental education, potentially addressing gaps in access to educational resources and creating pathways to broader participation. The use of interactive and engaging tools can also stimulate interest in STEM fields and sustainability-related careers.

Equity and Accessibility: GreenSCENT tools were designed with user-friendly interfaces and inclusive features to enable participation from students of diverse backgrounds and abilities. This focus supports socioeconomic inclusion by ensuring that educational opportunities are accessible to broader demographics. Providing equitable access to resources and education can help reduce socioeconomic gaps.

Skills Development: The project offered practical experiences in technology use for environmental monitoring, data analysis, and participatory reporting. These activities provided students with relevant skills that could enhance their future employability. Demonstrators such as Youth Design Assemblies actively promoted collaboration, innovation, and leadership, supporting the development of competencies beneficial for future job markets.

Long-term Sustainability: The project's emphasis on integrating sustainability into education aligns with creating long-term practices that schools and communities can continue to build on. Activities simulating real-world environmental monitoring and problem-solving can contribute to sustained educational and community efforts over time.

Stimulus for New Initiatives: Several Demonstrators reported that GreenSCENT inspired new project ideas and promoted meaningful collaborations. About 29% indicated that the project had led to new initiatives, while others were in the process of developing future proposals. This momentum can potentially encourage further socioeconomic benefits through funding opportunities, partnerships, and community-based projects.

In summary, the GreenSCENT project has indicated positive socioeconomic contributions through educational engagement, community participation, and accessibility initiatives. The project's activities may support skill development, social inclusion, and the potential for future educational and community resilience. These aspects collectively contribute to a society that is better equipped to address environmental challenges and adapt to future changes.

5. Open Innovation Challenge

The GreenSCENT platform, powered by Agorize, and the first Farm to Fork Open Innovation Challenge page were developed between M10 and M13 to be ready for the challenge launch in M14. UAB and BSC collaborated with Agorize to ensure a consistent brand representation that could be easily adapted for all future challenges within the GreenSCENT project. The platform aimed to use user-friendly language, avoiding jargon. Additionally, Agorize focused on providing easy navigation and instructions by using clear headings and HTML coding to ensure compatibility with assistive technologies such as screen readers. This carefully planned platform design attracted a large audience and contributed to the success of the Innovation Challenges.

Given their extensive experience in launching challenges, Agorize had high expectations of attracting a large audience and receiving solutions ranging from technological innovation to process improvement, all aimed at transforming how food is grown, processed, and delivered to consumers. Ultimately, Agorize hoped to receive solutions that were practical and scalable, while challenging traditional approaches in the industry.

The Open Innovation Challenge had two tracks: the Student Track (18-24 years old) and the Startup Track (no specific age group). Figure 26 and Figure 27 showcase the two tracks.

5.1. Communication strategy

Creating an effective strategy was crucial to reach as many students and as many startups as possible (Figure 25). Agorize divided the efforts into three parts:

1. In the **prelaunch phase,** they focused on creating the program scope, defining the target audience, scoping existing direct contacts, and creating a communication toolkit.
2. During the **application phase**, newsletters were sent to students and teaching staff, and direct mailings were sent to the community using a database of 38,000 students and 10,000 teachers. They also reached out to schools and teachers by phone. The partners and ambassadors network outreach were estimated to be over 10,000 contacts. Agorize also reached out to new professors who might be interested in disseminating the information to the student community. Social media posts were used to activate the digital community, and thumbnail redirection on Agorize.com, which has 30,000 monthly visits, was utilized. Conversion campaigns targeted users and participants.
3. In the **post-application phase**, they analyzed the number of applications received, assessed the best-performing channels, and made observations for future challenges.

