DESIGNING FOR SUSTAINABILITY: FOSTERING REFLECTION IN THE DESIGN PROCESS

EVA DURALL
AALTO UNIVERSITY
EVA.DURALL@AALTO.FI

HEIDI UPPA
AALTO UNIVERSITY
HEIDI.UPPA@AALTO.FI

TEEMU LEINONEN
AALTO UNIVERSITY
TEEMU.LEINONEN@AALTO.FI

ABSTRACT

Reflection is needed to provide solutions for wicked problems and to encourage social sustainability. Although reflection has been recognized as key in deep understanding and decision-making, it is rarely included in design agendas. In this paper we describe how reflection can enrich the design process, as well as their final solutions. We present design games as a participatory method that supports reflection and we exemplify it through two design cases. In each case, we point out several reflection triggers used in design games and we analyse the level of reflection they provoke. We conclude that opportunities for joint reflection are needed during the design process to enhance sustainable products and services.

KEYWORDS:
reflection, design, social sustainability, design games, case study

INTRODUCTION

The concept of sustainability and how to adapt it is currently in transformation. Sustainable development was mentioned for the first time in the "Brundtland report" and defined as "development that meets the needs of the present, without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development 1987). The ambiguity of this definition has given rise to new conceptions of what is sustainability. One of the most common ways to define sustainability is via three dimensions such as the ones suggested by Elkington (1997) in the triple bottom line concept: ecological, economic and social. Recently social sustainability has become increasingly important as Mulligan (2015) suggests in his model of Social Ecology (Figure 1).

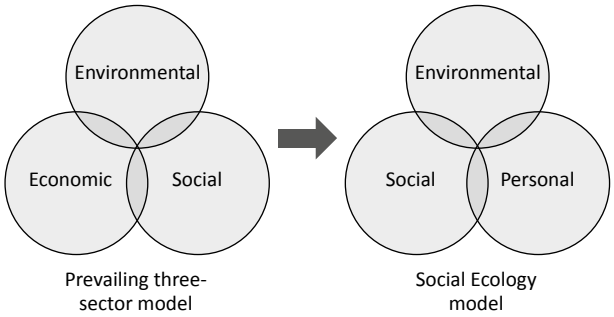


Figure 1. The concept of sustainability is shifting from the prevailing model to the social ecology model. (Image: Mulligan 2015, pp.5)

Social aspects of sustainability are important, not only for their connection to ethical, equal and democratic values, but because environment-friendly solutions will be experienced by individuals in relation to social groups and activities. Social sustainability has been presented in the urban context and defined through four domains: ecology, economics, politics and culture (Magee et al., 2013; James 2015). Each domain is divided into seven sub-domains. Well-being and health are included as part of the cultural domain.

According to the World Values Survey advanced societies have reached a level of wealth in which survival is taken for granted. As a result, there is an increasing emphasis on subjective well-being, self-expression and quality of life. In this context, one of the challenges regarding sustainability is how to define well-being. Traditional views of well-being have been oriented towards the minimisation of individuals' own active involvement. This has led to the development of disabling solutions in which people have progressively lost the "the skills, abilities and know-how that traditionally enabled individuals and communities to deal with the most diverse aspects of daily life: to take care of the environment, of others and often themselves" (Manzini, 2006, pp.11). From this perspective, improving wellbeing requires supporting individuals in taking responsibility of the consequences of their decisions.

Challenges dealing with sustainability can be defined as complicated, wicked problems. Finding a solution for these types of problems goes beyond regular problem-solving, which relies on classic scientific thinking. Wicked problems are incompletely defined, have multiple interconnections and, quite often, partial solutions only create more problems (Rittel and Webber, 1973). Design professionals can contribute to questioning initial assumptions in order to reframe problems, as well as working in multidisciplinary teams and in developing methods and tools for the working process. These practices are valuable assets when finding solutions for wicked problems as the ones related to sustainability.

