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Sinclear, Dorian; Flensborg, Linda Birch; Fogsgaard, Ask Lindblad; Löchtefeld, Markus

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Face-the-Waste - Learning about Food Waste through a Serious Game

DORIAN SINCLEAR, Aalborg University, Denmark
LINDA BIRCH FLENSBORG, Aalborg University, Denmark
ASK LINDBLAD FOGSGAARD, Aalborg University, Denmark
MARKUS LÖCHTEFELD, Aalborg University, Denmark

Fig. 1. Face the Waste – A provocative design game, where the users have to answer food waste related question in order to save food from being thrown into the bin.

Consumer food waste in industrialised countries is becoming an increasing concern as its impact on greenhouse emissions is comparable to that of the aviation industry. In recent years we have accordingly seen a growing interest in HCI to support users getting into more sustainable consumption practices. As part of this movement, we present in this paper a serious game called Face-the-Waste that is meant to increase users food literacy and educate them about the impact and development of food waste. Our serious game comes in the form of a public installation that uses provocative design to engage the users. They had to answer multiple choice questions and if they answered wrongly real food would be disposed into a bin in front of the users eyes. The aim with this was to create a strong emotional response and increase the level of reflection on the topic. In our evaluation we not only found that the users often voiced very strong emotional reactions but also engaged and discussed the question and their content. Furthermore, we demonstrated that such provocations can add a new layer for the design of serious games.

CCS Concepts: • **Human-centered computing → Interaction design**.

Additional Key Words and Phrases: Food Waste; Food Literacy; Sustainability; Serious Games; Provocative Design

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1 INTRODUCTION

Over the last years the efforts of the HCI community to develop solutions to contribute to a more sustainable future have drastically increased [4, 8, 23, 39]. A variety of different areas have been addressed in the past, ranging for example from interventions to reduce energy consumption [17, 32] to support or gamify recycling behaviour [12, 24]. Another

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area of concern in HCI research is food and food consumption related behaviour [2, 3, 13]. Especially, given that, what and how food is produced, what we eat or throw out has a direct influence on greenhouse gas emissions, it is important to increase the focus on this area.

Food production is responsible for around 26% of the world-wide greenhouse gas emissions [35]. With the worlds increasing population, it will be complex to reduce this impact. However, according to Poore and Nemecek 24% of these emissions can be attributed to food waste – meaning food that is not eaten but discarded either as part of the supply chain or by the end-customer [31]. In Europe alone approximately 88 million tonnes of food are wasted every year [38]. While the majority of the overall emissions stem from losses in the supply chain, approximately 38% are due to consumer waste. This means that world-wide approximately 2.2% of all greenhouse emissions are produced by food discarded by consumers which is more than the aviation industry's impact (~2%) [31, 35]. Due to this impact, reducing food waste has also been implemented as a sub-goal of the United Nations Sustainable Development Goals, 12.3 *"By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses"* [29].

However, so far only little HCI work focused on this SDG [18] compared to others and only few approaches have been proposed to mitigate this issue. These include for example augmenting the fridge to support the consumers purchase decisions and prevent excess food acquisition [10, 13] or apps that allow keeping a diary of thrown out food to foster reflection [14]. In this paper we try to address the issue at an earlier stage. Instead of focusing on interventions at the stage of consumption [34], we aim to increase the food literacy of the participants through a serious game [27, 30] with a provocative design angle [32, 36]. We created an interactive installation in which pairs of participants had to answer questions related to food characteristics such as the impact and amount of food waste, expiration date, usage possibilities of leftovers and correct discarding/composting. However, instead of engaging the users through challenge or a high-quality narrative we adopt a provocation: real food would fall into a bin in case the users answered wrongly. We employed this provocative design approach to engage participants in emotional reflections and create anxiety about answering the questions wrongly in the hope to spur more discussions between the users. It should be mentioned that the food that potentially would be "wasted" was collected with permission from a local supermarket's waste bin, in which products that were over the sell-by date would be disposed. This way no extra food waste was created as part of the installation, however the participants were not aware of this fact. The results of our observations and semi-structured interviews indicate that the participants exhibited high emotional involvement with the installation, while some claimed to not have learned much they could still recite detailed information from the installation.

