A Week Without Plastic Bags: Creating Games and Interactive Products for Environmental Awareness

Anna Gardeli, Spyros Vosinakis, Konstantinos Englezos, Dimitra Mavroudi, Manolis Stratis, Modestos Stavrakis

University of the Aegean
Department of Product & Systems Design Engineering,
Syros, Greece
{agardeli, spyrosv, modestos}@aegean.gr

Abstract. Interactive technologies and digital games can be valuable tools in raising awareness and persuading people to adopt more environmental friendly behaviour. Appropriate methods and paradigms for designing such systems and successfully blending the 'fun' element with the messages to be communicated are still under research. In this paper, we investigate the benefits and drawbacks of using games and playful interactive technologies for influencing people's behaviour towards the environment, through a series projects developed and publicly presented during a campaign for reducing the use of plastic bags. We present the design process and methodology adopted, the resulting projects, and a number of observations and preliminary results based on their public use.

Keywords: persuasive technologies, games, user motivation, user engagement, environmental sustainability, pro-environmental behavior.

1 Introduction

Interactive technologies and gamification are rapidly growing research topics that have the potential to inform, educate and change people's behavior about environmental problems related to ecological sustainability [1,2]. Interacting through persuasive technologies and ecologically-focused gamification transposes game mechanics and game design techniques to involve and motivate people to act, while at the same time disseminate essential information about human intervention to nature. The value and effectiveness of interactive technologies and games in education and sensitization about environmental/ecological problems has been shown through numerous scientific studies [3,4].

An important aspect of this research area is the incorporation of appropriate motivational and playful elements in the design of interactive systems to attract and retain users' interest, whilst achieving their educational or persuasive goals. Despite the recent emergence of generic methodologies and guidelines for designing persuasive systems [5,6], the successful selection and combination of design elements and technologies that lead to the expected awareness or behavior change, is still an open issue. There is a growing need for further paradigms and use cases in a variety of areas

that will eventually provide rich feedback on various design choices with respect to the target group and the desired outcomes.

Our research is along this line. We focus on design approaches for pre-environmental behavior through physical play and motivation within a social context and by using interactive technologies and computer games. In this paper, we present the development and an initial evaluation of a number of games and interactive systems that were publicly displayed in an information and awareness campaign for the reduction of plastic bags in the marine environment (LIFE14GIE/GR/001127). Selected student groups from two courses, in collaboration with their tutors, developed and tested eight different games and interactive installations that aimed to promote the campaign's goals in informing and educating people about the environmental problem through play and interaction. To achieve these primary goals, the games/interactive installations focused to attract people's attention, instill interest, engage them in understanding the problem with plastic bags and the environment and motivate them to participate in activities that promote ecological sustainability. In addition, the interactive installations motivated users to actual recycling through play.

2 Related Work

Over the last years, numerous studies and projects have applied persuasive technologies, motivational elements and playfulness in a wide variety of domains such as health and fitness, safety, environmental sustainability and more [7]. As being described by Fogg [8], persuasion is "an attempt to shape, reinforce, or change behaviors, feelings, or thoughts about an issue, object, or action". Persuasive technologies and gamification are motivational systems that rely on the assumption that technology can influence human behavior and habits. Designing for persuasion – or change - must be on purpose of "guiding the user towards an attitude or behavior change" [9] while at the same time keeps him/her motivated and engaged with the task/activity at hand.

Digital or hybrid games have grown to be a strong educational and persuasive tool, given their entertaining and motivating nature. Games intended for social and behavioral change are called games for change, and they mainly aim "to promote reflection and positive behavior changes in players in the physical world, through characteristics that persuade players to consider the social or political issue presented in the game" [10]. Instead of words, images or moving picture, games use their rule-based approach and interactions to persuade players. That rhetoric technique, called procedural rhetoric, is based on the abstraction of physical world systems in the game and it is directly linked to the game elements, mechanics and gameplay [6].

