Disaster Prevention Social Awareness
The *Stop Disasters!* Case Study

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Abstract—**Serious games are increasingly being regarded as a valuable means to support educative processes and make people aware of important issues. Some of these address social awareness domains with the goal of promoting collective recognition of a given local or global issue as a first step towards its resolution. Even though nowadays widely used, serious games still require further study with regard to their impact. This gap in studies is especially strong in the domain of social awareness. The goal of this work is to address this gap by studying the impact of a highly disseminated serious game that had not yet been evaluated in any way: *Stop Disasters!*. We studied the impact of the game both in terms of the awareness and player experience it created. As a result we found statistical evidence to a positive impact of the serious game in player's awareness to wildfire prevention measures achieved in an overall positive and valuable game experience. This result provides further evidence to the positive impact of social awareness serious games in transmitting messages regarding social relevant issues in an overall positive and engaging experience.**

I. INTRODUCTION

Serious games are increasingly being regarded as a valuable means to support educative processes and make people aware of important local or global issues. Many reasons are argued to contribute to their adoption, but a fundamental one is the capacity to engage people [1], [2], [3], [4]. Motivation is a key factor in learning [5] and therefore when compared to traditional ways of communicating information games have in some situations been found to better engage [4], [6], [7] and persuade [8] learners due to their challenging and interactive nature. At present the domains addressed in these games are diverse and range from expert knowledge [9], to health [10], business and management [3], culture and heritage [11] personal and social learning and ethics [12], [13].

Social awareness games address social relevant issues that are normally forgotten or are not very publicized [14], with the goal of promoting collective recognition of the issue as a first step towards its resolution. The idea is to transmit a message and not a skill. Informing and mobilizing people to issues such as cultural differences, human rights and environmental preservation among others [14] is fundamental for societal development [15], [14]. As such, this domain may have an invaluable impact in people's individual and collective awareness to existing local and global problems and help shape the path to their resolution.

Even though widely used nowadays, serious games still require further study with regard to the impact of the games created. This gap in studies is especially strong for the domain

of social awareness [14] in which highly disseminated games lack any study of their impact. To address this gap, in this work we present the study of a social awareness game that has high visibility and addresses an important issue in diverse communities worldwide: *Stop Disasters!* [16], [17], [18]. The specific goal of the study is to look for clues on the impact of the game both in terms of the awareness it can actually create and the means to achieve it from the player's perspective (e.g. enjoyment, pressure, value).

The document is structured as follows. In the next section we review existing social awareness games and studies addressing those. Then, we introduce the background information required to understand the domain of the game studied, followed by the description of the game. Next we present the design and results of our study followed by the conclusions and future work.

II. STUDYING SOCIAL AWARENESS GAMES

Given the wide variety of topics included, the social awareness domain is currently addressed in many serious games. It was identified on a 2012 survey [14] that many games have a social awareness dimension even if not always their main focus. However, even though several of the games surveyed are widely known (e.g. Darfur is Dying [12], [19]) have been awarded prizes (e.g. Elude [20], [21]) and address problems at a global scale (e.g. Global Conflicts [22]), to our knowledge, almost the totality of those have not been empirically studied with regard to the awareness they generate and the experience which players go through when playing such games.

Even though studies of social awareness resulting from serious games are still few, especially in the context of the quantity of existing games, some authors have already provided evidence to the impact that social awareness games can have. One of the studied games is Enercities [13], a simulation game designed to make players experience and learn about energy management and the implications of decisions on energy management. In this game players start with a small city which they have to expand and in this process balance the needs of the citizens (e.g. energy needs) with those of business (e.g. profit) and the environment (e.g. pollution). In order to determine the actual impact of the game, Knol and De Vries [23] carried out a series of studies. On a first study [23] with 76 participants across 4 countries a qualitative analysis of the game was performed in which the majority of students classified the game as fun to play, as providing a good challenge and said that they would use less energy after playing the game. Additionally, in another larger study [23] with 325 participants across 5

countries the authors also found statistically significant results for awareness differences between participants who played the game and those who did not. The dimensions of awareness included interest in learning about energy saving and "green energy"[1], concern about the environment, the link between economy/energy usage/environment, environment importance over economy and the personal need to decrease energy consumption. Finally, the largest study carried out [25], [23] with 653 participants found a statistically significant positive effect of Enercities on participants who played the game towards a general energy saving attitude at home and also towards the specific behaviors of turning off the TV instead of using standby (saves energy) and taking shorter showers (saves water).

