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PRACTICE INSIGHTS

Decide your Print, a workshop to foster systemic thinking about sustainability

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Abstract

The workshop “Decide your Print” engages high school students outside of classroom settings, with sustainability challenges, focusing on fast fashion’s socio-technical systems. Using collaborative decision-making and systemic analysis, the activity fosters understanding of sustainability’s interrelated dimensions — socio-ecological, technological, political, economic. Combining dialogue, evidence-based education and participatory approaches, it promotes critical thinking and actionable solutions. Conducted at the 2023 Genoa Science Festival in Italy, the workshop aimed to empower participants to propose multi-level strategies, showcasing the potential of informal education to address sustainability through interdisciplinary learning and systemic reasoning.

Keywords

Environmental communication; Informal learning; Public engagement with science and technology

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1 ▪ Introduction

Science festivals are increasingly shifting from being a "celebration of STEM" in order to engage non-specialists with science [Bultitude et al., 2011] towards occasions for discussion with the wider public around critical issues at the intersection of science, technology and society [Navas Iannini, 2023; Kerr et al., 2022; Ramsey & Boyette, 2021]. As platforms where the purposes and methodologies of science communication often cross those of informal education [Balestri et al., 2022; Bell et al., 2016; Ramsey & Boyette, 2021; Strick & Helfferich, 2023], science festivals have broadened their goals under the influence of the themes and interests of the 2030 Agenda's Sustainable Development Goals (SDGs), particularly SDG 4.7.

Indeed, sustainability topics are increasingly central in science communication settings, such as science festivals, due to their potential to promote engagement of younger groups, who are fundamental targets for sustainability communication [Bättig-Frey et al., 2023], because they are the "first generation" to experience the direct effects of climate change and they are the agents potentially able to catalyse the transformative sustainable change [Thomaes et al., 2023].

In recent decades, sustainability communication has been recognized as an independent research area within communication studies, aimed at introducing an understanding of the human-environment relationship in social discourse [Mauser et al., 2013]. This objective aligns with efforts, particularly in the educational field, aimed at achieving sustainability literacy. This concept focuses on providing the knowledge and skills necessary to empower individuals to critically analyze the local and global relationships between the economy, environment, and society [Lang et al., 2012; Perkins et al., 2019; Stibbe, 2009]. This is supposed to be addressed through transdisciplinary and participatory approaches [Leicht et al., 2018], that: 1) deepen sustainability competencies preparing students to address sustainability issues in complex and interconnected systems [Brennan et al., 2020; European Commission, 2015; Green et al., 2022; Kioupi & Voulvoulis, 2019; Marcos-Sánchez et al., 2022; UNESCO, 2020]; and 2) empower students as active participants in sustainable development efforts in order to make them able to understand both the immediate and long-term implications of their decisions [Wiek et al., 2011; UNESCO, 2020].

Against this framework, science communication can provide useful tools for engaging the public with sustainability issues, especially if a dialogue — and a participation-centered approach is adopted. Dialogue and participation represent two models of public communication of science which contribute to redefine the relationship between science and society [Navas Iannini, 2023], and which increasingly accompany, even if not replacing the information transmission model, or so-called deficit model [Bucchi & Trench, 2021]. Dialogue includes experiences that can be very different [Bucchi & Trench, 2016], but that are all characterized by two-way interactions, discussions, and mutual learning [Navas Iannini, 2023]. Participation however entails increased citizen engagement, actively shaping the interpretation and construction of scientific knowledge and governance [Bucchi & Trench, 2016].

