P/REFERENCES OF DESIGN

DESIGNERS' COMMITMENT TOWARDS SUSTAINABILITY: CLIMATE CARE AS A CHALLENGE FOR DESIGN EDUCATION.

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ABSTRACT | The current climate crisis poses an urgent need to raise people's awareness to promote a socio-cultural transition towards more sustainable and environmentally friendly lifestyles. In this case, technological innovation becomes a tool to support this change by designing interactive experiences that promote social education for sustainable development. Starting from this, the contribution presents the outcomes of an experimental and participatory workshop that uses the Sustainable Interaction Design (SIxD) approach, for the development of design solutions, capable of increasing people's knowledge, values and attitudes, in order to encourage them to adopt pro-environmental behaviours, through experiential learning and interaction.

1. Introduction

The current climate crisis poses an urgent need to raise designers' awareness to promote a socio-cultural transition towards more sustainable and environmentally friendly lifestyles (Clayton, Schwartz, 2019). Designing artefacts, services, and environments effectively about complex, confusing, uncertain, sometimes overwhelming, and often emotionally and politically loaded, such as climate change, climate extremes, and compound events, is challenging but related to the responsibility of design and education to increase ecological awareness.

This field has rapidly grown with the contribution of numerous disciplines, among which we consider Sustainable Interaction Design (SIxD) (Blevis, 2007; Blevis & Blevis, 2010), which has widened and deepened its scope towards establishing an experimental design-driven and human-centred discipline for motivating behavioural change, also concerning automated decisions that overcome people's awareness. Another impact of SIxD relies on integrating meaningfully rich visualisation of climate change trends with design, pedagogy, experiential and reflective actions about ethical decision-making, and emotional interactions (Clarke et al., 2019).

Starting from this, the contribution presents the outcomes of an interaction design education initiative, the Sustainable interaction Design for Climate Care, that has been developed as a design research and education workshop with the goal to foster sustainable futures. The design education workshop applied participatory, experimental, and collective design research competences to the interpretation of the world as made up of complex human-technology-environment assemblages (Light, 2022). The design education activities described in this contribution have been implemented within the EU H2020 funded research and innovation project GreenScent – Smart Citizen Education for a Green Future, a multidisciplinary project aiming to support and enable European citizens, especially the younger generations, to actively become the main actors of social change for sustainable development and environmental protection through education, citizen science, and civic engagement. GreenScent researchers and educators involved in the project have been engaged in the design workshop activities to answer questions like “Can we build on and expand the trained sensitivity to complexity for understanding complex phenomena through design?”, “Can we make use of design research methods to proliferate the means to make sense of the world?”, “Can we design interactive technologies aimed at fostering awareness, empowerment, culture and social coexistence?”.

In particular, the initiative provided the participant students coming from fields like interaction and experience design, graphic design, communication design, and service design, with concepts, methods, materials to tame challenges like designing systems for mitigating complex socio-technical and multi-layered phenomena (Norman & Stappers, 2015), such as climate change.

This contribution has the goal to increase designers' commitment towards sustainability and ultimately to turn design community culture into care through experiential learning and interaction. Par.2 introduces the two main aspects of the design brief that has been proposed to design students: the climate change challenge as a multi-layered and complex issue, and the Sustainable Interaction Design as the main perspective to take and develop for the education initiative.

2. The Design Brief of Sustainable Interaction Design for Climate Care

2.1 Climate Change as a Challenge

In the last few years, recent climate anomalies provoked by global warming, which have caused the hottest record of modern meteorological history and increased the frequency and intensity of extreme climate events, are the indisputable reality of an increasing climate crisis closest to the tipping point (Loi, 2022; Lovelock, 2020).

Indeed, all catastrophic effects caused by the Anthropocene are accelerating their negative impact on our global ecosystem with significant climatic, ecological and environmental changes that encompass environmental pollution, biodiversity loss, desertification, floods, and rising sea levels, which undermine the survival of all living species, including humans (Clarke et al., 2019; Toni, 2020).

Our society must limit Earth's temperature to 1.5°, compared to pre-industrial levels, to mitigate catastrophic consequences on our lives. This manoeuvre would require the reduction of global anthropogenic carbon dioxide emissions by about 45% from 2010 levels by 2030, reaching net zero around 2050 (IPCC, 2018). Since a significant part of these phenomena arises directly from the accumulation of lifestyles and habits related to an economic-industrial society without limits, the current environmental scenario requires a drastic change of direction, which would foster the social transition from an ecological-cultural point of view (Clayton & Schwartz, 2019).