Another game that has been studied with regard to its impact is Choices and Voices [26], a role play game to engage young people in exploring and discussing issues underlying violent extremism such as peer pressure, social exclusion and bullying. In [6] Lynn carried out a qualitative analysis of the game based on feedback from 83 students, 5 teachers and 2 police officers across 5 schools. The author found that the game was very effective at engaging students in discussing presented topics and understanding the importance of choices students make in their lives. From the teachers' perspective the game was also found to be a valuable tool with regard to the ability to engage students in an interactive setting and in discussed topics, which is a significant improvement with regard to typical tools (e.g. DVDs). Regardless of this, the authors do acknowledge that the lack of a follow up study does not enable them to draw more complete conclusions about the game effects on future student behavior. However, with regard to awareness itself, the engaged way in which students participated in the discussions after playing the game is already a significant sign of the awareness the game generated.

A final example of a social awareness game that has taken an evaluation step to support the effectiveness of its goals is PING (Poverty is Not a Game) [27], a role play game to raise awareness about the experience of being poor. In this game, players play the role of either a young girl or boy who faces diverse monetary hardships that lead them to difficult daily decisions. In a study [28] with 275 participants Neys *et al.* measured behavioral changes after a PING session and 3 months later. The authors found that in general, even though significant changes were not found for increased discussion about poverty with friends (right after playing the game and three months later), participants who initially showed no interest in politics changed to be interested. In this specific group, it was also found that poverty discussion with friends was higher than in other groups. Finally, results suggest that playing the PING serious game had an impact in supporting a higher engagement of a group of participants in the issue of poverty.

Based on the presented examples of social awareness serious game case studies we already find evidence [22], [15], [23], [6], [28] supporting that such games are actually able to achieve their goal: transmiting a message. According to each specific domain and serious game, this message can simply make people aware of a given issue or have a deeper

influence by generating discussion or even mobilizing people towards changing or influencing change. However, this body of evidence is still noticeably small. Given that there are many social awareness serious games, the gap is not in the creation of new serious games but on studying them. As such, in this work aim at contributing to the creation of evidence on the impact that social awareness games actually have and the experience they provide to players.

III. BACKGROUND ON WILDFIRES

In this work we address a serious game about social awareness, more specifically a serious game for social awareness about wildfires. But what is a wildfire? It may be defined as an uncontrolled fire, usually occurring in the countryside or wilderness areas, which destroys combustible vegetation, animal life and might harm any nearby local populations [29]. In contrast with other types of fires such as industrial fires, beyond their distinctive location, wildfires differ in their characterization [30]:

- Possible quick and unexpected changes in speed of propagation and fire direction;
- Capability to overcome gaps in vegetation such as rivers and roads;
- Frequent difficulty in accessing fire fronts due to terrain characteristics or lack of terrestrial access;
- Easily spread from the originating point to vast areas of vegetation;
- Strong impact of weather conditions such as air humidity, wind speed and direction.

Even though wildfires can be caused by natural phenomena such as lightning, nowadays many have their origin in either careless people or arson [29]. With regard to effects, wildfires may have an impact not only on the natural ecosystems but also on populations both close and far from the fire[2]. Some of the effects of wildfires are:

- Destruction of wildlife ecosystems (vegetation and animals), especially in areas with ecosystems non-resilient to wildfires [31];
- Accelerated soil erosion [31];
- Degradation of water catchment areas [32];
- Threaten/harm human populations and their livelihoods: health, belongings, agriculture and employment [29];

As previously mentioned, wildfires can naturally occur and, as such, the ecosystems of some regions are adapted to it. However, the increase in frequency may have disastrous consequences in both natural ecosystems and populations [31]. Furthermore, this problem is not peculiar to just one or two regions of the globe but spans through regions in all continents, from the Mediterranean region [31] to Australia [33].

Given the deep impact that wildfires can have and their global scope it is important to prevent them and mitigate their

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[1]"Green energy includes natural energetic processes that can be harnessed with little pollution."[24]

[2]The degradation of catchment areas harms water supplies of regions far from wildfires themselves.

consequences [29]. Based on diverse studies on wildfires there are several actions that can be taken to achieve this [29], such as:

- Limit development of high bush area near risk areas (e.g. houses);

- Build firebreakers to protect important areas;

- Monitor the forests for the occurrence of a wildfire and provide an early warning system for a quicker firefighter response;

- Make populations aware of measures that they may take to prevent and diminish the impact of wildfires;

In order to make people aware of the problem, its origins and measures to be taken, social awareness steps regarding this issue are required. Only if communities are aware of the characteristics and solutions for the problem can they promote solution-driven policy making, exhibit responsible individual behavior towards the problem and be prepared for prompt action in such a disaster situation.