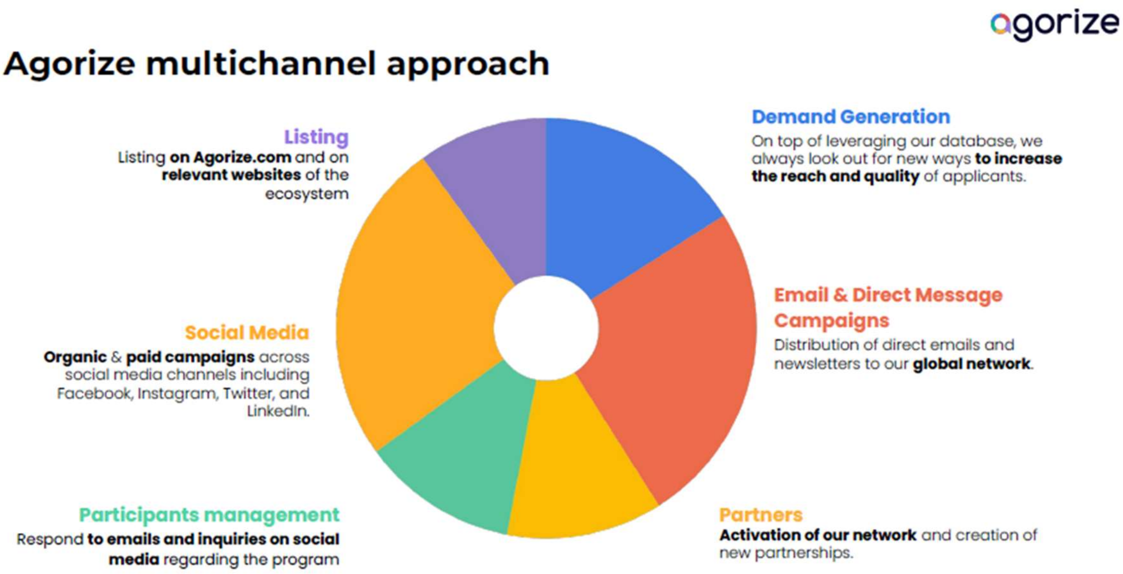


Figure 25: Communication approach for Open Innovation challenge

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101036480

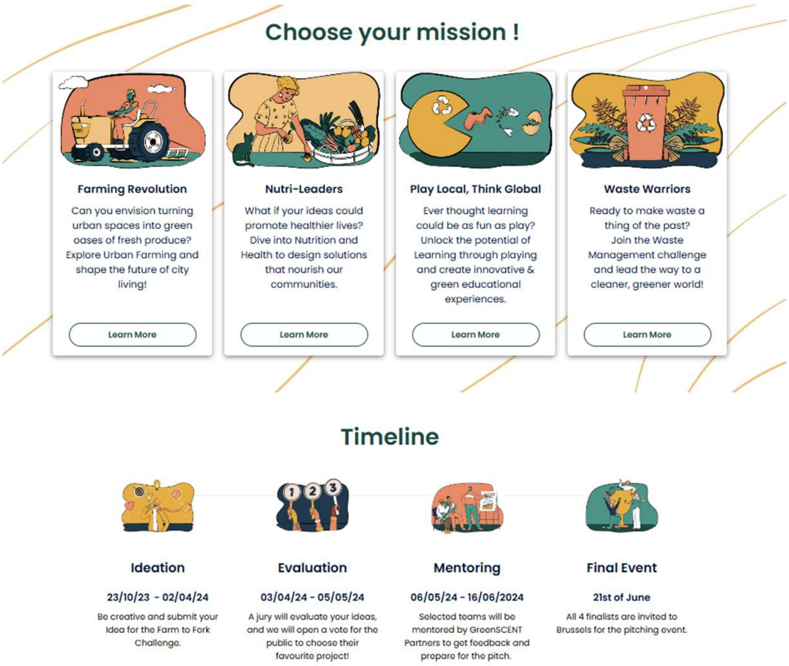


Figure 26: Student Track challenge

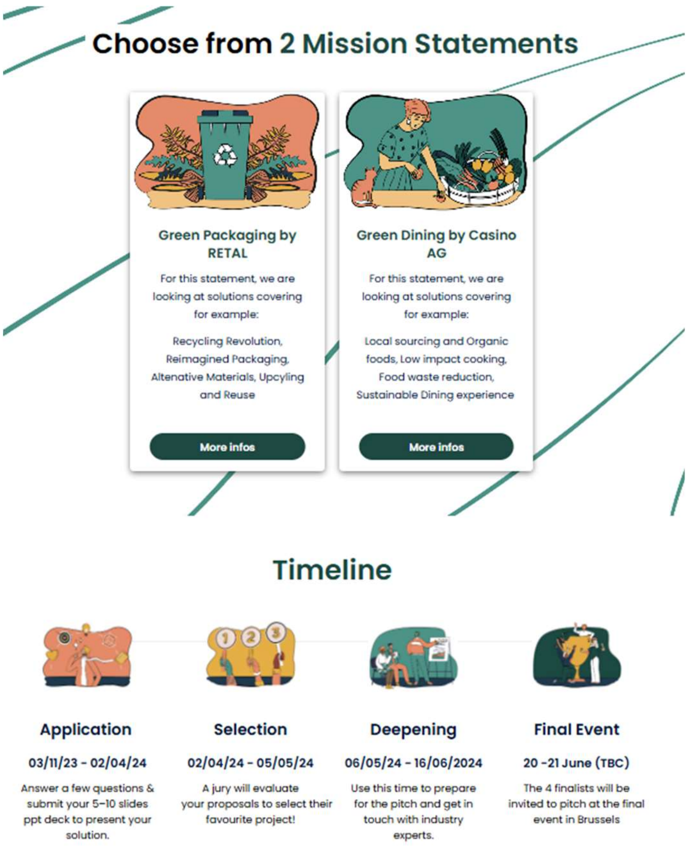


Figure 27: Startup Track challenge (consisting of two categories)

5.2. Final results

The Open Innovation challenge proved to be a big success, attracting a large number of participants from various countries (Table 4). The jury, composed of experts from industry partners and the GreenSCENT consortium, evaluated the projects based on the following criteria: innovation and creativity, feasibility and impact, sustainability, scalability and replicability, and community and stakeholder involvement. Four teams were selected as the final winners from each track.

Table 4: Number of applications per track

Student Track	Startup Track
1067 participants 468 teams 233 applications started 199 complete applications	98 participants 65 participations started 55 participations completed
Gender balance: 46,3% female - 52,6% male - 0,8% non-binary and 0,2% other	Gender balance: 31,1% female - 68,9% male
Number of countries reached: 45 Nationalities: 83	Number of countries reached: 40

The winner of the Student Track was Savior Worms from Sup Biotech France. Savior Worms developed an innovative system that uses mealworms and bacteria to transform plastic and organic waste into valuable products. Further details can be found on the Student Track page: Student Track.

For the Startup Track, two winners were selected from each category:

- In the **Green Dining category**, the grand prize winner was Revo Foods from Austria, which developed the world's first 3D-printed salmon filet. The second prize went to MAGNOTHERM from Germany, which focused on no-refrigerant, low-energy cooling technology, revolutionizing the cooling industry by completely eliminating refrigerants from the cooling cycle.
- In the **Green Packaging category**, the grand prize winner was Coffee Based from the Netherlands, which designed reusable and dishwasher-proof coffee cups made from coffee grounds or silverskin. The second prize went to Go Zero Waste (PaaSiot) from Spain, which offers a reusable packaging service interconnected with the Go Zero Waste App, making sustainability both accessible and efficient. Further details can be found on the Startup Track page: Startup Track.

6. AI and its impact to sustainability education

The impact of AI's recent rapid development on enhancing sustainability competences was explored through interviews with consortium members. Seven distinct themes emerged regarding AI's potential to enhance sustainability competences: aid for sustainable actions, aid for teaching sustainability, aid for learning sustainability, risks and limiting factors, new knowledge to support sustainability, removing barriers from knowledge creation, teaching, and learning, and varying impacts across themes. These themes were identified through thematic analysis using NVivo qualitative analysis software, which involved coding the interviewees' answers into different topics and further categorizing these topics into themes. The following sunburst chart illustrates the frequency of mentions for each theme and the number of topics within each theme.