Furthermore, limiting global warming is not only a matter of environmental justice but also social justice towards the new generations and the most vulnerable and marginalised people who suffer the most severe consequences of the dominant industrial system (Escobar, 2018). For these reasons, it is vitally essential to inclusively equip all people with an integrated and holistic approach to sustainability education to untangle and deconstruct the logic of the present and critically reflect on the values, beliefs, and visions that affect the today's technocratic and anthropocentric world, aiming at co-constructing new shared meanings that can contribute growing more accessible, equitable, and environmentally friendly societies (Cebrián & Junyent, 2015; Thackara, 2006).

2.2 Sustainable Interaction Design as a Critical Perspective

Within this scenario, the field of Human-Computer Interaction (HCI) can take on a significant role in supporting and promoting a new social transition capable of increasing people's knowledge, values, and attitudes towards a more sustainable future. That can happen through the construction of new relationships with digital technologies that go beyond the idea of evaluating interaction design as a simple bridging discipline for communicating with machines and of considering it more as a cultural phenomenon capable of transforming anthropocentric design principles and practices into a more responsible approach that relies on climate cure (Light, 2022).

This perspective can find great support in Sustainable Interaction Design (SIxD), i.e. a recent design movement that uses the complex concept of environmental sustainability as a critical key to rethinking the role and outcomes of those design practices that focus their objectives on ideating and developing interactive technologies (Blevis & Stolterman, 2007). As defined by Mankoff and his colleagues (Mankoff et al., 2007), two macro design principles are the backbone of SIxD:

Sustainability through Design: this principle uses interactive technologies for behavioural change that promotes sustainable decision-making processes and lifestyles. It can intervene both at an individual level (for example, making environmental data tangible to encourage people to increase their awareness in improving their ecological footprint) and at a public level, the aim of which is to allow a social movement, collective actions, and a long-term cultural change for advocating environmental sustainability (for example, simulating or predicting the long-term consequences of improper use of fossil fuel transportation or poor waste management).

Sustainability in Design: this principle focuses on promoting responsible design processes and practices for environmental sustainability to limit those technological developing systems implied in producing new physical products and hardware that could have a material impact on the environment, according to practices of minimising material content and consumption, increasing energy efficiency and extending the product life cycle to reduce potential scraps and discards at a minimum.

The objective of the proposition of the Sustainable Interaction Design for Climate Care education initiative is to embrace the principles of participatory and experimental design concerning the creation of interactive

training experiences based on technology-enhanced learning, which are promoted to encourage people to adopt and include pro-environmental behaviours (PEBs) within their lives in everyday society.
The GreenSCENT project framework to provides students participants with examples of hybrid scenarios capable of intertwining the interdisciplinary learning approach of Education for Sustainable Development (Cebrián & Junyent, 2015) – consisting of prioritising competencies such as problem-solving, critical and systemic thinking, and ethical decision-making and behavioural processes – with accessible and inclusive narratives and interactions that enrich the quality and engagement of the user experience.

3. The Sustainable Interaction Design for Climate Care Workshop

3.1 Workshop Methodology

This contribution highlights a particular experimental and participatory design research conducted within the program of annual summer workshops organised and promoted by the Department of Design at the University of the Republic of San Marino. On that occasion, the researchers organised an intensive co-design laboratory on topics related to SIxD for climate care involving 20 students from different Bachelor and Master Degree courses in Design from all over Italy. The entire workshop lasted five working days from Monday to Friday, in which the researchers structured the activities into a strict set of lectures and theoretical and practical activities (Figure 1).

Time Schedule

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
9:30		**Lecture 03**	**Workshop**	**Workshop**	**Exhibit development**
10:00		**Lecture 04**	Group presentation	UI Concept development	Poster Preparation & Print
11:00	**Brief Presentation**		Concept development - Interactions - User Experience - Service & Technologies		UI Prototype DEMO Preparation
11:30		**Workshop**			
12:00	**Lecture 01**	Concept generation - Cycle 3	Scenarios > Interactions > Flows		
13:00					
14:00	**Workshop**	Design Concept development:			
15:00	Concept generation - Cycle 1	- Presentation - Concept assessment - Ratings - Concept evolution	Scenarios > Interactions > Flows	UI Concept refinement and validation	**Final Exhibition**
16:00	**Lecture 02**		UI Concept development		
17:00	Concept generation - Cycle 2	Expression of interest > Group creation			
18:00					

Figure 1. Workshop time schedule.