Despite the recognised need for a holistic lens, both science communication and informal education about sustainability exhibit several limitations. Firstly, researchers have identified a notable absence of systematic and interdisciplinary approaches when investigating forums dedicated to public involvement in science communication settings [Delicado, 2004;

Ramsey & Boyette, 2021; Campos et al., 2021; Peterman et al., 2020]. In our own investigation of the past five years of programs at Italy's main science festivals, Genoa Science Festival[1] and Futuro Remoto Science Festival,[2] we found that out of 147 sustainability-related workshops, only 39 offered a multidisciplinary perspective, addressing at least two aspects of the Triple Bottom Line, which includes economy, society, and environment [Stanitsas et al., 2019]. Indeed, workshops organized by STEM institutions that were focused on the role of technological innovation (regarding chemistry, engineering, biology, environmental sciences) in sustainable processes, often overlooked the complexity inherent to sustainability issues.[3] Secondly, concerning science communication tools, a review of serious games found that while many focus on Sustainable Development, they often only cover part of sustainability's Triple Bottom Line [Stanitsas et al., 2019]. Most sustainability-themed games adopt behavioural approaches [Douglas & Brauer, 2021], aimed at changing individuals' behaviour with respect to environment-related choices from their own private sphere. This approach is also prevalent in environmental education frames [Hadjichambis & Paraskeva-Hadjichambi, 2020]. While many scholars have recognised this as a limitation [e.g. Schild, 2016; Barry, 2006], it is also clear that definitions of sustainability literacy tend to reference knowledge that fosters "the ability to engage intellectually and personally to improve on the environment, economics, and equity" [Perkins et al., 2019]. To avoid delegating the solution to sustainability-related problems only to individuals' actions, it is essential to promote approaches that help people understand how sustainability-related problems are interrelated, including the interconnections of the impacts of the individual and policy choices at a local, national and global scale [Jordan et al., 2023].

To respond to these gaps in engagement experiences both in science communication and informal education about sustainability we designed, we designed the workshop entitled "Decide your print. What style do you give to the world in transition?" (DyP). The workshop's name was inspired by the 2023 Genoa Science Festival theme, "Footprints". This title reflects the decision-making role that is central to the workshop experience, and the workshop's two focus areas: sustainable transition and fast fashion industry.

The workshop was designed to enable participants to frame sustainability as a complex social phenomenon and to foster students' system thinking capability, meaning the ability of "understanding complex interrelationships among the dimensions of sustainable development and the impacts of the interrelationships" [Williams et al., 2017]. To do this, we followed a key principle in game design for science communication: convey messages primarily through game mechanics, not text [Illingworth & Wake, 2021]. In our case, workshop mechanics mirror the sociological approach of socio-technical systems [Geels et al., 2017]. This approach examines sustainability phenomena by defining their various subsystems (socio-ecological, technological, political and economic) and studying the dynamics within each of them.

To enhance complex thinking, we decided to combine in the DyP workshop the three models of science communication as suggested by Navas Iannini [2023], through the following steps: 1) promoting conversation and reasoning about values (dialogue model), 2) providing

1. More information about Genoa Science Festival are available at http://www.festivalscienza.it (last accessed 29 January 2025).
2. More information about Futuro Remoto Festival are available at https://www.futuroremoto.eu/ (last accessed 29 January 2025).
3. The dataset of our programme analysis is available on Zenodo: https://zenodo.org/records/11083976.

evidence about sustainability (information transmission model) and 3) establishing the conditions, even in a fictitious context, to encourage people to make decisions about issues that mattered to them (participation model).

This practice insight aims to:

1. Revisit the workshop's design and the insights gathered from the participants during the workshop and from the researchers' notes.
2. Reflect on the dynamics of knowledge exchange and engagement between participants and social scientists, considering the difficulties in combining approaches from the three science communication models.
3. Examine how the proposed format can serve as a methodological tool for introducing the concept of sustainability in the fashion industry to a school-age audience in a systemic manner in public communication settings.

2 ▪ Methodology

This practice insight is developed according to foundational principles of Design-Based Research: integration of design and research, contextual learning, iterative cycles and collaborative effort [Barab & Squire, 2004]. It responds to the need of the team of researchers and practitioners for a collective reflection around the conceptualization, application, and refinement of the workshop's contents and objectives and of its positioning within the framework of the existing sustainability science communication tools.

