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D3.1 - GreenSCENT platform design and integration

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Executive Summary

This document presents the D3.1 - GreenSCENT platform design and integration by introducing the theoretical framework of the Sustainable Interaction Design, its historical roots, its current methods and research perspectives and, in particular, the *designing for low resource scenarios* approach developed in the GreenSCENT project. This deliverable describes the interaction and interface design activity developed within Task 3.1 - Design concept and interaction design of the GreenScent Identity, including the description of the iterative, participatory and incremental design methodology implemented in the task and all the design cycles, regarded as internal to the design team as well as with the involvement of end users.

At the core of the deliverable there is the EXPLOR design concept that integrates the many perspectives of GreenSCENT into an educational service and interaction design activity. EXPLOR suggests a unique journey that integrates multiple users' perspectives, including the teachers, the students, the researchers, into a sustainability education GreenSCENT scenario. The EXPLOR concept allows the reader to also put in relation the different technologies of the GreenSCENT ecosystem, the way of interacting with these systems and the possible adoption in sustainability education, meaning the GreenVERSE, the GreenSCENT mobile app, the GreenSCENT AR Mobile App and the GreenSCENT CleanAir App.

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

Index

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1. Design objectives

1.1 Sustainable Interaction Design as Framework

Since the '80s sustainable development has been increasingly appearing in national governments' political agendas. One of the foremost definitions of sustainable development, as articulated by Gro Harlem Brundtland, the president of the World Commission on Environment and Development (WCED), is as follows: "Sustainable development denotes the form of development that empowers the contemporary generation to fulfill its own requirements while ensuring that future generations are not deprived of the opportunity to fulfill theirs" (WCED, 1987).

In particular, the individuals most affected by sustainability challenges, such as climate change, are not imagined to be the future generations, but young people alive today, said Sir David Attenborough at COP26 in November 2021. And, as Tomlinson, et al. (2012) point out, a future of collapse and limits does not appear in an instance but a society slowly transitions into it (Remy, Huang 2015) and current western wasteful lifestyle cannot be maintained anymore. Sustainability education interaction design is the main field this research wants to contribute.

In the enthusiastic technocratic culture we live, as design practitioners and researchers, we might illusorily tend to actually practise the discipline as if we were in the full availability of infinite resources, unbounded potentials, and knowledgeable users. As a result, there has been a growing inclination among individuals to engage in socializing, communication, organization, and entertainment through digital means, thus embracing the utilization of cloud-based services reliant on digital infrastructure (Preist et al., 2016).

As already debated since the '70s, the Social Design movement (Papanek & Fuller, 1972; Brock, 1977) brought the focus of modern designers from solely looking at technology innovation to novel shapes of active and aware citizenship and social integration (Monteiro, 2019; Bassi, 2017; Moretti, 2019).

In particular, Socio design has been thought to strengthen social cohesion through a better inclusion of vulnerable people, especially those who are looking for a reintegration into social, emotional or working life, after being marginalised for lack of competences, abilities or information or for reasons related to their personal history (Pollini, 2022). Stemming from the roots of Socio design, this research has the ambition to create a continuum with sustainability through design (Mankoff, et al., 2007) and sustainability in design fields (Mankoff, et al., 2007). In particular, we want to contribute to Sustainable Interaction Design (SID) (Blevis, 2008; Blevis, 2007; Blevis, Stolterman, 2007; Odom et al, 2009) by advocating for sustainable use of technology and development of digital interactions. The last 20 years have seen increasing attention to Green Information Systems (IS) and to the contribution it can give to environmental sustainability by improving efficiency and effectiveness through automation, the provision of relevant information, and the establishment of better (more sustainable) services (Brauer et. al., 2016). Green IS is focusing on objectives such as learning, data collection and awareness raising (Lindenberg and Steg 2013), but the literature is demonstrating that today's crisis is encouraging a holistic turn into regeneration and a cultural shift is required (Light, 2022).

Recent developments in SID have critically discussed the undefendable nature of the cornucopian vision (Widdicks et al., 2022), meaning that digital infrastructure is limitless and continued progress is possible and preferable. From this perspective we advocate for intentionally moderating digital interactions and provide design solutions that span in one ideal continuum from fully digital to hybrid, until low resource scenarios where scarcity is prevailing abundance, and limits rule over desires.

By focusing on studying the reasons behind unsustainable digital interactions, this research wants to propose a case study analysis to disentangle the design concept generation behind the uses of different resources, being them of human, cultural, dimensional or technological nature, in sustainability education interaction design. In particular we aim at a purposeful and efficient use of all the needed resources in sustainability education, in view of resourceful growth of collective awareness, knowledge and competences.

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1.1.1 Designing for low resource scenarios

By implying both -in design and -through design, and thus advocating for reaching sustainability through design results and within design practices, SID requires that design practitioners and researchers confront their abilities with low resource scenarios. In this research our goal is to start developing a framework for a resourceful, yet inclusive, sustainability education that is able to integrate requirements and future opportunities of designing with limited availability of resources and contextual constraints (Beyer, Holtzblatt, 1999).

The authors would like to propose a holistic approach to address the resource concept, including a multiplicity and heterogeneity of perspectives, among which the technological one does represent a relevant dimension, only if in relation to the following:

- temporal dimension, meaning time availability;
- spatial dimension, meaning available spaces, rooms, outdoor settings;
- human dimension, meaning the human resources, skills, competences and abilities;
- affective dimension, meaning the affective engagement of the users in the interaction;
- cultural dimension, meaning sharing of habits and practices, and awareness of concepts;
- infrastructural dimension, the availability of electricity, bandwidth, hardware;

All of these dimensions are essential to describe the limited resources scenarios which are at the core of this chapter, and needed to explain, motivate and facilitate the adoption of technology.

The following paragraphs introduce the human factors, the contextual factors and the technological factors that have been used in the case study analysis to disentangle relevant projects and products that are relevant to the investigation of real world resourceful sustainability education.

Technology as a resource

Interaction design (IxD) values digital technology towards ambient challenges since the '90s with the early explorations within the ubiquitous and pervasive computing framework (Weiser, 1991, 1993) that extracted computing and communication resources out of standard desktop machines and embed them in distributed, small and multipurpose devices within the environment (Pollini, 2008). This moved the IxD and Human-Computer Interaction (HCI) paradigm toward a more dynamic perspective within computers that were widely spread throughout the physical world.

Main challenges designers and developers have to tackle are to define the appropriate hardware, architectural and application software mechanisms required by usable ubiquitous technology that can be explored in resource-constrained devices. Studies that explored bridges between system architecture and specific aspects of use, e.g. the ability for a user to operate specific functions and their implications for software infrastructure, demonstrated the intrinsic connection between use practices and the corresponding enabling resources (Pollini, 2008).

Technology can be perceived as a resource if it simplifies and does not overcome, if facilitates instead of burdens, if ready-at-hand instead of time consuming in itself and demanding specific competences and knowledge. Thus, in order to let people conceive, appreciate and value technology as a resource, it needs to be critically discussed with relation to human and contextual factors, allowing us to understand (and design for) the subjective, situational and emotional nature of the human experience in the real world (Hassenzahl, 2010).

The computational resources we refer to in the rest of the chapter are hardware and software resources: ranging from internet bandwidth and coverage, to multi-device Google account usage, until data storage availability. We are indeed considering digital devices and network availability in connection with logical resources associated with them, e.g. memory, data transfer and connection speed, refresh time, edit and writing rights permission, photo camera driver update.

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Software resources also include a variety of different digital contents and digital services as well, like the availability of technology-enhanced learning objects, or the possibility of easily using cloud-based services accounts, e.g. Google Drive accounts to access shared pictures, exchange data among devices, upload files to a project.

Among the hardware resources one might think about the storage capacity of handheld devices, for example to record videos and high quality pictures, or the size of the viewing screen in the classroom and the need for the students to have basic technology for advanced interactive technology, like XR viewing or 360° camera for recording immersive environments.

Infrastructural resources include support centers for teachers to facilitate the production of technology enhanced (e.g. AR and VR) learning objects; the maintenance of the servers; and the coverage of internet connection, as one of the fundamental factors to enable interactive learning. Software, hardware and infrastructure resources are clearly interconnected and dependent on one another: lack of connection impact on online contents availability and accessibility; lack of storage capability affects the overall computation of the device, especially in the case of mobile and handheld devices.

Human factors as resources

Human factors considered in this chapter are cognitive and socio-psychological factors of actors who interact with computational and physical resources, being educational managers, teachers or the students themselves, involved in sustainability education. Since digital technologies are tightly integrated into the embodied, experiential practice in the world, we actually experience them affectively as a component of our ordinary situated physical and socio-cultural contexts (Sengers et. al. 2008; Boehner et. al., 2008; Höök, 2008). Affective engagement refers to how the experiential field offered by the physical and digital setup fosters cognitive, emotional and inner engagement by providing a context of micro-perceptual interactions (Fritsch, 2009). The value of affective and human factors in education might be especially appreciated when some barriers and obstacles occur. A series of obstacles for technology adoption in teaching activities might arise (Aguayo et al., 2017; Alkhattabi, 2017; Wang, 2017)::

1. it is a novel technology for people;
2. people lack of knowledge for the implementation of educational experiences/experiments;
3. the lack of teachers' training;
4. the need for the students to have positive attitudes for technology addition into educational practice;
5. the lack of conceptual frameworks to rely on for searching for innovative educational practices for the application of technology;
6. the overload of information to be managed in dealing with interactive contents and media.

Understanding how to incorporate interactive and learner- centred approaches and collaborative learning techniques requires that teachers need to enhance their competence in integrating technology, designing and planning processes and implementing these initiatives with an inclusive approach to different parts of their teaching. And at the basics of this competence there are subjective and psychological factors related to attitudes towards the novelty of technology or students' acceptability, like 1 and 4, and cognitive factors related to knowledge, training and conceptual means (2, 3, 5, 6), the know-how to master technology and the advanced digital skills to use digital services.

Indeed, in broad definitions of digital divide, there is also the divide between those who have the necessary 'skills' to use technology effectively and those who do not (Warschauer 2011).

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Context as a resource

Discussions about access to technology frequently center around the notion of the 'digital divide'. Often understood to refer to the difference in access to technology between developed countries (who have technology) and developing countries (who do not), the idea of the 'digital divide' can also be applied within individual countries (for example between urban and rural areas) and even within individual classrooms (for example between learners who have access to technology at home and those who do not). This more nuanced understanding of the digital divide suggests that teachers working in high-resource contexts may find themselves working in resource-poor institutions or classrooms. Contextual resources might be provided by the features of the local territory, for example the vicinity of the institution to a relevant site for educational sustainability. This aspect may favour the visibility of relevant phenomena for green sustainability that are not always recognizable and present-at-hand. The direct exploration of local sites is extremely important for the learners' experience as well.

Resource-poor contexts might also be of temporary and transitional nature, for example due to infrastructure work in progress that affects broadband coverage in the whole building, or the availability of outdoor internet connection for on field explorations.

Technological, human and contextual factors have been used to foster the case analysis of Par. 3 that summarises the interaction design of physical-digital artefacts that have been selected since embedding scalable approaches to low-resource scenarios by design: meaning that designers conceived their own projects and products in order for them to be available in a variety of contexts, and with heterogeneous portfolios of resources, still maintaining the core values of the design concept and the quality of experience as key aspects of the project.

1.2 Objectives

The above described framework served as a theoretical and methodological framework for the accomplishment of the following objectives:

- first one, the design of services and products for Greenscent Sustainability Education, and to support the application of the newly defined European Certification of Climate and Environmental Literacy (ECCEL);
- second one, to assure scalability and modularity of the Greenscent technological solutions for low resources scenarios, meaning the realisation of inclusive and accessible project outcomes that are meant to be widespread to a great variety of school contexts and communities all over Europe, with different availability of human, technological, environmental and financial resources.

2. Design Methodology

In order to explore the understanding of technology for the support of sustainability education innovation, we organised many co-design workshops using different co-design approaches, both with interactive tools and analogue activities, with the aim to gather information about how sustainability education is perceived by attendees, explore attitudes towards the role of technology in addressing sustainable behavioural change, and understand stakeholders' visions of how emerging technologies could be utilised to benefit the activation of communities.

At methodological level, GreenSCENT proposes to implement local User Panels, a qualitative methodology that relies on a group of pre-recruited end-users whom the research team worked with throughout following a human-centred and participatory design approach to co-build and co-validate the expected outcomes of the GreenSCENT project. User Panels act as a form of longitudinal research that allows the researcher to observe something at more than one point in. User Panels are allowing the researchers to identify and solve the emerging educational challenges that hinder the European educational system from teaching pro-environmental behaviours to its citizens, especially among the young generations.

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We adopted the User Panels' participatory activities to repeatedly collect qualitative data from the end-users' requirements to obtain valuable insights to develop, test and validate both the GreenSCENT educational framework and the hybrid educational experiences provided by the technological demonstrators. In particular, the scope of that methodological approach is to transform user requirements into design opportunities to design new strategic pedagogies – including collaborative learning, debate, research-based learning, and inquiry-based learning – that can motivate people to adopt sustainable and environmentally aware behaviours.

This section describes how two main Sustainability Education technologies, the Air Quality App and the GreenVerse Interactive Platform, have been developed, demonstrated and discussed with the user panels in different co-design workshops held in 2022 at the following educational institutions; the Ellinogermaniki Agogi School in Athens, Greece, the Gimnazija Smart School in Novi Sad and the University of Novi Sad, Serbia, and the IES Raspall in Cardedeu, Spain.

The workshops intended to explore new future educational scenarios aiming at fostering awareness of sustainability among young people respectively through the exploratory research for a new product and collection of insights for the design process of the tool, and the adoption of immersive technology-enhanced learning experiences. Beyond the co-design, the objectives were to go beyond the acquisition of formal knowledge to foster:

- the promotion of dialogues, negotiation and interpersonal skills;
- the development of a matured personal point of view;
- the ability to relate scientific knowledge to systems of personal and social values.

We reflected on these aspects to analyse how they could affect the individual's decision-making processes to adopt responsible behavioural choices. In particular, the activities explored an educational framework that led a group of students to co-create new educational methods and learning processes by both exploring the concept of the Air Quality App and experimenting with the GreenVerse Interactive Platform, as a potential tool to stimulate reflective learning and sustainable actions that could have a positive impact on climate change.

The ultimate scope of the chapter is to illustrate the utility and practicality of our approach for other researchers interested in the co-production of digital, physical, and hybrid educational technologies with the target audience in order to provide the teachers and, ultimately, the students with new interactive and immersive solutions that support sustainability education.

The GreenSCENT iterative and incremental concept generation process is allowing the design team to come to concept fine tuning and finalisation by the following four phases:

- 1st cycle with Co-design Workshops with teachers and students: during the first year of the project three main Workshops have been held at the Ellinogermaniki Agogi School in Athens, Greece; at the Gimnazija Smart School in Novi Sad, Serbia and at the University of Novi Sad; and at the Universidad Autonoma de Barcelona, Spain;
- 2nd cycle internal to the GreenSCENT design team with individual and collaborative creative sessions aimed at ideas generation, concept development through the Attribute Listing method and concept validation;
- 3rd cycle involving two Youth Design Assemblies (YDAs) convened on February 2023 for a 3-hour workshop to generate ideas on four tools from the GreenSCENT project, all of which are still under development, I.e.: The Environmental Monitoring Tool, The GreenSCENT Citizen Journalism App, The GreenVerse Immersive Platform, and The Air Quality app, in order to develop an present ideas on how to use the apps in an educational setting.
- 4th cycle within the design team, that elaborated co-design workshops and assemblies ideas to the design specifications of GreenSCENT technologies.
- 5th cycle with Co-design Workshops with teachers and students that have been held at the Maunula Secondary School and Helsinki School of Mathematics (Maunulan yhteiskoulu ja Helsingin matematiikkalukio in Helsinki, Finland; at the Royal School in Transylvania in Cluj-Napoca, Romania.

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2.1 1st cycle with Co-design Workshops

The activities presented in this section are related to the experimentation of new educational scenarios in the GreenVerse Interactive Platform, a digital tool that enables students, teachers, and European citizens to acquire knowledge, skills and attitudes to tackle environmental challenges, related to the European Green Deal areas, through an augmented learning system. The digital tool is based on 360° environments, capable of articulating immersive information and narratives that enrich the quality of the user's learning experience.

The main objective of the co-design was to test and validate the user experience of the GreenVerse Interactive documentary demonstrator by involving a group of young students in a co-design session to improve the overall usability and accessibility of the prototype itself (see Fig. 1).

Fig. 1. Researchers are presenting to the students the functionalities of the GreenVerse Interactive documentary tool, at the Ellinogermaniki Agogi School, Athens, Greece.

The researchers guided the participants to interact with particular features of the demonstrator to identify whether the main aspects and functions of the interface would be maintained, because they are helpful and pleasant to use, or would be improved because of their limitations in comprehension and usage. The evaluation aimed to collect several impressions about the understanding and easiness of the GreenSCENT prototype to improve its functions through the participatory and inclusive contribution of the participants. The goal was also to collect several design concepts and ideas from the students as a design material to implement new features that could improve the usability of the final prototype.

These activities also explored the whole process of conception, planning and development of an interactive documentary. The methodology aimed to understand if the qualities of the GreenSCENT platform would be accessible and intuitive enough to empower younger users to upload and assemble multimedia content on the application autonomously. That would allow users to generate 360° interactive environments and, thus, provide an immersive experience linked to sustainability education.

The GreenVerse educational scenario focused on particular educational challenges on natural, cultural and societal heritage to:

- Promote awareness among young people of the importance of our common World Heritage;
- Encourage the young generation to actively become involved in heritage conservation on a local, as well as on a global level;
- Develop effective educational approaches and materials by working in synergy with educators and heritage conservation experts to introduce World Heritage Education into the curricula of secondary schools around the world.

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Both Workshops foresaw the proposition of this envisioning scenario to introduce the work with the preliminary prototype that has been respectively focused:

- In Athens, on the interactive documentary storyboarding, meaning the definition of the documentary scope and concept, the sequencing of the contents and the structure of the interactions. The storyboard has then been used to generate 360° interactive environments in the GreenVerse.
- In Novi Sad, on the paper prototyping of the immersive experience, meaning the use of a spherical grid paper template enabling the students to figure out what the model of the interactive environment was. Working on the paper model allowed the students to gather the proper dimensions and visual resolution of their storyboard contents.

Fig. 2. On left: students are generating storyboards to define the structure and contents of their interactive documentaries to develop on the GreenVerse application during the co-design workshop at the Ellinogermaniki Agogi School, Athens, Greece. On the right: students are testing the results of their immersive documentaries by using paper-based prototypes during the co-design workshop at the University of Novi Sad, Novi Sad, Serbia.

2.2 2nd cycle: GreenSCENT design team

Next to the design activities carried out during the 1st cycle, the Greenscent design team elaborated the obtained results of the research into valuable design knowledge, in particular by developing design challenges to be tackled during the project.

In this section the authors discuss the relevant issues in sustainability education that arose during the co-design activities with relation to the role of teachers, the user engagement, the empathy with sustainability goals, the 'making visible' approach and the issues about scalability and universality.

Focusing on teachers

Teachers are the bridge between knowledge and students. However, they have no time for teaching sustainability education during their ordinary activities because the topic is not in the official curriculum of the

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national schools' educational programmes. Only well-motivated educators adopt integrative or extracurricular teaching activities to dedicate a short time for sustainability education.

Competence enhancement: Although sustainability education is a complex subject that requires extra learning to enhance appropriate educational competences, teachers have a short time to implement their teaching curriculum. In that case, technology must provide some tutorials, education guidelines or toolkits to improve their competences on sustainability education.

Easy to learn: Educational technology must be adaptable to different levels of digital literacy. Technology must be easy to understand to encourage its adoption in regular learning programmes. It can offer short instructional videos or short educational pillows to facilitate knowledge acquisition.

Easy to use: Technology must facilitate the work of the teachers by providing educational tools that students can utilise autonomously. The digital tools can offer pre-structured resources (pre-sets of data, environments or multimedia resources) or pre-structured teaching formats (selection of examples, scenarios, or experiments) to save time for preparing the lesson or coordinating the class during the educational activity.

User Engagement

Students must be involved in hands-on activities to give them the opportunity to directly experience the values of adopting sustainable behaviours. Equipping technology with some user-entrapment strategies can help teachers encourage students to take an active role in the activities while creating curiosity and interest in participating.

Learning-by-doing: A learning-by-doing experience is able to raise student's awareness about the consequences of a particular behaviour by making tangible the added benefit of that action while it is performed. That is because practice-based activities clearly show cause-effect evidence of a particular behaviour. In that way students can raise awareness by experiencing real-life situations that make theoretical learning more memorable and tangible. Moreover, practical activities allow students to interact directly with nature and increase their empathy for the environment.

Long-lasting education: Sustainability education cannot be limited to temporal or spatial conditions. An effective learning environment must prolong sustainability education outside the educational institutions to continue in the course of everyday life. Considering this, technology can transform practice-based activities into daily habits through an iterative school-home process that can affect not only students' behaviours but also the attitude of their parents. In that case, stimulating a parent-child interaction can help the educational community involve parents in the educational process. That, in turn, enables the social community to tackle conservatism on sustainable topics.

Gamification: Game strategies can be implemented into technology to make sustainability education more engaging and pleasant to learn and experience. Challenge-based education is a good example to increase sustainability because it enhances collaboration among students and sustains the activities in the long-time perspective turning simple exercises into positive behaviours. In addition, rewards or honours can encourage user engagement because they can offer to students personal benefits (for example, less homework or more good votes) or advantageous social positions (for example, the best sustainable student of the month) that can have a positive social impact inside their institution.

Make visible invisible

Technology can raise awareness of sustainability among people by showing the complexity of the phenomena invisible or imperceptible to human's senses by utilising immersive and augmented learning experiences. Many techniques and approaches can be used to make more effective use of technology in education, helping people to understand problems, make decisions, predictions, or measure and assess the impact of a particular action.

Anticipation of actions: Technology can stimulate critical thinking by reporting the consequences of a particular sustainable choice through simulations or predictions, which are able to make visible the consequences of that action along a timeline. That can help people to correlate a problem to the past to understand the causes and prevent it in a near-future situation.

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Comparison: Technology can measure the pros and cons of a particular product or behaviour and compare each other to help people increase their awareness of sustainability by giving them the opportunity to ponder their sustainable actions.

Clear explanation: Providing theoretical information with visual and interactive resources and narrations allows people to understand the complexity of a particular phenomenon related to sustainability education. For example, transforming scientific literature into an inclusive narration can help educators to spread the message toward not-expert people.

First-person experiences: Technology can provide immersive and augmented learning experiences with a personal narrative perspective to increase emotional connection to a specific problem. That setting can be experienced through concrete examples that report real-life or real-world examples, which enable people to impersonate themselves in a particular situation and, hence, raise awareness of the related problems by stimulating their empathy.

Scalability & universability

During our co-design activities with digital demonstrators, we discovered that accessing innovative digital education in resource-constrained environments can give rise to operational challenges that render those emerging technologies impractical. Often, the failure of interoperability may derive from the traditional top-down design mindset focusing primarily on stereotypes that influence decisions without considering any meaningful contribution from the diversity of excluded communities or specific environmental conditions of a given context. Considering this, sustainability education must provide sustainable digital experiences compatible and scalable to the level of resources of a particular educational scenario. As previously observed, enabling an equivalent digital educational experience, characterized by augmented and immersive features, through low-resolution or tangible alternatives like offline applications or paper-based templates, has the potential to enhance the overall accessibility of the technological service, particularly in resource-constrained contexts.

Personal navigation

The experiences can be developed through the use of different navigation systems according to the objective of every single narration. The views are: Pan & zoom 2d images; Panoramic navigation (spherical); Walk through (3D navigation on the 3 axes). A combination between them can enhance more immersive and flexible experiences. For example, the google street view in combination with google maps, provides two different levels of narration and information. Different navigation can also combine together different types of variables, such as time, spatial or geographical position and so on.

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Fig. 2. The exploration of the semantic field emerging from the research outcomes. The overall map (above) and a detail of it (below).