The close collaboration between the participants generates the opportunity to conceive and prototype tangible design solutions aiming at increasing ecological awareness and pro-environmental behaviours. Starting from a short introductory brief in which the research team presented the purpose of the Sustainable Interaction Design for Climate Care education initiative, the same researchers introduced and described the specific objectives and expected outcomes of the workshop. Specifically, the introductory part of the workshop explained to the participants the design methodology they would have adopted during the design process, which was based on design challenge-based learning (Blevis, 2010). This methodology, which lays on the studio-style learning approach, uses a combination of learning strategies such as:

- promoting collaboration;
- encouraging public critique and engagement in peer learning;
- ensuring that thoughtful problem-setting precedes problem-solving;
- fostering transdisciplinary, values-centred goals.

The entire design process divided the laboratory into three macro theoretical and practical modules or activities to develop the project:

- lectures;
- concept generation;
- interaction design concepts prototyping.

The first two macro activities were carried out in the first two days of the workshop. At the same time, the third and most important activity was carried out in the three remaining days that have concluded the laboratory. The proposed design education activities are described in detail in the following sections.

3.2 Design Education 1 – Lectures from the Experts

Over the first two days, this first macro phase provided a series of lectures' and insights conducted by four different experts in the fields of physical geography, behavioural psychology, energy and environmental engineering, digital media accessibility, and responsible innovation for society. Such a diverse panel of researchers allowed participants to acquire fundamental knowledge and skills to address the complexities of issues related to climate change and sustainability through a transdisciplinary perspective. Furthermore, the topics exposed by the various lectures served as theoretical content to support the concept design activity, aiming at helping participants devise design solutions capable of addressing environmental issues related to sustainability and, at the same time, encouraging pro-environmental actions associated with climate care.

During Day 1 and Day 2 the workshop hosted four lectures. That provided specific skills and design ideas that were as consistent as possible with the objectives of the overall research project. In particular, the lessons concerned the following research topics:

- "Climate change: the urgency for a change and a challenge for the future", Prof. Biljana Basarin, Department of Geography, University of Novi Sad, Novi Sad, Serbia;
- "Pro-environmental behaviours", Dr. Raffaele Barresi, Faculty of Psychology, International Telematic University UNINETTUNO, Rome, Italy;
- "Sustainable because Accessible: Inclusion & Diversity", Dr. Sarah Anne Mcdonagh, TransMedia Catalonia, Universitat Autònoma de Barcelona, Barcelona, Spain;
- "Responsible Research and Innovation", Dr. Zarrin Fatima, VTT Technical Research Centre, Helsinki, Finland.

3.3 Design Education 2 – Iterative and Collective Concept Generation

As for the first module, the second activity was conducted in the first two days of the laboratory through two main phases, which allowed the students to creatively generate different design concepts that offered valid solutions for climate care. The first phase was characterised by an intense brainstorming sessopm, which generated a collective mind map in which each participant individually collected and sorted numerous themes, trends, and keywords on sustainability that consequently allowed the students' groups to define the design challenges associated with raising awareness on the urgency of environmental sustainability.

All the design challenges have been identified and collected around eight specific areas of intervention that coincide with the strategic objectives of climate neutrality pursued by the European Green Deal: 1. Climate Change, 2. Clean Energy, 3. Circular Economy, 4. Green Buildings, 5. Smart Mobility, 6. From Farm to Fork, 7. Biodiversity, 8. Zero Pollution.

In particular, design students' groups identified a series of critical issues related to human factors like intrinsic motivation for behavioural change, the role of personal values, the influence of community and group culture. Afterwards, in the second phase of the module, the students associated the design challenges with a divergent design phase of generating future concepts. This last phase adopted the speculative design approach (Dunne & Raby, 2013), which enabled students to imagine possible and alternative technological educational experiences that could solve specific environmental challenges, aiming at encouraging and promoting sustainable solutions for climate care.

In order to facilitate the design concept reporting and documentation of each group design process, the research team provided everyone with paper-based graphic templates to collect and describe all functional, technological, and morphological characteristics of each generated concept. Subsequently, the students clustered all the concept solutions through card sorting based on common areas, characteristics, and keywords on a whiteboard. That process created a collective design space to encourage collective design critique to validate, improve, and/or integrate the proposed solutions (Figure 2). The second module included a further brainstorming cycle and two iterative concept generation and refinement cycles. This last phase concluded in the afternoon of the second day with a definitive design concept development process, where the students presented, discussed and voted on all the final solutions that emerged during the whole concept generation activity. At the end of the voting, the research team divided the students into four groups of four people each. Every group selected a concept among those that received the most interest in being developed and prototyped it in the third phase of the workshop.

Figure 2. Image representing the idea concept generation process for documenting students' ideas and design concepts.