The workshop was designed between February and October 2023 by a team composed of science communicators and several social scientists with expertise related to the social studies of gender, risk, and sustainability. A pretest was performed in a high school in Rome (with 18 students aged between 16–17 years), based on the feedback received, the team made modifications to the content of the materials (adding cards with examples of NGOs involved in blockchain tracking in clothing, as well as communication campaigns targeting adolescent, and simplifying the wording of some of the cards) and the organisation of timing in the various phases.

DyP was officially performed at the Genoa Science Festival in November 2023, over 2 days for a total of 5 sessions of two hours each, involving a total of 120 students (14- to 19-year-olds).

The insights we consider here derive from the qualitative analysis conducted by three of the social scientists involved in the workshop, based on participants' responses to two initial questionnaires via Mentimeter, from the researchers' ex-post notes on the main themes that emerged in the discussion tables, and from the proposals developed on the Miro platform and the notes on the ensuing discussion.

3 ▪ Workshop design and gathered insights

This section is based on the description of the workshop design and on the insights gathered from the participants during the workshop and from the researchers' notes, to highlight and revisit the main aspects of the workshop design.

The workshop was structured into 3 phases. Each phase pursued a specific objective and was characterised by a different mode of public involvement. The workshop's format revolved around Play Decide, a framework for developing games based on collaborative decision-making, where participants are provided with elements to learn and reflect through cards, featuring facts, issues, and narratives to articulate their perspectives on a specific policy. Decide games enable players to engage in debates and navigate complex issues, taking into account various perspectives, and to refine their own opinions.

Decide your Print (DyP) was developed as a public engagement activity within the Horizon Europe project gEneSys — Transforming Gendered Interrelations of Power and Inequalities in Transition Pathways to Sustainable Energy System. The project investigates the social and gender inequalities within 4 main socio-technical systems that compose the energy system: socio-environmental, political, economic and technological. Socio-technical systems are interacting with ensembles of engineered artifacts embedded in society, linked with economies, and connected with ecology [Siddiqi & Collins, 2017]. Examples of socio-technical systems differing in purpose are telecommunication networks, electric grids and large-scale manufacturing systems [Siddiqi & Collins, 2017]. The complex interactions of humans, technologies and natural resources embedded in the socio-technical systems can have negative, neutral or positive impacts on sustainability [Gebler et al., 2022]. The fashion industry is a pertinent example of how these subsystems operate in an integrated manner with impacts that span from the individual to the global scale [Dzhengiz et al., 2023]. In this sense, the topic of Fast Fashion (FF), which is the focus of this study, is particularly well suited to illuminating the complexity of choices regarding sustainability transitions, understood as long-term, multidimensional, and fundamental transformation processes through which established societal systems shift to more sustainable modes of production and consumption [Bidmon, 2023]. FF is a production and consumption model that is based on the rapid release of garments onto the market with very low prices obtained from savings in every production segment, which exacerbates all the environmental and social impacts of the fashion value chain, from production to distribution to consumption [Niinimäki et al., 2020].

The first phase aimed to actively engage participants in the workshop theme, arousing their interest and activating their reflexivity on FF and sustainability. Firstly, participants accessed the Mentimeter software from their smartphones to respond to questions about their consumption behaviours, knowledge, and attitudes towards FF (Figure 1).

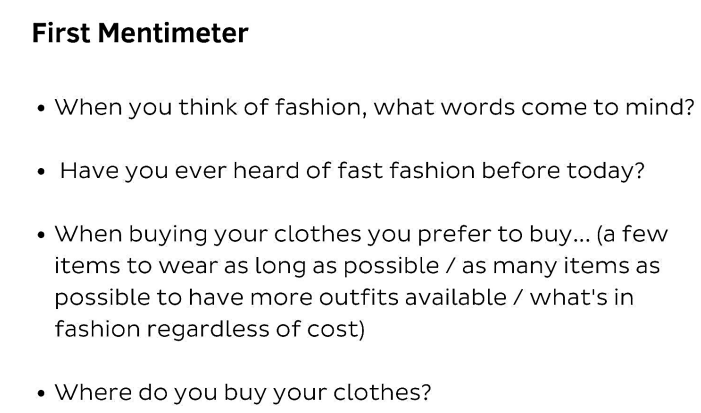

Figure 1. First Mentimeter test.