Numerous studies (e.g. [11, 12]) also suggest that interactive installations combining a digital interface with physical activity present strong indicators of producing positive behavior change results, especially when combined with entertaining elements. A typical example is the "playful toothbrush" system [13], an interactive game with motivational and educational purposes. With a vision-based motion tracker the system makes a game out of the activity of brushing one's teeth, where the user brushes the teeth of a 'virtual self' through physical interaction. Another example which focuses on

pro-environmental behavior is “Gaia”, a multiplayer mobile augmented reality game combined with a public installation that helps users learn about waste management and recycling in a fun way. Users walk in the city to collect virtual objects through their mobile interface and bring them to the recycle bins, whilst learning facts and tips about recycling.

Some approaches additionally provide a form of feedback to users concerning the effects of their actions to help them reflect and improve their future behavior. For example, UBIGreen investigates a mobile tool for tracking and supporting green transportation habits [14]. A mobile phone-based application provides personal awareness about green transportation behaviors through iconic feedback. Small graphical rewards are earned by selecting pro-environmental means of transportation, and the user performance is also reflected in the phone’s wallpaper. Another example is BinCam [12], a smart recycle bin that informs the users’ social network about her recycling behavior by posting images of thrown-away items whenever the lid opens and closes. As such, it helps users reflect on their own and other people’s waste-related habits.

Finally, several influential projects and approaches in developing interactive installations and games also emerged from ‘The Fun Theory’ campaign, an initiative that aimed in exploring people’s environmental behavior and persuade them to change by allowing them to experience the fun side of acting responsibly [15]. It focused in exploring three aspects of human behaviour: environmental psychology, fun theory, operant conditioning. Among others, projects included a piano staircase for motivating people exercising by using traditional stairs instead of escalator, ‘The World’s Deepest Bin’ for motivating the collection of garbage and placement in an interactive bin, and the ‘Bottle Bank Arcade Machine’ about recycling glass bottles and cans.

3 Design Process

‘Week without plastic bags’ was a campaign organized in the island of Syros as part of the LIFE DEBAG project, which included many different actions with informative and educative purposes, such as training seminar for primary and secondary education teachers, beach litter cleanup actions, etc. Its main objective is to inform about environmental issues related to the use of plastic bags and to persuade consumers to replace them with more environmental friendly solutions. The Department of Product & Systems Design Engineering of the University of the Aegean supported the project by implementing interactive technologies and games that promoted the campaign’s messages as co-ordinated student projects in two different courses: computer games / edutainment and interaction design. The methodological framework used for developing the projects was based on the following phases: 1) preliminaries and introduction, 2) briefing, 3) research, 4) design, and 5) evaluation.

The first phase was initiated by a presentation and analysis of the main goals of the LIFE DEBAG project. Course tutors and the collaborating scientists from the project explained the main objectives and provided guidelines regarding the methods and techniques that should be used in the following phases. Preliminary activities also included project planning which involved team assembly, role assignments (coding,

physical computing, visual & industrial design, interaction design, communication design and research) and the documentation of a project plan.
Following educational material that has already been taught during the lectures and tutorials of the two courses, students formed groups (3-4 students) and started briefing (phase 2) by defining goals, constraints and future design directions of the project. The main methodological tools that assisted in this phase was the eight-step design process for creating persuasive technologies [5] and the P.A.C.T. scoping technique [16] followed by a preliminary use of exploratory scenarios and early sketches [17,18].

The methodological core for researching, designing and evaluating (phases 3-5) interactive installations and games was mainly based on design approaches in HCI and Interaction Design for games, digital product and service design [16,19]. It encompassed a number of design goals focusing in dealing with product's behavior, visual and physical form, interaction, playability and digital interactive content. The research, design and evaluation processes that the students followed involved a multilayered set of techniques for a) conducting research, b) collecting data and c) modeling raw information, d) defining requirements, e) laying out a basic design framework, f) defining interactive content and mechanics (especially in the case of digital games), g) designing prototypes (low & high fidelity) and f) testing and evaluation.

The research perspective in this work was human-centered and followed a user-driven design research. The methodological tool for conducting research was based on the scoping technique of P.A.C.T. [16] and the first four steps from Fogg's design process [5], which provided the grounds for analyzing: People (receptive audience), Activities in terms of Actual and Target Behavior, and Inhibitors of Target Behavior, Context and the Technologies involved.