Information and Communication Technologies (ICT) have become integral part of everyday lifes, daily practices and experiences in the modern societies. Digital tools can help to understand complex cause–consequence relations, which can be made more transparent and visible for the users by creating easier, more usable and understandable solutions, (Leinonen et al., 2014). In Human Computer Interaction (HCI) research, critical reflection has been connected to the identification of unconscious assumptions that may have a negative impact on people's lives. According to Sengers et al. (2005), the identification of these gaps can open new opportunities and design spaces.

In this paper we mainly focus on the socio-cultural, personal and environmental aspects of sustainability. Based on a literature review, we describe how reflection can be a valuable asset when designing sustainable products and services. We present two design cases that introduce reflection in the design process through participatory methods, particularly design games. We analyse the role of reflection in both cases and we identify several design game elements that trigger reflection.

REFLECTION IN DESIGN

Sustainable lifestyles are difficult to achieve if, first, as individuals and as society, we do not consider the future implications of our current actions and practices. The development of products and services that encourage reflection can help develop awareness and eventually, modify behaviour. At the individual level, reflecting on everyday actions and values can lead to a more balanced understanding of the self and its interactions with the world (Gelter 2003). In this regard, reflection "is an important ethical tool to take control of your own life" (Gelter, 2003, 343). At the group level, reflection is connected to awareness and responsibility taken for future consequences of current actions (Dewey 1933). Therefore, designs that support sustainability should not only be the result of reflection, but also offer opportunities for reflection.

According to Dewey (1933), reflection consists in active and careful thought about the assumptions that underlie any belief or form of knowledge, as well as the implications that these might have in the future. Reflecting means to identify connections and make hypotheses about the consequences of our actions. This has been connected to effective decision-making in wicked problems (Pee et al., 2000; Peltier, Hay and Drago, 2005; Schön 1983). Therefore, reflection is especially relevant for achieving understanding about complex issues as the ones involved in designing sustainable solutions.

Some authors have outlined experience as a key condition for reflection, either after (Boud, Keogh and Walker, 1985; Dewey, 1933; Kolb, 1984) or during the action (Schön, 1983). Reflection-after-action is considered to enable linking our actions with their consequences, as well as to identify behaviour patterns and hidden values and beliefs (Sas and Dix, 2009). As a summary, we could say that reflection helps us reach new understanding of our experiences. However, reflection is not a regular practice and thus, reflective skills remain untrained (Sas and Dix, 2009).

Designers working on Human Computer Interaction (HCI) can create opportunities for reflection that challenge the assumptions that underlie technology (Agre, 1997; Gaver and Martin, 1999; Dunne and Raby, 2001). So far, diverse approaches to HCI design that focus on reflection, such as reflective design (Sengers et al. 2005), slow technology (Hallnas and Redstrom 2001), inquisitive design (Dalsgaard 2008) and technology as experience (McCarthy and Wright 2004), are gaining recognition.

Reflective design (Sengers et al. 2005) through its critical approach to reflection seeks to offer the opportunity to experience the world and ourselves in different ways. Building from participatory design (Ehn 1992; Greenbaum and Kyng, 1991; Muller and Kuhn, 1993) critical design (Dunne and Raby, 2001), ludic design (Gaver and Martin, 2000), value-sensitive design (Friedman et al. 2013), critical technical practice (Agre 1997) and reflection-in-action (Schön 1983), Sengers and her colleagues elaborate on several strategies that can trigger reflection among users and designers. In this regard, the authors suggest flexible interpretations, user participation, dynamic and rich feedback to and from users, as well as the inversion of metaphors and cross-boundaries used in design, among others, as ways of creating design experiments that help analysing society's values and tacit assumptions.

Proposals on how to introduce reflection during the design process draw attention on participatory design approaches (Sengers et al. 2005). Participatory methods are relevant in sustainability context because often individuals' environmental motivations are overestimated while other factors such as compatibility with lifestyles or aesthetics remain under-estimated (Scott et al. 2009). Design games can be regarded as one example of a participatory design method which supports individual and collective reflection through dialogue and tangible materials (Brandt 2006; Durall, Leinonen and González, 2014; Vaajakallio 2012).