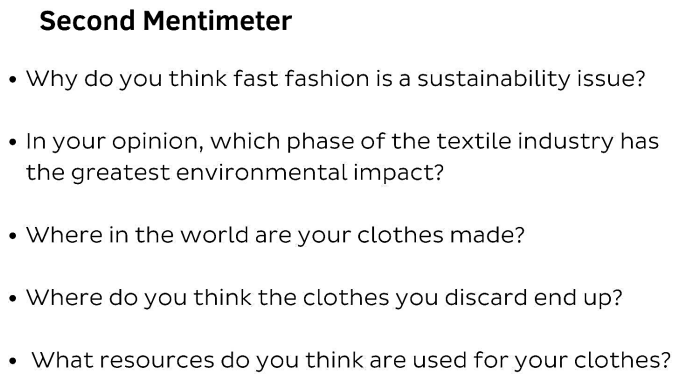

Figure 2. Second Mentimeter test.

Then, participants, science communicators, and researchers briefly commented on the responses that were visualised as histograms and word clouds.

After this, participants watched the first video "What is Fast Fashion" created specifically for the workshop in order to present a common understanding of FF as a social phenomenon.

Afterwards the organisers moved to frame the topic from analysis of the individual knowledge and behaviours to a discussion on the broader social, political and environmental implications. A second set of questions prompted the reflection on the relationship between FF's value chain stages and sustainability (Figure 2). Then, the responses were displayed and briefly commented on.

Finally, the video "Fast Fashion and Sustainability" was shown to provide answers to the questions previously posed to the participants by presenting, through data and images, the main socio-ecological implications of FF.

Some interesting aspects emerged from the answers given to the Mentimeter quizzes. Interestingly, the majority identified environmental concerns, like resource use and transportation, as the most pressing issue when it comes to FF. Labour exploitation also emerged as a relevant theme. Participants did not perceive consumption behaviours as having a major environmental impact in the fashion value chain, despite its economic importance. Instead, they focused on production and disposal as the most impactful phases. This suggests a gap in understanding of the interconnection between different stages in the fashion cycle.

After this initial phase where the main concepts and common language related to FF were collectively built, we moved on to the second phase of the workshop dividing up the audience in 4 discussion groups. Each discussion group has the task to observe the implications of FF from the perspective of its subsystems and then propose potential solutions to reduce its impact. This part was structured following the PlayDecide model,[4] with some changes to adapt the Decide model to our goals: the 4 discussion groups, in fact, did not discuss a specific policy but reflected the 4 subsystems of FF (socio-ecological, technological, political, economic).

Participants were randomly assigned to one of the subsystems with the task of observing the implications of FF from different perspectives and then propose potential solutions to reduce

4. https://playdecide.eu/about.

Figure 3. Example of question card (socio-environmental table).

Figure 4. Example of informative card (socio-environmental table).

its negative impacts. Each discussion group was equipped with materials designed to navigate the complexity of the issues at stake: a) question cards for each subsystem with the function of activating the discussion (Figure 3); b) informative cards for each subsystem providing useful data for the development of proposals (Figure 4); c) a central graphic at each table (Figures 5; 6) illustrating the 4 subsystems, the steps in textile production in a linear economy, from raw materials to disposal, and a world map representing the geographical location of the steps in the textile value chain. The discussions were facilitated by one or more researchers in order to involve all the members of the group and were conducted with a focus on the subsystem of each table, and to explain the possible interrelations with the other subsystems.