3.4 Design Education 3 – Interaction Design Concept Development and Modelling

The third phase of the research team conducted this third phase of activity in the last three days of the workshop. That module allowed participants to carry out a converging and synthetic design activity, which enabled students to transform the most promising concepts – selected in the previous module – into more defined and tangible design solutions through developing mock-ups and functioning digital prototypes. To study and define all interaction principles and models, and the functional characteristics of each design project, the researchers proposed the students adopt the scenario-based design method. That approach enables designers to report relevant user experiences that show representative cases of real-life situations, which expresses in detail the actions performed by the end-users while interacting with a specific context through a step-by-step description (Carroll, 2000; Rosson & Carroll, 2012). According to the purposes of the workshop, the students represented user scenarios where specific challenges or problems related to sustainability education occurred and were resolved by envisioning possible design futures.

The students envisioned interaction scenarios by adopting at first the visual form of the storyboard (Carroll, 2000) and then the prototyping define and implement the role and look-and-feel of the projects. Once the technological, aesthetic, and functional properties and interaction principles were defined, the students transformed their design into concrete working interface prototypes. Although there were only three days to develop the projects concretely, with the help of the researchers, the participants had the opportunity to validate the functionality and usability of their solutions through a quick interactive and iterative cycle of testing and measurement of the results achieved (Rizzo et al., 2001).

To conclude the work process of design education, all four projects were presented and exhibited by the students in a public plenary presentation in a small exhibition within the university, which involved other students, teachers and external visitors. The presentation consisted of a description of the projects depicted on an A2 presentation table – where students showcased their objectives, interaction scenarios and interface mock-ups – and a demonstration of the interactive prototypes.

4. Results of the Design Workshop

4.1 Design Projects

The final results of the research and design experimentation were represented by design projects, which, in turn, guided them in developing interactive prototypes inspired by SIxD principles. All the final projects open a critical reflection around four themes related to climate care: biodiversity, zero pollution, circular economy, and climate change, which arose from the future scenarios and concept generation and prototyping. The four research projects conceived during the design process of the workshop are described below.

4.2 First Project – B-Place

The B-Place mobile application offers a community-based service based on collaborative and participatory social innovation, which aims to promote travel experiences with reduced environmental impact from a bottom-up perspective (Figure 3). The digital platform aims to facilitate sustainable mobility and ethical and conscious consumption by providing users with an AI-based service that evaluates and compares different destinations to each other according to the degree of sustainability generated by their travel offers.

The level of environmental impact of a given location is generated by an algorithm that combines:

- A quantitative data analysis consisting of open-source environmental parameters deriving from meteorological and air quality stations presented in the local area,
- A qualitative data analysis produced by the reviews by the travellers, which take into consideration a series of evaluation parameters, such as the air quality and liveability of the place, the availability of urban green spaces and the sustainable mobility services, the use of clean energy and the zero-mile power supply provided by local facilities, and the presence of sustainable products and services based on circular economy.

In that way, this open and spontaneous sharing of information allows users to plan their travel itineraries by responsibly choosing many factors, such as sustainable transport, services, and facilities that the community recommends or even provides on the application as a responsible alternative to fast travelling.