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The exploration of the design themes informed the generation of high level concepts, developing values, ideas and services stemming from the analysis of user requirements, user stories, and the main challenges.

One of the concepts is shown below in Fig.3, the Time Machine, further inspiring the development of novel services and interfaces.

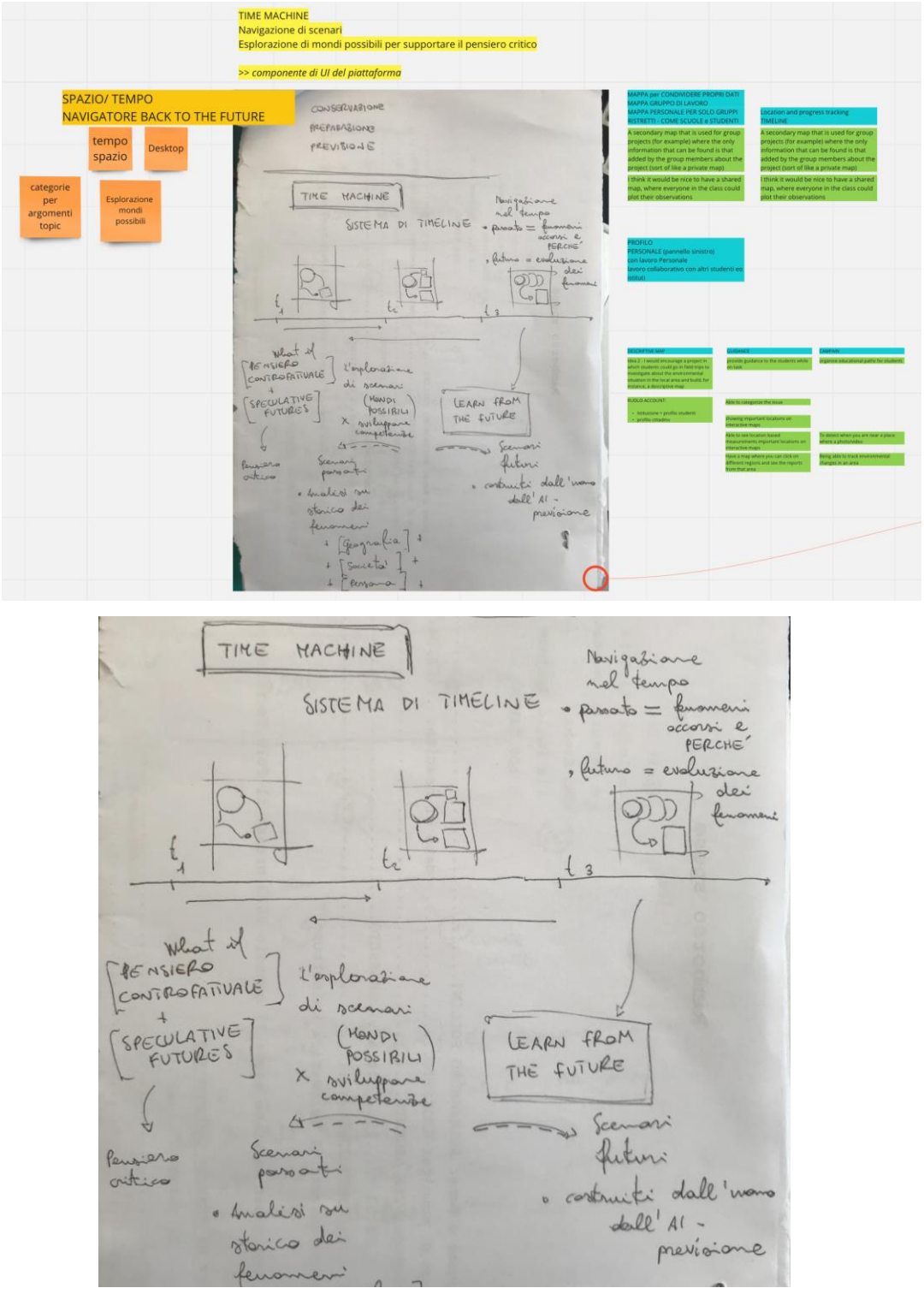

Fig. 3. The TIME MACHINE high level concept as developed by the design team. The overall presentation (above) and a detail of it (below).

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The TIME MACHINE concept has been then further elaborated into the GreenSCENT Explor concept developed for the sustainability education activities presented in Par. 3.1.

2.3 3rd cycle: Youth Design Assemblies (YDAs)

The GreenSCENT Youth Assemblies convened on February 1st and 2nd 2023 for a 3-hour workshop to generate ideas on tools from the GreenSCENT project, all of which are still under development. There were 22 participants in Assemblies 1 and 2, and 20 in Assemblies 3 and 4. Participants were aged between 14-25 and from Italy, Spain, Greece, Finland, Serbia, Romania and Denmark. The assessed tools were:

- The Environmental Monitoring Tool,
- The GreenSCENT Citizen Journalism App,
- and The GreenVerse Immersive Platform

The purpose of the meeting was to develop and present ideas on how to use the apps in an educational setting. Developers from UNINETTUNO attended the brainstorming session and had the opportunity to present the tools and exchange with the Assemblies' members. As the tools are still under development, the participants entered the innovation process in the ideate level, moving forward to a level of starting the prototyping of the ideas.

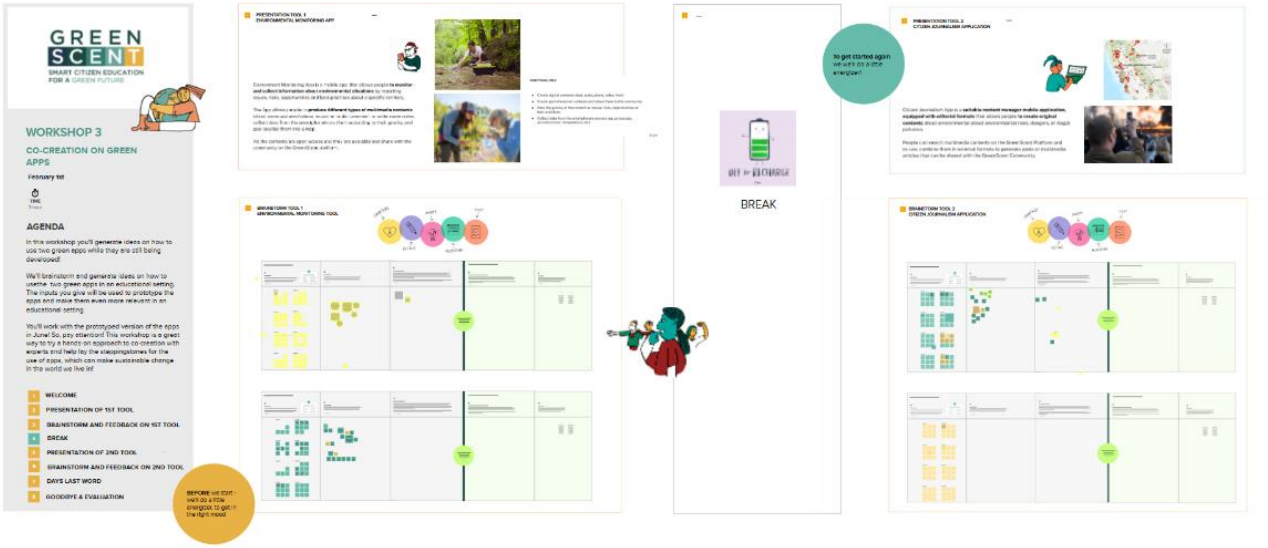

Fig. 4. The visual and online collaboration board used in the Youth Assembly Workshop 3 aimed at the Co-creation on Green Apps. The overall map (above) and a detail of it (below).

Process

The participants were provided with the necessary tools and commenced the brainstorming session by individually engaging in a brainstorming exercise, aimed at generating a maximum number of ideas. After the individual brainstorm, smaller groups brainstormed and clustered their ideas, then worked with detailing and prototyping them into coherent identities. In the end of the brainstorm, the participants pitched their ideas to another group in their assembly and to the developers from UNINETTUNO.

Output

The participants developed more than 100 ideas on how the green apps could be used in an educational setting and more generally; which features the apps could incorporate and other interesting and useful ideas and reflections regarding the use of the apps. The insights and ideas have been collected and described in a report, and have been used in the designing process of the apps.

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06 THE ENVIRONMENTAL MONITORING TOOL CONTINUED

A CLOSED MAP FOR GROUP PROJECTS IN SCHOOL

The environmental monitoring tool should give accessability to work in closed maps, where the only information found in the map is added by the group members in the project.

This could for instance be used if students go to a field trip to meassure different types of pollution or other interesting elements in the sorrounding environment being used in school.

MOBILIZATION OF AFFECTED CITIZENS

The app could have a group chat or a place where a community or town could talk about their envorinmental issues.

The app should advise the citizen to use this feature when they see a problem within their community and share it with other citizens or decisionmakers in that particular town or area. To support the mobilization of citizens they could be a possibility to schedule a meeting whitin the app, in order to discuss the issues at hand.

If the issues isn't achievable to fix by citizens, then take it to a higher level of authority and/or notify decisionmakers.

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09 THE GREENSCENT CITIZEN JOURNALISM APP

With the GreenSCENT citizen journalism platform, users will be able to collect information, monitor and report environmental issues or solutions about a specific area or territory. Below are the participants' ideas on how to use the app:

IDEAS ON HOW TO USE THE APP TO RESEARCH PURPOSES

Publishing new research

- A great way for researchers to publish their work, as well as a good source for university students to consult it in open access
- Useful for educational problems - e.g. if someone works on a paper, they would be able to use the app to get data
- Able to share news articles
- Able to peer review through use of reliable sources
- Would be useful to have a part of the app which automatically analyses data

Risk management of misinformation

- Should be reliable to use in research
- Hard to identify which information is reliable or not - but you could maybe show who is presenting the data
- There should be a fact checking software or moderators to prevent misinformation or uneducated people improperly using the app

IDEAS ON HOW TO USE THE APP IN AN EDUCATIONAL SETTING

Educational approaches

- Using it in class for different subjects, maybe writing an essay, but also understanding different mechanisms in nature
- Thinking exercise: "Why are some environmental topics more popular than others?"
- Encourage students to go out and tell about their experiences with what's happening in their local area
- Teachers could have a feature where they can create a quiz using the information/photos in the app and have the students try to figure out where it is and what happened

Transdisciplinary learning

- Biology/language teacher (or several teachers together, multidisciplinary) can make homework tasks related to the app. For example writing an article about a lake nearby. Teacher could highlight the best articles posted

Supporting education online/remote

- A way for teachers to teach remotely, if conditions such as those during COVID happen again

HOW TO REACH USERS FOR THE APP AND INFLUENCE AS MANY AS POSSIBLE

Go through the trending apps at the moment (e.g. TikTok or Instagram), creating informative videos to promote the app, showcasing its main characteristics in order to catch the general public's attention

The app should be closely related (or at least in accord) with other social media apps, such as Instagram or twitter, so it could reach more people and influence many to also start using the app.

Fig. 5. The output of the Youth Assembly Workshop 3 aimed at the Co-creation on Green Apps.

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2.4 4th cycle: Greenscent design team

The Youth Assemblies outputs have informed the design process since the students' insights have been taken as inspiration for the Greenscent design team creative work. In the 4th cycle, a design concept generation activity was conducted with a focus on summative evaluation. Through a convergent process, the technological drivers, user research, and design research outcomes were intertwined, resulting in a cohesive and meaningful integration of technical specifications, user requirements, and interaction and experience insights.

In several in-person and online creative sessions the team developed the sustainability education EXPLOR interaction design concept described below in detail (see Section 3). The following statements allow to understand the concept:

- *What is an interaction design concept?* An interaction design concept is not only and specifically focused on a product or service, it is rather the integrated product-service solution taking the perspective of all the relevant stages of human interaction with a system, including the social aspects and the role of technology;
- *What is a sustainability education concept?* A sustainability education concept is the solution (in this case provided by GreenSCENT) describing the purposeful education activity aiming at the innovation of a sustainability culture, through the involvement of students, teachers, schools, families, local communities and companies.

The EXPLOR concept is an integrated solution of product, services and interactions coming from the interdisciplinary, participatory and incremental GreenSCENT approach and describes the structure of the educational format, the interactions with technologies and the production of contents towards reaching sustainability education goals and behavioural change.

The EXPLOR concept description is further detailed in the next section.

2.5 5th cycle: Greenscent design team and pilot studies

The 5th cycle of design has been characterised by two field experiments in Romania, at the Royal School of Transylvania, and in Finland, at the Maunula Secondary School and Helsinki School of Mathematics (MAYK), co-design workshops. Both workshops involved GreenSCENT partners' teachers, students and parents in the simulation test of the EXPLOR concept journey, meaning in testing all the interactions, materials and technologies developed so far by the project.

In particular the workshop participants had the opportunity to enter the preliminary journey imagined for teachers, for example in the educational scope phase and in the mission-based learning, and for students, for example in the investigation of the challenge and exploration of the phenomenon.

The aim of this cycle was to carry out a comprehensive and end-to-end simulation of the future GreenSCENT activity including:

- The educational format,
- The effectiveness and recognized value of the current mock-ups,
- The future interactions with technology and services,
- The theoretical framework on competences, qualifications and assessment methods,

The simulative nature of the test has been made necessary since all the project's outputs, including the educational materials, the mockups and the contents, like the educational challenges and the skills' cards.

Under the guidance of ECQA and CSRC, the 'Climate Change' skill card was tested, discussed and finetuned by teachers of Lower Secondary and High School. They provided ECQA and CSRC with valuable insights in the concrete needs of this target group, for example:

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Only 10-14 statements/learning outcomes per area were considered useful and feasible, and the statements should be summarised on a higher level. This is highly important feedback for the GreenSCENT design and exploitation of results. The feedback and input from teachers will be considered to tailor the skill cards and certification process to the needs of schools.

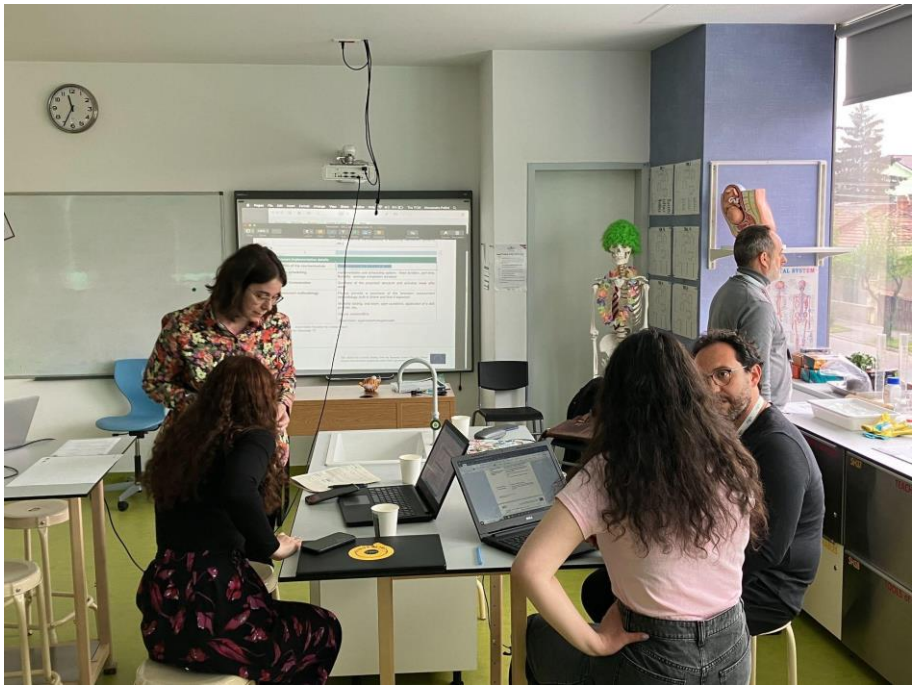

Fig. 6. Teachers are exploring and preparing the theoretical framework on competences, qualifications and assessment methods to use and test with their students during the co-design workshop at the Royal School of Transylvania, Cluj-Napoca, Romania.

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Fig. 7. Teachers are discussing the current mock-ups of the GreenSCENT mobile application during the co-design workshop at the MAYK, Helsinki, Finland.

Fig. 8-9. Students are noting their observations about local environmental issues and developing a storytelling report on those evidences to develop an immersive experience with the GreenVerse immersive tool during the co-design workshop at the Royal School of Transylvania, Cluj-Napoca, Romania.

Fig. 10. Students are conducting on-field activities to collect evidence of environmental phenomena to develop an immersive experience with the GreenVerse immersive tool during the co-design workshop at the MAYK, Helsinki, Finland.

Fig. 11. Students are presenting their immersive experience with the GreenVerse immersive tool during the co-design workshop at the MAYK, Helsinki, Finland.

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3. GreenSCENT Ecosystem

3.1. EXPLOR Design Concept

This concept aims to represent an invitation to become 'explorers' of nature, environment, planet: curious investigators that, while exploring, make the invisible visible and open potential possibilities for understanding, deep investigation and action.

The explorer's metaphor wants to establish a set of services and tools to help approach climate change challenges in ways that

- add layers (rather than subtract),
- enable possibilities (rather than reduce),
- diversify points of views,
- enable a portfolio of strategies & actions to tackle (complex) challenges (rather than single-point solutions).

Moreover this metaphor allows us to ground the sustainability education instructional design upon a map, that would be useful for students to make informed learning paths, as to what seems important to understand and explore first.

The exploration metaphor allows them to create a visual and service ecosystem, an infrastructures, a topography, where people, data, and contents might be navigated throughout space and time. Beyond these, there are, not visible at first glance, relationships between them that determine values and meanings in this specific context.

Through the exploration of the challenge, the learning missions are proposed to kids, teenagers, researchers and educators by means of its physical (and virtual) space.

The service and interaction design concept

Service design in sustainability education is a crucial component of contemporary education systems, aiming to equip educators and students with the knowledge and skills required to address the critical environmental and social challenges facing our world. EXPLOR introduces a comprehensive service structure designed to facilitate the learning journey in sustainability education. This structure begins with clearly defined learning objectives related to sustainability, enabling learners to develop their knowledge, attitudes, and behaviors regarding sustainability issues. It progresses towards the culmination of user-generated content, which involves the creation of reports, podcasts, and videos. This interactive approach fosters the development of creativity, communication, and collaboration skills among learners.

Incorporating service design in sustainability education is a necessary step towards equipping the next generation of leaders with the capacity to address the challenges of sustainability by starting with the learning domain exploration, students can gain an understanding of how sustainability issues cut across different disciplines, industries, and communities. Then EXPLOR fosters challenge-based learning, where learners tackle real-world problems built to facilitate critical thinking and problem-solving skills. Two core activities of the model are proposed based on the challenge: the in-depth exploratory study, that allows the dive-in immersion into the subject, and the on-field exploration, that enables students to observe and learn from real-world evidence. The on-field activities bring the learners into the natural environment they are investigating and support their understanding of the proposed phenomena. Moreover, there are conceptual connections among contents that can be further addressed with the direct experience of climate change related events.

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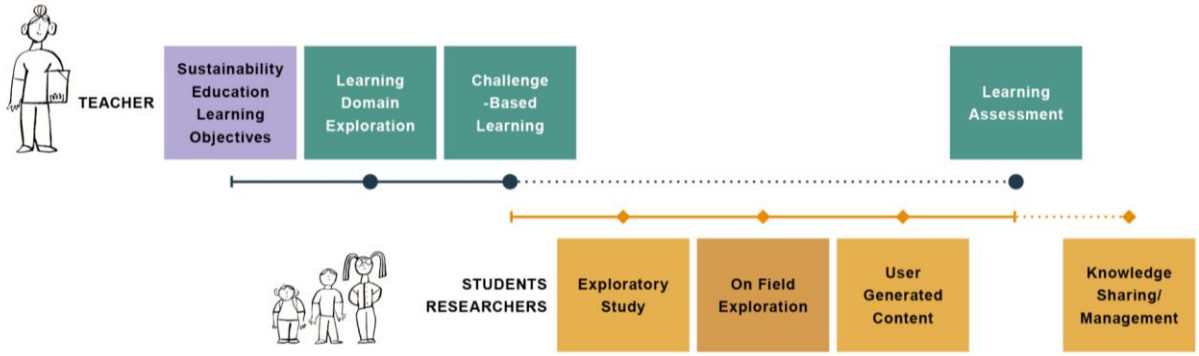

Fig. 6 Representation of the steps of the EXPLOR learning journey

In the following figure the system supporting the EXPLOR journey is shown. In particular:

- The GreenSCENT Knowledge Graph, aiming to support the Sustainability Education learning objectives investigation;
- The Responsive Web Platform, aiming to support the design and the authoring of the mission based learning as well as the students' investigation of the phenomenon;
- The Toolkit for supporting the teachers' preparatory activity;
- The GreenVerse Interactive Platform, for edit, visualise, generate and share sustainability interactive documentaries;
- The Mobile App, for collecting data and evidences from the field, enriching user contents and sharing the collections;
- The CommonPlace Book, embedding personal diaries and storytelling functionalities; and the scientific publication that might be thought as an outcome of the learning activities, with a different format than the documentary.

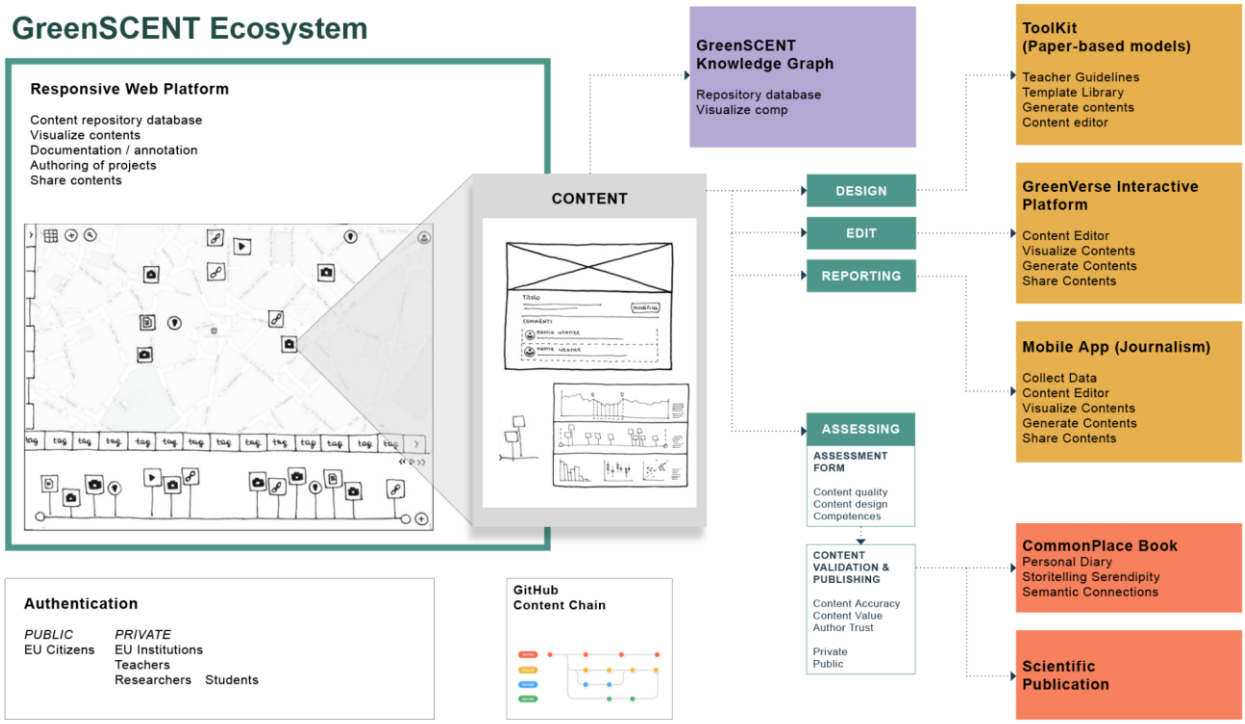

Fig. 7 The diagram showing the logical connections between system's components and phases of activity.