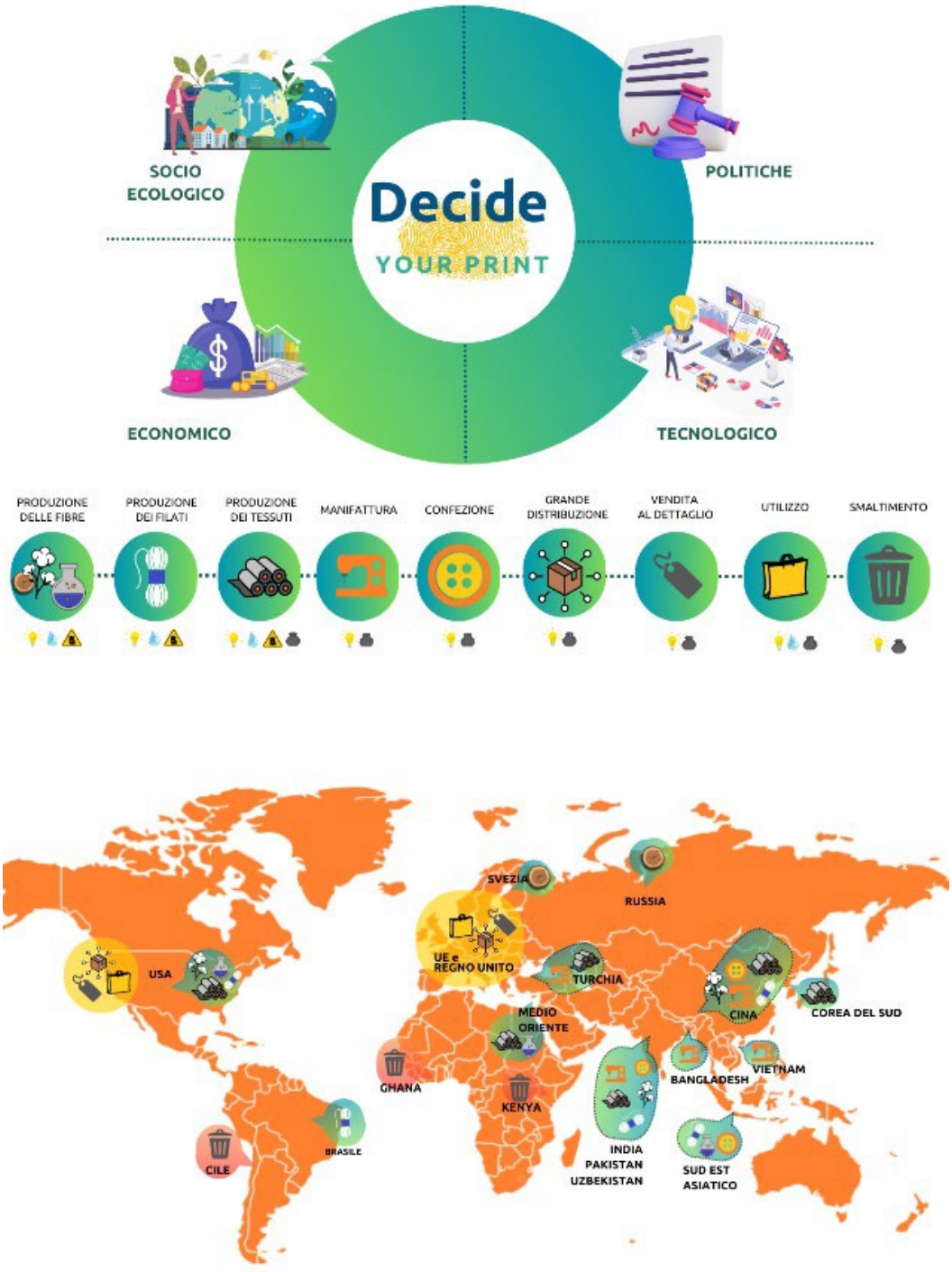

Figure 5. Central Table Graphic used in each discussion table (subsystems, textile blockchain, geographical location of textile production phases).

In this phase the complexity was “unpacked” through a process of simplification made possible by the division into subsystems. Students openly discussed the main aspects of the subsystem and formulated proposals to address emerging negative impacts through collaborative work. Facilitators in this phase had the task of mediating between informational

Figure 6. Subsystem discussion table.

content and the direct experience of the students to help them make it as relevant as possible to their experience, interests, and previous knowledge before the workshop.