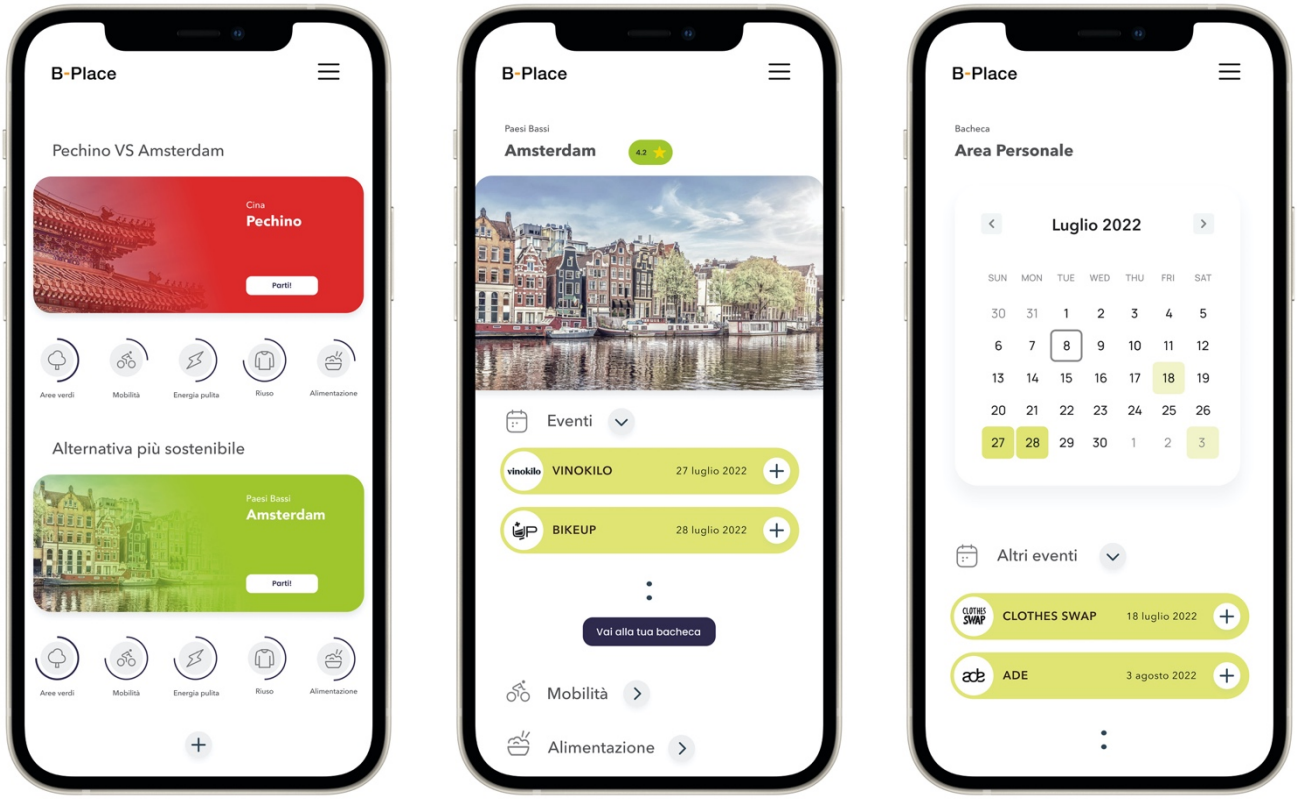

Figure 3. Interface mock-ups of the B-Place project.

4.3 Second Project – 123…Earth!

The 123...Earth! design is a relevant example of design for children approach that aims to raise awareness among young generations through hybrid narratives and mobile experiences that allow children to understand and touch the emergency of the climate crisis first-hand (Figure 4). The goal is to develop a multi-sensory experience based on the interaction with a personal teddy bear, which acts as the main character in a Augmented Reality (AR) based storytelling. The teddy bear is thought to demonstrate a tale by mean of a conversational interface. Through personal dialogue with it, the system stimulates reflective learning by requiring kids to take notes of their daily pro-environmental actions, as it is a personal diary capable of recording users' everyday behaviours.
Based on the choices made by the young, the system compares them in relation with those of other online

users to calculate the expected consequences of particular behaviour on the environment at a collective level.

Furthermore, by using some principles of gamification, 123…Earth pushes children to improve themselves and acquire new sustainable skills, collaborating, aiming at overcoming daily challenges that encourage sustainable development (for example, reducing water or energy consumption by carrying out daily environmental activities such as turning off lights when they are not needed or not wasting water for brushing teeth).