Slow technology is a design philosophy that puts into practice some of the strategies outlined by Sengers et

al. (2004, 2005). In this case, Hallnas and Redstrom (2001) suggest "slow technology" as an alternative to the efficiency paradigm. From this perspective, time becomes the key condition for reflection. Design of technical solutions should be oriented towards creating spaces and moments for reflection and doing new things instead of applying technology to compress time to do given tasks (Hallnas and Redstrom, 2001, pp.203).

Inquisitive design and technology as experience take experience as the primary element when designing for reflection. Inquisitive design (Dalsgaard 2008) is strongly influenced by Dewey's ideas on reflection, introducing experience, conflict and inquiry as a strategy to support reflection. In this approach, people are considered active and resourceful actors, ready to engage in exploration and experimentation. When conceptualising technology as experience, McCarthy and Wright (2004) call for developing richer models for HCI that truly take into consideration experience and how people make sense of it. The inclusion of elements linked to experience such as emotion, desire and playfulness challenge rationalist assumptions of HCI and introduce a more complex picture of the ever-changing and ambiguous world we live in. In this regard, openness and incompleteness are two traits that designers can use to support a dialogic relation between different stakeholders.

Despite the increasing corpus of research focusing on reflection, the concept is still under discussion and scholars held different views on what can be considered reflection and where are the limits. A good example can be found on the identification of different reflection levels. Drawing on the work of Dewey (1933); Mezirow (1981); Kolb (1984); Kember et al. (2000); Hay, Peltier and Drago (2004) and others, the reflection process can be divided into awareness, critical analysis and change. Although authors differ in the boundaries between the different stages, all agree that there is a hierarchical relation, which means that each of these stages builds on the previous one.

Fleck and Fitzpatrick (2010) identify different levels of reflection that can be supported by interactive technology: (1) *Revisiting*; (2) *Revisiting with explanation*; (3) *Dialogic reflection*; (4) *Transformative reflection* and (5) *Critical reflection*. In the initial levels of reflection (Revisiting and Revisiting with explanation), the role of technology is to create awareness by recording experiences, optionally allowing for annotations. In level 3, Dialogic reflection, technology is used to augment vision as it happens with "sensor technologies, which can record, detect and represent data or aspects of experiences not otherwise available to human perception" (Fleck and Fitzpatrick, 2010, 220). Displaying this type of information can help people make connections and see things from multiple perspectives (Boud et al., 1985; Schön, 1983). In level 4, transformative reflection, technology allows revisiting an event in order to achieve a fundamental change. Asking questions and challenging personal assumptions is key in transforming understanding and practice. Finally, critical reflection (level 5) consists of a reflection-based change resulting from taking into consideration wider socio-historical and politico-cultural contexts (Ward and McCotter, 2004). In the next section we present two design cases that make use of reflection levels as part of the design process through the use of design games.

REFLECTION THROUGH DESIGN GAMES

The definitions of design games vary depending on how they have been used (Vaajakallio, 2012). According to Vaajakallio (2012), games have been adopted in design for several purposes: for design research (Habraken and Gross, 1988), for design education (Iversen and Buur, 2002), for user empowerment (Ehn and Sjøgren, 1991) and for engaging stakeholders (Brandt and Messeter 2004). All these authors assume that design games are based on participation, imply a certain degree of competition, as well as the requirement of rules and tangible game elements (Brandt, 2006).

Despite the differences, in all the approaches mentioned above design games seek to augment understanding by reflecting on the issue the game is dealing with, that's to say, the "design space". According to Botero (2013, pp.59), this can be defined as "the space of potentials that the available circumstances afford for the emergence of new designs at multiple levels". From this perspective, design games' capacity for improving communication and empathic understanding helps to define the design space, but also to transform and expand it (Durall, Leinonen and González, 2014).