Figure 28: Main AI themes and topics identified from the data

As shown in Figure 28, the largest theme, covering almost a third of the entire data, was aid for sustainable actions, which included eight topics. The next two largest themes were risks and factors limiting the potential, and aid for teaching sustainability, with the former including six topics and the latter five topics. The three medium-sized themes were aid for learning sustainability, new knowledge to support sustainability, and removing barriers from knowledge creation, teaching, and learning. Each of these three themes comprised three topics. The theme of different impacts across fields was unique, as it turned into a theme with no other related topics, which is why the outer layer of it appears white in the sunburst chart. The following tree map figure illustrates how these different themes and underlying topics are related and how often they were mentioned.

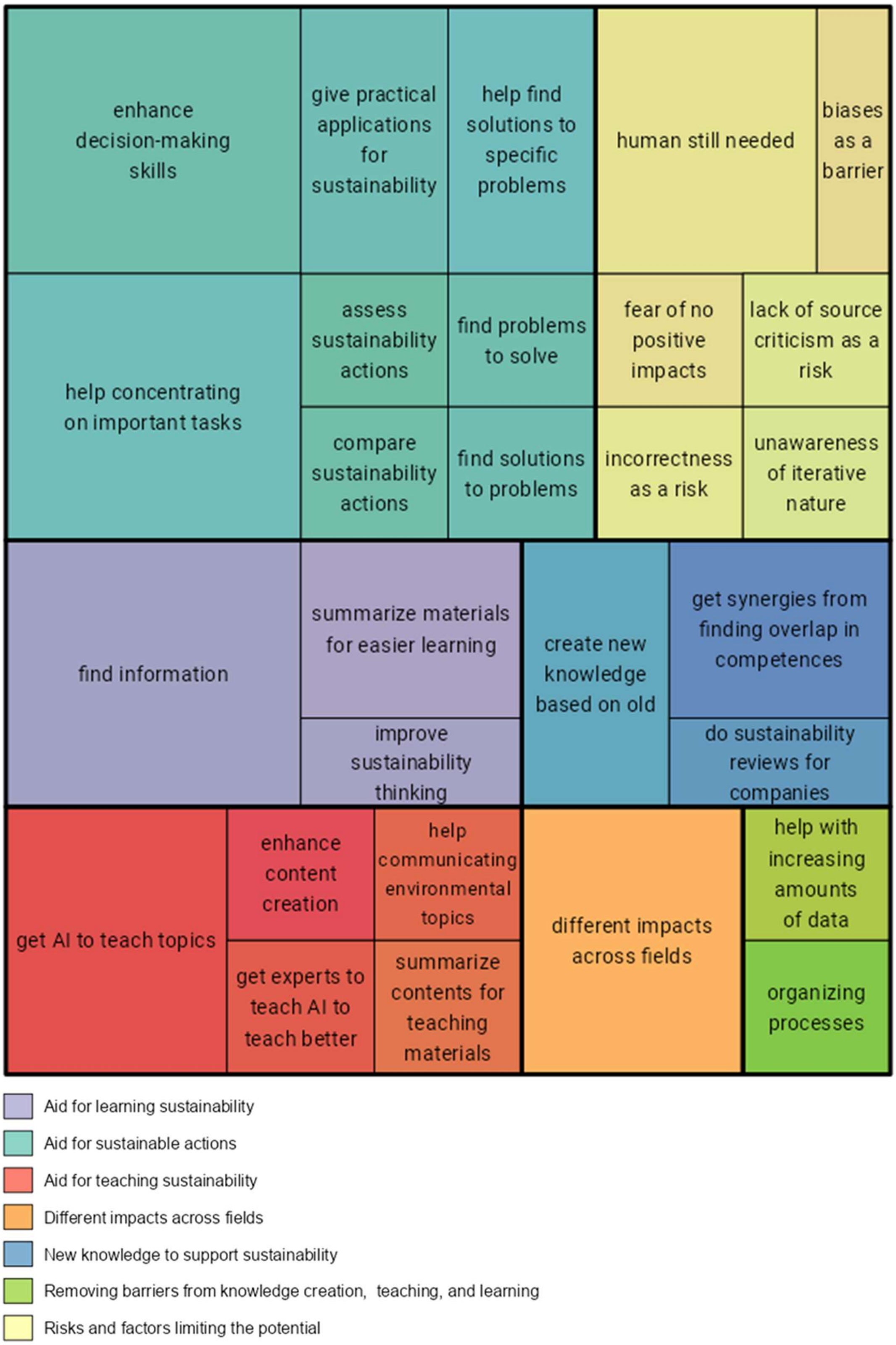


Figure 29: Tree map of the themes and topics identified from the interview data

As shown in the tree map above (Figure 29), many of the larger themes included one or two major topics along with some smaller ones. Six topics, in particular, stand out: enhancing decision-making skills, helping to concentrate on important tasks, finding information, getting AI to teach topics, the necessity of human involvement, and different impacts across fields.

The first three topics—helping to concentrate on important tasks, finding information, and getting AI to teach topics—focus more on individual-level support for learning. In contrast, the other three—enhancing decision-making skills, the necessity of human involvement, and different impacts across fields—address the impact of AI at a higher, organizational, or even institutional level. One of these higher-level impacts falls under the theme of risks and potential limiting factors, while another describes impacts rather than being a concrete impact itself. This suggests that more potential is seen at the individual level, while bigger limitations or risks are associated with the higher level. However, it can be argued that although the potential of AI to enhance sustainability competences is more frequently discussed in terms of concrete applications at the individual level, the impact of higher-level applications can be equally or even more influential due to the nature of organizational and institutional impacts.

In the context of aiding sustainable actions, the two most frequently mentioned topics were the potential of AI to enhance decision-making skills and the potential of AI to help concentrate on important tasks. For example, regarding AI's potential to help concentrate on important tasks, one interviewee stated:

> *"The hope is that the AI tools will show us [a] new way to do things, and this will make us able to concentrate better on the specific things that make things work".*

This focus on aiding actions towards sustainability implies that action is particularly needed, and AI can assist in finding time and plans for these actions. It also suggests that there is hope for AI to help make sense of the complex systems involving the environment, people, and economies, leading to better decisions for sustainable development.

In the context of teaching sustainability, the most significant topic was getting AI to teach topics. This mainly encompasses AI's potential to help people learn about various subjects and then apply this new knowledge to solve sustainability-related problems. As one interviewee put it:

> *"I would see it as a very educational tool that could be used and then you could learn competencies there or gain knowledge around sustainability".*

In the context of learning sustainability, the most significant topic was the potential of AI to enhance sustainability competences by helping find information. This is closely related to the previously discussed topic of AI teaching topics. The nuanced difference is that the former refers to using AI and the texts it creates as a source, while the latter refers more to using AI to find other sources. For example, one interviewee mentioned that AI could be used to:

> *"…help you identify, for example, the references that you can use for your own growth".*

So far, all the topics mentioned discuss the possible positive impacts of AI on sustainability competences. However, a significant theme in the interviews was also the risks and factors limiting its potential. The most prominent topic within this theme was the need for human involvement. This topic encompasses sentiments around the necessity of humans to check AI results or use AI as a tool rather than automating processes entirely. For example, one interviewee expressed hope that there would always be human control when AI is used. This topic is closely related to other topics under the theme of risks and limiting factors, such as biases, iterative development of AI, and inaccuracies, which likely contribute to the perceived need for human oversight of AI.

The theme of different impacts across fields stands out along with the previously mentioned topics. This theme is not so much about a positive or negative impact of AI on sustainability competences but rather a description of the potential impacts in general. It encompasses sentiments around impacts differing based on the field of impact or the background of the individuals affected. For example, one interviewee mentioned that the potential to enhance sustainability competences would be completely different for someone in another field of work based on their background.