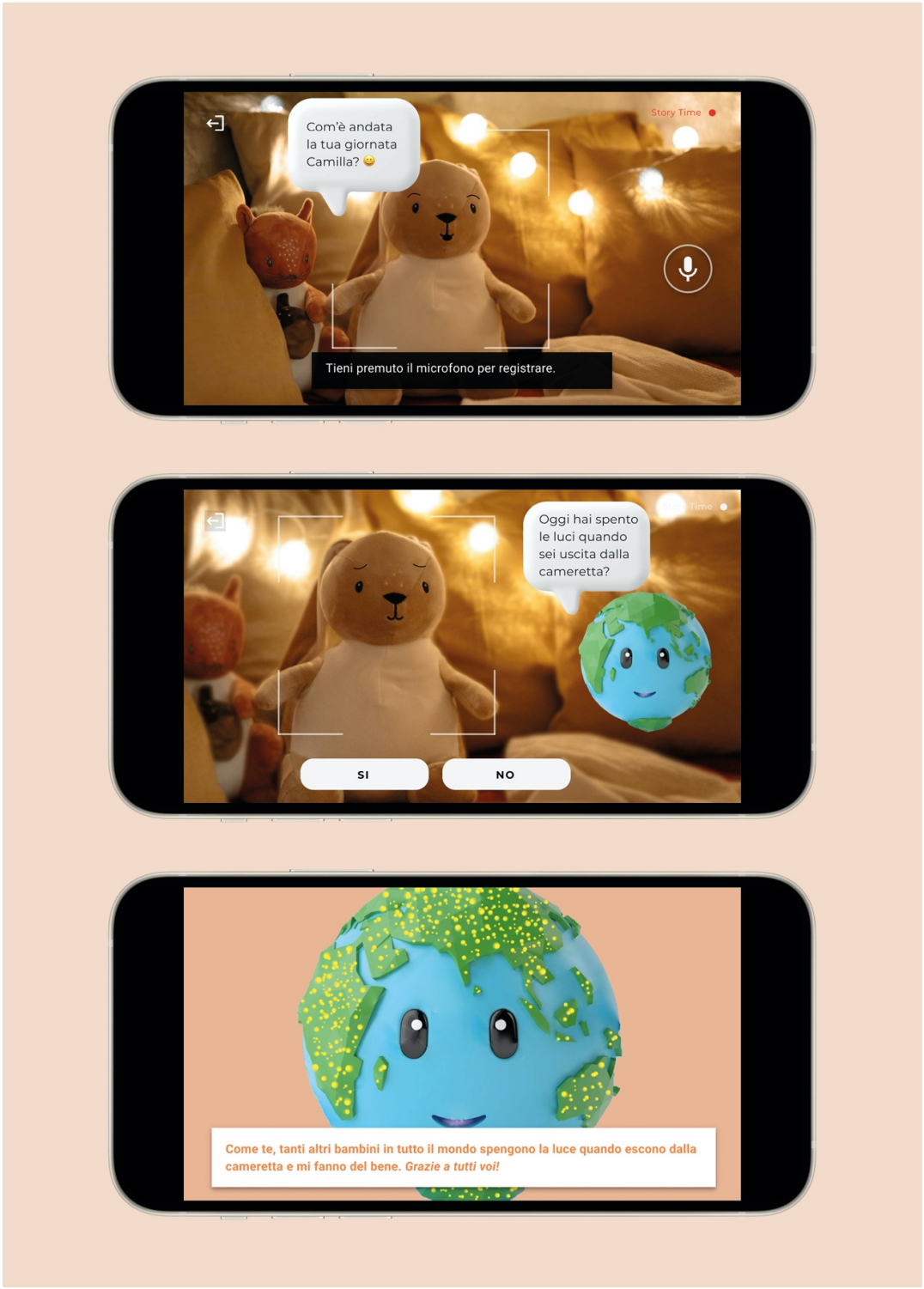

Figure 4. Use case scenario of the project 123…Heart!.

4.4 Third Project – Focus

Focus is a mobile app that explores the biodiversity loss caused by the negative impact of anthropocentric activities on natural ecosystems. In particular, the service aims to increase citizens' awareness of digital pollution through AI-based services. That is a sensitive argument nowadays even though not properly addressed as a source of environmental pollution because invisible and intangible to the users: for example, it is difficult to make it evident in the act of sending an email or uploading a post on a social network. It is hard thus to increase the appropriate awareness of each individual on their behaviour in the digital world.

The service offers a hybrid educational experience that takes place by scanning the photo of specific local vegetable or animal species through the app, from which the users can trace and display all the values relating to its taxonomy and its risk of extinction. Focus will display photos of endangered animals or plants in specific spots of an urban location that are easily visible and accessible to all citizens who wish to engage with the mobile app.

Once the image has been scanned, an image recognition and web crawling service provides the user with the extinction rate of a given species and visualise that through the graphical resolution rate of its corresponding image (Figure 5). The resulting graphic effect, that negatively or positively affects the quality of the image, is therefore proportionally influenced by the percentage rate of extinction of the scanned animal or plant. The greater the degree of extinction of the given species, the greater the degree of pixelation of its image. The species of a given habitat are interconnected with each other as well. So, users can observe how the loss of a species can inevitably compromise the survival of the remaining species annexes.

Furthermore, to stress the urgency that affects the degradation and fragmentation of natural habitats caused by global warming, the system can simulate the loss of biodiversity in a specific local area in the short- or medium-term period by visualising a georeferenced map associated with a timeline.