The capacity of games for reaching high levels of involvement has been analysed from different fields, and gamification techniques have been explored. As Deterding, Dixon, Khaled and Nacke (2011) define it, "gamification" refers to the adoption of game design elements in contexts that are not related to games. Some examples of the techniques used in non-game contexts are rewards, levels and badges, among others. Design games differ from this tradition since they clearly try to create a gaming situation with stakeholders. In these cases, the inclusion of competition elements, such as setting goals and obtaining points, seeks to increase playability, rather than user retention.

In the two cases presented below, design games were utilised as a part of the concept development process. We analyse how reflection happens in both cases and we identify the key elements that trigger reflection.

DESIGN CASE 1:
FEELER – LEARNING & WELL-BEING PROTOTYPE

From a sustainability point of view, growth paradigm values such as individualism and consumerism are controversial since they create an unsustainable scenario when they are scaled. According to Sterling (2001),

education faces similar issues since people are educated to "compete and consume" rather than to "care and conserve".

Sustainable education (Sterling, 2001) calls for putting the attention back on learning in order to escape the managerial and economic logic present in many education systems. As Sterling defends, this shift will create better chances of a more sustainable future for all. Feeler (Figure 2) is a design concept that addresses questions connected to sustainable learning, such as the relation between learning performance and well-being. The visualisation of this information is expected to foster students' reflection and awareness.

Figure 2: Feeler concept prototype.

Feeler research builds on the idea that learning is influenced by other aspects of life that go beyond what takes place in formal education contexts. Recognizing these relations can be helpful for self-directing learning and feeling better. Actually, the ability to learn has been connected to well-being. One example of how this has been applied in formal education can be found in the Kyky project (*http://www.opiskelukyky.fi/english/*) in which partner universities and student unions analysed the elements involved in study ability and identified methods and best practices for supporting students' ability to study.

Current trends in technology design based on self-monitoring of personal data offer wide possibilities for developing self-reflection. Personal informatics, life-logging and Quantified Self are some of the approaches that look at people's self-generated data about states, inputs and behaviours in order to enable self-understanding through awareness and reflection. As Li, Dey and Forlizzi (2011, pp.405) highlight, the availability of measurable personal data can be used "for self-reflection to help people become more aware of their own behaviour, make better decisions, and change behaviour". In Feeler design, study performance data is collected through brain wave monitoring devices with the aim of helping learners identify their level of focus in the task they are performing. Regarding well-being, physical activity and sleep are considered relevant indicators for measuring how balanced a person's lifestyle is. Although quantitative data is supposed to bring a more objective picture of people's actions, all this information is combined with subjective indicators, such as how people felt after performing these activities. Therefore, it will be possible to better assess how sustainable the learning process is in relation to lifestyle. The visualisation of these different types of data is expected to foster learners' self-reflection and, if considered necessary, behaviour change. In this regard, Feeler design can be framed, according to Fleck and Fitzpatrick reflection levels (2010) mostly as *dialogic reflection* since by displaying hidden information, students can make connections and analyse their learning experience from different perspectives.

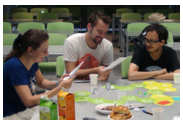
Feeler design research follows a participatory design approach. From the very beginning, it has been considered important to include views from the academic community through interviews and participatory design sessions. The latter ones were conceived as opportunities for joint reflection between design researchers and the session attendants. With this aim, a design game focused on reflection was created (Figure 3). We include a list of the Feeler game elements and a short description of its role and connection to the research (Table 1). The game was intended to break the ice and foster communication in a relaxed atmosphere.

Figure 3: Feeler Reflection Game session.

Feeler Reflection Game was created for a series of participatory design sessions organised with design students from Aalto University (Finland) and Kyushu University (Japan). In the first session, the game was used as part of a focus group in order to improve understanding and open the discussion. Later, the game was adapted for a co-design workshop in which attendants explored different ways of visualising their personal data. In this case, the artefacts produced supported dialogue during the sharing session allowing the emergence of design issues and challenges regarding how to support reflection through data visualisation.