IV. *Stop Disasters!* SERIOUS GAME

Stop Disasters! (Figure 1) [34] is a free to play serious game developed by Playerthree [35] and UNISDR [36]. It is a disaster simulation strategy game with the educational goal of making players understand the risks underlying 5 types of natural disasters and how simple measures may be effective in preventing and mitigating the impact of those disasters. The game is free to play and is considered to be a social awareness game [14] focused on environment, social responsibility and education issues. In the game players are tasked with the mission to prepare a community living in a disaster prone area[3] to prevent and mitigate the impact of those disasters. To do so, the player has a set of (disaster type specific) actions related to several subjects from construction materials, to early warning systems and education that, when properly used, help the player save people's lives and livelihoods when the disaster actually occurs.

In this work we were tested a specific scenario: "Wild Fire". In this setting, the player had the task of managing a Central Australian suburb community living in an area of arid planes. The main goal of the player is to prevent people from becoming injured or dead, protect their houses and also water towers, mines, community buildings, hospitals and schools. The game actions available to achieve this are the following:

- **Build** - house, hospital or school - these can be used to house/relocate populations, treat them and educate them to better deal with wildfires;

- **Upgrade** - house (metal roof, metal shutters, protect electrics, ladder & hose, roof sprinkler, remove fuel sources), mine (same as house except first two which are not available), school (building reinforcement), hospital (building reinforcement) and water tank (protection with fire resistant materials);

- **Land Management** - firebreaks and defenses (fire resistant trees);

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[3]The game has 5 scenarios, each representing a different type of natural disaster: tsunami, hurricane, wild fire, earthquake and flood.
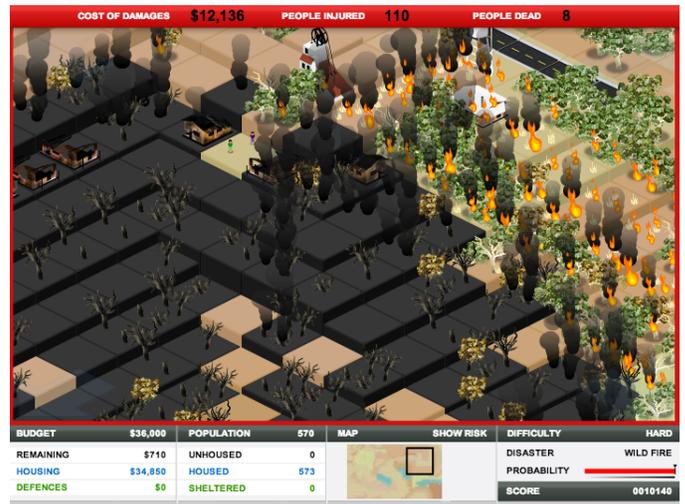
Fig. 1. *Stop Disasters!* serious game screenshot. In this case the player can no longer perform preventive actions since the wildfire has already started. The lack of preventive measures is causing generalized devastation [34].

- **Community Action** - school (awareness educational packs, 2 weeks training for disaster preparation), hospital (1 week course training for disaster preparation) and community center (warning radio system, evacuation training, siren alarm system and evacuation signs).

Additionally, when the player performs certain actions he/she can unlock key facts about the scenario. Those range from simple awareness messages regarding local communities wildfire preparedness to actual in-game clues that not only inform but help players follow the best practices. Examples of best practices are [29]:

- Remove fuel sources around buildings makes them safer from wildfires;

- Communities should have warning systems that makes populations aware of existing wildfires and can in this way more readily mobilize them to action;

- Important buildings (e.g. hospitals) should be built on safer areas since they are reference locations for people to take shelter;

- Education is key to prevent wildfires and make people aware of its dangers, and therefore may reduce the number of wildfires and save lives;

- Fire safety behavior is built over time through community communication channels.

V. *Stop Disasters!* USER STUDY

In this work we present the results of a user study carried out to collect evidence on the impact that the *Stop Disasters!* serious game had on players. This study specifically focused on the game wildfire scenario and the information collected regarding key elements for the situation presented in the game and the player experience while playing.