Students conducted interviews with stakeholders and other close collaborators from the LIFE DEBAG project campaign. They mainly focused in analyzing users, their behavior and everyday activities. Understanding pro-environmental behavior of people and their engagement with the ecological problem of plastic bags led to the analysis of the actual contexts where people mainly come in close contact with getting, using or disposing a plastic bag (e.g supermarkets, shops, beaches and other coastal environments, and household). Moreover, contexts where people gather, have time to spend in learning and getting informed about environmental issues have also been identified. Analysis of potential technologies and experimentation on physical computing and games design techniques were the final stages of the research agenda. The main outcomes of the research can be summarized in Table 1.

Analyzing and modeling raw data by the use of personas was the core of developing models that explained what was observed. The last step in modeling information and towards the definition of requirements was done through the use of scenarios or stories about personas interacting with an anticipatory version of the future product.

The next phase involved the definition of the design framework where students focused on interaction and games design, physical computing, and visual and industrial design for the interactive installations. In the case of digital games, the students further focused on selecting and applying appropriate game world aesthetics, story and mechanics that balance well with the intended purpose and the messages to be communicated, using the popular Mechanics-Dynamics-Aesthetics (MDA) approach [20].

Table 1. People, activities, target behavior and inhibitors in four different contexts.

People	Activities	Target Behavior	Inhibitor(s)	Context
market customers	use free plastic bags for carrying goods	avoid plastic bags, use reusable cloth bags	forget to carry cloth bags, prefer plastic bags for reuse, lack of motivation to avoid plastic bags	super markets, shops, kiosks
tourists, working personnel at beach or coastal areas, kids	carry items in plastic packaging / bags, playing with plastic toys, relax, listen to music	collect and recycle plastic waste, avoid carrying plastic bags and packaging, avoid leaving waste	lose things at the beach, not motivated to collect and recycle plastics, not informed about environmental issues	beaches, coastal areas
adults relaxing and socializing, kids, tourists	socializing, playing games, relaxing	learn about environmental threats, collect plastic packaging and bags	lack of time, no visible information spot	public places, meeting points, cultural sights
family	doing household activities, playing games, relaxing	avoid using plastic bags for packaging	not informed about threats, not informed about alternatives, formed a strong habit	house

Finally, the design process concluded by designing low fidelity prototypes followed by more detailed designs of highly interactive games and installations. A series of (play)testing and refinement led to the final prototypes, which were publicly presented and tested during the LIFE DEBAG campaign.

4 Description of the Projects

In total, eight projects have been implemented, six interactive installations and two platform computer games. Five projects focused on informing and educating about collecting and recycling plastic waste of the coastal and marine environment while also promoted actual recycling through play. Two projects focused on the replacement of plastic bags by cloth bags principally in urban environments. One project focused on informing and providing awareness about the consequences of plastic bag use. Concerning the interaction techniques, the two computer games are presented through a visual/graphical interface, one of the installations uses a hybrid GUI and physical interaction, while the rest use physical and tangible interaction alone. Table 2 presents a summarized description of the projects and Figure 1 shows selected screenshots and concept designs.

The two platform games have been developed on the Unity game development platform and both provided a desktop and a tablet version. The interactive installations have been developed using the physical computing platform Arduino, sensors, actuators, NFC/RFID technology, and other peripherals.

Table 2. The eight implemented projects with their aims and content, motivational factors and technology – user interface employed.

Name	Aim/content	Motivational factors	Technology / UI
Bag to the future	replacement of plastic bags in everyday life	rewards, points, progress, visual or audio feedback	Unity game engine
Finding bags	consequences of the use of plastic bags	rewards, points, progress, visual or audio feedback	Unity game engine
Arbino	rewards for good behavior	rewards, points	Arduino, NFC technology
Bagar	rewards for good behavior, consequences of the use of plastic bags	rewards, points, visual or audio feedback	Arduino, NFC technology, motion sensors, mobile app
DE - BAG	replacement of plastic bags in everyday life	rewards	Arduino, NFC technology
SEArch	consequences of the use of plastic bags	visual or audio feedback	Arduino, NFC technology
The JunkBox	rewards for good behavior	visual or audio feedback	Arduino, motion sensors