Further steps in Feeler design research include the development of small pilots that help improving students' experience when self-monitoring, as well as developing a working prototype. Simultaneously, more participatory design workshops will be organised in order to present and discuss design scenarios and concepts.

Table 1: Feeler Reflection Game elements

Feeler Reflection game elements:	**Description:**
Tangible game objects: *Game board* 	Represents the journey followed by a person since she starts to self-monitor until she changes a behaviour. The squares of the board are independent from each other enabling its rearrangement. This was useful during the discussion that followed the game.
Dice 	In the game, certain decisions are consciously made by players, while others are random since they depend on the dice results.
Pawns 	They are visual representations of the characters that identify the players during the game. At the beginning of the game, players choose from six different options, which are associated to personas.
Character cards 	Include a description of each character, which is a persona, built out of user research.The story behind each persona explains the reasons why each of the characters is interested in self-monitoring. During the game, players annotate their During the game, players annotate their actions in the character cards. This supports participants' reflection once the game has ended and facilitates later analysis by designers.
Inspiration cards 	During the co-design workshop, participants created their own visualisations. The inspiration cards were provided in order to introduce ideas from design approaches focused on reflection.
+/– Cards 	Present challenges and possibilities associated with different aspects of self-monitoring.
Stickers 	In certain squares, players are asked to choose elements such as the technological device they plan to use, as well as the type of data visualisation. The stickers represent these choices.
Data sheets 	In the co-design version of the game, players received a dataset with the the characters' self-monitored information. At some point, they were asked to visualise part of this data.
Aesthetic quality 	The use of basic shapes and vivid colours was intended to create a playful atmosphere, in which players felt confident and relaxed. Game character' visuals followed a hand-drawing style in order to strengthen the storytelling aspect.
Information visualisation 	Game instructions are displayed in the squares through visuals. Additionally, the layout of the character cards synthesises all the information needed to solve the tasks presented to players through text and visuals.
Game design (structure and rules)  	Players advance one square each turn, so they have to go through all the phases of self-monitoring and perform a specific action in each square. In the game, players' goal is to change the behaviour of the persona they play. For this, they need to reach the last square of the game, which can only be reached if a certain number of points has been collected. Depending on the decisions taken during the game they earn or lose points. Some choices are conscious, while others are randomly made.
Game experience 	The game follows a journey structure in which each square represents a stage in the process of self-monitoring. Through storytelling techniques, participants get immersed in the scenario presented and they identify with their characters. The creation of an immersive experience improves players' understanding about the design context and provokes richer discussions after the game.
Facilitation 	Feeler Reflection Game was used in two settings: in a focus group and in a co-design session. In both cases, facilitation was oriented to the creation of a relaxed atmosphere during the game. Facilitation during the discussion that followed the game encouraged participants to reflect on the decisions taken while playing. Players' answers to the questions and comments made by the facilitator, as well as by other participants. This helped to identify new ideas and issues in the concept design.

DESIGN CASE 2:
SHAPE – SUSTAINABLE MEAL PROTOTYPE

The development of the Shape sustainable meal prototype was a part of larger research project and collaboration between different universities, institutions and companies (Kauppinen, Kurppa, Mikkola, Pusa, Raatikainen, Seliger, Uppa and Vieraankivi, 2014). One of the aims of the project was to add transparency to the food chain and to support sustainable food choices in the lunch cafeteria context by making environmental consequences visible in decision-making. Although there is growing public interest towards sustainability, behaviour patterns still do not support sustainable behaviour (Vermeir and Verbeke, 2006).The purpose of the Shape sustainable meal prototype is to make the food chain more visible; it is designed to connect intentions, actions and understanding about the environmental consequences of an individual's choices

(Figure 4). As Vermeir and Verbeke (2006) pointed out, communication design can have a successful impact in changing consumption behaviour towards sustainability. In this regard, information visualisation and IT can support reflection in order to explain complex entities and relations around sustainable solutions, practices and systems.