Fig. 2. Example of a fully upgraded house (metal roof, metal shutters, protected electrics, ladder & hose, etc) and with fire breakers surrounding it which reduce the risk of fire reaching the house [34]. Notice the difference of this house, and the surrounding area, to the one burning in Figure 1.
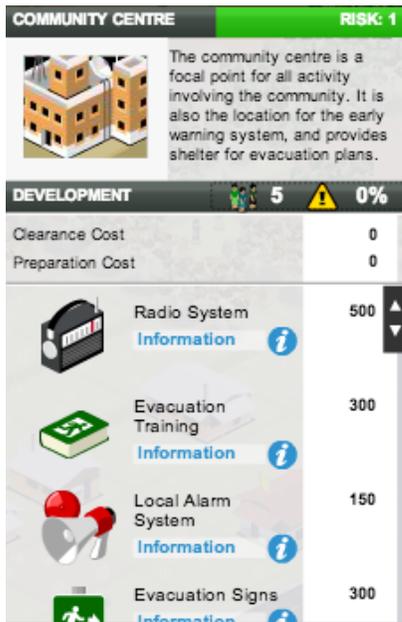
Fig. 3. Possible upgrades to the local community through the community center [34].

A. Experimental Design and Material

To measure the impact of *Stop Disasters!* on players we used a combination of two quasi experimental designs. In one of the components we aimed at measuring the game's impact on the participant's awareness to knowledge that could help them individually and collectively deal with wildfires. To this end we created a questionnaire (awareness questionnaire) in which we asked four questions, each assessing the participant's knowledge about a specific topic:

- **Topic 1 (T1)** - vacant land management (helps reduce propagation of wildfires);

- **Topic 2 (T2)** - inhabited land management (helps reduce impact and propagation of wildfires);

- **Topic 3 (T3)** - community management - initiatives and materials (helps prevent and react to wildfires);

- **Topic 4 (T4)** - community management - community mechanisms (helps coordinate reaction to wildfires);

Fig. 4. Example of detailed information about the metal roof upgrade. [34].

This questionnaire was then used in a one group pre-test/post-test design in order to measure the difference in participants' performance before and after playing the game. For each of the topics we had a specific list of measures identified from available game actions that contributed to deal with wildfires in that topic. Based on a response to this questionnaire, we then considered that the more actions players were able to identify, the more aware of wildfire prevention and mitigation solutions players were.

In combination with the previously introduced experiment we employed a one group post-test design to test the players' game experience. After performing the gaming sessions, players were asked to answer an adapted version of the Intrinsic Motivation Inventory (IMI) [37] questionnaire. The IMI is a validated questionnaire [38] used to measure participants' experience of a given performed activity in the following dimensions: interest/enjoyment, perceived competence, effort/importance, value/usefulness, pressure/tension, and perceived choice. Each dimension is characterized by a set of sentences that the participant has to rate using a 7-point Likert Scale, where 1 means not true at all, 4 somewhat true, and 7 means very true. In our adapted version we did not use the perceived choice dimension because it was not relevant to our case study. Based on this adapted version of the IMI we measured player's subjective experience of playing *Stop Disasters!*.

B. Procedure

The experimental procedure was guided by a form which provided participants with all the required information and guided them through the experiment. Additionally, the experiment had no set time limit but participants were informed that the complete procedure should last for about 1 hour and 15 minutes. The form started by presenting the participant 6 profile questions (e.g. gender, age group, occupation, etc). Next, participants were asked to assume a geographical area especially prone to wildfires and answer the pre-test questionnaire regarding the awareness to wildfire related knowledge. After completing the questionnaire, participants then advanced to the game session in which they were first given basic information about the *Stop Disasters!* serious game and then asked to play the "Wild Fire" scenario twice, in easy difficulty (all the in-game information to perform this was provided). Following the game session, participants answered to the adapted IMI questionnaire to assess their game experience and then answered the post-test questionnaire on awareness to wildfire related knowledge. Finally, players were asked whether they wanted to give any additional feedback and thanked for their participation.

C. Participants

The study had the participation of 27 people, 18 male and 9 female. In terms of age, most participants had between 26 and 35 years old ($n = 21$) but there were also others with under 18 years old ($n = 1$), between 18 and 25 years old ($n = 4$) and between 36 to 50 years old ($n = 1$). Most of the participants were portuguese ($n = 23$) but we also had Slovak ($n = 1$), Austrian ($n = 1$) and French ($n = 1$) participants and 1 participant that did not disclose her nationality. With regard to occupation, participants were mostly students ($n = 12$), researchers ($n = 10$) or consultants ($n = 3$). Notice that 2 participants reported being both students and researchers. Additionally, all participants ($n = 27$) reported using computers more than once a day. However, with regard to the frequency that each participant plays videogames, answers showed noticeable differences: 2-3 times a week ($n = 6$), 4-6 times a week ($n = 5$), less than once a month ($n = 5$), 1 to 4 times a month ($n = 4$), do not play ($n = 4$), 1 or more times a day ($n = 2$) and once a week ($n = 1$).