3.1.1. Ecosystem model

GreenSCENT develops an ecosystem of technologies that work together to deliver a sustainability education environment accessible and adaptable to different socio-cultural contents and user requirements. The

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GreenSCENT concept aims to confer to teachers, students and European citizens adequate tools and learning experiences capable of covering all aspects of sustainable education through different digital tools and services. The GreenSCENT ecosystem consists of a series of different technologies that are:

Responsive web platform: it is the main tool that stores and collects all the multimedia content generated by the users for their educational purposes. The system presents a geographical and timeline interface that allows users to explore and visualise specific content related to environmental issues or best practice in particular temporal and spatial circumstances. All users not only can get information about those resources but also can generate their own material that can be shared on the system with the GreenSCENT community. The web platform also acts as a hub for institutions in which teachers can create an educational space for their students to explore sustainable topics, provide information for their training and respond to educational challenges by producing multimedia resources through the use of the other GreenSCENT technologies.

Immersive environment: is an authoring digital tool that enables users to generate 360° immersive and interactive scenarios where it is possible to integrate multimedia content – generated through the mobile application – to create original informative and engaging educational experiences related to sustainability education.

Knowledge graph: It is a database that collects all the sustainable competence that are required by the European Citizen to tackle environmental issues. All the competences focus on the eight areas of the European Green Deal. All the competences are identified under Knowledge, Skills, Attitudes statements and related to the European Qualification Framework (EQF) levels. The competences are illustrated through a semantic network that represents the relationship between them based on their affinity. The knowledge graph supports the digital platform by providing information that can be used by users to train themselves on a particular area of the Green Deal. The Knowledge graph also can be used by teachers to understand which level of competence can be appropriate to students who are tackling a particular educational challenge.

GreenSCENT Mobile App: it is a mobile application that enables users to report and collect multimedia evidence about environmental issues or best practices they might encounter in their real-life local contexts. The reporting system can be used also for groups of students to collect data for their educational purposes.

Guidelines toolkit: it is a toolkit that can support teachers on delivering sustainable education to students by using the GreenSCENT tools. The toolkit provides teachers with guidelines on how to conduct particular learning challenges or programs with their study. Moreover, the toolkit is able to deliver analogue tools and templates to conduct sustainability education in scenarios with resource limitations, i.e. when it is not possible to utilise the digital tools due to the lack of technological, infrastructural or human rescuers.

GreenSCENT AR Air Quality Mobile App: is a mobile application tool that supports the learning experience of Air Quality concepts, using storytelling and gamification elements the students will discover different lessons and assess their knowledge in a fun and easy way, using tools like Augmented Reality to learn about the Air Quality maps in an immersive form. The lessons in the App cover a range of important concepts related to air pollution. Starting from the fundamental understanding of what air pollution is and the composition of air, the lessons delve into its detrimental effects on health. Students will also learn about the everyday habits that contribute to air pollution and how it can be measured. Additionally, the curriculum empowers students to develop skills in reading maps, enabling them to take action to minimize their exposure to air pollution. Furthermore, students will gain insights into their role as responsible citizens in decision-making processes aimed at safeguarding the quality of the air we breathe. The app will be focused on Android to ensure accessibility for schools that may lack resources but will also be available with some small differences for apple users.

GreenSCENT CleanAir App is a simple intuitive mobile application that aims to facilitate working with students on the CleanAir initiative. The app will be available both for Android and IOS for mobiles and tablets. With an initial web interface, the school tutor will design together with students the locations where air quality measurements will take place. Then, the app will facilitate the deployment and collection of the air quality passive sensors. The app will allow students to take pictures of each location and it will automatically store the GPS location and specific time when the sensors were deployed/collected.

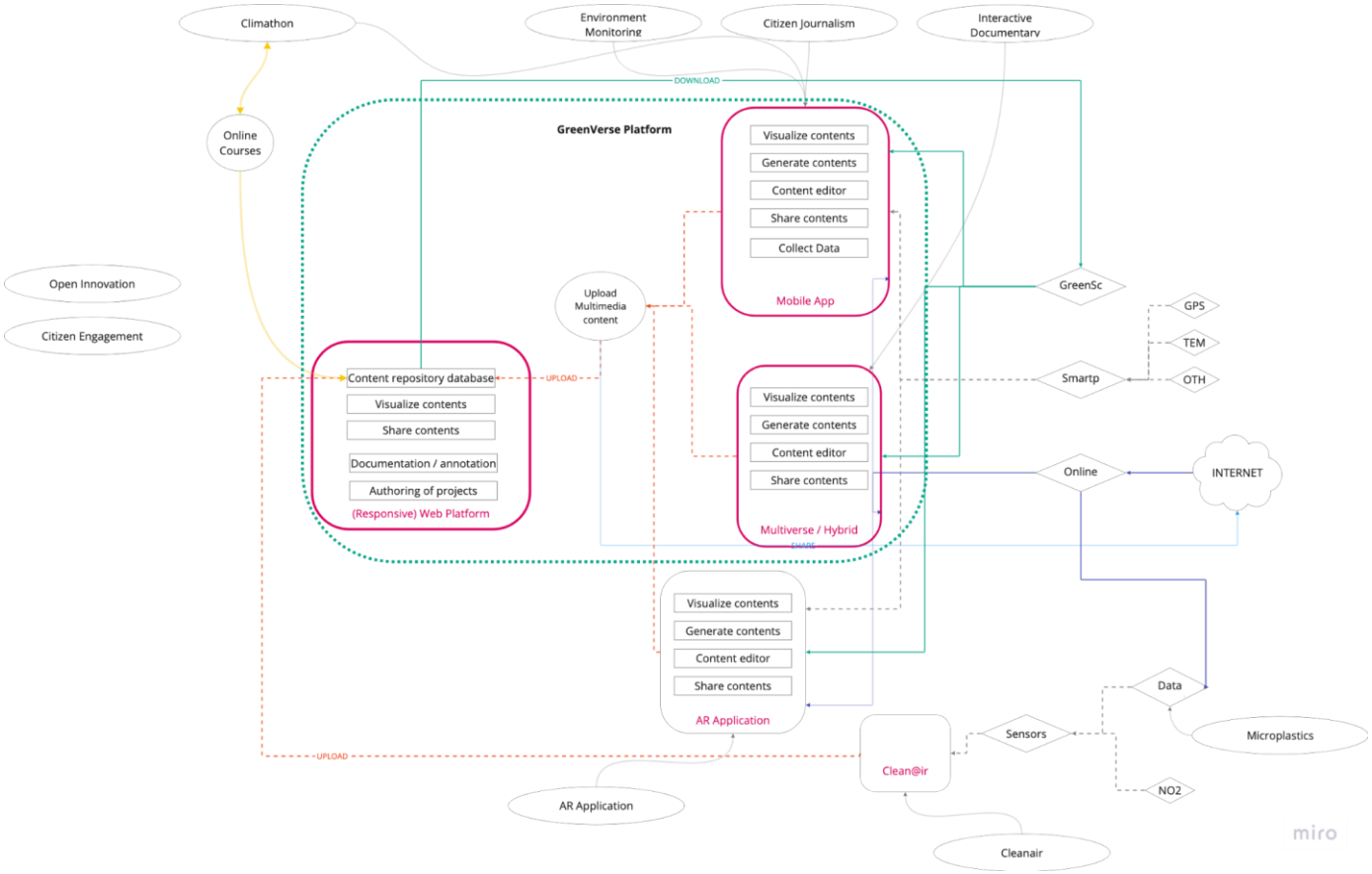

Fig. 7 The GreenSCENT Ecosystem of technologies

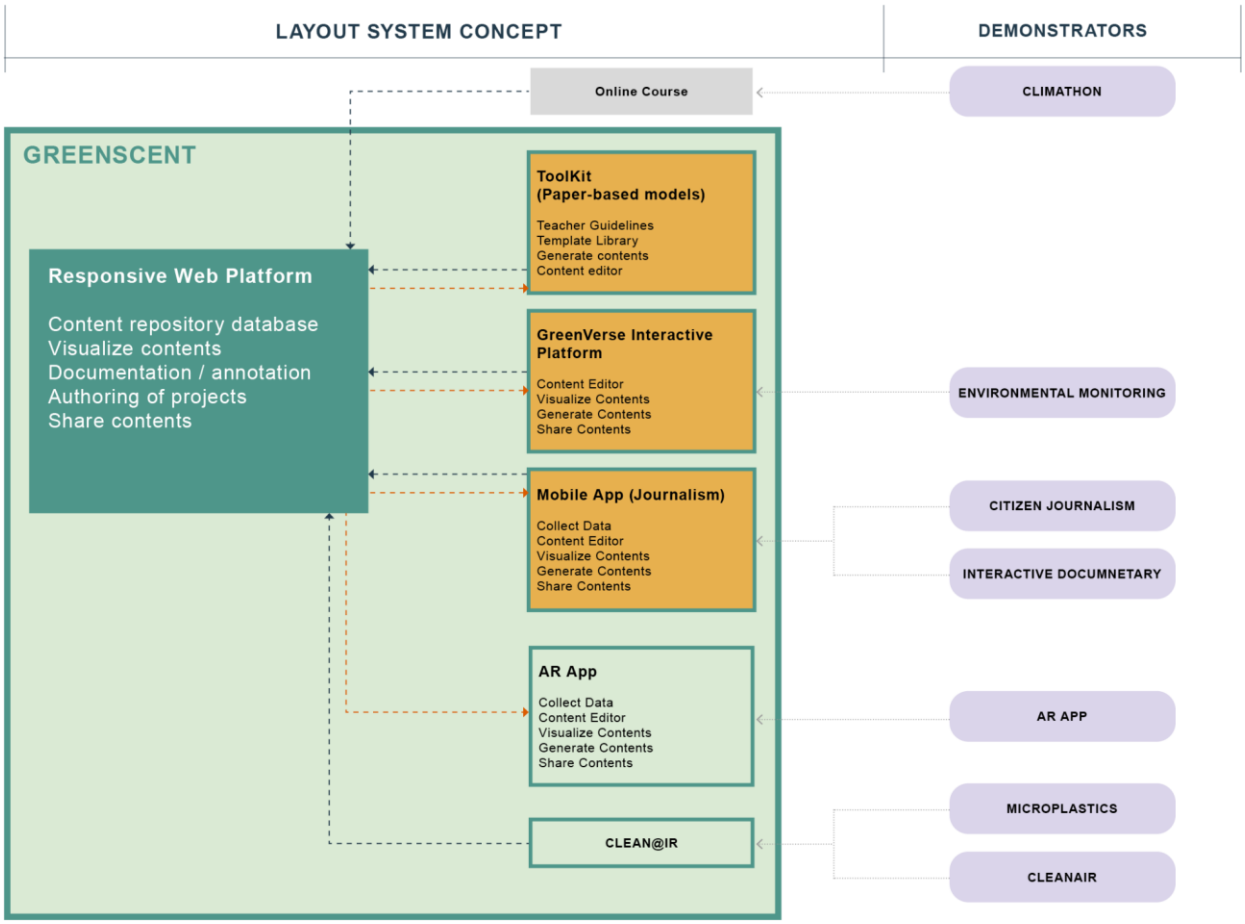

Fig. 8 The detail of the Greenverse ecosystem

3.1.2. EXPLOR Digital Sustainability Validation (Know-Cure Method)

Digital transformation and environmental issues are phenomena that are bringing about significant changes in the contemporary context, posing new ethical problems and questioning previously established and consolidated approaches and choices for dealing with life.

Starting from those who study the processes of experiencing digital devices, the role of data within a design process is investigated in GreenSCENT to understand how awareness of environmental issues can increase. This is the starting point of the project that is committed to exploring how companies can align their efforts to provide digital services that support a sustainable economy. In this context the EXPLOR concept will be critically discussed, evolved and validated through the application of a brand new method, the Know-Cure[1], a digital sustainability validation method developed as a component of the Ethical Compass[2]. Know-Cure is a design workshop method aimed at exploring the design for digital from several ethical points of view, to highlight even the most hidden and insidious parts for a designer, useful to guide design and development choices.

The method is therefore intended to support the inclusion of a new section, the digital sustainability, with a collaborative, integrable and open framework, adaptable to all collaborative design solutions and guided by a series of sustainability tips for digital, which will be used by teams to recognise the supply chain of their service and achieve their objectives.

[1] Terenzi, A. (2023) know-cure: un kit di orientamento per la sostenibilità digitale. MA Thesis in Interaction and Experience Design. University of the Republic of San Marino.

[2] Tangible Ethical compass, retrieved at the URL: https://tangible.is/en/ethicalcompass

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The future steps of the research will encompass the adoption of the Know-Cure method to validate and broaden the scope of EXPLOR. At the same time further co-design workshops in Romania and Finland will allow the researchers to experiment interactive prototypes and demonstrators in interaction design experiments.

4. GreenVerse Design

4.1. Objectives

Through the use of 360 video technologies, the GreenSCENT platform will allow teachers and educational designers to create 360 video experiences on which students can contribute by creating contents that will enrich the 360° scenarios proposed, and which will then be reusable and further enriched by other users, students, educational institutions.

4.2. Requirements and scenarios

We experimented with co-design activities proposing a referential future scenario in which the GreenVerse is expected to be utilised during a learning experience based on educational challenges related to environmental sustainability. The scenario is the following:

"Martin, who is a passionate middle-aged high-school teacher and environmental enthusiast, learns about GreenSCENT. When he was young, Martin loved film-making. He dreamed of becoming a famous director producing engaging movies able to convey positive social messages. This passion may be why, when he learns about GreenSCENT, Martin decides to experiment with an interactive movie post-production tool that GreenSCENT partners provide free to use.
Martin downloads from the GreenSCENT website a concise user-manual of the tool and begins experimenting with it. He finds the software to be rich in features and easy to use, especially powerful when used to enrich and connect 360° panoramic video fragments.
Martin knows he can use a 360° inexpensive video camera that the high-school where he works recently bought. He then decides to organise an educational visit to a waste management plant. He asks the plant manager permission - for him and his students - to record some operations, and upon receiving consent, Martin and his class, go to the plant for a one day visit and shooting session.
Martin places and activates the 360° camera in a few selected plant locations to record the main process steps. While the plant manager explains the process, his students listen and record explanations while taking pictures, short videos, and notes. All students can do that by using their smartphones, equipped with the GreenSCENT content collection app.
When back in class, Martin uploads the 360° panoramic recordings on the GreenSCENT platform. Then he and his students begin to use the immersive interactive documentary authoring tool. They start working cooperatively to link the immersive clips in a virtual tour. They enrich every clip with additional interactive elements coming from the recordings they made that very day. Martin and his students preview the resulting interactive documentary and find it engaging and useful. They add other content from the GreenSCENT platform to further improve it".

4.3. Interaction and interface design

The guidelines presented in this document focus on managing multimedia content related to green deal topics. These guidelines serve as the foundation for defining a preliminary prototype of the GreenVERSE platform. The platform is composed by three main components:

- The Content Management System (CMS),
- the Interactive Documentary tool,
- Citizen Journalism tool.

The "Content Management System (CMS)" is not an official prototype required by the project but it is the mandatory core of all the other tools. It provides a user-friendly interface, enabling content creators and editors to easily store, manage and publish multimedia pieces of content that can be used by the official prototypes required by the project. Advanced features include categorization, the ability to formulate complex semantic searches by merging keywords and tags, sorting by topics, author, location, and more, as well as the capability to update semantic metadata.

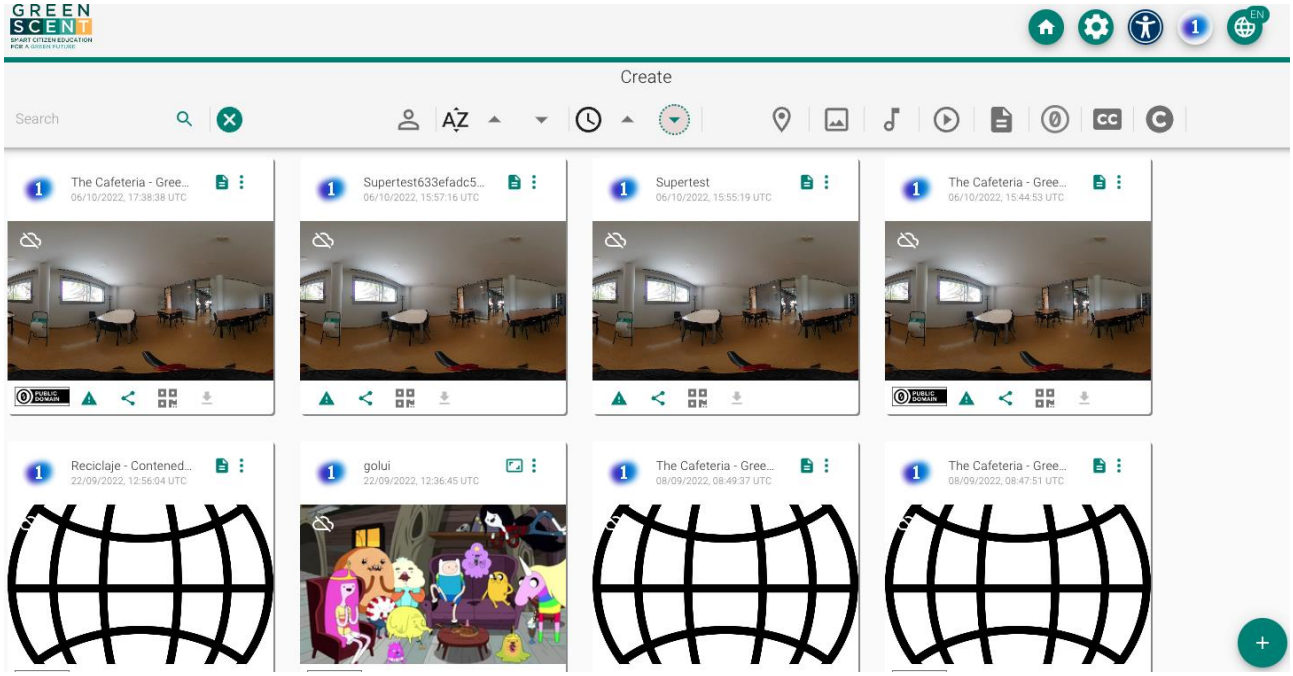

Fig. 9 Prototype of the interface of the CMS

The "Interactive Documentary" tool prototype offers a seamless and intuitive interface, allowing authors to create immersive experiences based on 360 pictures/videos without requiring specific technical expertise. It encompasses a robust set of features, including rich text editing, multimedia embedding, and integration of interactive elements. The interface is designed with a responsive layout, ensuring optimal usability across various devices and screen sizes. By utilising this authoring tool, content creators can streamline their workflows, enhance content quality, and deliver engaging and compelling digital experiences.

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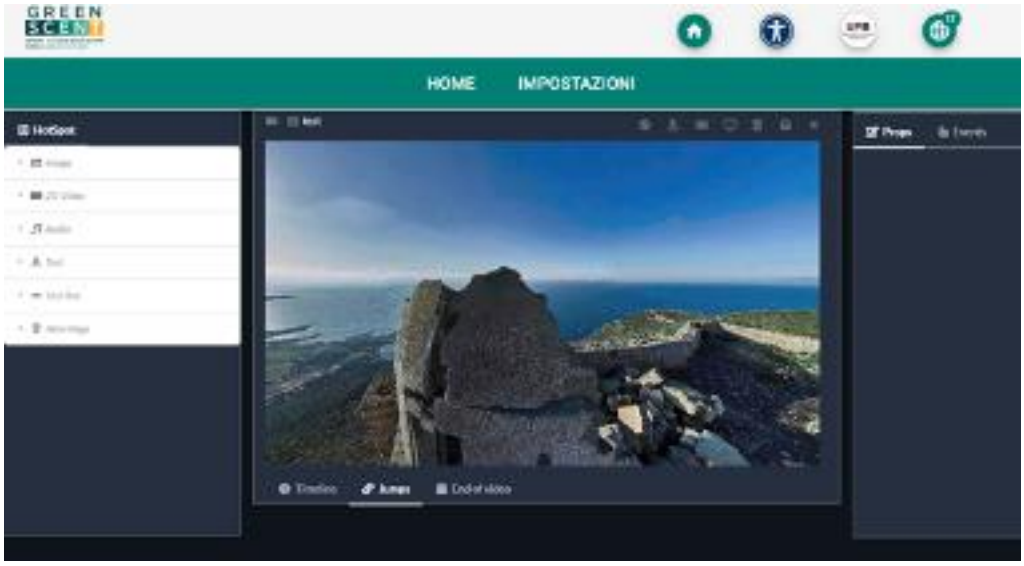

Fig. 10 Initial interface of the Interactive Documentary tool

The "Citizen Journalism" tool prototype enables the creation of reports on specific environmental issues. This prototype also provides a user-friendly interface, facilitating the reporting and tracking of issues throughout their lifecycle. Users can create detailed issue tickets, including comprehensive descriptions, severity levels, photos or videos illustrating the problem, and associated geographical coordinates. Once a report is created, it becomes immediately visible to the domain admin for further processing. The prototype incorporates a dedicated lifecycle for handling report state transitions, comprising four statuses: to be approved, approved, rejected, and solved.
Furthermore, it is worth noting that environmental reports can also be generated using the mobile app available on both iOS and Android. This mobile app is another specific prototype named "Environmental Monitoring" and it is described in the next chapter of the present document. Anyway the mobile app extends the capabilities of the Citizen Journalism prototype, empowering users to conveniently produce reports on-the-go.

4.4. Prototyping and early testing

In order to ensure the effectiveness and usability of the GreenVERSE platform, we are conducting early testing throughout the development process. The early testing phase will involve the Content Management System (CMS) prototype, the Interactive Documentary prototype, and the Citizen Journalism prototype.
Feedback gathered from the early testing phase will be useful to refine and enhance the prototypes. It will help us identify any usability issues, fine-tune the user interface, and address any technical challenges. By incorporating feedback, we can ensure that the final version of the GreenVERSE platform meets the needs and expectations of its intended users.
Through early testing, we aim to create a robust and user-centric platform that effectively addresses the content management, interactive storytelling, and citizen journalism needs of our target audience

5. GreenSCENT Mobile App

5.1. Objectives

The GreenSCENT mobile app aims at catering to environmental issue tracking. Its primary objective is to empower individuals and communities to proactively monitor and address environmental concerns. Through the mobile app, users can generate detailed issue reports, encompassing a comprehensive description of the problem, severity level, and relevant multimedia such as photos or videos for visual evidence. Leveraging GPS

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technology, the app automatically captures and associates geographical coordinates with each report, facilitating precise location tracking.

5.2. Requirements and scenarios

Mobile app requirements and future scenarios have been investigated during the Youth Assemblies in February 2023. The method and the outputs have been described in Section 2.3. In this paragraph the description of user requirements and scenarios is provided through the excerpts of the YA report posted below. In particular the following themes have been discussed:

- User requirements, in the form of wishes and requests (see Youth Assemblies Report Screenshot n. 05);
- Future use scenarios, (see Youth Assemblies Report Screenshot n. 06);
- Technology specifications, in the form of possible features (see Youth Assemblies Report Screenshots n. 07 and n. 08).

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05 THE ENVIRONMENTAL MONITORING TOOL

With the environmental monitoring tool, users will be able to reuse their uploaded environmental data and share content that can be used in publication, research, journalism, school and university programmes. Below are the participants' ideas for how to use the app.