Figure 4: Concept idea for the Shape sustainable meal mobile application. (Image: Elina Johanna Ahonen 2014)

Visualising sustainable food chain means taking all main aspects of it into consideration: production, processing, distribution, consumption and reuse/ disposal – including harvesting, transportation, use of energy, food preparation and packaging. In the prototype carbon footprint is used for measuring and visualising environmental impacts of the whole food chain. In Finland lunch meals in educational institutions are financially supported by the government and have to follow official food recommendations (VRN, 2014): the minimum amounts of protein, grains and carbohydrates are predefined. This needed to be taken into account when designing the application and its meal structure. Currently this prototype is scaled for one restaurant and their menu options. The application structure is: Menu (meal options) > Meal (divided into dishes) > Dish (with ingredients) > Ingredients (details about production place, nutrition and carbon footprint). The carbon footprint of the meal is calculated based on recipes and carbon footprint data is calculated for each ingredient. The carbon footprints of different meals can be compared on the menu-view (Figure 5). The idea for the application prototype was tested in focus group sessions by using design games (Figure 6). A meal design game was designed to simulate situations and decisions related to lunch eating practices. Details and game elements of the Meal Mesign game are explained in the table 2.

The sustainable meal mobile application prototype and its design process offers possibilities for learning through reflection. Here we present this case via five levels of reflection by Fleck and Fitzpatrick (2010). The first (1) level – *revisiting* – happens when the user uses the application: adds personal details such as diet preferences or possible allergies and views different meal options or records information, images or videos

Figure 5: User interface views of the Shape sustainable meal mobile application prototype. (Image: Elina Johanna Ahonen 2014)

Figure 6: Focus group sessions were arranged to develop and test the application prototype concept.

regarding her eating habits. In the focus group sessions revisiting level reflection happened while participants constructed meal options by using tangible game elements.

Table 2: Design game elements for the Sustainable Meal Design game.

Sustainable (lunch) Meal Design game, game elements:	**Description:**
Tangible game objects: *Game board* 	Game board reminds the tray and other artefacts typically used for eating lunch meals in Finland. Helps to simulate an eating situation in lunch cafeterias.
Ingredient cards 	Ingredient cards contain photographs of typical dishes, drinks and ingredients often used for preparing lunch meals and side dishes.
Coins	Coins represent money used for paying for the meal.
Pen & paper	Pen and paper are needed for making notes and calculations (game stage 3).
Aesthetic quality 	Helps make the game more realistic, engaging and inspiring. For instance, trays and coins used in the game were made with plywood and engravings in order to create a more realistic experience.

Information visualisation  	Colour coding used in the cards to group different ingredients based on the nutrition types: Yellow = fat (butter, oil, margarine), red = protein (meat, fish, chicken, dairy), blue = carbohydrates (bread, grains), green = fibre, vitamins (vegetables, other). Symbols with relative numbers (low 1 > high 9) expressing the qualities of each ingredient: ecological impact & carbon footprint, health & nutrition, price. Relative numbers help to compare the qualities of each ingredient with others.
Game design (structure and rules) 	In the game, players have to go through 3 stages: 1. Participants are asked to describe their usual and typical lunch meal by choosing ingredient cards and placing them on the game board. The purpose of this stage was to introduce the subject and participants to each other. 2. Participants are asked to describe their preferred, favourite lunch meal option. This stage focused on revealing the values and assumptions behind the decisions. 3. The task is to design an optimal sustainable lunch meal option for your taste preferences. Meals needed to fulfil predefined official meal recommendations. This stage focused on the comparisons and decisions made during the task.
Game experience 	Game experience simulates a meal in a lunch cafeteria. Participants are asked to share their experiences and thoughts verbally after each task in a discussion with other participants. Competitive aspects are introduced during the third task. Here, players face limitations dealing with nutrition values and price information. The winner is the participant who gets the lowest carbon footprint (calculated together from all of the chosen ingredients cards).
Facilitation 	Focus group sessions were organised to develop and test ideas for the application prototype. The aim of the facilitation was to create a comfortable and good atmosphere for discussions. The facilitator supervised the design game sessions and led discussions by asking questions from the participants to reveal and challenge personal assumptions and choices. Focus on making sure all aspects were covered during the discussions.