In conclusion, many different applications for AI to enhance sustainability competences emerged in the interviews with consortium members. Aid for sustainable actions was the most prominent theme, with supporting themes such as aid for teaching and learning sustainability, new knowledge, and removing barriers also arising. Although the discussion focused on the potential of AI to enhance sustainability competences, some risks and limiting factors were also identified, with the biggest being the need for human oversight to prevent AI from making decisions without supervision. Overall, the sentiment of the interviews was mostly positive, with a lot of potential for AI utilization identified. The interviews suggest that AI can aid in building sustainability competences in many ways at both individual and institutional levels, for both teachers and learners. However, they also emphasize that AI should be utilized with an awareness of potential issues and measures to mitigate them. The overall impact of AI on sustainability competences warrants caution but also shows great potential.

7. Discussion and Conclusion

This deliverable D6.7 has analysed the impact of each of the GreenSCENT Demonstrators from the perspectives of both technical experts and class teachers. In the mid-term assessment document (D6.6), the role of teachers, professors, course designers, school managers, directors, and university program coordinators was strongly emphasized. By involving these individuals through pilot schools and universities, GreenSCENT empowers them to lead change. The role of class teachers was particularly essential for our project because they are aware of the 'small data' within their classrooms, such as students' group working methods and effective strategies for maintaining student motivation and active participation.

Through discussions with the class teachers involved in GreenSCENT, the project team realized that for the successful implementation of the Demonstrators across various educational institutions, there is a need for a pedagogical expert who can create an effective deployment strategy. This can help technical experts understand how young students think and perceive, how they interact, and how to maintain their levels of motivation and interest. Some of the Demonstrators, such as the Environmental Monitoring app, were created by experts who had been working with the commercial sector for a long time. The GreenSCENT project required many experts to shift their focus to young students, which inevitably led to gaps in communication and understanding the needs of the young pupils. As one of the school directors mentioned during an interview about whether they had difficulties in maintaining student motivation, the response was:

"Students need an element of discovery in what they do"

This proved particularly true for the work related to CleanAir@School, YDAs, and even Microplastics (despite the activity not continuing as planned). The discovery of something new often leads students to continuously discuss it with their peers, teachers, and families. This can be a strong indicator for staff and technical experts to decide whether an activity should be repeated the following school year. Students need to see a purpose and understand what their efforts are being used for. For example, one school had microscopes to analyse lake and river water samples collected during the Microplastics activity, which further increased the excitement. For some students, the YDAs felt similar to a youth parliament, which was both new and exciting for them.

In addition to integrating the element of discovery, the schools also recommended having more tangible outputs for the students. However, this may not always be possible due to the various purposes of the digital tools. Often, adults assume that students will happily use all types of tools, but this is not always the case. This leads to a discussion about hands-on experience versus digital learning and highlights the role of class teachers and supervisors, who have the best knowledge regarding their students' interests.

The need for a pedagogical expert can also be explained by the different age groups involved in working with the Demonstrators, including primary school, secondary school, and university students. For instance, Climathon was well received by university students, whereas the same students found CleanAir@School to be very basic and would have preferred more data analysis tasks. This highlights the point that, due to the large age differences, impact assessments could have been performed separately for each age group. However, given the limited number of Demonstrators, the project team chose to take a holistic view of all perspectives.

In general, the schools were able to test their own environments regarding integrating one of the Demonstrators into their curriculum in the future. It was also a unique opportunity for the schools to understand the types of in-house expertise they have. For example, some teachers had an interest in air pollution, which helped in conducting the CleanAir@School Demonstrator. However, in cases where the school lacks teacher expertise or if there is not enough time for the teacher to conduct the activity, it would be beneficial to have a dedicated person to help with the activities. For instance, a staff member from UNSPMF helped with the Climathon lectures, as the concept was quite new and sometimes difficult to understand for some students and teachers. Additionally, a staff member at EA school from the R&D department supported the teachers by conducting workshops and guiding the students with practical tasks. This type of support is necessary because all activities must be completed within school hours, and teachers do not have time after school to manage the project work.