2 RELATED WORK

In recent years we saw an increasing interest in Human-Food Interaction research across a large range of topics [2, 3]. However, compared to the amount of work that focused on creating new food experiences or encouraging healthy consumption, only little work focused on preventing and mitigating food waste. One solution that directly mitigates food waste and that gained prominence in recent years is food sharing via online social media communities. Ganglbauer et al. analysed the foodsharing.de Facebook community and highlighted how this kind of platforms can facilitate fluid changes between global thinking and local action through transitions from online arrangements to offline actions [15]. Ganglbauer et al. also applied the FridgeCam as a technology probe in order to understand food waste in daily behaviour better [13]. By applying a practice lens they uncovered different themes on how food waste is often a result of moments of consumption within the users practices. They present several design opportunities to support the everyday practices of individuals towards reducing food waste. Similarly, Farr-Wharton et al. used colour coding and the FridgeCam to

raise participants' awareness of available food items in the fridge thereby preventing potential excess shopping and in-time usage of the food [10]. Their findings demonstrate how a properly augmented fridge can assist in preventing food waste. In our work however, we aim to mitigate food waste by creating awareness around the impact and increase food literacy, thereby hoping to change the practices of the participants already before they would lead to potential waste.

Prior work also focused on mobile applications that help to reduce food waste [9, 14]. Ganglbauer et al. developed a mobile food waste diary, to enable users to reflect on moments of food waste and the rationale behind them [14]. The users had to actively enter a free text with a reasoning for their actions, which helped with creating a reflection on the complex aspects of food waste. In [9], the authors compare three different applications with slightly different angles to prevent food waste and they identified food literacy as a crucial aspect for the success of these apps. Our installation tries to follow this approach as well, but with a strong emotional experience angle instead of a mobile app.

With the BinCam, Thieme et al. presented a social persuasive system to motivate reflection on food waste and recycling behaviour of young adults to create behavioural change towards more sustainable practices [6, 7, 40]. The system uses a smartphone attached to the underside of a bin that would upload images of the trash that the users throw out to Facebook, thereby creating social pressure on the users. Their results indicate that this increased the users' awareness and reflection on their recycling behaviour and the influence. Altarriba et al. extended on this idea and created a smart bin concept that uses the power of pranking and social dynamics between groups of students in order to create awareness of each others food waste [1]. Similarly to the BinCam it would also post a picture on the social media account of one of the group members [6, 7, 40].

Serious Games, i.e., games with a serious intent, for example to educate about a serious problem or to promote behaviour change and to motivate users [27, 30] have been wildly applied to a variety of application cases [21, 28, 43]. In the area of Sustainable HCI we have specifically seen a variety of investigation and approaches using serious games to foster more sustainable recycling behaviour in users [5, 12, 20, 22, 24, 25, 33, 37], with some success. For example Santti et al. reported an increase of the recycling rate of biowaste from 76% to 97% and for recycled plastic from 25% to 84% in their participants in student apartments in Kuopio (Finland). Despite these promising approaches comparably little work focused on food waste related serious games [11, 16, 41]. Verloop as well as Gruter focused on collecting data about food waste [16, 41] while Ferreira et al. designed a learning game to educate children about the issues regarding food waste [41]. Similarly, in this paper we focus on increasing food literacy. Instead of a digital game we created a physical installation where the users would have to face real food waste as a potential consequence of their performance.