These discussions generated a multitude of ideas and insights with local and global ramifications. Challenges arose in some groups, particularly where the topic was less familiar for the audience. For example, proposals from the technology-focused working group, required a prior knowledge about technologies involved with the recycling of fiber clothing or modular garments. Nonetheless, the group identified the disposal phase as a potential area for technological advancements, proposing solutions like more efficient recycling systems.

The political table tackled policy solutions, advocating for economic incentives for sustainable companies and disincentives for polluters through increased taxation. Establishing designated donation and exchange points in cities, alongside stricter export regulations, were additional proposals. Supporting technological advancements, particularly in disposal and sustainable materials acquisition, resonated across multiple groups. Similar to the socio-environmental discussion, participants called for a labelling or rating system to readily identify socially and environmentally responsible companies.

The economic table focused on strategies like stricter taxes for polluters, increased research funding for efficient disposal technologies, and promoting second-hand clothing via discounts. Additionally, leveraging European funds for adopting sustainable technologies was identified as a key point.

The socio-environmental table prioritised consumer awareness campaigns utilising influencers and public figures, alongside educational events. Proposals also included stricter regulations, fair and green labels for ethical labour and environmental practices, promoting donation and exchange spaces, and encouraging second-hand shops and company

collaborations. The workshop graphics helped to frame the global geographic scale of the phenomenon under consideration. In this way, we were able to address aspects that are often generally overlooked in communication and engagement initiatives of, about and for sustainability [Newig et al., 2013]. The subsystems discussion made explicit reference to the "inconvenient side" of sustainability understood as the impossibility of maintaining a consumption-driven lifestyle while ensuring enough resources for future generations [Voci & Karmasin, 2024]. Students discussed how textile industry sustainability means extending the life of clothing, reuse and recycle as far as possible used garments.

Finally, in the third phase, complexity was reconstructed through a plenary session fostering an effort of systemic reasoning. In an inter-group discussion, a representative of each group presented the results of the discussion and proposals that emerged. After this, the facilitators highlighted the connections and overlapping themes across the different subsystems, and these were linked together through a collaborative digital mapping tool, Miro (Figure 7; 8). This phase stimulated awareness of the systemic dimensions by highlighting to what extent the proposals from one group could generate impacts on, or, needed the collaboration from the recommendations developed by other groups, thus enabling a systemic reflection on the interconnection between subsystems [Gray et al., 2019]. This phase, represented by the inter-table discussion, is crucial for achieving the objectives of the workshop in terms of the complexification of the problem addressed through a systemic approach. In fact, through the discussion participants had the opportunity to understand that most of the proposals transcended the domain of each subsystem and their feasibility required an interaction with processes of other subsystems (see Figure 7). Furthermore, the discussion also allowed the identification of the internal diversities of the subsystems further complexifying the proposed solutions. For example, the clear emergence of generational issues as when according to one of the discussion tables not all consumers have the same ecological impact; the consumption choices of adults have a greater impact than those of young people due to their purchasing and decision-making power. Therefore, the participants proposed awareness campaigns specifically targeted at adults with highly impactful consumption patterns. The dialogue also brought out the dark sides of the sustainable textile industries, such as the loss of work in manufacturing countries due to certain technological innovations, forms of taxation or legislative measures, or energy and water consumption in reference to the textile recycling processes.

4 ▪ Reflections and lesson learned

This section explores the dynamics of knowledge exchange between participants and social scientists, evaluating how the format can function as a methodological tool to introduce sustainability in the fashion industry to school-age audiences through a systemic approach in public communication.

4.1 ▪ *Exchanges between social scientists and participants*

DyP was designed to integrate the three models of science communication, aiming to enhance participants' complex thinking and decision-making skills [Navas Iannini, 2023]. Furthermore, the exchange dynamics between participants and students enabled researchers to reflect on the overlaps among models rather than their strict separation. This aligns with

Figure 7. Final discussion.

Metcalfe's [2019] observation that "deficit activities appear to be an important component or prerequisite for dialogue and participatory activities" [p. 16].