IDEAS ON HOW TO USE MAPS AND TRACKING PROGRESS

Maps connected to areas

- The app should have a map where you can click on different regions and see the reports from that area
- The map should show important locations on interactive maps and notify you when you are near a place with a photo/video

Maps based on topics

- Maps should have different layers divided by topics and the definition of each topic. For instance, "roadside flowers", "polluted lakes", "edible plants", etc.
- It would be good to have a definition of each main point (for example, if a map is made about different environmental disasters, it would be good to have the definition available in order to compliment the map and clear up any doubts the students may have)

Maps with an impact

- Users could recommend stores where you can buy sustainable products
- Notify when something good happens in your local area
- Markers on the map of our area with useful facilities such as recycling areas or parks
- The app itself should also promote walking instead of using public/personal transport
- The app should suggest environmental challenges and offer ideas of more sustainable alternatives

IDEAS ON HOW TO USE THE APP IN AN EDUCATIONAL SETTING

Field trips using the app

- Students could go in field trips to investigate the environmental situation in the local area and build, for instance, a descriptive map
- I would be useful to provide some form of cheap air/water pollution testers
- Use the photographic features to collect images of local polluted areas and collect information
- Provide guidance to the students while on task

Progress tracking

- Using the app as a tracking device, taking pictures in the same area where we are taking care of/doing harm to the surroundings, to see how it changes and the effect we have on an area

Competition in school/class

- A "competition" running for one month on who uses the bike more when getting to school and at the end there would be a winner. There would be other "competition" running as well, for those who don't bike to school
- Have students take before and after photos of the challenges that they have been set
- The challenges should be as encouraging as possible to make it fun and interactive
- A quiz, where you can guess what kind of environmental problem is in the picture on the screen

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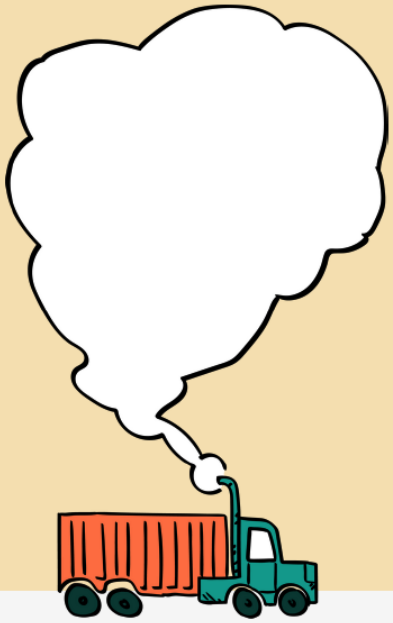
06 THE ENVIRONMENTAL MONITORING TOOL CONTINUED

A CLOSED MAP FOR GROUP PROJECTS IN SCHOOL



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This could for instance be used if students go to a field trip to meassure different types of pollution or other interesting elements in the sorrounding environment being used in school.

MOBILIZATION OF AFFECTED CITIZENS

The app could have a group chat or a place where a community or town could talk about their envorinmental issues.

The app should advise the citizen to use this feature when they see a problem within their community and share it with other citizens or decisionmakers in that particular town or area. To support the mobilization of citizens they could be a possibility to schedule a meeting whitin the app, in order to discuss the issues at hand.

If the issues isn't achievable to fix by citizens, then take it to a higher level of authority and/or notify decisionmakers.

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07 THE ENVIRONMENTAL MONITORING TOOL CONTINUED

IDEAS ON FEATURES TO IMPROVE THE USE OF THE APP

Data collection features

- An educational tab with interesting ecology facts and tips on how to live more sustainably
- Automatic diagrams and charts and a feature to compare data
- Organise the posts by tag (location, type, etc)
- Be able to take pictures and record videos. Use AI paired with camera
- Be able to connect to devices to register measurements
- Be able to compare information of different places

Shared and private apps

- A map where everyone in class could plot their observations
- The app should have the posibility to work in closed map, for instance, when doing a group projects
- An option to see specific disasters/infra-structures, for example a building collap-sing, a lake, a city - and different info about each place such as the PPMs, the temperature, the light pollution, etc.
- Geo-tracking feature that caters to what has happened/is happening in local areas. That way, if we travel, the app can use our location to decide what information to show first

User experience and accessibility

- Lots of colors, graphs, diagrams, all sorts of things (updates from other cities too)
- The app should provide different ways to testing e.g. air or water quality. There should be different options for documentation, hence students or citizens would be able to also test and check up on the data outside of school
- Engaging and interactive design with different media types (photo, text, video, sound)
- Available for different levels from primary school to university students

Gamification

- The app could have some kind of an award system, to motivate use of the app
- Simulate a small garden where you grow vegetables with points from using the app

Resources

- Access to relevant resources on the web
- Able to detect possibly dangerous and harmless species
- Be able to make reports to authorities

THOUGHTS ON INFORMATION RELIABILITY

Reliability of information

- Implement measures to improve data reliability, e.g. ways of doing fact checking
- Task for students: Find mistakes/ misinformation from people's posts, and fix them

Information missing

- There could be somet information which people seem not to be posting (for example about extinction, it's hard to notice). This should somehow be visible in the app

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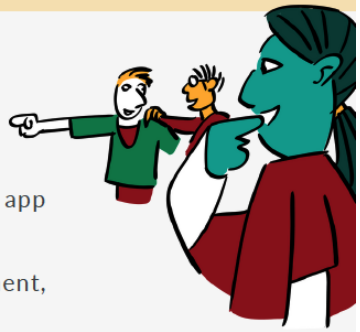
08 THE ENVIRONMENTAL MONITORING TOOL CONTINUED

IDEA: A CALL TO ACTION

- The app should contain a feature to mobilize people locally for recycling events, planting trees, cleaning up streets
- The app can give contact information on people or companies who can regulate a specific area, which the users can contact with collected information on envorinmental issues

USING THE APP IN TEACHING



- Treasure hunt; find this and that and plot it into the app (making the students observe nature)
- When students learn a new word related to the environment, they can learn it by searching for real life examples
- Teacher could divide the class into small groups, and each of them would have their own continent/region to study what kind of environmental issues that are typical for that area
- Use the app to teach how to save energy and avoid waste

5.3. Interaction and interface design

Fig. 11 Welcome page (on the left) and Report creation (on the right) mockup design.

With a focus on user-friendliness, the GreenSCENT mobile application wants to offer an intuitive interface that enables users to effortlessly report and track environmental issues using their mobile devices. In a dedicated section of the app, users can access a list of reports specific to the selected domain. It also allows them to filter the reports by type. Each row in the list presents key details of the issue, such as the creation date, the distance from the current position to reach the report, and an avatar that identifies the owner. Clicking on a row provides users with access to a dedicated page displaying comprehensive information about the report, including the title, description, severity level (low, medium, high), selected hashtags, and more. The page also offers the functionality to access Google Maps to obtain directions to the reported issue's location, along with a forum for discussion where users can engage in conversation through posted messages.

Fig. 12 Viewing reports in list mode (on the left), Viewing reports in list mode (in the middle), and Viewing reports detail (on the right) mockup design.

5.4. Prototyping and early testing

To manage the lifecycle of the reports, the prototype incorporates a dedicated framework. Users can access a specific page accessible only to logged-in users, listing the issues they are currently managing and allowing them to handle report state transitions.

The issue lifecycle adopted for managing environmental issues (*refer to Figure 1*) consists of four statuses: **to be approved**, **approved**, **rejected**, and **solved.**

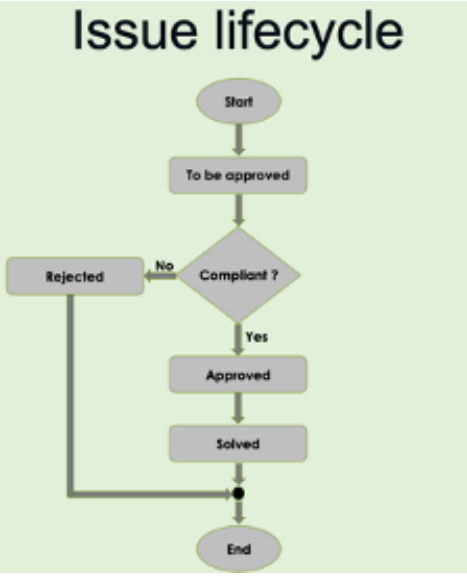


Table. 13. Environmental Issue Lifecycle

Transitioning between states is defined in *Table 1*, indicating which initial state can move to which other state and who can perform the transition (owner and/or domain admin).

Current State	New State	Who can do it
	To be approved	Any registered user (via Mobile APP or SCENT Web Platform)
To be approved	**Approved**	Doman admin
To be approved	**Rejected**	Doman admin
Approved	**Solved**	User who reported the problem or institution admin

Table. 2 Environmental reports transition state

Overall, this prototype of the mobile app for environmental issue tracking empowers individuals to actively participate in environmental stewardship. By providing a user-friendly interface, robust features for issue reporting and tracking, and fostering community engagement, the app prototype aims to facilitate collective action, raise awareness, and contribute to building a more sustainable and environmentally conscious society.

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To ensure the effectiveness and usability of the environmental monitoring mobile app prototype, we will conduct comprehensive preliminary tests throughout the development process. The feedback collected during the testing phase plays a crucial role as it will be possible to identify usability and performance problems and to identify possible areas for improvement.

Such feedback will allow us to improve the user experience, address any identified weaknesses and ensure that the final version of the app is user-friendly, reliable and effective in enabling people and communities to actively participate in monitoring environmental issues.

6. GreenSCENT AR Mobile App

6.1. Objectives

The main objective is to create a tool that supports the learning experience of Air Quality concepts, that can be used at any point of the school year, where students are able to explore the basic concepts of Air Quality, using Augmented Reality as a tool to engage and explore Air Quality information in a more interactive way.

We are firm believers that human centred design should involve users from the first stages of the conceptualization of the digital product, in this case the AR app. This way we can iterate and create something that adjusts to the needs and challenges the students current experience, as well as getting to know their context to propose additional support materials so the application can have the best reception by the students, but also by their teachers, parents, etc.

The main topics that will be covered will be:

- The concept of air quality
- The difference between air pollutants and greenhouse gases
- Human habits and their implications on air quality
- Bad air quality and its consequences on health
- Geographical boundaries in air quality
- The concept of Air Quality Index (AQI)
- How to read an air quality map
- Daily actions citizens can do to have better air quality

6.2. Requirements and scenarios

After working on the User Experience Research (UXR) part of the process, we summarised the main findings here:

1. The Air Quality information needs to be explained really well to differentiate concepts, specially greenhouse gases vs air pollutants.

2. The Air Quality Index map gets users attention and is not difficult to explore.

3. Air Quality is not part of the official curriculum, so it can be implemented at any point of the year in the environmental sciences (or related) classes.

4. The principal challenge is to make the invisible visible.

5. The teacher engagement is key for the correct implementation of the use of the App and the learning of Air Quality topics.

6. Students tend to relate cars with bad air quality and health problems related to lungs.

7. Storytelling can be a great way of making the information friendly and relatable.

8. Apps like kahoot work really well implementing quizzes to assess knowledge in the classroom.

Which led us to create the principal requirements:

- Lessons that differentiate the principal topics that will be covered
- Every lesson should have an assessment part to evaluate that the students understood the lesson

- To make the app more accessible, not all the lessons will have an AR element
- To make the app more accessible, it will be designed primarily for Android
- An Air quality portal will be created that will have all the support materials, and link to the other air quality demonstrator so the students will have all the information of the "Air Quality Greenscent universe" in the same place.
- Support materials such as infographics, videos and articles will be created to support teachers in the implementation of the activity with the app

Based on the UXR we created three different Personas to summarise all the findings on the different users, they can be found in the UXR Report

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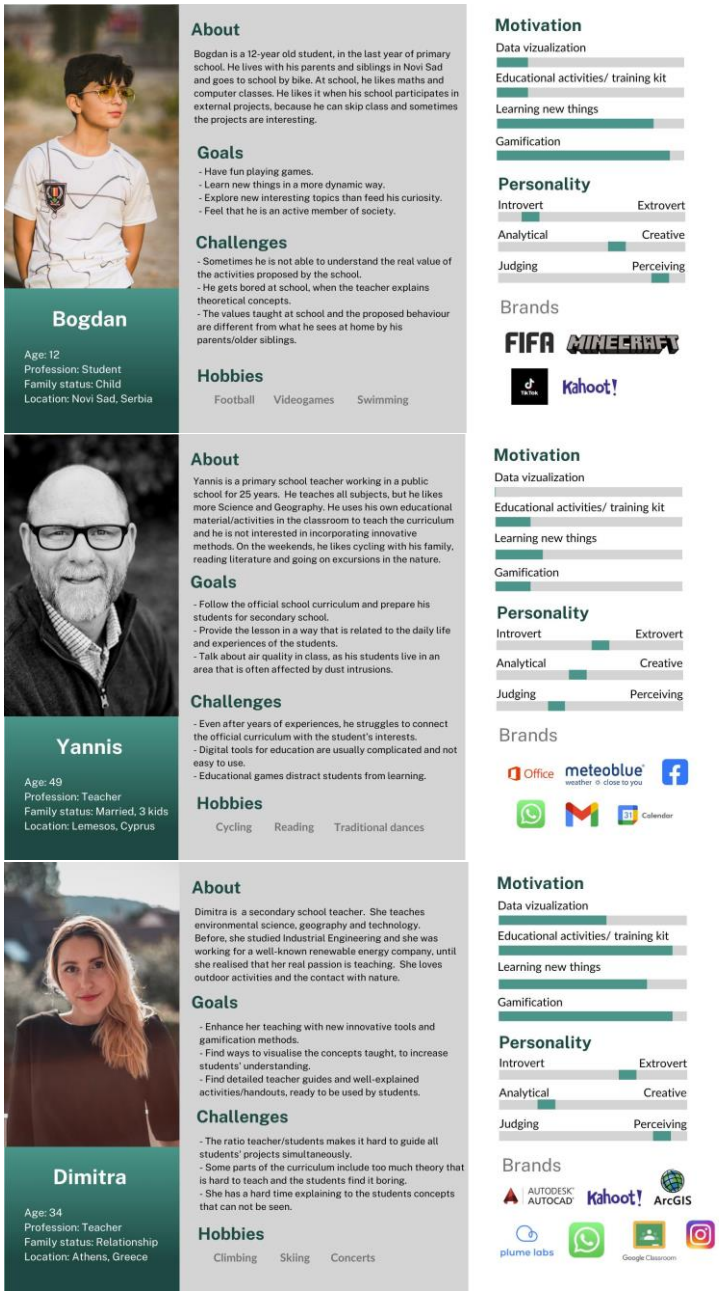

Fig. 14 The three personas developed during the UXR.

6.3. Interaction and interface design

After having the principal findings and users defined we focused on different ideas and sketches for the information architecture. Finally we decided to go with a version where different lessons (regular and Augmented Reality ones could explore all the topics designed for the principal objectives).

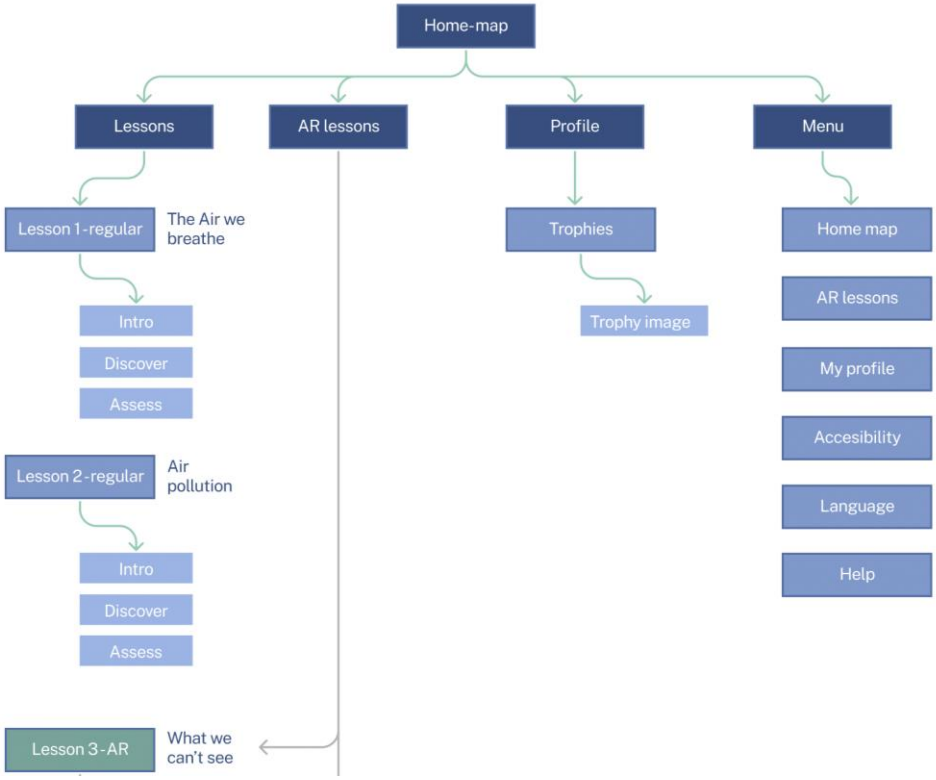

Fig. 15 The Air Quality Mobile App information architecture.

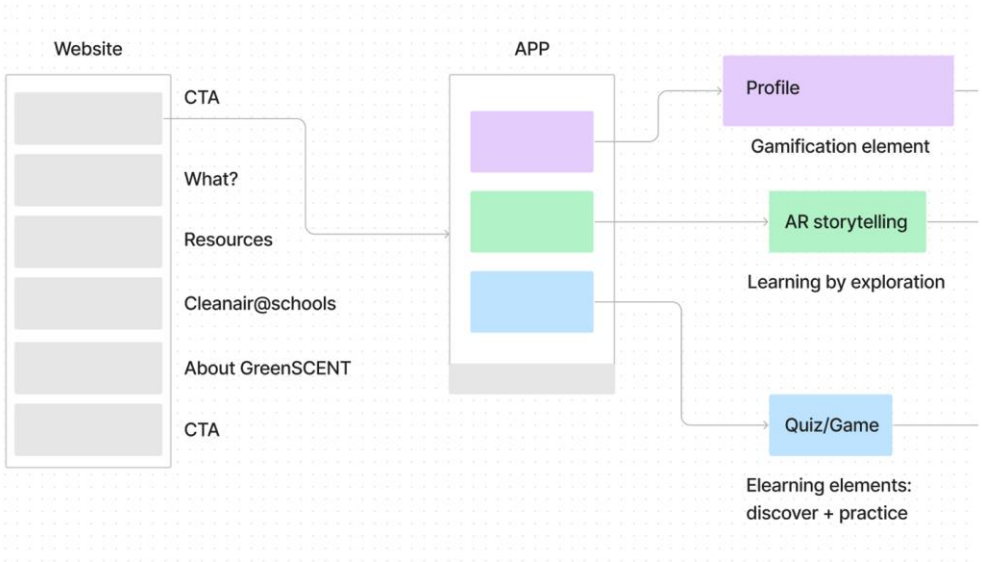

Fig. 16 The Air Quality Mobile App components.

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6.4. Prototyping and early testing

Right now we are finishing the content of the app, the first AR maps and the illustrations that will support the content of each lesson, we've had several iterations in both lines, this is an old example of the city map that the team was exploring:

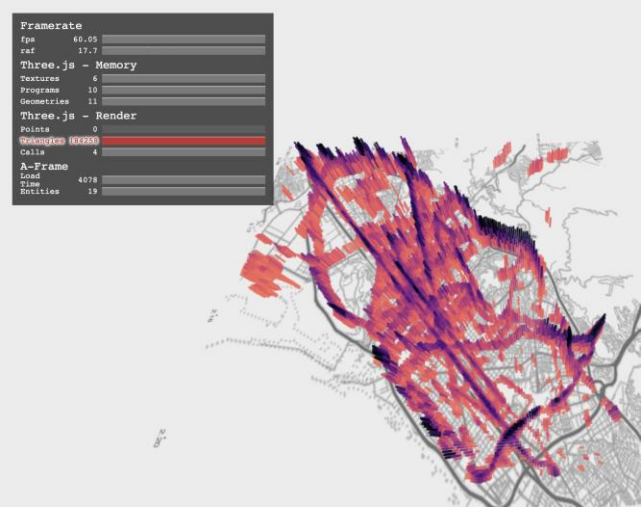

Fig. 17 Tests of the AR maps.

The Lessons and content storyboard can be found here

Lesson	Name	Learning (Discover)	Evaluation (Challenge)	Interaction
1	The air we breathe	Card Slideshow	Multiple choice	Regular
2	Air pollution	Card Slideshow	Multiple choice	Regular
3	What we can't see	Card Slideshow	True or False	AR
4	A matter of habits	Clickable hotspots on img	True or False	Regular
5	Particles all around		Game?	AR
6	Air pollution has no boundaries	Accordeon	True or False	Regular
7	The Air Quality Index	Card Slideshow	Multiple choice	Regular
8	The colours of air quality	3d Image view	True or False	AR
9	Comparing air quality	3d Image comparison (tab)	True or False	AR
10	A risk to our health	Accordeon	True or False	Regular
11	Actions we can take	Card Slideshow		Regular
12	Cleaner air for all	Accordeon	True or False	Regular

Table. 3 The table of Lessons.

Some flows of the prototype are explorable here.

The choice of colours are based on the GreenSCENT colour palette but focused on the blue as the main colour to improve accessibility for people with colorblind vision problems. The character that appears in a lot of the screens will be explained in detail in the support materials, we want to make use of storytelling so the users find the app friendly and can empathise more with the contents and activities.

Fig. 18 UI design of the Air Quality mobile application.

The high fidelity prototype was explored in the first Youth Design Assemblies and got a really great response. We validated the proposal for rewards after each lesson. We found out that students that might be out of the scope of the age range are also interested and would love to have access to more advanced resources.

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There were some request that are out of the scope of the app, but still very interesting like:

- AR: playing with scenarios and boundaries, for example an empty landscape and adding modules to see how the air quality changes and may be improved
- The app could contain a Pokemon Go type of game but instead of visiting poke-stops one is visiting good air or/and bad air quality regions and areas
- Geoguessr type of game where 2 or more people try to guess what the biggest source of pollution is in that region
- A competition-style game mode where one gains points for taking walks or visiting areas with good air quality. The game can have leaderboards together with classmates, friends or family.
- Levels of knowledge depending on age

Some of the activities were focused on proposing ideas where the app could be used for or supported from and we will definitely take those comments into account, in the website we could offer different ideas on ways to approach the use of the app in the classroom.

7. GreenSCENT CleanAir App

7.1. Objectives

CleanAir app is a simple intuitive mobile application that aims to facilitate working with students on the CleanAir initiative. The app will be available both for Android and IOS for mobiles and tablets. With an initial web interface, the school tutor will design together with students the locations where air quality measurements will take place. Then, the app will facilitate the deployment and collection of the air quality passive sensors. The app will allow students to take pictures of each location and it will automatically store the GPS location and specific time when the sensors were deployed/collected.

7.2. Requirements and scenarios

During the User Experience testing in Girona (2022) and the online Youth Assemblies (2023), the requirements for the GreenSCENT Clean Air App (including the initial web interface) were defined.

Testing in Girona was carried out with 12 schools including more than 150 students. The activity aimed to carry out CleanAir@Schools activity to test some aspects of the demonstration: engagement with schools, handling of sensors, initial information about air pollution, data collection and usage of an expert app. For the web interface, 4sfera's team engaged with teachers via excel files to share the information and location where the sensors were to be deployed. For the App, in particular all schools attempted to use 4sfera's expert App to test the usability.

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Fig. 19 Manual data collection (left) versus App testing (right).

During the Youth Assembliers (May 2023) over 2 days, 56 (38 participated in an online workshop on May 3. and 4). After some initial presentations on air quality, the participants were asked to simulate CAS activity. Using 4sfera's expert app the participants simulated the deployment and collection of tubes. In group work one, the participants provided feedback on questions regarding:

1. Their experience of the exercise,
2. The usability of the app,
3. The presentation on air pollution.

Feedback on the expert App, which was used to set up the requirements for the new simplified app:

- Easy and accessible. Good that there was both IOS and Android
- Initially confusing but ended up fine
- Improvement of the app
    - Improve looks
    - Make it more attractive
    - Add pictures/icons
    - Some users felt it was basic and would add more
- Keep/new features:
    - Allow user to manually add code (without having to always scan)
    - Allow sharing of the images taken
    - Add instruction tab, link to instructions pdf, link to activity presentation (include video)
    - Links to air quality information/monitoring data/world map with data…
    - See the results after exercise

The above feedback together with features to perform CAS activity has set up the requirements below. For the web interface:

- Very simple and easy to use (as if you had a paper map and put thumbtacks on it).
- Simple map
- Provide the list of points so that the teacher/tutor can simply move the markers on the map and can add a small description
- Information to be stored in a back-end linked to CleanAir App
- Possibility to visualise the results (NO2 concentrations) (if possible)

The requirements GS CA App are:

- Very simple (3 clicks concept) and easy to use (no training).
- No internet connexion during the activity
- Should work on ipad/tablet.
- Re-use known icons from https://fonts.google.com/icons?icon.platform=web, for example.