3 FACE-THE-WASTE - DESIGN AND IMPLEMENTATION

Given the previous success of serious games in a variety of different other sustainable HCI application contexts, we decided to design a serious game to increase food literacy and thereby hope to reduce food waste. However, instead of creating a fully digital game, we aimed to create a serious game in the form of a large physical installation. The aim was for the user to learn about the general impact of food waste and increase food literacy. The game followed a classic quizz game show design similar to for example "Who Wants to Be a Millionaire?"[1], where the user is posed a question and can chose between four possible answer possibilities. Overall, there were 41 different questions that span a variety of areas related to prevention and mitigation strategies for food waste, for example, "When should you throw milk

[1]https://en.wikipedia.org/wiki/Who_Wants_to_Be_a_Millionaire

Fig. 2. Overview of the Face-the-Waste Installation – Left: The installation re-imagined a living room, with two chairs, a carpet, the display for the game content and the back drop with the conveyor belt. Right: Close-Up of the conveyor belt and the garbage bin in which the food would fall down as well as the display showing the game content.

out?" with the correct answer being "When it smells bad" or "Keeping tomatoes close to other fruit and vegetables will do what?" with the correct answer being "Make them go bad sooner". Furthermore, we also asked question to the general issue of food waste for example "Approximately how much of a family's total food purchase is thrown out on average?" where the answer is "approximately 20%". After the user chooses one option, the user will be told whether the answer was right or wrong and afterwards some tips or more information related to the question will be given.

To increase emotional dimension and potential self-reflection during interaction with the installation we employed a provocative design approach. With provocative design we refer to the idea of challenging existing norms by for example creating predicaments through interaction design. While previous studies that applied this idea have shown higher levels of self-reflection on their own behaviour in users [32, 36], it is important to not alienate the users too much, as if the design is perceived too strange it might not be effective [32]. Emotional involvement has in the past been shown to have a significant impact on learning and retention [19]. For our installation this provocation would happen when the users would answer wrongly. Instead of just loosing points or something similar, an actual piece of food would run down a conveyor belt and fall into a bin (compare Figure 1). As already mentioned the food that would be thrown out, was sourced from a local supermarkets garbage bin, where food that was over its sell-by date would have been discarded. We selected pieces of fruit, vegetables and other food items that while over the sell-by date were still looking rather fresh and probably would still be consumable. The users did not know about this fact, so they were in the disbelief that they would create food waste in case they answered wrongly. It should be noted that the food was not actually discarded but that the authors removed it regularly from the bin and consumed it after each day of testing, so no food was wasted as part of the installation. Before the question is shown a piece of food would run out on the conveyor belt from behind the backdrop, to show the users what is at stake for this question. If the user answers correctly the food would run back behind the back drop and would be considered saved, in case the user answers wrongly the food would fall into the bin.

The general appearance of our installation was based of the look and feel of a 60's living room. For this we used two comfortable chairs, a carpet, a small table on which a TV remote was placed and a display on the side that would show the games content. In front of the users would be a white back-drop with a hole in it in which we placed the outlet of the conveyor belt. An overview can be seen in Figure 2 (left). To steer the attention of the users a bit away from

the display we had a spotlight on the conveyor belt and the garbage bin as can be seen in Figure 2 (right). The overall aesthetics were meant to increase emotional involvement as it creates a comfortable atmosphere and steer the focus to the main elements of the game content and the conveyor belt. The two chairs where chosen as we wanted potential users to interact in pairs and prevent the forming of larger groups around the installation. The goal here was to create discussion between the users and investigate whether the potential danger of wasting food would become a discussion point between the users. To align with the theme of a living room, the users would interact with the installation using a TV remote to select the right answers via the remotes buttons one to four. On the audio side, we matched the theme of the 60's and more classic game shows, playing Bossa Nova style elevator music using a Bluetooth speaker.

The whole installation was implemented using Processing and Arduino. The display and the Arduino were connected to a laptop that was hidden behind the backdrop and ran the game. To enable the interaction via the TV remote we used an infrared receiver connected to the Arduino to decode the signals sent by the TV remote. The conveyor belt was custom build using a stepper motor, four 3D printed cog wheels and thin plastic pieces as links similarly to a continuous track (e.g., found in tanks or bulldozers). The placement of the food on the conveyor belt was done manually, meaning that one of the authors would be seated behind the backdrop and either exchange or place a new piece of food on the belt before a new question was posed.