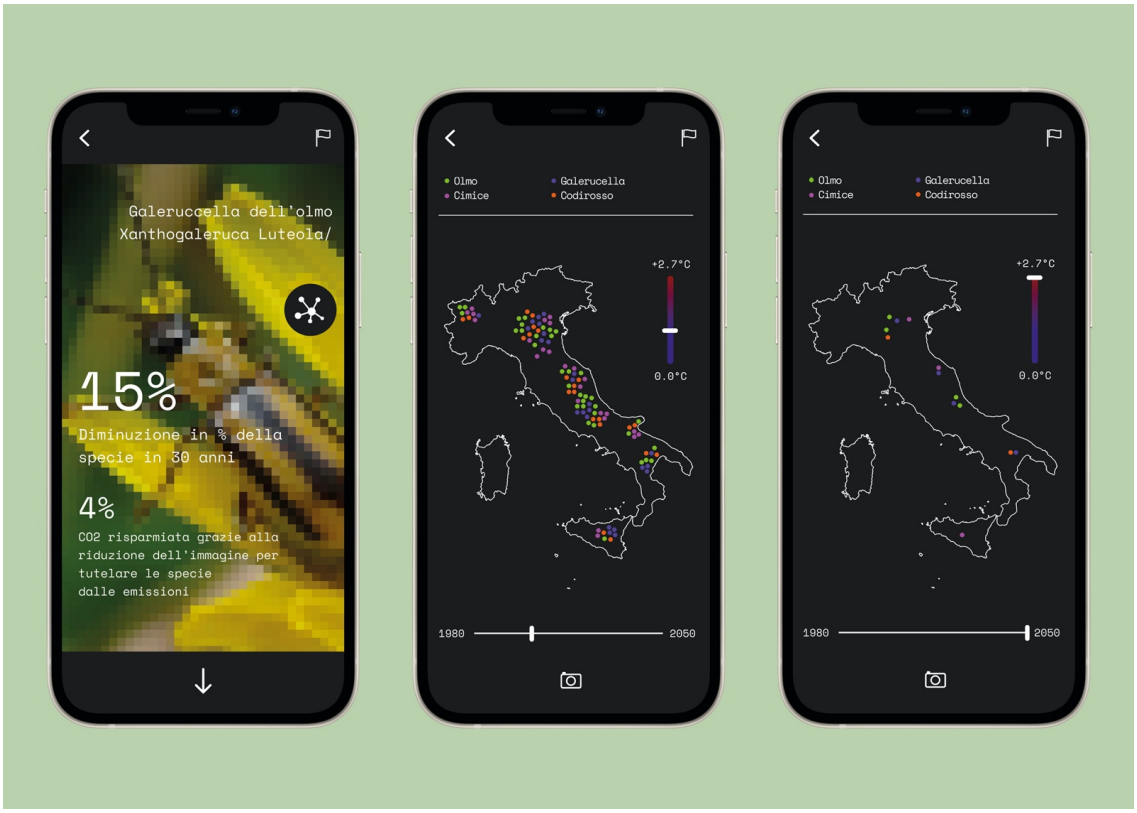

Figure 5. Interface mock-ups of the Focus project: The effect of pixelation emphasises the percentage of extinction of a specific animal or vegetal species.

4.5 Fourth Project – How Much Does it Cost for Us?

How Much Does it Cost for Us? proposes an AI-based mobile app that analyses human decision-making responsibility on conscious consumption choices through a more-than-human perspective in which man lives in an ecosystem that is increasingly interwoven and interconnected with autonomous agents and smart things that give rise to increasingly sustainable, augmented, and intelligent new interactions (Giaccardi & Redström, 2020). Specifically, starting from Lovelock's speculative vision of the Novacene (Lovelock, 2020), namely the era where artificial intelligence permeates everyday life, completely autonomous and intuitive artificial agents become assets that contribute to resolving the problems of climate change by removing human awareness of the climate care equation.

In this case, the prototype explores the idea that human irresponsible behaviours towards environmental care may have no relevance for a sustainable future any more because of that issue will be solved by hyper-intelligent machines – as already happens among the living species of our biosphere – that will be able to adopt resilient and mitigative strategies to regulate the terrestrial ecosystem.

Based on these considerations, the prototype explores and traces new and innovative interaction scenarios between human and technological artefacts in the domestic context.

The project concerns the development of an AI-based plug-in specifically designed for home automation systems such as Alexa, which autonomously manages the consumption on behalf of the users, providing them with affordances and constraints for the action that are designed for making them reflect upon home sustainability. In that case, the plug-in maintains the household carbon footprint within the correct thresholds of environmental sustainability dynamically and adaptively based on the changing situations occurring in the home environment.

However, How Much Does it Cost for Us? seeks a peculiar solution to support users' pro-environmental awareness through daily training. The educational approach occurs through a constant negotiation of decisions with the users, in which each individual is encouraged to reflect on the detriments of their irresponsible actions and, therefore, to adopt virtuous and sustainable behaviours towards the environment (Figure 6). The app monitors the users' daily domestic consumption through the home automation system. If the AI intercepts negative consumption behaviours – for example, the under-load of the washing machine – it temporarily stops human action and invites the users to negotiate their behaviour and to encourage them to make responsible and sustainable decisions. If the users maintain correct and efficient behaviour, the AI supports their actions by showing data and infographics highlighting the reduction of their CO2 emissions.