The second (2) level of reflection – *reflective description* – occurs through the application structure, for example when tagging or organising information inside the application. The current structure of the prototype includes carbon footprint, recipes, ingredients and price information. Users can question the sustainability of their choices by comparing each meal's carbon footprint value. They need to make decisions between meal options and justify them. This is not directly visible, but it can be supported in development versions, for instance, by adding questions or providing options for tagging elements and organising personal information. In the focus group sessions, participants explain the reasons why they made certain choices and discuss them with others.

Supporting dialogue (3) as a level of reflection is not yet possible in the current prototype. However, users can use the prototype to discuss and compare their choices. Options for future development allow users to chat, comment, make posts, give feedback about the content and share content with other users. Those features enable competitions and group challenges. In the focus groups, dialogic reflection happens when participants share experiences and ideas, which brings additional perspectives to the discussion.

The level of *transformation* (4) is fundamental in behaviour change. The sustainable meal mobile application can support users in making desired behaviour changes by providing information in an easy, understandable and pleasurable format. By monitoring their behaviour, users can support the transformation process. The application can help to visualise the change and to give feedback on the way the change is proceeding – preferably in comparison with other users. Comparisons are important because peer pressure can support sustainable behaviour despite of an individual's negative personal attitudes (Vermeir and Verbeke, 2006). Persuasive features, such as competitions or calculation of weekly sustainability points, can increase motivation towards more sustainable meal options.

The ambitious goal of the application prototype is to enable *critical reflections* (5) by connecting personal choices with wider ecological consequences, perhaps in the future also with ethical, health, social, and politico-cultural aspects. In the current application version this level of reflection is already supported by visualising the carbon footprint information of each meal, dish and ingredient. We discovered in the focus group sessions that carbon footprint information encouraged participants' reflection and affected their meal choices. However, further studies are needed to gain more understanding on users and behaviour change in the lunch meal context and to verify long-term behaviour changes. For strengthening reflection, the next versions of the prototype should include more participation opportunities, which can contribute to behaviour change also through peer pressure.

DISCUSSION

Looking at the two design cases presented, we can distinguish between two moments in which reflection

can be introduced: during the design process (A) and in the final design (B).

During the design process, the adoption of participatory design methods responds to the need of reconsidering the politics of design practice, as well as to include the views of those affected by the final design. However, when talking about reflective design (Sengers et al., 2004) it is important to take into consideration that the main focus is on questioning unconsciously assumed values. In the first design case presented, Feeler, designers aim to question values connected to the efficiency paradigm, as well as certain learners' attitudes, such as the dependency on formal education institutions and the disconnection between lifestyle and study performance. In the second design case, the aim of the prototype is to encourage reconsideration of the environmental impacts of food choices and eating.

Design games have been used in both cases to support joint reflection between designers, researchers and other stakeholders during the design process. In this regard, we want to highlight certain aspects of design games that are particularly suitable for supporting reflection. For instance, tangible design game elements work as "things to think with" (Papert 1980) and act as boundary objects (Star 1989) between designers and participants. The use of a game, specifically created for the situation, contributes to develop an empathic understanding between participants (Durall, Leinonen and González, 2014) and creates an engaging experience that can be used later as a basis for discussion. In the following table (3), we have listed those game features that we consider key for triggering reflection.

Table 3: Reflection triggers in design games.