4 EVALUATION

We evaluated the installation over the course of a two-day exhibition at Aalborg University in a well situated room. The target audience chosen for the installation were young students in the age group of 18-35. We chose this target group not only because it would be the expected audience in a university setting, but also because Comber et al. found that this group – while having strong positive attitudes towards sustainability – would not always act appropriately [7]. Besides other factors Comber et al. also reported missing knowledge as a factor that would lead to a worse behaviour, which suggested to be a good intervention point for our Face-the-Waste installation. While we aimed to have pairs interacting with the installation (see above), we did take no measures to prevent participants interacting with the installation by themselves or in larger groups, however, the majority interacted in pairs with the installation.

The participants were greeted by a starting screen that would introduce the game and how the participants should interact with it, afterwards the questions were selected randomly and the game was open-ended, meaning that the participants were free to answer as many questions as they liked and stop at any point and leave. If no question was answered for two minutes the software would reset itself automatically to the start screen again. This could also be done by the operator if new participants entered. For our data collection, we logged how many questions were answered and whether they are answered correctly. Furthermore, as one of the authors would serve as the operator of the app and the conveyor belt (place new food items on it), we had the possibility to easily observe the interaction between the users and their reactions e.g., to the food falling in to the bin in a covert manner [42]. Participants were made aware of the fact that their actions would be observed and that they agreed on their data being used, once they entered the room, by a sign on the outside.

Additionally, we conducted semi-structured interviews with 9 participants that were randomly selected but that all answered at least 10 questions (with at least one correct and one wrong answer) together with at least one more participant. The interviewed participants all were students and between 20 and 28 years old (avg. 24 years) and five of them identified as female (four as male) and all gave consent before the interview. Besides demographic questions we asked questions related to their relationship to food waste, their experiences with the game, their learning outcome and their feelings related to the food falling into the bin.

5 RESULTS & DISCUSSION

We had overall more than 80 unique interaction sessions (e.g. either a single user, a pair or groups of user) at our installation that answered 379 questions in all. From these 379 questions, 212 were answered correctly (167 wrong). However, not all of these are due to missing knowledge. It became clear from our observations and the discussions between participants that for several questions they either misinterpreted the question or selected the wrong answer possibility by accident. While this is to be expected, we also saw several cases of discussions around constant myths of food preparation, for example the question "Is it safe to reheat spinach and parsley?" where a common misconception is that spinach should not be reheated, when in fact it is completely safe, spurred several heated discussions between participants. Specifically, we saw that several participants who answered wrongly reacted very strongly and insisted that their answer was correct and that it was not their fault that the food fell into the bin. Many participants also showed very strong emotional reactions to the food waste falling into the bin through for example screams and sighs and several claimed that the questions were impossible to answer correctly. This specifically happened for the questions that related to the general development and impact of food waste on the environment, where some participants voiced that they found it unfair and they couldn't have known that before. In general, we observed constant discussions between participants that interacted in pairs or groups, nearly all questions, explanations and tips were discussed. We saw particularly strong discussions between participants after wrong answers, where participants would often discuss who was to blame for the food falling into the bin. Another observation was that the majority of participants – despite whether they answered right or wrong – took the time to read the explanations and tips that were shown after the question was answered. One thing that we expected to happen beforehand was that participants on purpose would answer wrongly to make the food fall into the bin. However, while we could observe several participants voicing this idea, none of them acted on the impulse. One of the interviewed participants (P2, 26years) even mentioned that she was thinking about deliberately answering wrongly so she could then take it out of the bin and eat the food, but still decided against it.