7.3. Interaction and interface design

As part of the User Experience testing in Girona (2022) and Youth Assemblies (2023), we asked teachers and students to use 4sfera's expert app, Passive Sampler, to test usability and explore possible requirements for the new development. The new app is to be developed using the basis of the Passive Sampler app but adapting it to be used by the educational community, making it simpler and easier to use without a previous knowledge of air quality.

From the outputs listed in point 7.2 of this document, it was decided to develop a completely new mobile application but also a web interface where the teachers and students could work on the planning of the distribution of measurement locations around the school. The new mobile app will take the requirements already listed above. The interaction/interface design are sketched below:

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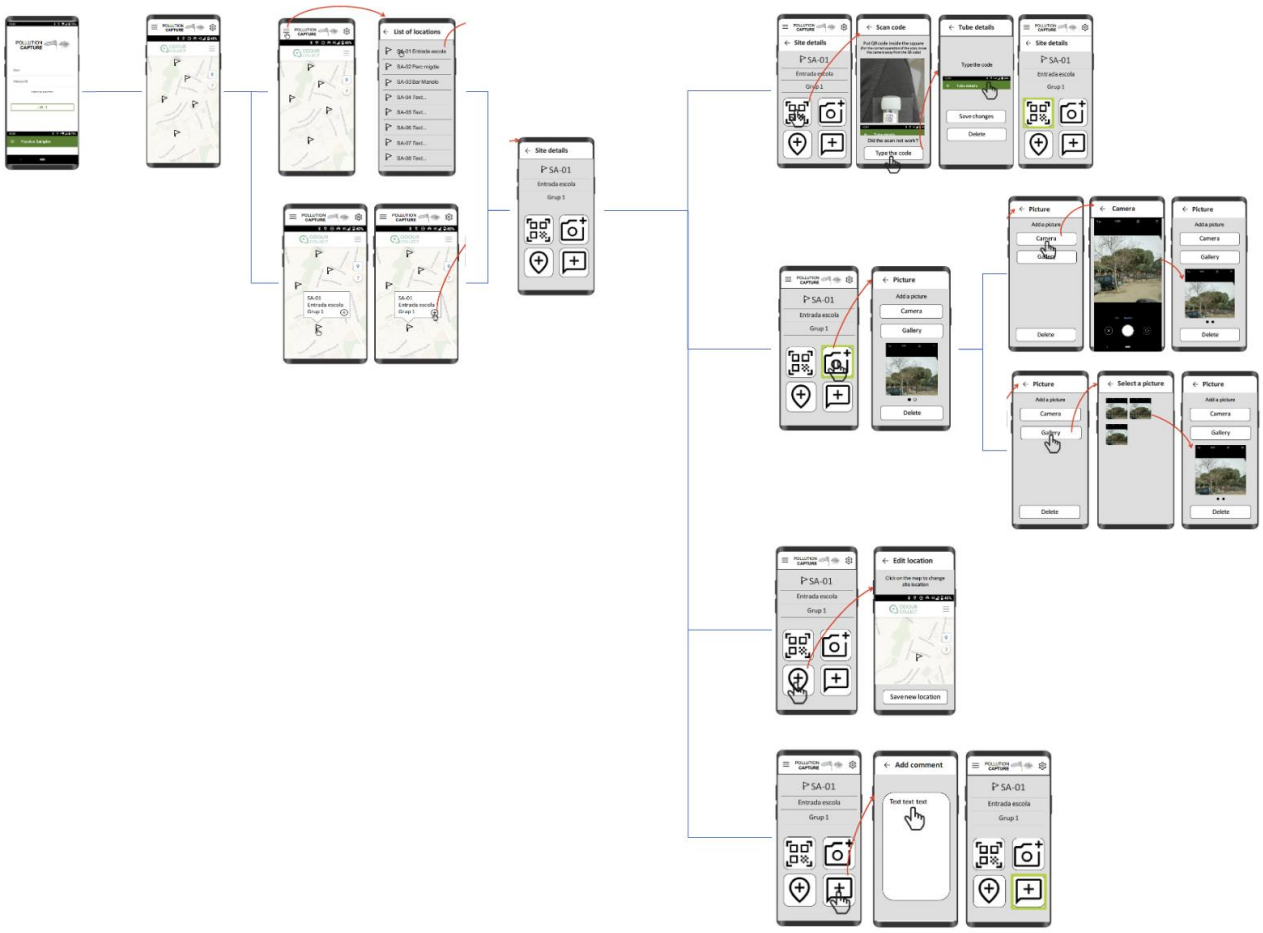

Fig. 20 The CleanAir Mobile App information architecture.

7.4. Prototyping and early testing

The web interface's main feature will be a map where teachers and students can plan the fieldwork. After a login page, the user will find a page with a map. The teacher with the students will drag the pin into the map, deciding where the samplers will be placed.

During the process of location selection, the user should be able to group the locations, name the group and colour each location of the group with the same colour.

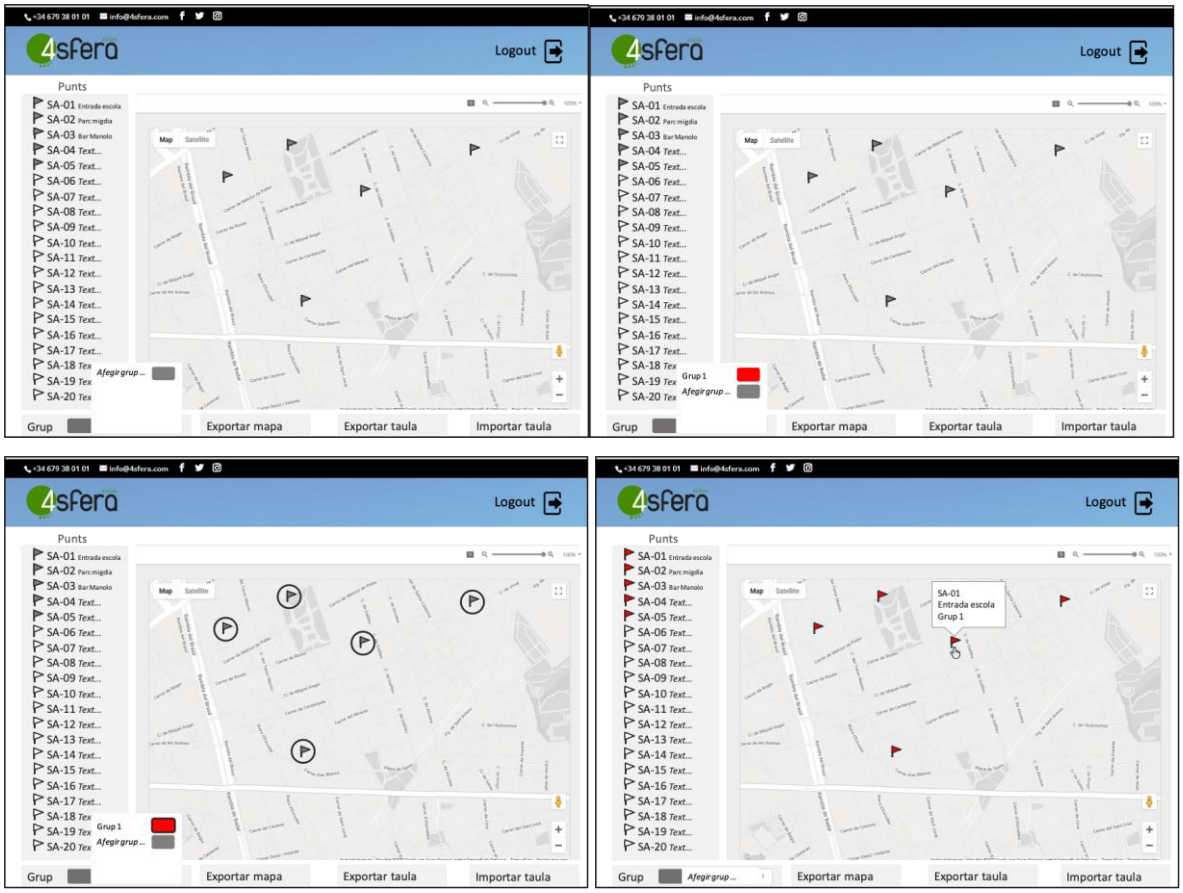

Fig. 21 The CleanAir UI design.

After placing all the pins, the user should be able to export the map and the table with all the information.

The **GS CAS mobile app** will be fed from the plan designed in the interface by the teacher and students.

The design and colours will be based on the GreenSCENT colours.

The purpose of the application is to save the field work information: list of locations where the samplers will be placed, date and time of deployment/collection and the GPS location (latitude/longitude) when the samplers are placed. Moreover, it will allow the user to take pictures of the location and add comments.

Below is a summary of the main screens that the app will contain.

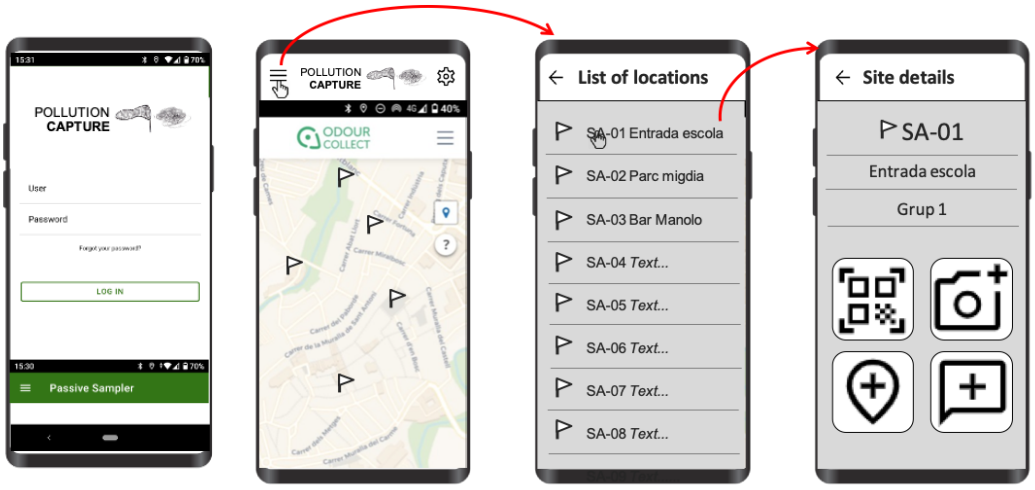

Fig. 21 The CleanAir wireframes.

The navigation to each location will be done via a map or via a list of locations. The list will include all location names with site ID and site name. Clicking on a location will take the user to the details of the location.

From the map (home page), the user will obtain information from all locations by, clicking on a pin (via a popup), By clicking on the popup, the user will go to the site details page. All information about the site should appear on this page. Also, the site details page should have 4 buttons to perform these actions:

- scan the QR code,
- take a photo,
- change the location and/or
- add a comment.

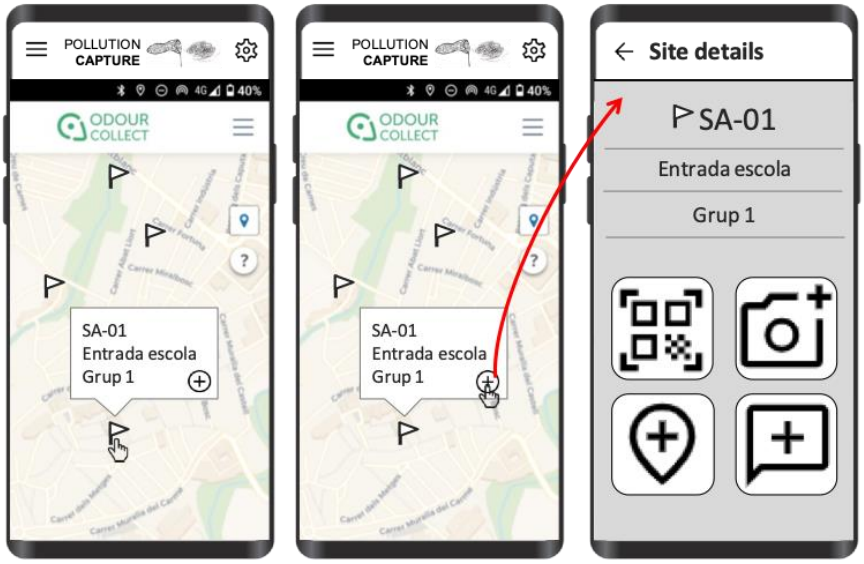

Fig. 22 The CleanAir wireframes and site details.

From the site details page, by clicking the scan icon, the user should access the scan code page. In this page the user **scans the QR code** of the tube sticker. If the scan does not work or detects a number that is not correct, the user should be able to edit the number by typing it manually. Once the QR code has been entered correctly, the user should be able to go back to the site details page .

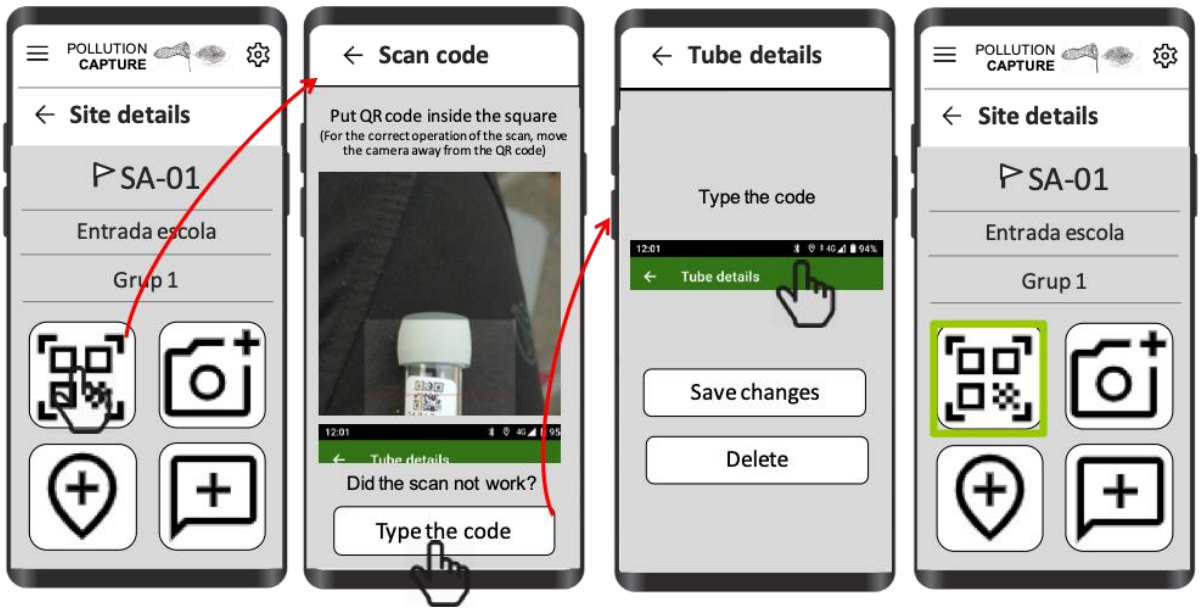

Fig. 23 The CleanAir wireframes, tube and site details.

Beyond scanning the QR code to save the location metadata, the "site details" screen will allow other functions that are explained below: **Take pictures of the location**. This will be done by taking a picture or by uploading a picture of the phone's gallery.

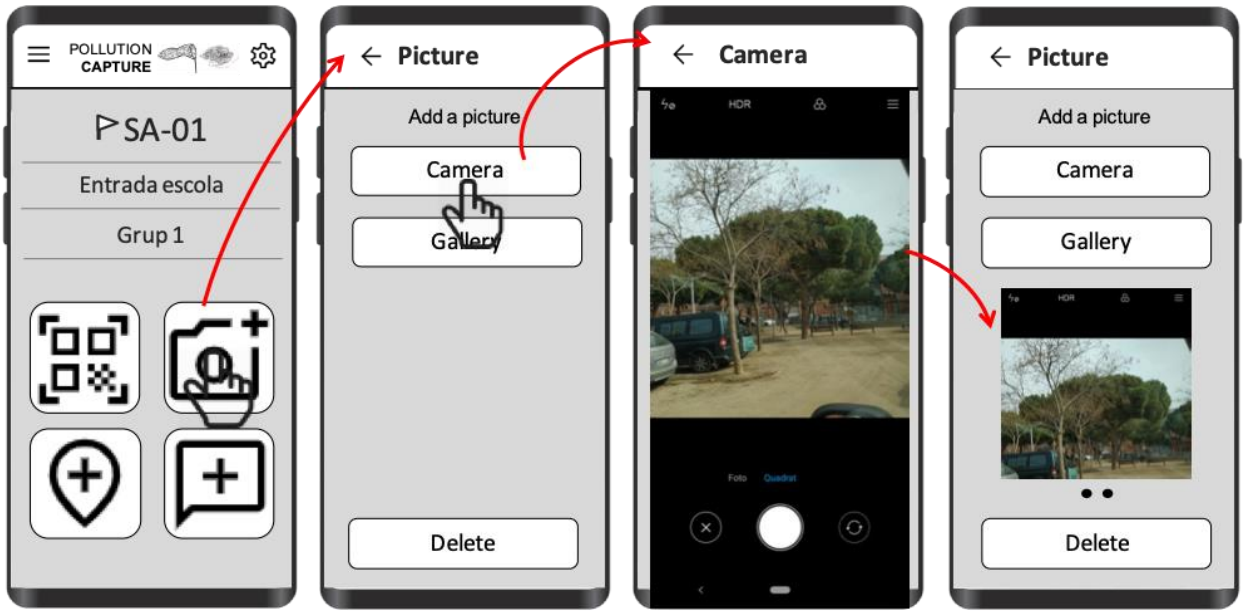

Fig. 24 The CleanAir wireframes and evidence collection.

If the initial location is provided via the web interface, the user can edit the location by using the phone's GPS. Moreover, the user can leave comments of each location.

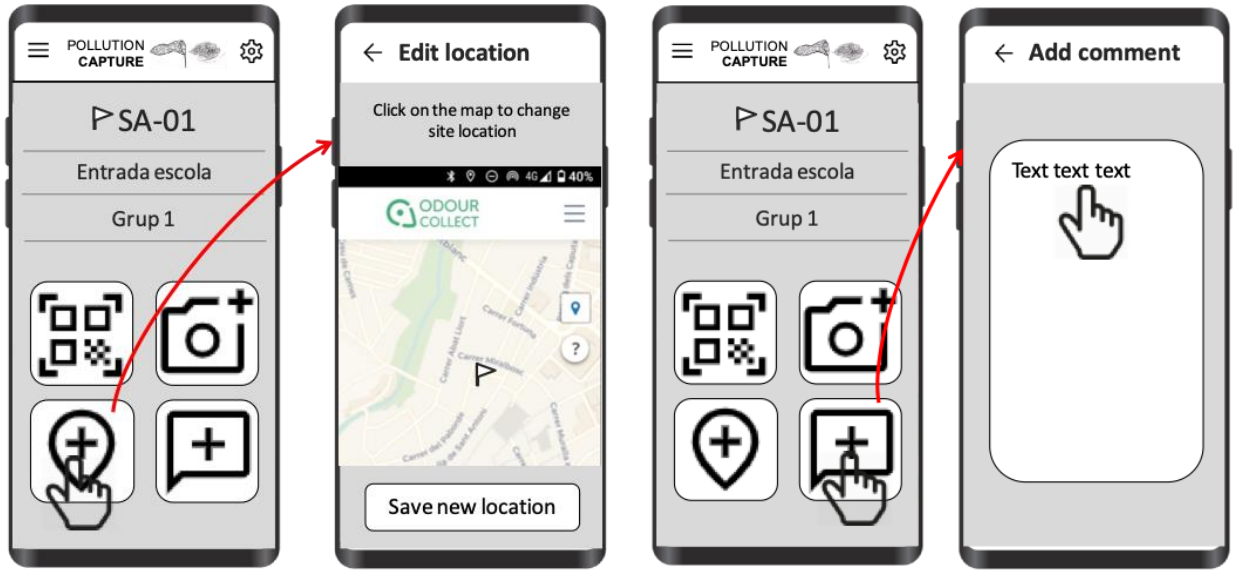

Fig. 25 The CleanAir wireframes and evidence collection.