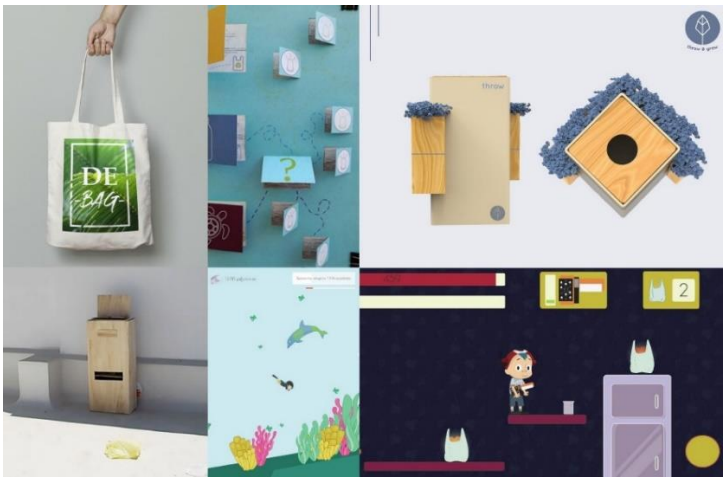

Fig. 1. Concept designs and screenshots from a selection of the implemented projects.

Bag to the future (digital game). The first game was built on two main content objectives: the replacement of plastic bags in everyday life and the awareness of the consequences of their use. Based on the fact that the negative effect on the environment of the use of plastic bags is not immediately visible, the future self of the young character appears to inform him about the situation in the future where the problem is most visible and unavoidable. As a mission, he/she has to collect all the plastic bags, with a device called "bag-exterminator", and replace them with fabric bags, baskets or different temporary storage means, friendlier to the environment. His/her purpose is to save the future by changing the behavior and habits of the grown-ups, who use plastic bags recklessly every day. His/her mission is secret, so the user is playing against time and noise.

Finding bags (digital game). The second game informs about the factors that contribute to the destruction of the underwater environment and the dangers that marine

life is facing, that can either be trapped by a plastic bag or consume it. The main goal of the game is to clean the ocean by collecting plastic bags in an underwater environment and transfer them with safety to the vessel, where they will be recycled. A secondary goal is to save fishes and turtles if they are trapped by a plastic bag. There is not a winning situation· you can collect as many bags and save as many fishes and turtles as you can. The game uses microsimulations to show the level of pollution. The game overs when your time is up or the pollution level is too high.

Bagar (interactive installation and game). Bagar is a hybrid installation and interactive ecosystem includes: an application that run on portable devices (tablet or smartphone), an interactive installation with physical prototype and infrastructure based on web technologies. The main functionality is based on the speed / judgment / reflex game logic where users try to place the waste at the correct position in the bin/system. The system personalizes users, records users' performance and rewards users with a LIFE DEBAG cloth bag considering their score. Users can see their ranking, the total number of plastic bags they have loaded into the bin and participate in a knowledge questionnaire, that addresses the topics that the project deals with.

Arbino (interactive installation and game). Based on the game genre of treasure hunting, the main goal of this project was the collection and placement of plastic bags in an interactive bin. The system identifies the number of the collected bags using proximity and presence sensors, and stores the actual score. Users, who collect a large number of bags, get rewarded by the system with a LIFE DEBAG cloth bag, automatically delivered by the corresponding mechanical output of the system.

JunkBox (interactive installation). JunkBox is an interactive recycle bin and music jukebox, that can be used in coastal environments where users (swimmers, beach visitors, tourists, kids etc.) have time to relax and entertain while can collectively participate in recycling. Users are prompted to collect plastic waste and place it in the interactive installation. In turn, the system identifies the number of items collected by its sensors, sums and stores the actual score for each user and provide reward by allowing to select and play songs from a database, like a real jukebox.