Working groups' facilitators found themselves facing two fundamental barriers in their communication: (i) raising awareness about the relevance of the topics discussed and; (ii) conveying complexity while unpacking the dimensions and sub-systems of the FF/sustainability nexus.

In an effort not to replicate top-down approaches of communication, scientists tried to investigate the lived experiences of the students regarding the theme of FF through the initial surveys of participants and discussions in the working groups. In other words, to bring up the relevance of the topic based on the students' views, scientists had to create connections between the high-level theoretical knowledge of the topic and what students experienced in their daily life. For example, the working group on the economic dimension veered away from a discussion on the price of the clothes while the one focusing on the policy dimension prompted students to reflect on neighbourhood-level policy instruments. Through a series of cues, the discussion was progressively extended to other levels, maintaining, as much as possible, the link with their lived experiences. This was easier for some working groups such as those discussing the socio-environmental aspects and more difficult for others such as the one focusing on technology. Indeed, students had a hard time

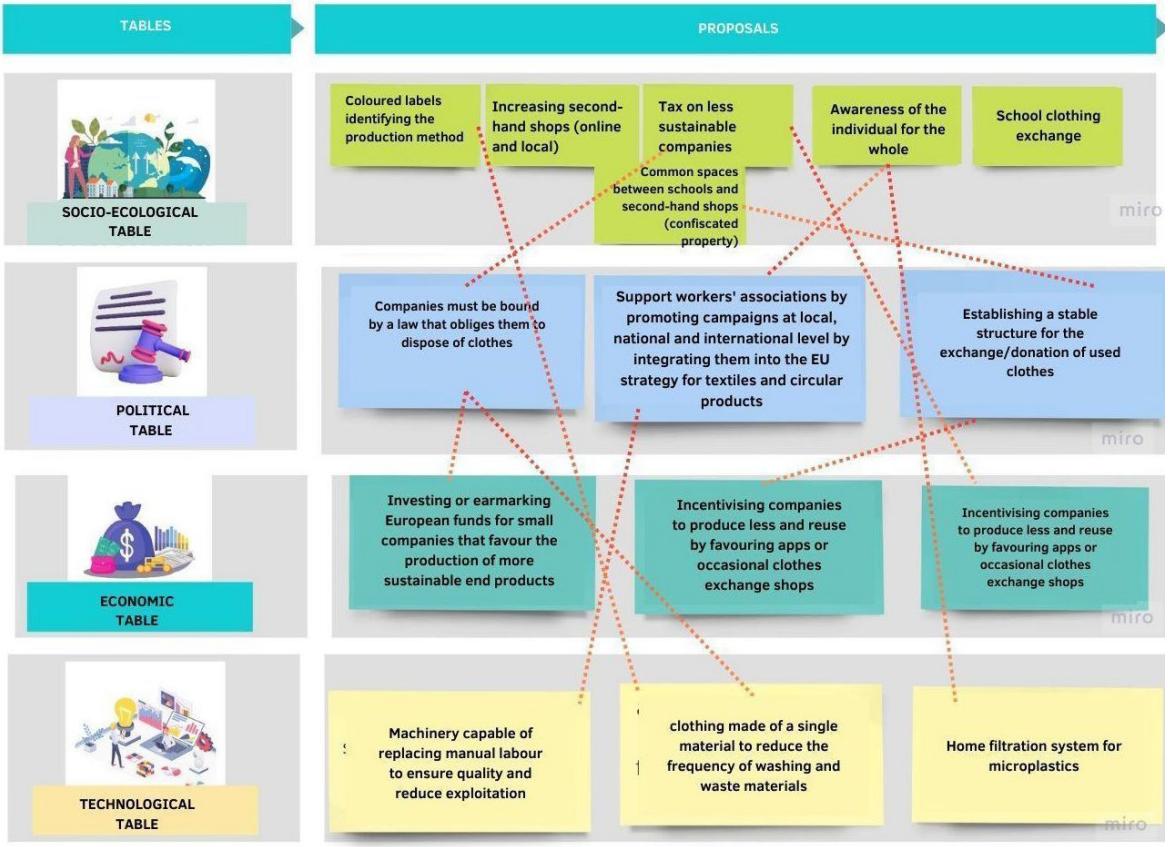

Figure 8. Examples of Miro processing of final proposal.

understanding what technology meant in the context of FF and what kind of improvements could be suggested. In any case, the exercise helped scientists to understand which aspects students valued and how to redirect their communication accordingly.