The project team also noticed that having an expert in the classroom with the students greatly affects their enthusiasm and motivation. This was observed during the visit of the GreenAIR expert at the Royal School of

Transylvania (RST), who held a session with students from Grades 7 – 10 in autumn 2024. The app was experimented with by the students during the previous school year (2023), but the feedback received was satisfactory, unlike the extremely positive feedback received after the expert's visit the following year.

In addition to the in-house expertise of the school staff, future projects can also assess the existing school curriculum to determine whether a certain Demonstrator could be beneficial. This was the case with the Finnish school (MAYK), which already has an advanced student curriculum covering topics such as air pollution and sustainable lifestyles. As a result, many of the Demonstrators were deemed unsuitable for the school. Nonetheless, the school expressed interest in the CleanAir@School Demonstrator due to its location near the highway, but it could not be implemented due to a lack of time.

Despite certain difficulties, the Demonstrators were able to create a positive change in the student community by increasing interest in science-related topics and activities and encouraging students to make changes in their lifestyles. For example, the YDAs explained the impact of climate change from several perspectives (Clean Energy, Farm to Fork, Zero Pollution, and Circular Economy). For several schools, it was the first time that such citizen science activities were conducted.

The engagement methods of the GreenSCENT pilots and demonstrators were designed to be fair and motivating for students and teachers, as evidenced by feedback and experiences exchanged within the project team based on the GreenSCENT RRI framework. Key issues identified included the flexibility and adjustability of methods, which provided resources suitable for different educational contexts and learners. Methods that did not require high-end technological solutions or those offering flexibility supported a more inclusive approach to environmental education. Hands-on learning experiences and practical exercises helped bridge the gap between practical and academic knowledge. Involving young people in sustainability discussions and curriculum design significantly improved students' agency, allowing them to co-design the curriculum and learning outcomes. However, exclusion risks were identified, particularly for students with disabilities in physical hands-on exercises and in ensuring diverse and unbiased participation in Youth Design Assemblies. The GreenSCENT project addressed these challenges by establishing norms for interaction and creating a safe space for participation, publishing guidelines for fair and inclusive Youth Assemblies. These reflections underscore the importance of designing inclusive and flexible engagement methods to enhance active environmental citizenship in education.

Although the Open Innovation Challenge was not specifically a Demonstrator, the competition attracted a large audience and an extremely high number of submissions. For future citizen science projects, the Open Innovation Challenge could inspire younger school students, particularly those in primary and secondary schools, and help build the spirit of innovation and entrepreneurship from an early age.

The exploration of AI's impact on sustainability education through interviews with consortium members has provided insights into both the potential benefits and challenges associated with AI integration. The findings suggest that AI holds significant promise in enhancing sustainability competences, particularly in aiding sustainable actions, teaching, and learning. The positive sentiment expressed by interviewees indicates a strong belief in AI's potential to contribute to sustainability efforts.

However, the identified risks and limiting factors, such as the need for human oversight and the potential for biases, highlight the importance of a cautious and balanced approach to AI adoption. Ensuring that AI is used responsibly and effectively will require ongoing attention to these challenges and the development of strategies to mitigate potential issues.

Overall, the interviews suggest that while AI can be a powerful tool for building sustainability competences, its implementation should be approached with careful consideration of both its potential and limitations. By addressing these challenges, AI can be harnessed to support sustainable development and education, thus contributing to a more sustainable future.

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9. Annexes

9.1. Annex 1 – Interview questions for Demonstrator developers

1. Have you worked with citizen science before?
2. What were your expectations before the start of the activity? (ex. Your expectation from the students? use of the app?)
3. What was the age group that you worked with?
4. How many students used the tool?
5. Did you use many prototypes before the official start of the activity? (user testing)
6. What was the learning process of the students?
   a) Did you expect a different learning process to happen or was everything similar to your expectations?
   b) Did you have to teach the students a short lecture before the activity started?
7. What skills have the students learnt through your demonstrator? (IT training (such as using a website), Equipment training (such as using an app), Measurement training).
8. Did you have to modify something to improve student learning or motivation?
9. How was the tool used by the teacher in class?
10. Does the Demonstrator address participants with functional diversity (special needs)? If yes, what adjustments did you make?
11. Did you have a balance of gender diversity?
12. Was there any difficulty in data collection?
13. What would you do differently if you wish to repeat the activity elsewhere?
14. What will happen after the project ends?