Design game elements:	**How reflection is provoked:**
Tangible game objects (board, cards, coins, rewards, pawns, ...)	Help to contextualise and make connections with people's previous experiences. Tangible game objects can simulate existing situations, as well as introduce new metaphors that offer a new perspective.
Aesthetic quality	Create a playful and inspiring environment that supports engagement and trust.
Information visualisation	Presents new views about the subject. Helps synthesising complex information.
Game design (structure and rules)	Forces players to make choices that can lead to conflict situations and dilemmas.
Game experience	Engages participants with the subject and increases their motivation. Engagement has a positive impact on participants' level of consciousness with the actions performed.
Facilitation	Helps to create good atmosphere for discussion. Has a strong role in identifying unconscious assumptions and challenging them through reflective questions.

Some of the sessions organised as part of design research followed a co-design approach. In those, participants were asked to create visualisations that were later analysed and discussed during the sharing sessions. These collective creative moments appeared to be highly relevant for the identification and reflection of tacit assumptions. By asking to create something, design researchers could observe the type of choices participants made. This gave them a greater understanding of the participants' implicit assumptions and helped them make questions that challenge these ideas.

Although the range of methods and approaches that can be used for supporting reflection is not limited to design games and co-design, it would be beneficial to explore more alternatives that can be adopted to increase designers', end-users' and other stakeholders' reflection during the design process. The design cases presented here adopt the following strategies to support reflection: focus on personal experience, the contextualisation of technology in culture rather than culture in technology and the inversion of metaphors (Sengers et al., 2005).

Considering the strong connection between experience and reflection (Dalsgaard 2008; McCarthy and Wright, 2004), it can be more meaningful for people to begin identifying how sustainable their current practices are. By providing "hidden" information, such as body data dealing with brain wave activity, physical activity or rest, as well as a carbon footprint of food, people can contrast what they think they do, with what they actually do. This brings what Dewey (1933) defined as a state of perplexity and confusion that triggers reflection. For instance, the design game about food consumption habits makes use of conflicting interests such as health and ecological options in order to create dilemmas among participants and, therefore create discussion and reflection.

The contextualisation of technology in culture, as well as the introduction of metaphors that challenge traditional views require a more explicit critical approach. In this regard, the emphasis on well-being and carbon footprint bring a different perspective on how studying and eating are usually presented.

Although Feeler and Shape are two design cases that seek to foster people's reflective skills, reflection is framed slightly differently in each case. In Feeler design research, the attention is drawn to awareness and reflection, while the Shape prototype seeks to change people's behaviour by fostering reflection on the wider societal implications of individual practices. By providing a measure such as carbon footprint that shows the connection between individual choices and

environmental effects, the Shape prototype presents a clear message and urges people to act.

While the Shape prototype seeks to be a practical tool that helps to make and reconsider daily decisions on sustainable lunch choices, the Feeler prototype is conceived as a probe, inspired by slow and calm technology, and therefore the information presented allows for more flexible interpretations. In this case, the intention is not to change behaviour, but to create awareness on how different aspects of life are connected to learning and have an impact on it. In this regard and as a final remark, we would like to note the importance of defining the purpose of the designed reflection tools. As we outlined, the different decisions executed in the Feeler and the Shape prototype are designed to support different levels of reflection.

CONCLUSION

Good, sustainable solutions do not only solve ecological problems; they encourage social sustainability by creating and increasing well-being in socio-cultural contexts for both individuals and groups. Personalised solutions are needed to support reflection and behaviour changes on personal and socio-cultural levels.

In this paper we have described the role of reflection in designing for sustainability. The two cases presented show how reflection can enrich the design process, as well as the actual solutions. As our cases show, participatory and co-design methods can be applied to foster reflection. Design games are examined as a participatory method that supports reflection between designers, end-users and other stakeholders. We identified different design game elements acting as reflection triggers, which can encourage reflection in various ways. Despite the strengths of design games for enhancing reflection, we consider it necessary to further explore also other design methods focusing on reflection.

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