4.2 ▪ *DyP a methodological tool for system thinking in sustainability science communication*

As pointed out by Newig et al. [2013], sustainability, and consequently communication about sustainability issues, is inherently complex for at least three reasons: 1) the high levels of uncertainty and complexity characterising sustainability issues, 2) the ambivalence of sustainability goals, characterised by conflicts of interest and different values underlying these goals, and, finally, 3) the multiplicity of actors that contribute to the decision-making and implementation of sustainability measures, which forma long chain from governance decisions to the behavioural choices of individuals [Newig et al., 2013]. Accordingly, the concepts of complex and system thinking are central in sustainability literacy [Stibbe, 2009].

DyP aimed to engage students in complexity characterising fast-fashion issues through three key strategies:

i) Empowering decision-making: by placing students at the centre of the process, DyP encouraged them to make decisions within the intricate textile system.

ii) Enhancing understanding of complex processes: the informative materials provided in the workshop simplified and defined the essential elements of the textile system, making its complexity more accessible to students.

iii) Encouraging discussion among conflicting interests: DyP facilitated group discussions where solutions generated by different groups were merged, allowing conflicting interests to be identified and potentially resolved in a plenary session.

These strategies have been integrated into a tool, DyP, which stands out as innovative in the field of science communication, particularly in non-formal education settings, for several reasons.

DyP does not focus on the private sphere or individual choices but embraces a systems thinking approach using the socio-technical systems interpretive framework. This approach examines phenomena by defining their various subsystems and studying the dynamics within each subsystem (between humans and technologies) as well as external dynamics between systems.

The adoption of a systems thinking approach together with the need to use different models of science communication led us to innovate a widely used tool, the PlayDecide. This is generally used for different user communities to develop card games aimed at small groups (4 to 8) in different contexts (from school to business), in order to bring out positioning and decision-making on different topic policies. Instead, we used the intra-group discussion to foster dialogue between participants and social scientists and used the mechanics of the workshop, the division between groups, to mirror the sociological approach of socio-technical systems. By implementing this approach and facilitating exchanges where individual proposals interacted, participants could consider both the internal facets of systems and the relationships between different systems, crucial for addressing complex issues like sustainability.

The adoption of an approach based on systems thinking promotes the diffusion of interdisciplinary learning, in which social sciences perspectives are represented. Despite some successful but challenging examples of interdisciplinary integration between social scientists and STEM in science communication initiative [e.g. Bruine de Bruin & Morgan, 2019], scholars continue to emphasize the need to integrate perspectives and knowledge from the natural sciences with those from the social sciences and humanities in science communication practices [Campos et al., 2021; Trench, 2023; Delicado, 2004].

5 ▪ Conclusions and future directions

DyP workshop showcases the potential of sustainability communication to foster systemic thinking and interdisciplinary engagement on sustainability issues. By focusing on the fast fashion industry, the workshop effectively combines dialogue, evidence-based learning, and participatory decision-making to address the environmental, economic, social, and technological dimensions of sustainability. Its use of socio-technical systems and systems thinking frameworks allows participants to grasp the complexity of sustainability transitions and develop actionable solutions.

However, the workshop's two-hour format limited the depth of discussion on trade-offs and interconnections between subsystems. To address this, future implementations could adopt

extended or modular formats to allow for deeper exploration. Expanding the workshop to formal educational contexts or applying it to other sustainability challenges would test its adaptability and broaden its impact. Future applications of the workshop should also include structured evaluations.

The DyP model provides a valuable example of integrating STEM and social sciences to bridge gaps in sustainability communication. By empowering participants to navigate and address the complexities of socio-technical systems, the workshop promotes critical thinking and participatory problem-solving.

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