In the semi-structured interviews 8 out of 9 participants explicitly mentioned that their general experience with installation was pleasant and comfortable and that the overall living room style setting including the music worked really well. With respect to the conveyor belt, it became clear from the interviews that it helped the participants to reflect stronger on their daily habits: "You are really made aware of the little things that fall into the trash, which is really something everyone does every single day many times. But here it's just like every little thing makes you: no now there comes one more!" (P3, 23 years). One participant even went so far to describe the conveyor belt as a friend that was trying to help him save food, and not a potential punishment (P7, 27 years). Most participants also mentioned that they saw it as their responsibility to make the food move backwards again and not fall into the trash and several voiced how frustrated they felt when it would fall down. Two participants also mentioned the absurdity of the way we presented the food. We did not always present large quantities of food and from time to time even a single grape would be on the belt which made them question whether this is connected to the degree of difficulty of the question, however, this was completely randomized.

In terms of learning outcomes all participants said that they at least learned one new thing, and 5 participants specifically mentioned that they paid attention to the explanation and tips if they answered wrongly. However, 3 participants also mentioned they learned "not that much" (P5, 24 years) and that they knew a lot of it already, where one participant particularly mentioned that she did in the past actively tried to reduce her personal food waste. To some extent contradicting this low learning outcome is that 2 of these participants recited accurate numbers and facts that

were mentioned during the game which they also acknowledged not have known before. These recited facts all related to the large impact of household food waste. We also found a connection between the participants emotional involvement when food fell into the bin and the self-reported learning outcomes. Here 5 participants explicitly mentioned that they felt bad about it and said they learned a significant amount of new knowledge.

Generally, the results indicate that our use of provocative design in connection with a serious game can be considered a success. While, we did not explicitly control for learning outcomes through a post-questionnaire, or investigated the effect on potential behavioral change, the observed strong emotional reactions and the results of the interviews highlight the involvement of the participants with the installation. Such emotional involvement has in the past been demonstrated to result in higher learning outcomes in serious games [19]. Furthermore, the high amount of wrong answers, indicate that the participants didn't have all the knowledge they were exposed to.

The discussions we could observe between the participants in addition showed that the provocation increased the participants desire to answer correctly and thereby could have increased their reflections on the questions. And despite the fact that the interviewees claimed not to have learned much new information, they demonstrated knowledge with exact numbers that they were unlikely to have before. Furthermore, we also can conclude that our provocation was not too strange and did not alienate the participants [32] as no participant described the conveyor belt in a negative manner and one even compared it to a friend. It can be concluded that the provocation acted as a motivating element in the game that increased the engagement with the presented issue of food waste. Usually serious games spur the users motivation through the games challenge and reward progress or through a high-quality narrative that captivate the users and is part of a thoughtful progress making them reflect on the serious issue addressed in the game [26]. However, our results indicate that a provocation can create similarly engaging serious games. While, it will not always be possible to find suited provocation in other areas and we are still missing a lot of information about how to best provoke the users for such purposes, we provided evidence that it can be another design element for serious games.

6 CONCLUSION

In this paper we presented Face-the-Waste a serious game in the form of an interactive installation in which participants answer questions related to food literacy and the impact and amount of food waste, but, instead of engaging the users through challenge or a high-quality narrative we adopted a provocation: real food would fall into a bin in case the users answered wrongly. Using such a provocation as part of a serious game has to the best of our knowledge not been done before. From our results it seems that this is a promising approach to spur discussion and reflection about the serious issue that the game relates to. Clearly, our results do not allow us to make any claims about long-term learning outcomes, but the observed behaviour and the feedback we received, indicate a high level of emotional engagement with issue of food waste. Thereby, we demonstrated that such provocations can add a new layer of engagement for the design of serious games. It is also clear that such provocations can not easily be applied to all contexts and as previous work indicates not all levels of provocation might be suited to create proper engagement [32]. For future work, we plan to extend our evaluation and investigate long-term learning outcomes in a game with and without provocation as well as see how such provocation can be used in other serious games relating to other sustainability issues.

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