8. Annex

8.1. EXPLOR UI design

8.1.1 Wireframes

Launcher control

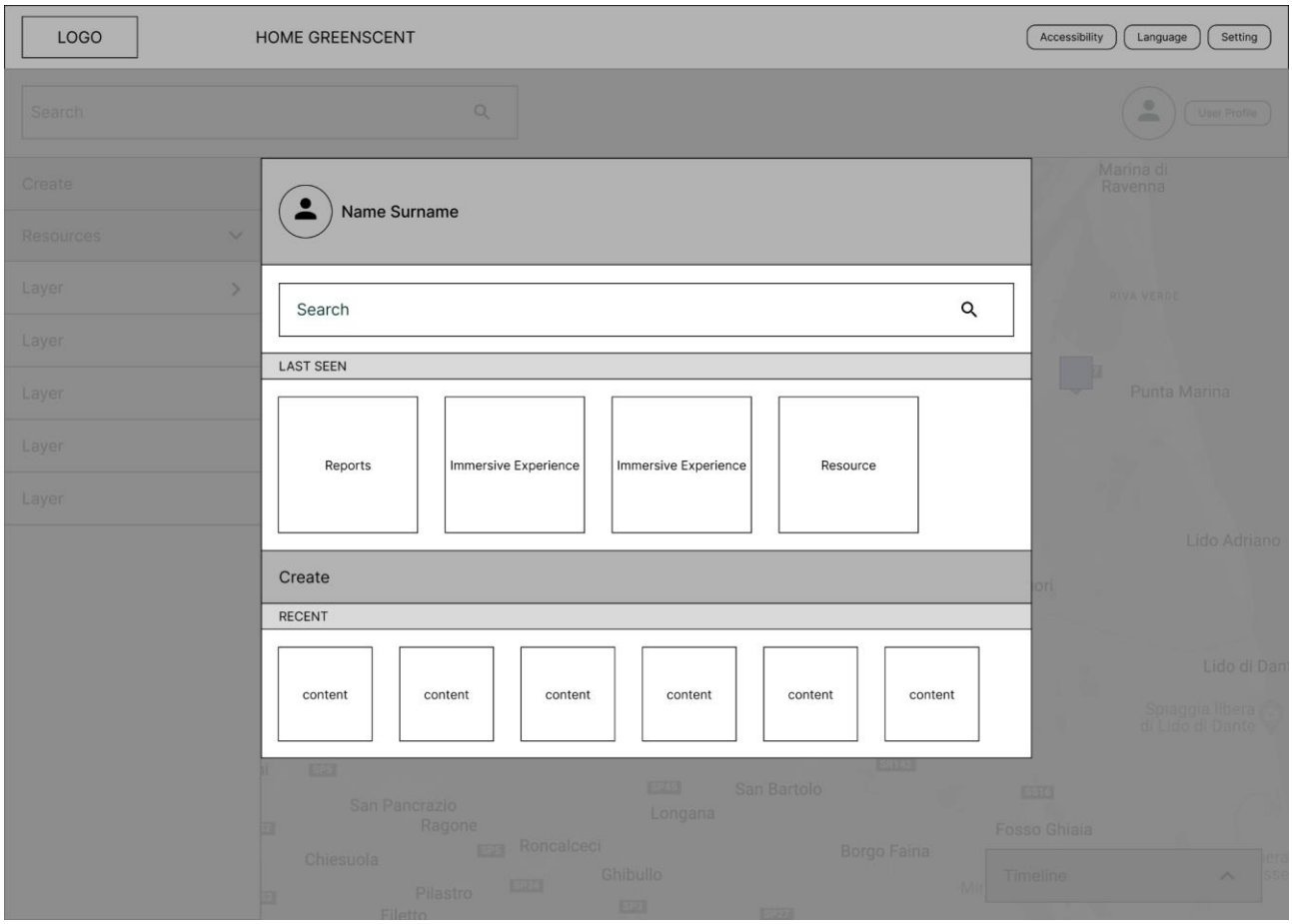

Fig. 26 Launcher control

Homepage with filter section

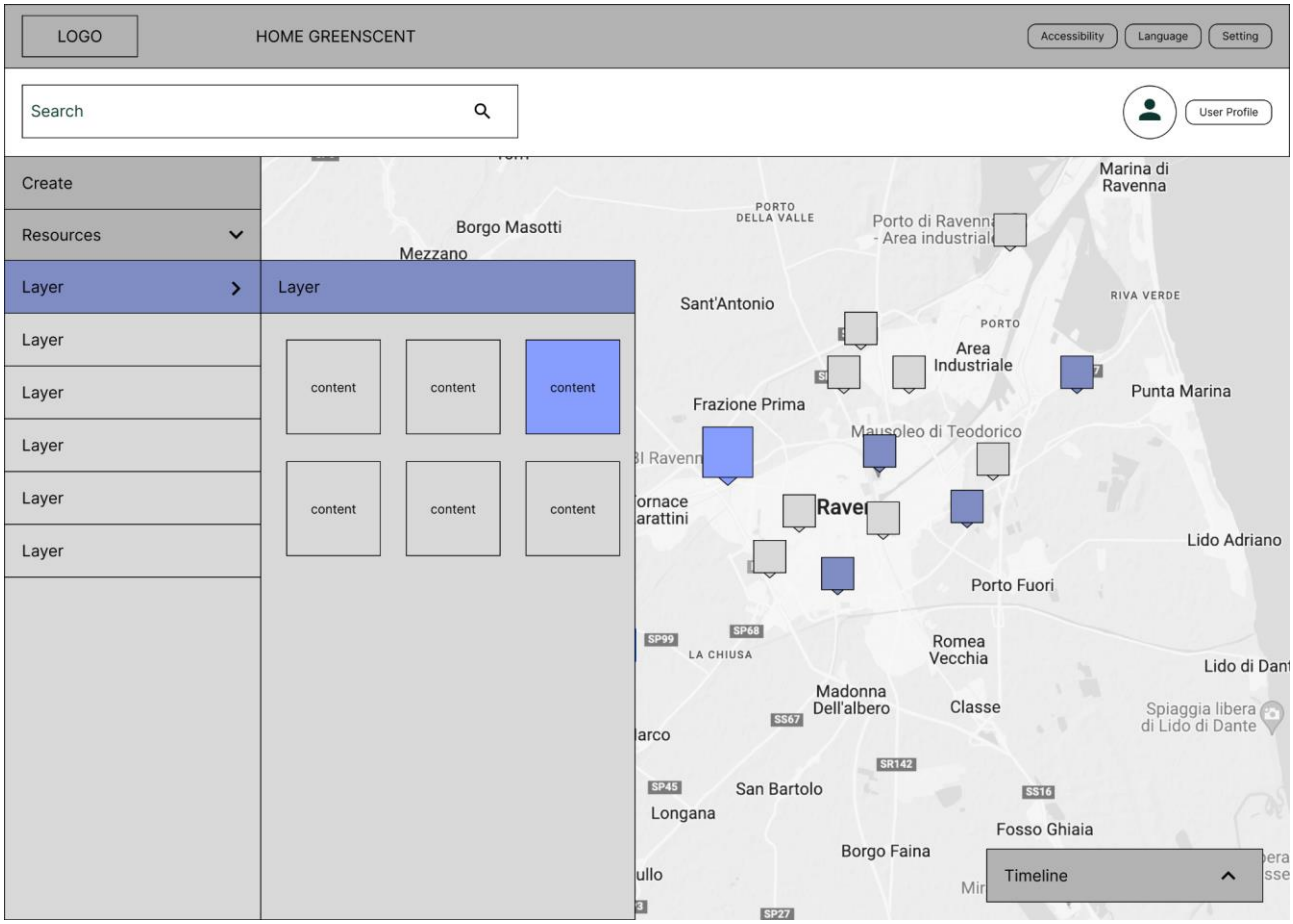

Fig. 27 Homepage with filter section

Homepage with timeline

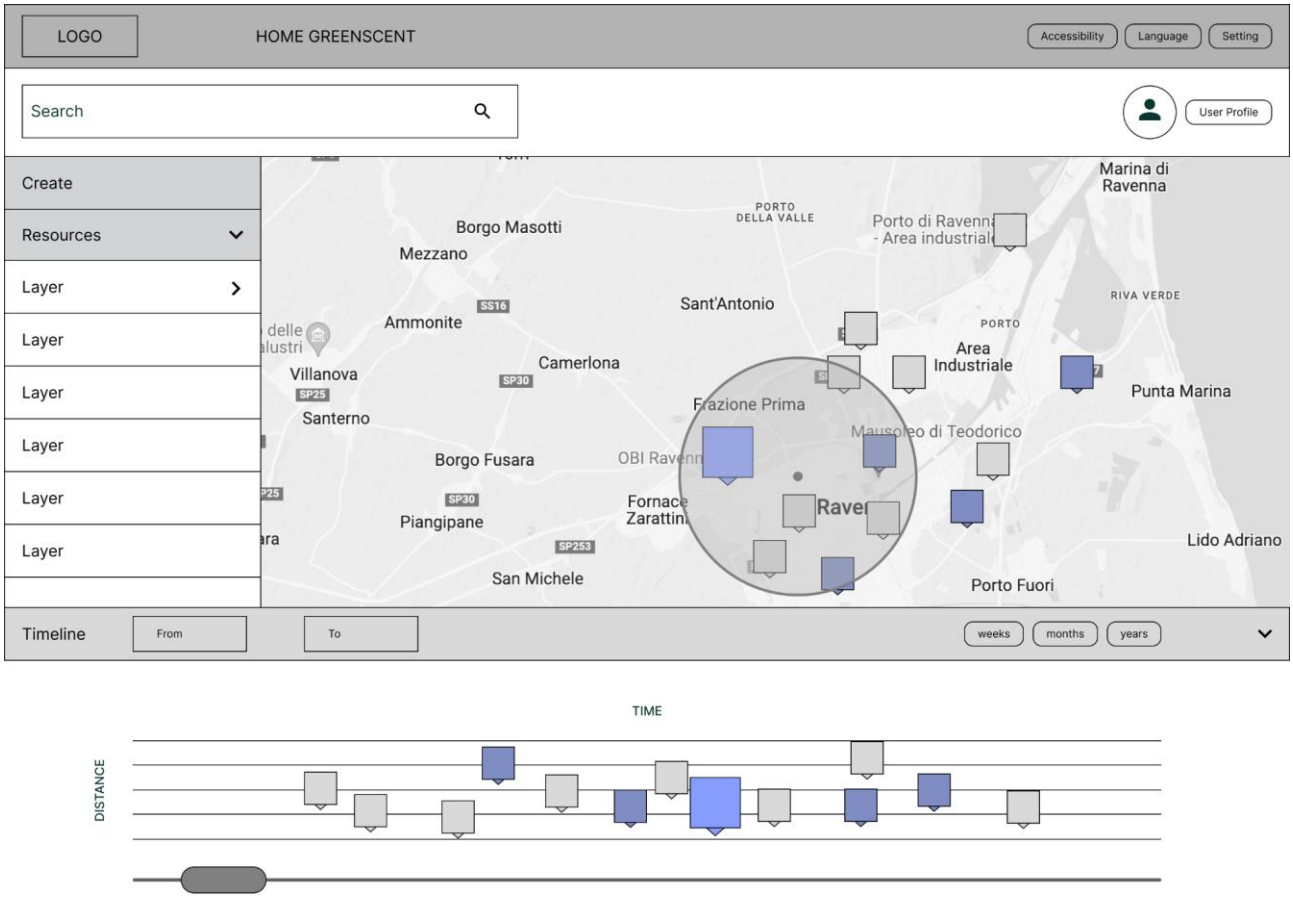

Fig. 28 Homepage with timeline

8.1.2 EXPLOR UI design

Launcher control

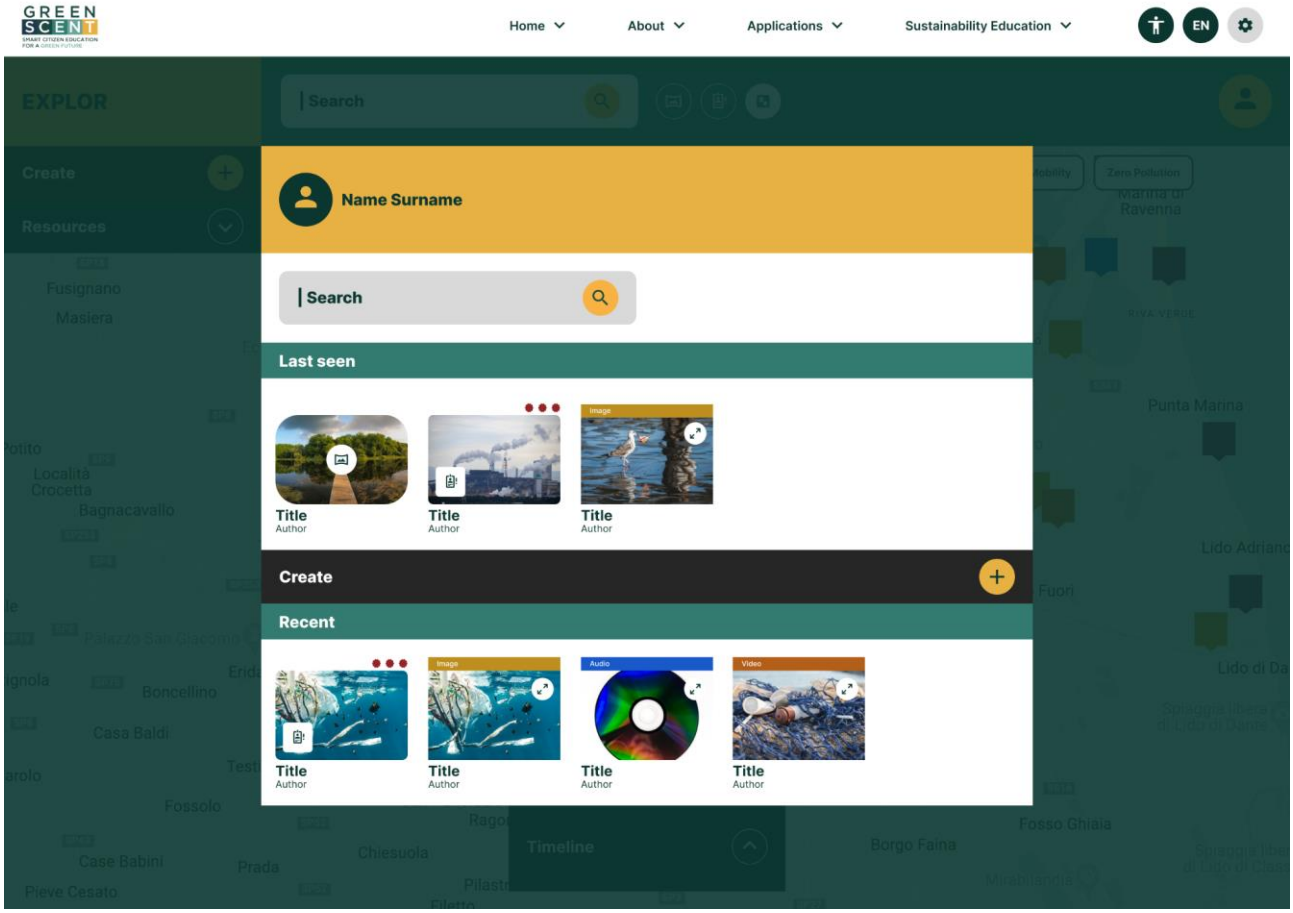

Fig. 29 Launcher control

Homepage

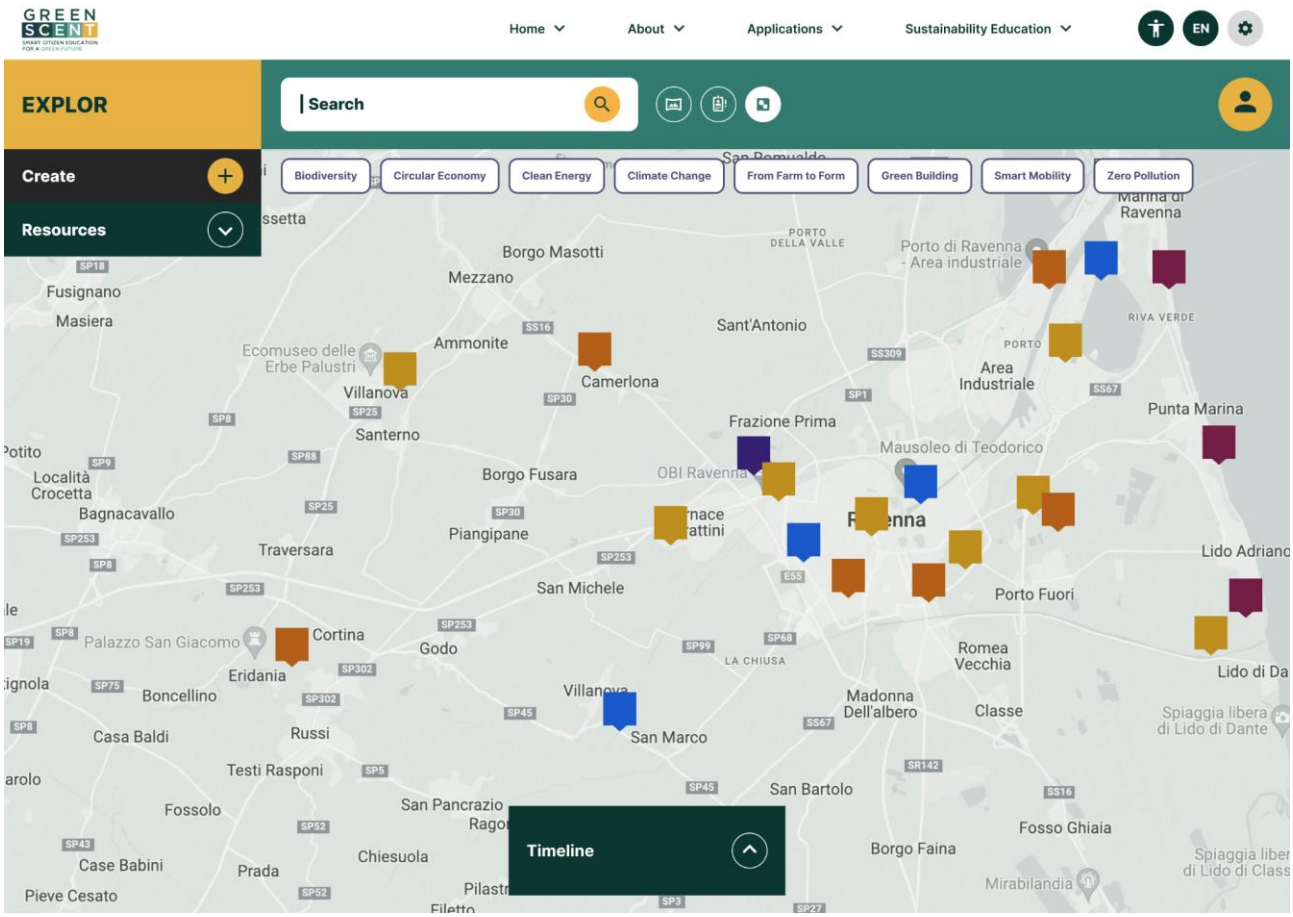

Fig. 30 Homepage

Homepage with resource filters

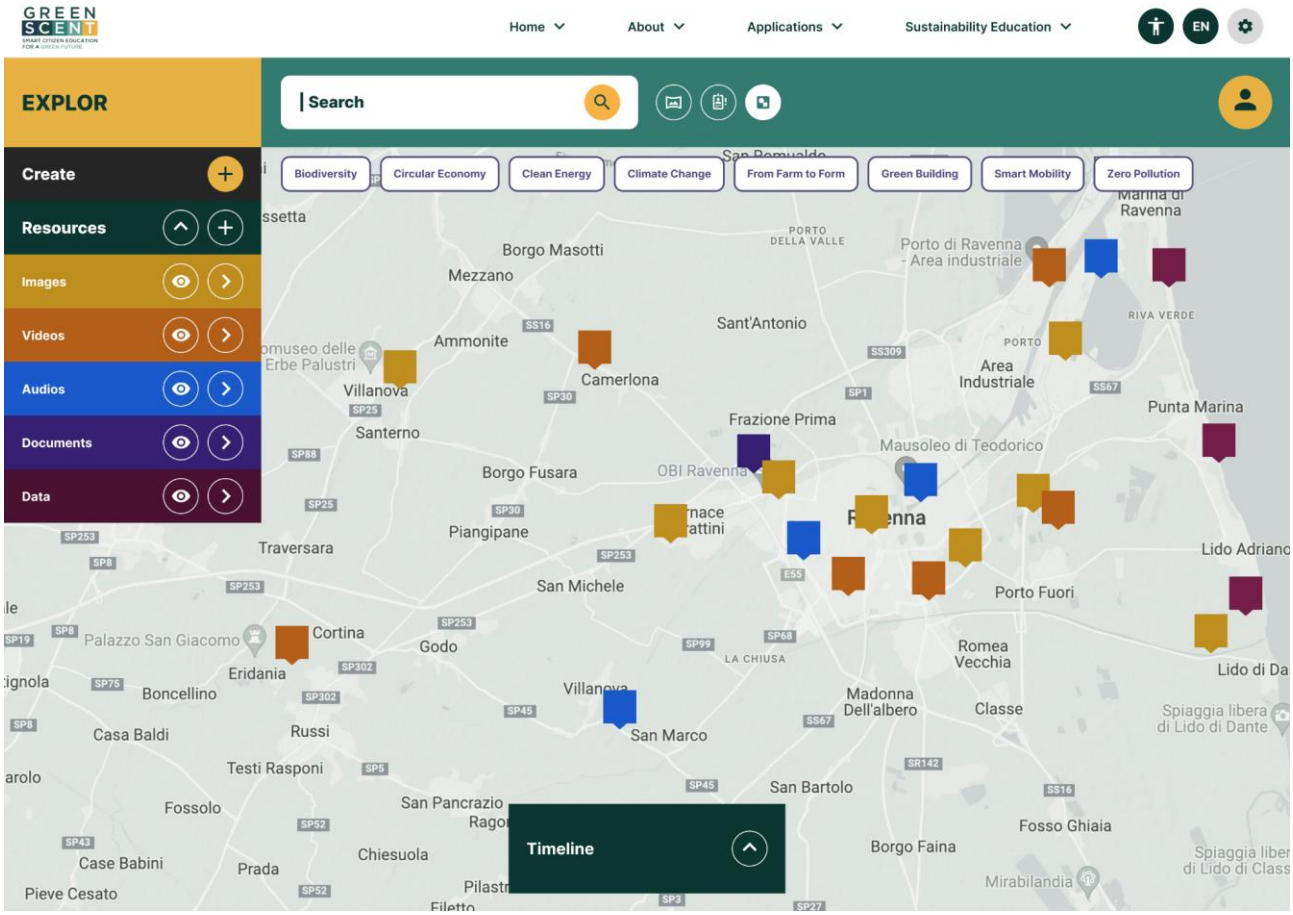

Fig. 31 Homepage with resource filters

Homepage with hidden filters

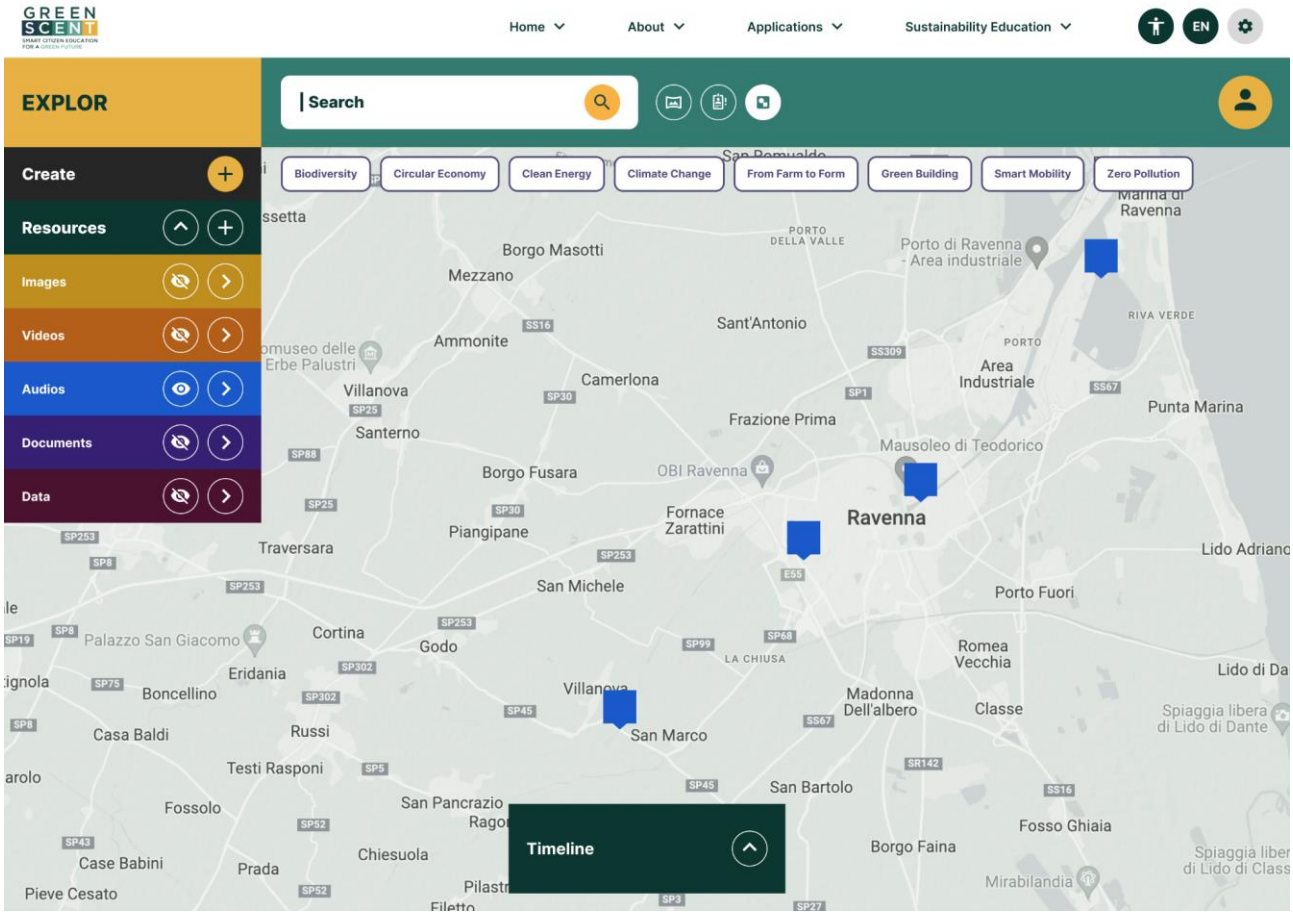

Fig. 32 Homepage with hidden filters

Homepage with details on a specific filter

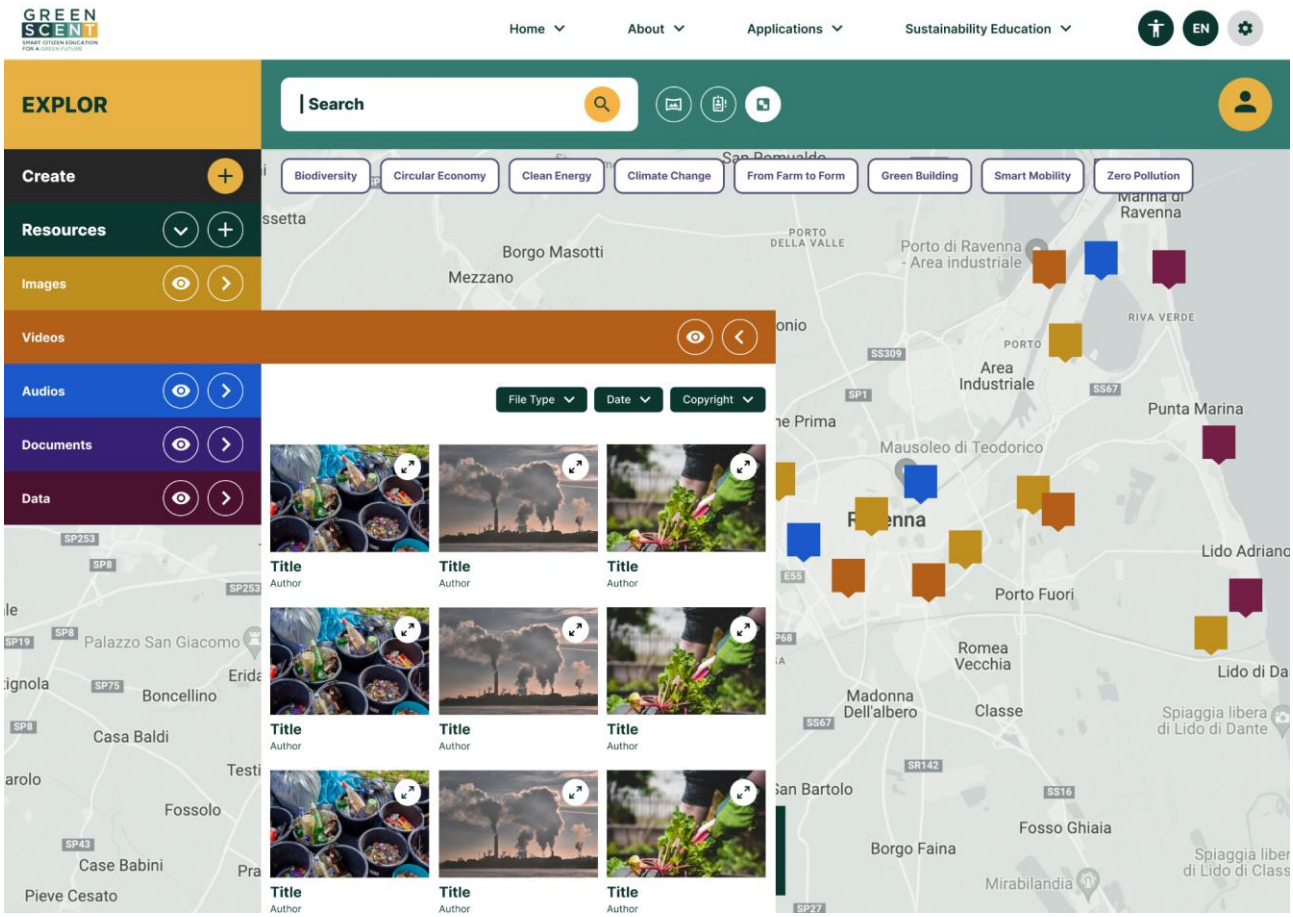

Fig. 33 Homepage with details on a specific filter

Homepage with search console

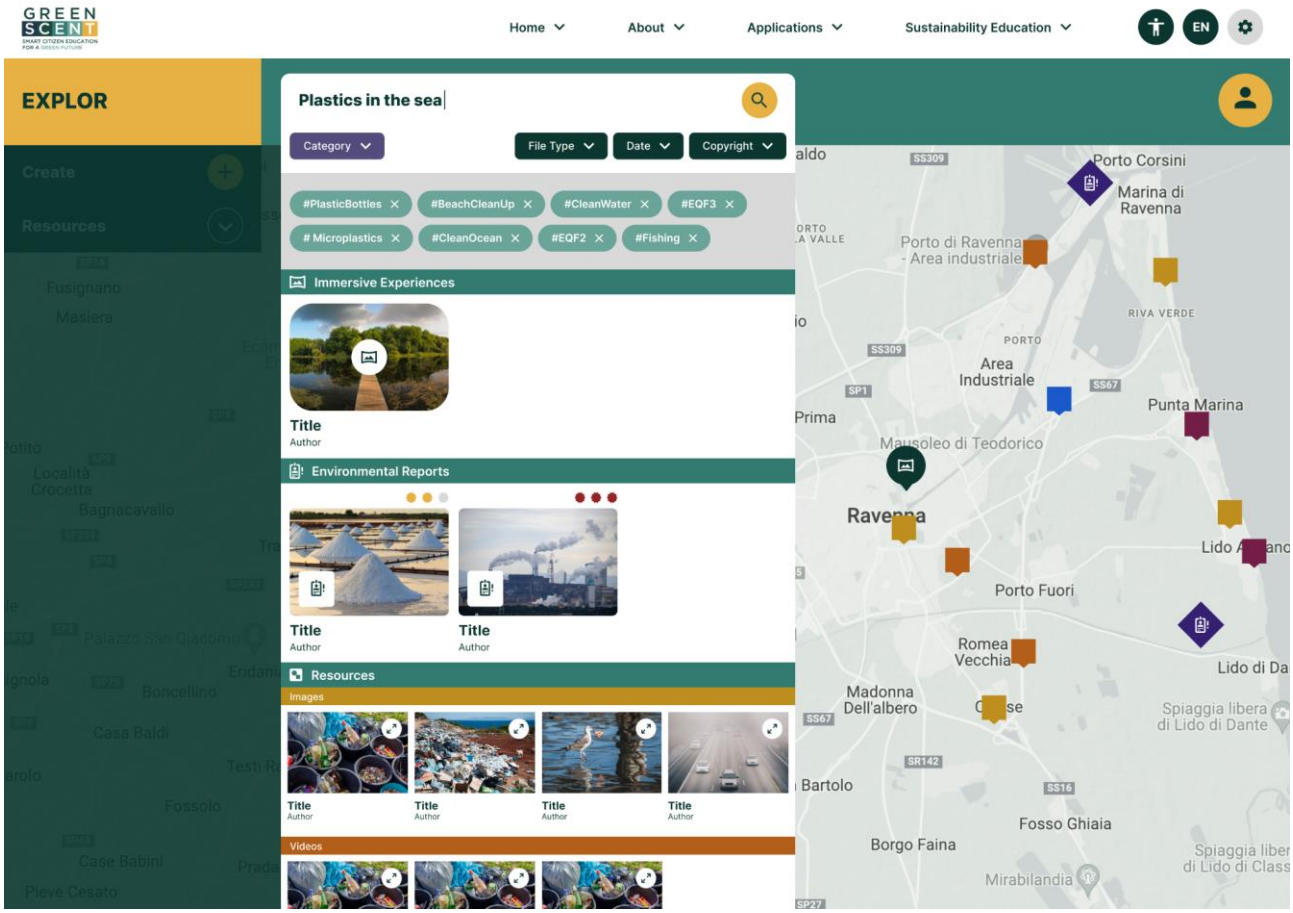

Fig. 34 Homepage with search console

An highlight on a single report

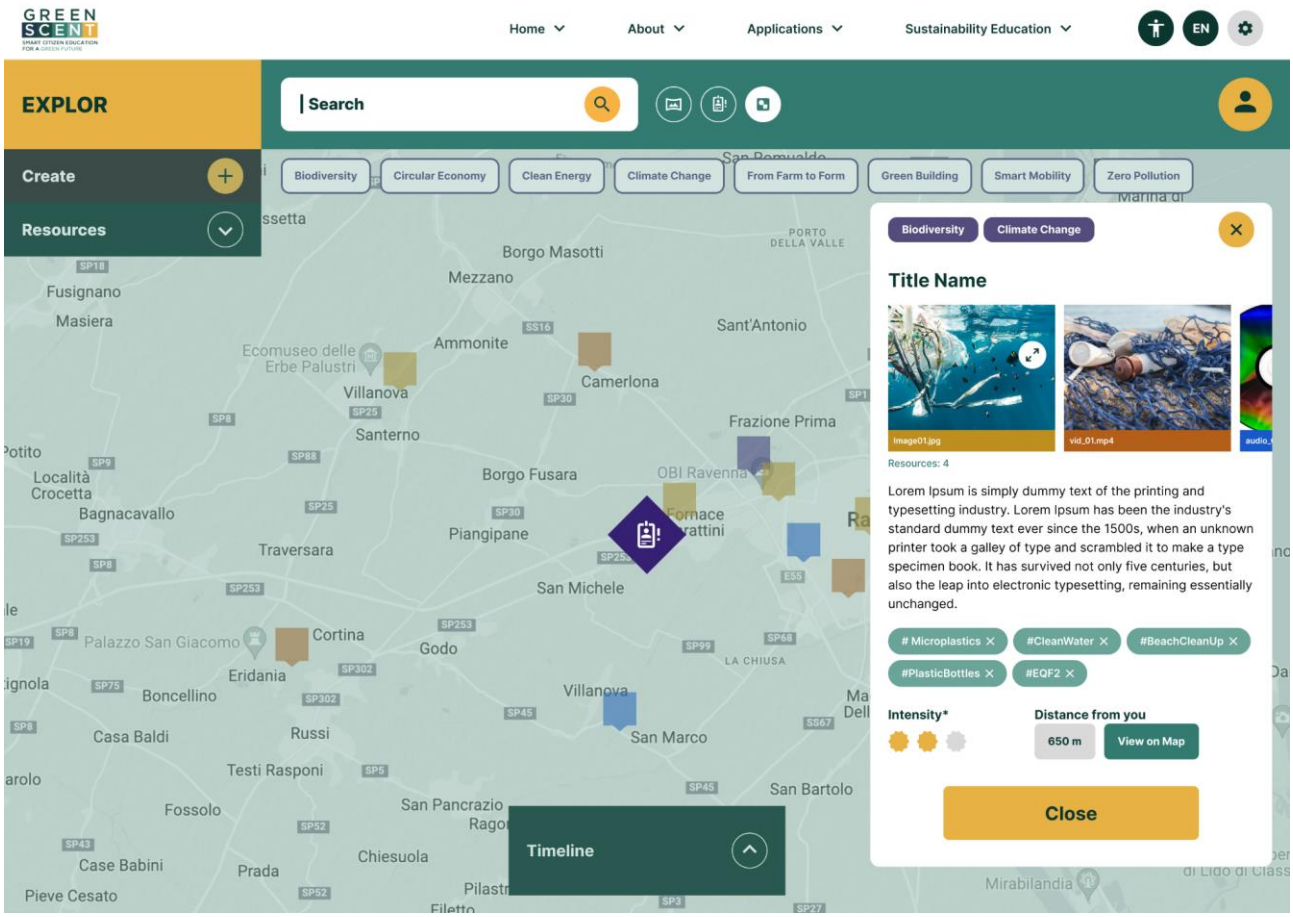

Fig. 35 An highlight on a single report

User Profile board

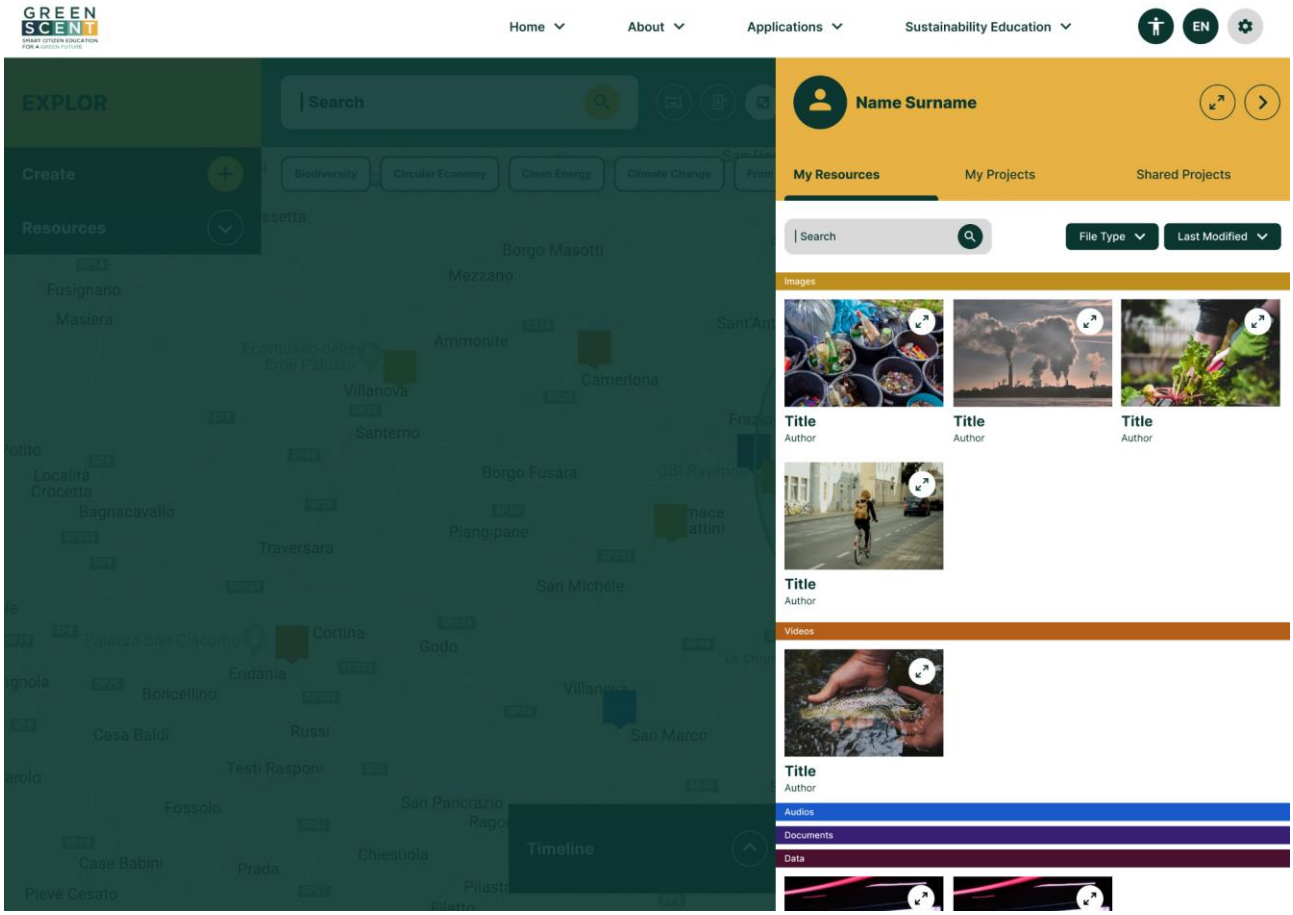

Fig. 36 User Profile board

Timeline

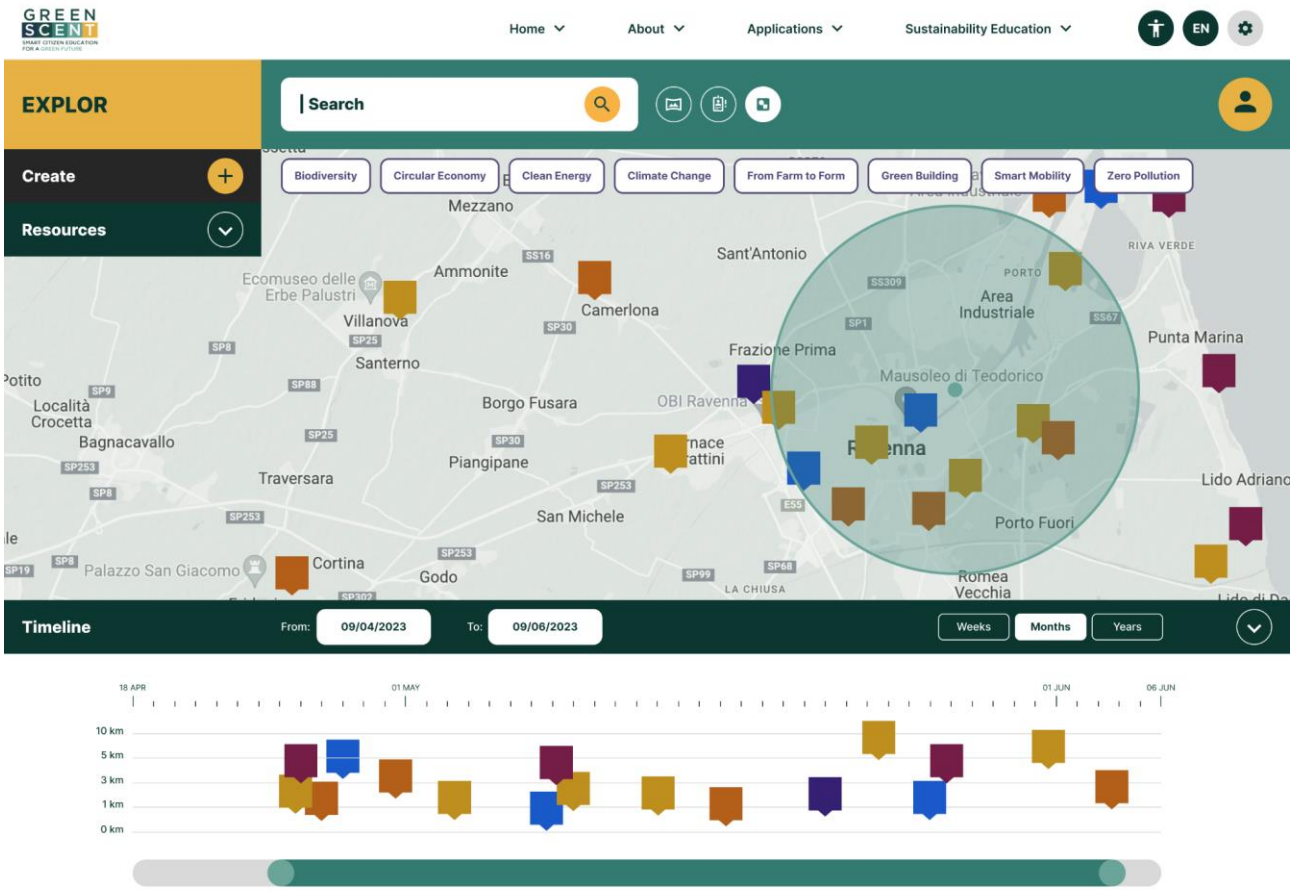

Fig. 37 Timeline

Content creating form

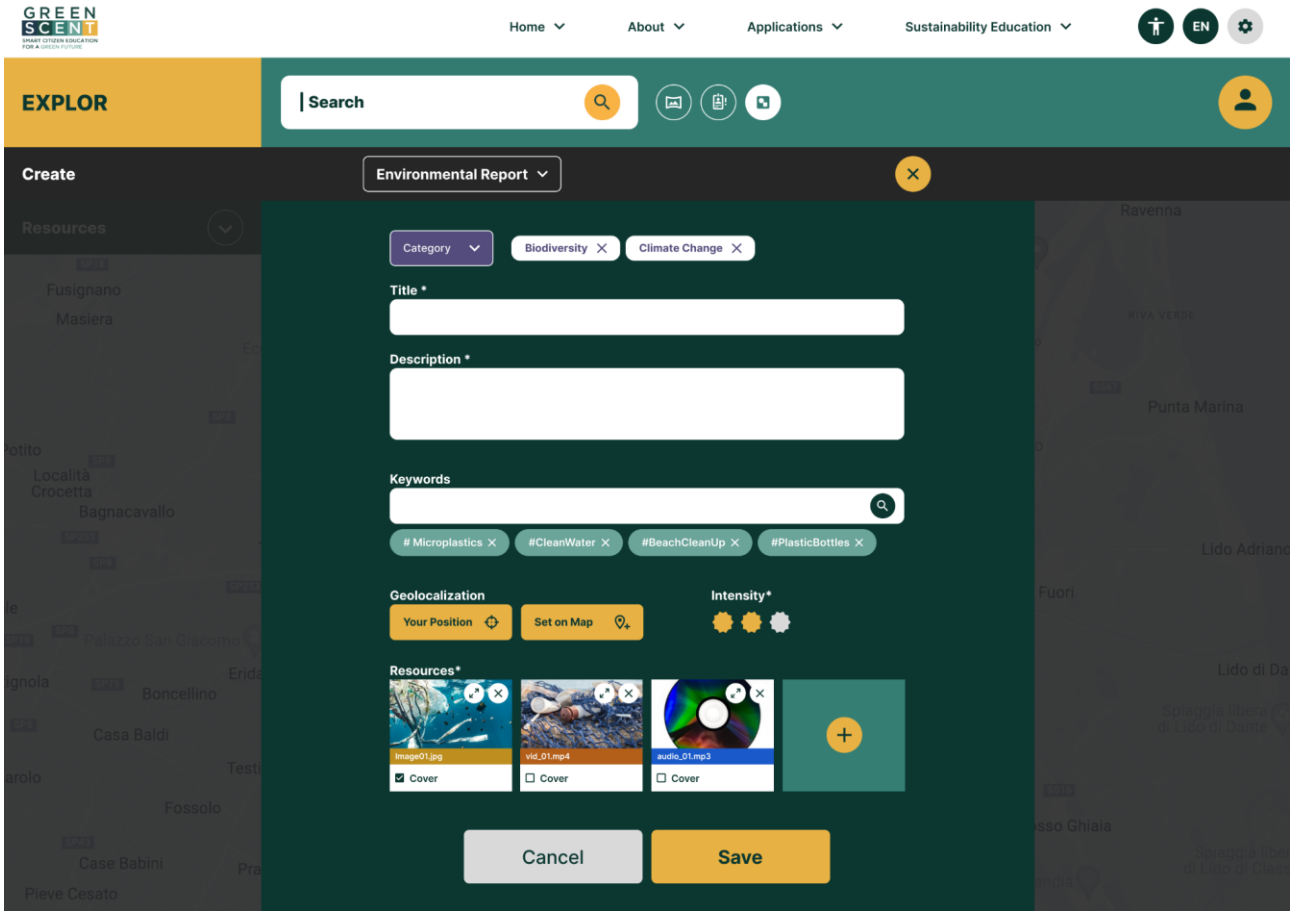

Fig. 38 Content creating form

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8.2 AR Mobile App Interface design

Links for all documents cited in the description of activities:

- User Experience Research Report
- High Fidelity Prototype
- Storyboard of lessons content

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8.3 CoDesign Workshop Implementation

8.3.1 Modules description

This paragraph provides the Workshop modules' description with main phases, methods and procedures.

Module 1

Future Sustainability Education

World Heritage components: educational challenges on natural, cultural and societal heritage:

- to promote awareness among young people of the importance of our common World Heritage and of the UNESCO 1972 World Heritage Convention [awareness & knowledge],
- to encourage young people to become involved in heritage conservation on a local as well as on a global level [active participation & contribution],
- to develop effective educational approaches and materials by working in synergy with educators and heritage conservation experts to introduce World Heritage Education into the curricula of secondary schools around the world [educational methods].

[Problem setting]

1. Define the problem:
    a. What are the main educational challenges you face?
    b. Are these challenges related to lack of knowledge? Are they relating to context and culture? Are they relating to attitudes and values?
2. Analyse the problem:
   Please use the following schema to describe them:
   CONTEXT: When does the problem occur?
   PROBLEM: How does it become explicit?
   ROOT: What is the root cause of the problem?
   EMOTION: How do you feel about the problem?

[Problem solving]

3. What if you will have superpowers:
    a. How will you solve the problem if you would have unlimited time, space, support, and powers?
    b. What are the alternatives to fix / solve the problem?