Grow and Throw (interactive installation). Throw & Grow is an interactive installation for watering plants and a recycle bin. The design of the system is based on volunteer action for preserving the environment. Through a personalized engagement with the process, users will be interested in adopting "their own plant" and gain personal emotional satisfaction through helping the environment. The bin identifies object delivery through its sensors and provides its user with the ability to water a plant locally or remotely to another installation, depending on user preference.

SEArch (interactive installation and game). SEArch is an interactive, physical game, based on a combination of a treasure hunt and Q&A type of games that has an informative purpose. The gaming process includes using a map to locate three hidden objects that are placed in a specified area. Users are then prompted to answer a number of questions, concerning the effect of plastic waste at sea, in order to win the game. The interactive installation consists of a physical box that houses the electronic parts and affords interaction, a map and a physical board that presents the story and information.

DE – BAG (interactive installation). DE - BAG is an interactive installation and product designed to prevent consumers from purchasing plastic bags at sale points in supermarkets and shops. The idea of the project is that cloth bags can support NFC

technology for affording intact transactions: collect or redeem rewards or collected points, gamify point collection among users/customers at the cashier's desk.

5 Public Presentation and Preliminary Evaluation

During the 'Week without plastic bags' campaign, visitors had the chance to interact with the systems that have been implemented by our student groups, which were presented in public exterior and interior spaces (Fig. 2). Users were mainly children about 7 to 12 years old, usually formed in groups, accompanied either by parents or teachers while many university students and other adult passersby (tourists, town residents) visited the event. We used a combination of in situ observation, video recording, questionnaires and interviews in order to evaluate user enjoyment and motivation and gain some initial understanding about possible benefits and pitfalls of our design choices.

Fig. 2. Visitors interacting with the projects in the central square of Hermoupolis, Syros

Regarding user experience, we reached some findings implying that users were *attracted*, *engaged* and *motivated*. Initially, the presentation (physical and interactive elements) of the projects managed to draw the attention of multiple users. Most of them (mainly children) returned to play/interact multiple times with the prototypes, in the same or different days, which is a strong indicator of engagement.

As expected, we noticed that gamification and playfulness had an important role in users' enjoyment and motivation. Installations and games that strongly incorporated these aspects had a higher return rate compared to static installations that just communicated a message. Gamification mechanisms, such as, providing instant feedback on performance to create competition and giving rewards, played a major role in keeping the users engaged and motivated. In addition, we observed that this repeated use of the persuasive systems was of high importance in developing targeted user behavior in the long run. In short term, it allowed monitoring user performance over

time and observing their progress. We further noticed that the social aspect in the public installations was strong. Users exhibited social behavior and intentionally collaborated with each other. In some cases, users learnt how to play/interact by watching others. Children had a tension to collaborate with each other, although our games/systems have been designed to be single-user. There were groups of two or more people in front of the screen or installation, discussing and helping each other to fulfil the purpose of each game/task. After their interaction, a lot of users communicated their knowledge and experience to other passersby, motivating them to participate as well. Users exhibited online social behavior by disseminating their score and achievements on social networks even on the games/installations that did not support the features (they used manual methods). This way, the message, and some knowledge, were disseminated to more individuals. Based on these findings, we suggest that persuasive systems, especially public ones, should incorporate social and collaborative features in their design.

In most cases, users needed different levels of support depending on interaction complexity, and gameplay. Younger users needed more assistance with complex tasks, and a few of them failed to complete more than one task. Furthermore, a limited number of users diverged from the actual scenarios and tried to explore different features of the systems. In addition, most users preferred the tablet device to the laptop for the two digital games, despite the fact that laptops also had touch screens.

We also made a number of observations regarding technical issues. Given the ambient noise of the environment, especially during the outdoor presentations, the sound in most projects was low; alternative techniques (visual or haptic) should be used as feedback. Environmental lighting conditions affected the calibration of the sensors and thus auto-calibration mechanisms needed to be implemented. Finally, physical prototypes were prone to failure when users acted beyond the specified limits of the experiments.