9.2. Annex 2 – Interview questions for Class teachers

Demonstrator (activity name):

1. Has the school participated in similar activities before?
2. What were your expectations about the activity? And how did they evolve?
3. Do you believe this activity was a good use of study time for the students?
4. How would you describe your expertise on specific topic of the CS project?
5. How familiar are you with specific tool used in the CS project (for example air quality sensors) usage?
6. How can the students be motivated further, if needed?

9.3. Feedback survey for Demonstrator developers

1. How much responsibility is offered to the participants (with options depending on interests, availability and knowledge)?

- Not much, no single participant is relied on to carry out a specific task
- A lot, the project depends on specific individuals to carry out certain tasks
- Something in the middle
- I don't know

2. Are the participants satisfied with the process of participation in the project?

- Yes, and it has been measured
- Yes, but it has not been measured
- No
- I don't know

3. Are participants satisfied with the results of the project?

- Yes, and it has been measured
- Yes, but it has not been measured
- No
- I don't know

4. How are the project outcomes shared?

- Scholarly outputs e.g. peer-review publications, open data sets
- Grey literature e.g. reports, working papers, policy briefs
- Popular media e.g. social media, magazine or newspaper articles, TV or radio, newsletters, leaflets
- Events e.g. conferences, community talks lectures, workshops, fairs, seminars or webinars
- None of the above
- I don't know

5. At what level does the project contribute to the formal education of participants (for example, by working with schools)?

- Pre-primary-level education to children
- Primary-level education to pupils
- Secondary-level education to pupils (middle and high school)
- Tertiary education to students (university, college and vocational courses)
- Adult education or life-long learning
- The project does not contribute to the formal education of participants
- I don't know

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9.4. Class teacher feedback survey per Demonstrator

Demonstrator: Name

Note the Class teacher had to complete a separate survey for each Demonstrator. The survey was the same for all class teachers.*

1. Please read the following items and assign a value from 1 to 5, where 1 is: "not at all" and 5 is "in a very significant way (Likert scale)

a) The activity carried out positively influenced the students' attitude towards science
b) The activity carried out provided students' with new competences in the use of scientific instruments (for example sensors)
c) The activity carried out improved the students' scientific competences (including data gathering and data analysis)
d) The activity carried out improved the students' scientific reasoning skill and their critical thinking attitude
e) The activity carried out improved the students' interest for scientific-related careers
f) The activity carried out improved the students' attitudes towards environmental issues
g) The activity carried out improved the students' knowledge about the activity at hand and related issues
h) The activity carried out improved the students' motivation and self-esteem
i) The activity carried out improved the relationship within the students'

2. For the items that scored 3 or higher, please tell us what specific improvements/changes did you notices? How did they manifest? (few examples would be sufficient).

3. Additional information: For example, some changes that would interest more participants or engage them better.

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9.5. Youth Design Assembly student feedback survey

1. What did you like about participating in the Youth Assemblies?

2. Is there something you did not like about the activity?

3. What should be improved and how?

4. Did you learn something new?

- Yes
- No

5. If yes, what new thing did you learn?

6. Do you think that you will change any of your habits as a result of the activity you carried out?

- Yes
- No

7. If yes, what will you change?

8. After participating in the Youth Assemblies you feel

- More interested in learning about the areas in the Green Deal
- Less interested in learning about the areas in the Green Deal
- My interest for this topic did not change

9. After participating in the in-person meetings you feel

- More interested in learning about Clean Energy
- Less interested in learning about Clean Energy
- My interest for this topic did not change

10. After participating in the Youth Assembly you feel

- More interested in science-related topics and activities
- Less interested in science-related topics and activities
- My interest for science-related topics and activities did not change