Duration: 45 minutes

Prototype exploration: functionalities and application to problems

Demonstrate the most relevant functionalities and prototype application
Imagine how it might solve the educational challenges

Duration: 1 hour

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Module 2
Day 1 Wrap-Up session
Duration: 30 minutes
Participants: Consortium partners + Teachers

Module 3 Air Quality short lesson
Air Quality basic knowledge
Duration: 30 minutes

Module 4
Interactive Documentary
Main phases

1. Take pictures of the School surroundings Scenario
2. Build the scenario environment in the platform
3. Immersive and interactive experience design
4. Documentary: research for contents' production and annotation
5. User experience: GoLive with the interactive immersive environment

Interactive documentary reference scenario
Martin, who is a passionate middle-aged high-school teacher and environmental enthusiast, learns about GreenSCENT.
When he was young, Martin loved film-making. He dreamed of becoming a famous director producing engaging movies able to convey positive social messages.
This passion may be why, when he learns about GreenSCENT, Martin decides to experiment with an interactive movie post-production tool that GreenSCENT partners provide free to use.

Martin downloads from the GreenSCENT website a concise user-manual of the tool and begins experimenting with it. He finds the software to be rich in features and easy to use, especially powerful when used to enrich and connect 360° panoramic video fragments.

Martin knows he can use a 360° inexpensive video camera that the high-school where he works recently bought. He then decides to organize an educational visit to a waste management plant. He asks the plant manager permission - for him and his students - to record some operations, and upon receiving consent, Martin and his class, go to the plant for a one day visit and shooting session.

Martin places and activates the 360° camera in a few selected plant locations to record the main process steps. While the plant manager explains the process, his students listen and record explanations while taking pictures, short videos, and notes. All students can do that by using their smartphones, equipped with the GreenSCENT content collection app.

When back in class, Martin uploads the 360° panoramic recordings on the GreenSCENT platform. Then he and his students begin to use the immersive interactive documentary authoring tool. They start working cooperatively to link the immersive clips in a virtual tour. They enrich every clip with additional interactive elements coming from the recordings they made that very day. Martin and his students preview the resulting interactive documentary and find it engaging and useful.
They add other content from the GreenSCENT platform to further improve it.

Duration: 2 hours

Module 5
Air Quality - Designers for a day

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

6. Create your avatar
7. Storytelling Dice activity (using pieces of paper with air quality concepts)
8. Paper prototype of a game (3 screens) with the avatar selected and one of the stories voted

Duration: 2 hours

Module 6 (referred to as Module 1 in UAB Workshop)
How are you feeling? From environmental anxiety to environmental action

Description:
This activity acts as an icebreaker for participants.
Participants have the opportunity to communicate how they feel about the environment.
Materials: Dixit cards

Follow these steps:
Presenter asks the room: "How are you feeling when you think about the environment?"
Each participant then chooses one or two cards that represent how they are feeling about the environment.
Each participant explains why they chose their card and how it symbolises how they are feeling.

Module 7 (referred to as Module 2 in UAB Workshop)
Slow Motion Animation As a Tool for Co-creation

Description:
A stop motion animation is a sequence of photographs or drawings that you make one by one, using micro-movements to capture your characters and objects.

In this activity, participants will have the opportunity to create their own "green" story.

Materials: Flat surface, lamp, mobile phone, tripod, white A4 sheet of paper, printed GreenSCENT cut-outs, sellotape, scissors, blue tack, cocktail or bbq sticks, markers and letters from a board game (optional).

To make your own stop motion animation, watch this video tutorial or follow these steps:

- Download the Stop Motion Studio App
- Simply take your cut out character.
- Turn it around.
- Break your wooden stick to size.
- Place it on the back of your character.
- Take Sellotape, and attach it to hold the stick in place.
- Add a ball of blue tack to the base of the stick.
- If you want to add a background, it helps to have a wall behind you as a surface.
- You can fix them using blue tack.
- For adding captions or speech, you can use letters from a board game or make your own speech bubbles.
- The most important thing is to have your camera steady, and in the same place.
- Each time you make a movement in your scene, you must take a photograph.
- Once you put all of the photographs together in a sequence, it creates the effect that they are moving on their own.

Module 8 (referred to as Module 3 in UAB Workshop)
Cut and stick your green ideas: The GreenSCENT book

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

Description:
Similar to the stop motion animation, this activity asks participants to create their own "green" story by using cut outs taken from the GreenSCENT video.

Materials: GreenSCENT character cut-outs, colouring pens, scissors, glue or sellotape.

Follow these steps:

- Cut and stick their "green" ideas to an A4 workbook.
- Add colours to your GreenSCENT character.
- Create your "green" story.

Module 9 (referred to as Module 4 in UAB Workshop)
Recycling ideas: What can different cultures teach us about recycling? Furoshiki

Description:
The purpose of this activity is to teach participants how to reuse cloth to create a reusable bag.
It also aims to foster cross-cultural awareness between different cultures and their different approaches to sustainability.

Material: Old cloth.

Follow these steps:
See infographic.

Module 10 (referred to as Module 5 in UAB Workshop)
Immersive Green stories: The GreenSCENT immersive platform

Description:
The purpose of this activity is to showcase the GreenVerse platform to participants and demonstrate how to create accessible immersive stories about sustainability.

Materials: Computer and projector.
Showcase functionalities of the GreenVerse Platform.

Module 11 (referred to as Module 6 in UAB Workshop)
Accessibility requirements of tools and materials: GreenSCENT for All

Description:
The purpose of this activity is to teach participants about how to be accessible online by using camelcase hashtags and adding alternative text to images.

Follow these steps:
Take a picture to capture how you are feeling at the end of the workshop or take a picture that captures what you have learned/thought and choose alt text and your hashtag.
Post your picture, caption and hashtag online through Twitter, LinkedIn, Instagram or Facebook.

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8.3.2 Workshop Agenda collection

Athens Workshop Agenda

Workshop / DAY 1
14.30 Organisers arrivals & Preparation Workshop preparation Participants: Consortium partners
15.00 Module 0 Warm-Up & Introduction Duration: 30 minutes Participants: Consortium partners + Teachers
15.30 Module 1 Future Sustainability Education Natural Heritage cards / components: educational challenges on natural heritage Educational challenges [Problem setting] Unlimited resources - Ideas and concepts [Problem solving] Prototype exploration: functionalities and application to problems Demonstrate the most relevant functionalities and prototype application Imagine how it might solve the educational challenges Duration: 2 hours Participants: 5 Consortium partners 6 Teachers (3 Primary school teachers + 3 Secondary school teachers) 2 Educational managers [English]
17.30 Module 2 Day 1 Wrap-Up session Duration: 30 hour Participants: Consortium partners + Teachers

Workshop / DAY 2 - Students
9.00 Organiser arrivals & Preparation Workshop preparation Participants: Consortium partners
10.00 Module 3 Air Quality short lesson Air Quality basic knowledge Duration: 30 minutes [Greek]

<table>
<tr><td colspan="2">10.30 Break</td></tr>
<tr><td>10.45 Module 4
<u>Interactive Documentary</u>

1. Prepare the Greek School Scenario with pictures
2. Advanced interaction with both:
- Creation of immersive scenarios
- Contents' production and annotation

Duration: 2 hours
Participants: Consortium partners + (Lower) Secondary School students (14-15 years' old)
4 students
[English]</td><td>10.45 Module 5
<u>Air Quality - Designers for a day</u>

1. Create your avatar
2. Storytelling Dice activity (using pieces of paper with air quality concepts)
3. Paper prototype of a game (3 screens) with the avatar selected and one of the stories voted

Duration: 2 hours
Participants: Consortium partners +
Primary School / (Lower) Secondary School students (10-13 years' old)
4 students
[English]</td></tr>
<tr><td colspan="2">13.00 Lunch</td></tr>
<tr><td colspan="2">14.00 Modulo 3 Air Quality short lesson
Warm-Up & Introduction to Air Quality basic knowledge
Duration: 30 minutes
Participants: Consortium partners
6 Teachers
5 Parents
[Greek]</td></tr>
<tr><td colspan="2">14.30 Module 5
Air Quality - Designers for a day

30 break

Duration: 2 hour
Participants: Consortium partners
6 Teachers
5 Parents
[English]</td></tr>
<tr><td colspan="2">16.30 Module 2
Day 2 Wrap-Up session
Duration: 30 hour
Participants: Consortium partners + Teachers + Parents</td></tr>
</table>

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Novi Sad Workshop

Workshop / DAY 1 (Monday 23 afternoon)
14.30 Organisers arrivals & Preparation Workshop preparation Participants: Consortium partners
15.00 Module 0 Warm-Up & Introduction Duration: 30 minutes Participants: Consortium partners + Teachers
15.30 Module 1 Future Sustainability Education World Heritage cards / components: educational challenges on natural, cultural and societal heritage Educational challenges [Problem setting] Unlimited resources - Ideas and concepts [Problem solving] Prototype exploration: functionalities and application to problems Demonstrate the most relevant functionalities and prototype application Imagine how it might solve the educational challenges Duration: 2 hours Participants: 2 Consortium partners 5-6 High school teachers 2 Educational managers [English]
17.30 Module 2 Day 1 Wrap-Up session Duration: 30 hour Participants: Consortium partners + Teachers

Workshop / DAY 2 Tuesday 24 Morning
9.00 Organiser arrivals & Preparation Workshop preparation Participants: Consortium partners
9.30 Modulo 0 Warm-Up & Introduction Duration: 30 minutes Participants: Consortium partners + Students

10.00 Module 1

Future Sustainability Education

World Heritage cards / components: educational challenges on natural, cultural and societal heritage
Educational challenges [Problem setting]
Unlimited resources - Ideas and concepts [Problem solving]

Prototype exploration: functionalities and application to problems

Demonstrate the most relevant functionalities and prototype application
Imagine how it might solve the educational challenges

Duration: 2 hours
Participants:
2 Consortium partners
5-6 University Professors
2 Educational managers
[English]

13.00 Lunch

14.00 Modulo 0
Warm-Up & Introduction
Duration: 30 minutes
Participants: Consortium partners + Students

14.30 Module 4

Interactive Documentary

2. Prepare the Greek School Scenario with pictures
4. Advanced interaction with both:
   - Creation of immersive scenarios
   - Contents' production and annotation

Duration: 2 hours
Participants: Consortium partners + University students
6-10 students
[English]

14.30 Module 5

Air Quality - Designers for a day

5. Create your avatar
6. Storytelling Dice activity (using pieces of paper with air quality concepts)
7. Paper prototype of a game (3 screens) with the avatar selected and one of the stories voted

Duration: 2 hours
Participants: Consortium partners +
Secondary School students
6-10 students
[English]

17.30 Module 2
Day 2 Wrap-Up session
Duration: 30 hour
Participants: Consortium partners + Teachers [+ Parents]

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Workshop / DAY 3 (Wednesday 25 Morning)
9.00 Module 0 Warm-Up & Introduction Duration: 30 minutes Participants: Consortium partners + Researchers
9.30 Module 6 <u>Roundtable on Air quality monitoring [Hybrid session]</u> Presentation 1 - State-of-the-art in air quality monitoring and the Cleanair@schools initiative- 4Sfera (online) - 10min Presentation 2 - CALIOPE air quality modelling system - BSC - 10min <u>Open Discussion - 40min</u> What are the most relevant functionalities and prototype applications in the research field? How might the main visualization and research outcomes be envisioned? What are the educational challenges for teachers of teachers? Which kind of tools do teachers need to use? Imagine how Clean@ir might solve the educational challenges they face? <u>Designers for a day - 60min</u> Duration: 1 hour Participants: 3 Consortium partners 2 Researchers 2 Educational managers [English]
11.30 Module 2 Wrap-Up session Duration: 30 min Participants: Consortium partners + Professors + Teachers

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UAB Workshop

Workshop / Day 1 (30 May 2022)
09.00: Registration and Coffee
09.15: Presentations
09.30: How are you feeling? From environmental anxiety to environmental action "How are you feeling when you think about the environment?" Duration: 15 minutes Participants: Consortium partners & researchers
09.45: GreenSCENT activities with children and youths: From adult centric perspective to a children/youth perspective Duration: 15 minutes Participants: Consortium partners & researchers
10.00: Slow Motion as a tool for co-creation Duration: 15 minutes Participants: Consortium partners & researchers
10.15: Hands on activity: Collaborative GreenSCENT slow motion Duration: 45 minutes Participants: Consortium partners & researchers
11.00: Cut and stick your green ideas: The GreenSCENT book Duration: 30 minutes Participants: Consortium partners & researchers
11.30: Coffee break
11.45: Recycling ideas: What can different cultures teach us about recycling? Furoshiki Duration: 15 minutes Participants: Consortium partners & researchers
12.00: Hands on activity: Create your GreenSCENT bag! Duration: 15 minutes Participants: Consortium partners & researchers
12.15: Immersive Green stories: The GreenSCENT immersive platform Duration: 15 minutes Participants: Consortium partners & researchers
12.30: Hands on activity: Navigating the platform Duration: 30 minutes Participants: Consortium partners & researchers
13.00: Accessibility requirements of tools and materials: GreenSCENT for All Duration: 15 minutes Participants: Consortium partners & researchers
13.15: Q&A

ITACA Workshop Campus: 29 June & 11 July 2022

Time	Activity
09.00 - 09.20	Introduction to UAB, GreenSCENT Project & Audio Description
09:20 - 09:30	Let's practice. Now, self describe yourself!
09.30 - 09. 45	How the 360 camera works
09.45 - 10.00	Create your own script
10.00 - 11.15	Create your own audio-described 360 image!
11.15 - 11.45	**Break**
11.45 - 13.45	Create your own audio-described 360 image! (continued)
13.45 - 15.00	**Lunch**
15.00 - 16.15	Video showcase: Let's find solutions
16.15 - 17.00	How can we be changemakers?

Detailed description of the activities:

First session: 9:00 - 11:15

Time: 09:00 - 09:20

1. **Introduction to UAB, GreenSCENT project & audio description - 3 videos**

Welcome to UAB
Welcome to the GreenSCENT project
Let's break the ice with an activity! Let's go!

Catalan AD Clips: https://uab-my.sharepoint.com/personal/1422379_uab_cat/_layouts/15/onedrive.aspx?id=%2Fpersonal%2F1422379%5Fuab%5Fcat%2FDocuments%2FDatos%20adjuntos%2FAD%20Catalan%2Ezip&parent=%2Fpersonal%2F1422379%5Fuab%5Fcat%2FDocuments%2FDatos%20adjuntos&ga=1

Clip 1: Les de l'hoquei
Clip 2: Moebius

A. We will show participants 3 videos
B. After that, we will ask participants the following questions:
    a. What is happening in the video?
    b. Who are the main characters?

C. We will then collect information/ideas.
D. Then, participants will hear the audio description of the video to have access to more content. We then ask them the following questions:

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a. Is it clear what is happening?
b. Do you think you have access to more information?
c. Could you "visualize what was happening"?

E. We finally show the video with the audio description and subtitles. Let's make all our content accessible. Is the experience of watching a video for all?

Time: 9:20 - 9:30

2. Let's practice. Now, self describe yourself!

A. We will ask participants to self describe themselves in three words.
B. The facilitators will start to "break the ice"
C. We will record participants' responses in a 360 video.
D. We will show participants an example of a 360 video.

Time: 9.30 - 9. 45

3. How the 360 camera works

Participants will be shown how the 360 camera works.

A. We will take a 360 photo of the group in a circle.
B. We will take a 360 video of the group in a circle waving.
C. We will show participants their 360 photo and video inside.
D. Inside, participants will be split into two groups, each group will be shown the platform and an example of a Green story.
E. Each group will select one scenario to work on to create their Green story taken from eleven different scenarios (Japanese Garden, Toilet, UAB, library…).

Time: 9.45 - 10.15

4. Create your own script

A. Participants will be guided to create their script for their 360 photo.

Time: 10.15 - 11.45

5. Create your own audio-described 360 picture!

A. Groups A and B will be guided by a facilitator to create their own audio-described 360 picture to add to their scenario.

Break: 11.15-11.45

A. During the break, facilitators will upload each groups' 360 photos onto the platform.

Second session: 11:45 - 13:45

A. Facilitators will show participants the GreenSCENT platform where they can create their videos to share on their social media.
B. With the help of a facilitator, each group will create an immersive green experience by adding accessibility features, such as audio description.

Break: 13.45-15.00

A. During the lunch break, facilitators will work on the GreenSCENT immersive story.

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Third session: 15:00 - 17:00

Time: 15:00 - 16:15

6. Video showcase: Let's Find Solutions

1st Round:

A. Group A will show their videos to Group B, highlighting the environmental challenges they identified in their scenario.
B. Group B will then work together to come up with solutions to Group A's environmental challenges using a large sheet of paper or the white board.
C. Group B will present their solutions to Group A's scenario.
D. Both groups can discuss and note down their solutions to Group A's scenario.
E. Facilitators can record their responses on the white board.
F. Both groups can work together to identify any accessibility challenges in Group A's scenario.

2nd Round:

A. Group B will show their video to Group A, highlighting the environmental challenges they identified in their scenario.
B. Group A will work together to think of solutions to Group's B environmental problem. Participants can note down their solutions using a white poster and post-it notes or the white board.
C. Group A will present their solutions to Group B's scenario.
D. Both groups will discuss their solutions to Group B's scenario.
E. Facilitators can record their responses on the white board.
F. Both groups can work together to identify any accessibility challenges in Group A's scenario.

Time: 16:15 - 17.00

7. How can we be changemakers?

A. Participants will be asked the following question:
    a. What can I teach my parents?
    b. All the participants will write/paint/… a list of actions/activities/.. they can teach their parents/friends/ grandparents about the environment and about accessibility.
B. Participants will be asked to share their images/stories on social media using hashtag #GreenSCENTProject
tagging GreenSCENT
and Transmedia Catalonia

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Royal School, Romania - Workshop Agenda

Before going 15m **LEARNING ASSESSMENT** All participants	>GreenSCENT Assessment Questionnaire - EX ANTE
Workshop / DAY 1	
9:00 - 9:15 15min **WARM-UP & INTRODUCTION** Consortium partners + Teachers	Pres - Greenscent general presentation - WS objectives (journey e test simulation) - WS Agenda
9:15 - 11:15 1:30h **SUSTAINABILITY EDUCATION LEARNING OBJECTIVES +** **LEARNING DOMAIN EXPLORATION** 1. Knowledge graph exploration. 2. Instructional Design: Challenge-based learning activity Test Skill card Teachers - Lower Secondary 2 - High School 2	1. GreenSCENT Competence Framework: https://publish.obsidian.md/greenscent/ Choose areas of interest > go to 'Climate Change' 2. Test Skill card 'Climate Change' 3. Instructional Design Template a. General information b. Instructional design details (ADD resources table) c. Implementation (ADD support materials: i.e. 1. Presentation of the challenge, 2. Readings)
11:30 - 12:30 1h **CHALLENGE-BASED LEARNING** **STUDY EXPLORATION** How student respond to the educational challenge How student document themselves to a particular environmental topic Students - 9 students lower secondary	Pres - Greenscent general presentation - WS objectives (journey e test simulation) - Learning Challenge (built and presented by the teachers) - How to take evidence to create a story Documentation: - Local Journals - Local News Demo of the app - show functionalities

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12:30 - 13 Lunch	
13:15 - 14.00 45min **ON FIELD EXPLORATION WITH APP (TEST & EVALUATION)** Test the early version of Mobile App: Collecting & reporting evidence on sustainable issues or best practices Students - 9 students lower secondary	Test APP: - How to collect multimedia content and how to georeference it - Smartphones + app (account)
14:00 - 14:30 30min **USER GENERATED CONTENT (DOCUMENTARY)** Prepare an Education Scenario story with pictures and Jumps Students - 9 students lower secondary	Storytelling - A3 papers - Pens & pencils Mobile devices to see the collected multimedia resources. Demo of the interactive documentary
14:30 - 16:00 1h.30min **360 DEMONSTRATOR + SHARING CONTENT** Test the GreenVerse towards TIME MACHINE (with Jumps): - Creation of immersive scenarios - Content's production and annotation - Content's sharing (format) Students + Teachers - 9 students lower secondary	360 Tool: - 3 Pcs with internet connection - Account for the platform Share data from smartphone to pc - Environment composition
16:00 - 16:30 Presentations of students' work to Teachers 10 min each group	
17.00 - 18:00 **PARENTS** Future sustainability education Parents	Explore parent-kid learning interaction Introduce research activity

- 4/5 parents (any age)	- diary

Workshop / DAY 2	
8:00 - 10:30 (flight at 12:10) Teacher Workshop with Skill Cards	
Teachers - Lower Secondary 2 - High School 2 - **Primary 2**	

After going 15m **LEARNING ASSESSMENT** All participants	>GreenSCENT Assessment Questionnaire - EX POST Second iteration

MAYK School, Finland - Workshop Agenda

Before going 15m **GreenSCENT Competence Questionnaire ASSESSMENT** All participants	>GreenSCENT Assessment Questionnaire - ONLINE PLATFORM + GUIDELINES EX ANTE
Workshop / DAY 1	
8:45-9:00 Coffee at meeting room (Inno) **9:00 - 9:15** 15min **WARM-UP & INTRODUCTION** Consortium partners + Teachers	Pres - Greenscent general presentation - WS objectives (journey e test simulation) - WS Agenda
9:15 - 11:00 1h45min **SUSTAINABILITY EDUCATION LEARNING OBJECTIVES +** **LEARNING DOMAIN EXPLORATION** Knowledge graph exploration. Instructional Design: Challenge-based learning activity "Make visible the invisible" Test Skill card Teachers - Lower Secondary 2 - High School 2	1. GreenSCENT Competence Framework: https://publish.obsidian.md/greenscent/ Choose areas of interest > go to 'Climate Change' 2. Test Skill card 'Climate Change' 3. Instructional Design Template d. General information e. Instructional design details f. Implementation [The teachers might also spend more than 2h if needed]
11 - 12.30 1h.30 **INTERFACE CO-DESIGN** Students - High School (17-18 yrs) 4-5 students	Workshop engaging students in co-design of interface and service A4 wireframe templates

12:30 - 13 Lunch	
13:00 - 13:15 15min	Questionnaire Ex ante
13:15 - 14 45min **CHALLENGE-BASED LEARNING** **STUDY EXPLORATION** How student respond to the educational challenge How student document themselves to a particular environmental topic Students - 9 students (14/15 yo) Lower Secondary	Pres - Greenscent general presentation - WS objectives (journey e test simulation) - Learning Challenge (built and presented by the teachers) - How to take evidence to create a story Documentation: - Local Journals - Local News Demo of the interactive documentary 360 app

14 - 15
1h
 	
ON FIELD EXPLORATION WITH APP (TEST & EVALUATION)
Test the early version of Mobile App:
Collecting & reporting evidence on sustainable issues or best practices
 	
Students
- 9 students lower secondary
 	
Coffee and fruits at the meeting room after the field exploration.
	APP + notebook:
	- How to collect multimedia content and how to georeference it
	
	- Smartphones (android)
	
	- Report with notebook (analogue)
	  - Title
	  - Story
	  - Level of importance

15 - 16:00 1h **USER GENERATED CONTENT (DOCUMENTARY)** Prepare an Education Scenario story with pictures and Jumps Students - 9 students lower secondary	Storytelling - A3 papers - Pens & pencils - Jumps (temporal & spatial) Mobile devices to see the collected multimedia resources.

18.00 **Dinner Restaurant Loiste, Kaivokatu 3, 10th floor**	

Workshop / DAY 2	
8:45-9:00 Coffee at meeting room (Inno) **9 - 11** **Teacher Workshop with Skill Cards** Teachers - Lower Secondary 2 - High School 2	Workshop engaging teachers and educational managers in discussing and fine tuning Skill Cards
10.30 - 12.30 2h **WHAT IF… I WOULD HAVE USED THIS APP** **360 DEMONSTRATOR + SHARING CONTENT** Test the GreenVerse towards TIME MACHINE (with Jumps): - Creation of immersive scenarios - Content's production and annotation - Content's sharing (format) Students + Teachers - 9 students lower secondary Presentations of students' work to Teachers **Lunch**	Demo of the app show functionalities 360 Tool: - 3 Pcs with internet connection - Account for the platform Share data from smartphone to pc - Environment composition

After going 15m **GreenSCENT Competence Questionnaire ASSESSMENT** All participants	>GreenSCENT Assessment Questionnaire - EX POST Second iteration

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