6 Conclusions

This work outlined the methodological steps and decisions towards the development of a set of prototypes that aimed at informing and educating users in a playful and engaging way about the problem of plastic bags. The findings of our preliminary evaluation concerning user interaction indicate positive results, though interactive installations that where detached from their actual context of use (e.g. DE-BAG, JunkBox) had lower impact and should be evaluated again. Our observations suggest that interactive technologies and computer games can improve the dissemination of information about environmental problems and contribute towards the advance of awareness and user engagement. After a week in participating the campaign and based on performance measurements (between sessions) and questionnaire feedback (pre and post intervention), users, passersby and audience exhibited a significantly higher degree of awareness for the project's goals. Finally, project stakeholders of the environmental problem that participated to the gathering and workshops identified interest towards further development and extension of the current work in different areas/disciplines.

References

1. Gardner, G.T., Stern, P.C.: Environmental problems and human behavior, 2nd ed. Allyn & Bacon (2002)
2. Vlek C., Steg, L.: Human Behavior and Environmental Sustainability: Problems, Driving Forces, and Research Topics. J. Soc. Issues, 63(1), 1–19 (2007)
3. Froehlich, J.: Gamifying green: gamification and environmental sustainability. In: The gameful world: Approaches, issues, applications, pp. 563–596 (2015)
4. Reidsma, D.: Advances in computer entertainment: 10th International Conference, ACE (2013)
5. Fogg, B.J.: Creating persuasive technologies: an eight-step design process. In: Proceedings of the 4th international conference on persuasive technology, p. 44 (2009)
6. Oinas-Kukkonen, H., Harjumaa, M.: Persuasive systems design: Key issues, process model, and system features. Commun. Assoc. Inf. Syst., 24(1), 28 (2009)
7. De Vries, P.W., Oinas-Kukkone, H., Siemons, L., Beerlage-de Jong, N., van Gemert-Pijnen, L.: Persuasive technology: development and implementation of personalized technologies to change attitudes and behaviors. Springer, Heidelberg (2017)
8. Fogg, B.J.: Persuasive Technology: Using Computers to Change What We Think and Do, Morgan Kaufmann (2002)
9. Hamari, J., Koivisto, J., Sarsa, H.: Does Gamification Work? – A Literature Review of Empirical Studies on Gamification. In: 47th Hawaii International Conference on System Sciences, pp. 3025–3034 (2014)
10. Hosse, I.R., Zuanon, R.: Games for Change: The Strategic Design of Interactive Persuasive Systems. In: Universal Access in Human-Computer Interaction. Access to Learning, Health and Well-Being, pp. 442–453 (2015)
11. Chiu, M.C et al: Playful Bottle: A Mobile Social Persuasion System to Motivate Healthy Water Intake. In: Proceedings of the 11th International Conference on Ubiquitous Computing, NY, pp. 185–194 (2009)
12. Thieme, A. et al.: We'Ve Bin Watching You': Designing for Reflection and Social Persuasion to Promote Sustainable Lifestyles, In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, NY, pp. 2337–2346 (2012)
13. Chang, Y.-C. et al.: Playful Toothbrush: Ubicomp Technology for Teaching Tooth Brushing to Kindergarten Children. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, NY, pp. 363–372 (2008)
14. Froehlich, J et al: UbiGreen: investigating a mobile tool for tracking and supporting green transportation habits. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, ACM, pp. 1043-1052 (2009)
15. The Fun Theory, 2009. [Online]. Available: http://www.thefuntheory.com/. [Accessed: 28-Jul-2017].
16. Benyon, D.: Designing Interactive Systems: A Comprehensive Guide to HCI and Interaction Design. Harlow, England (2010)
17. Carroll, J.M.: Making use: scenario-based design of human-computer interactions. Cambridge, Mass: MIT Press (2000)
18. Preece, J., Sharp, H., Rogers, Y.: Interaction Design: Beyond Human-Computer Interaction, 4th edition. Wiley (2015)
19. Goodwin, K.: Designing for the Digital Age: How to Create Human-centered Products and Services, John Wiley & Sons (2009)
20. Hunicke, R., LeBlanc, M., Zubek, R. MDA: A formal approach to game design and game research. In: Proceedings of the AAAI Workshop on Challenges in Game AI (2004)