Figure 6. An interaction scenario of the How Much Does it Cost for Us? project in the form of visual storytelling.

5. Discussion

The reflections and educational design experiences reported so far highlight the urgency of a substantial change in our lifestyles to promote climate care, which will have to pass through a profound rethinking of the educational paradigms and principles if modern society wants to foster sustainable development. That will aim to become a framework of integrative and multidisciplinary education for behavioural change, which can be adopted and shared at a systemic level by all individuals and social and institutional groups. Specifically, the potential of design-driven approaches for climate care action can take advantage by integrating data-driven explanatory models and AI-based solutions with user-driven approaches. This will enable the definition of intelligent systems for awareness raising, emotional, moral and cognitive engagement, and self-efficacy in introducing behavioural change and novel habits thorugh new interactive artefacts (Garito et al., 2021; Lovelock, 2020).

The results that emerged from the educational experience outline many design values linked to SIxD that can make human-machine interaction more effective in increasing the learning process of pro-environmental behaviours. Final reflections are described here below.

5.1 Making the Invisible Visible

Through the use of data, SIxD must develop design solutions that make those intangible aspects imperceptible to humans visible, such as visualizing complex phenomena related to climate change, predicting the outcome of particular personal decision-making choices or simulating the side effects of anthropocentric development on the planet (Blevis & Blevis, 2010). The proper use of storytelling can support the subjective experience of the interaction by displaying clear evidence of the phenomena objectively and concretely to avoid users generating the formulation of bias or preconceptions on specific assumptions on environmental sustainability.

5.2 Responsible Training

If sustainability is considered a lifelong learning journey (Cebrián & Junyent, 2015), educational training experiences based on SIxD need to sustain their values and principles over time to constantly support people in integrating pro-environmental practices into their everyday practices. For example, products or services that make visible that each of our actions is interconnected to a broader system of ecological interactions are significant solutions that can encourage people to carry out, in many of their habits, only actions that have positive scalar effects on a given environmental problem. In the same way, interactive experiences based on coaching or training that encourage people to compare multiple behavioural choices and habits can increase people's awareness of adopting pro-environmental decisions as they can constantly stimulate people's decision-making process during their routines.

5.3 Sense of Belonging

The SIxD strategies must elicit behavioural change through emotional communication that sensitizes individuals to acquire empathy towards global and collective problems of climate change relating to care and respect for the planet with the same level of attention that we adopt for ourselves (Light, 2022). To do that, products and services must provide engaging experiences that make users feel connected to other people through the same interests, attitudes, or environmental issues to elevate the active participation and collaboration of individuals in a broader social coalition, which can increase climate care collectively (Dourish, 2010; Manzini, 2015).

6. Conclusion

The Sustainable Interaction Design for Climate Care Workshop as been conceived as a design education method for University students with the goal of engaging them in tackling the entropy of our post-modern ecosystems and to exercise with complex systems design, often requiring to reflect upon social, technical and environmental components of our experience in the world.

Interaction design has been centred on information technology and computing innovation from its foundations as an autonomous discipline. The workshop allowed the design students to both get acknowledged about technologies such as Artificial Intelligence and Augmented reality and to design the appropriate interaction and interface models, within the situation of their future design scenarios.

The education initiative taken by the authors wanted to experiment with a workshop arrangement for:

- engaging design students in dealing with complexity as a paradigm for learning systemic, critical and transformative design research;
- committing design students in environmental sustainability and climate care, with the goal of developing their sense of ownership, responsibility and accountability towards the planet survival;
- reaching out a broader audience of those that will be engaged by the design students' work, meaning leveraging upon their design to raise awareness on climate care and to create an impact on the local communities.

The Sustainable Interaction Design for Climate Care Workshop implemented a project-based and challenge-based one-week residential design education centred on teaching, practising and improving the quality of design research methods. Interaction design didactics is thought to benefit from the application and critical revision of methods related to research and study, design concept and design critique, as well as prototyping with digital and material forms, in view of design project improvement.

To conclude, the research shows how SIxD can have a strategic role in increasing designers' commitment towards sustainability because it enables technology-enhanced learning to provide meaningful digital and hybrid experiences, which support experiential and reflective learning, stimulate and support awareness and individual decision-making actively, and promote collective participation to generate common critical thinking that can address the challenges of the climate crisis by contributing to more responsible and sustainable social and cultural progress.

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