D. Wildfire Prevention Awareness

To analyze the game's impact on participants' wildfire prevention measures' awareness, we used their answers to the awareness questionnaire. However, 5 participants did not reply to the post game awareness questionnaire and henceforth these were excluded from the analysis. Figure 5 depicts the median, mean and standard deviation for the number of game related measures (to prepare and react to wildfires) listed by participants in both the pre-game (in blue) and post-game (in orange) questionnaires. In this graph we can also observe an additional category to the 4 topics previously described. Many of the participants' replies listed game related measures in a topic different to that in which that measure was being counted. Since the objective of the study is to measure the participants' awareness to the diverse measures available we created this extra category to evaluate the player's awareness to the different measures regardless of the question in which they mentioned it. By inspecting the values in the graph from Figure 5 we may observe, in all the topics and the overall category, that the mean value in the post-game questionnaire (Table I) is superior to the mean value in the pre-game questionnaire. However, by inspecting the standard deviations associated with each bar we may observe that there was a very high variability between the amount of measures listed in the different participant's answers. Even though the mean values are an indication that the game did have a positive impact in the participants' awareness to wildfire prevention measures we need further statistical analysis to test this hypothesis.

TABLE I.   MEAN AND STANDARD DEVIATIONS.

	Pre-Game			Post-Game		
	Median	Mean	StDev	Median	Mean	StDev
Topic 1	1	1.09	0.68	2	1.95	0.79
Topic 2	1	1.09	1.51	3	2.86	2.59
Topic 3	1	1.14	0.94	2	2.09	1.38
Topic 4	0	0.36	0.58	1	1.14	0.94
Overall	4.5	4.68	2.42	9	9.64	3.91

By applying the Shapiro-Wilk test we found evidence against normality in our data (test results are summarized in Table II). Notice that even though the post-game data for topic 3 and overall data show no evidence against normality
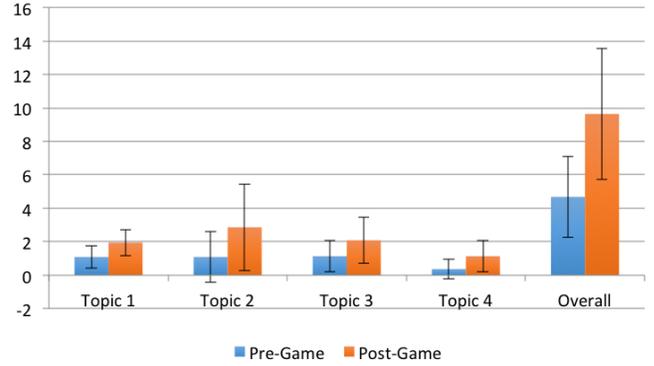
Fig. 5. Graph of mean and standard deviation for awareness questionnaire. Values for both individual questions and overall of measures analyzed.

their pre-game pairs do. Therefore we must proceed with non-parametric tests. Hence, we applied a Wilcoxon Signed-Rank Test to each pair of pre/post data. Based on the results of the test (Table III) we can then conclude that:

1) The number of wildfire prevention measures related to vacant land management that players where aware of before playing the *Stop Disasters!* game ($Mdn = 1$) was significantly lower than those they were aware of after playing the game ($Mdn = 2$), $T = 136.0$, $sig = 0$, $r = -0.57$;

2) The number of wildfire prevention measures related to inhabited land management that players where aware of before playing the *Stop Disasters!* game ($Mdn = 1$) was significantly lower than those they were aware of after playing the game ($Mdn = 3$), $T = 134.5$, $sig < 0.01$, $r = -0.42$;

3) The number of wildfire prevention measures related to community management (initiatives and materials) that players where aware of before playing the *Stop Disasters!* game ($Mdn = 1$) was significantly lower than those they were aware of after playing the game ($Mdn = 2$), $T = 94.0$, $sig < 0.01$, $r = -0.41$;

4) The number of wildfire prevention measures related to community management (community mechanisms) that players where aware of before playing the *Stop Disasters!* game ($Mdn = 0$) was significantly lower than those they were aware of after playing the game ($Mdn = 1$), $T = 66.0$, $sig < 0.01$, $r = -0.45$;

5) The number of overall wildfire prevention measures that players where aware of before playing the *Stop Disasters!* game ($Mdn = 4.5$) was significantly lower than those they were aware of after playing the game ($Mdn = 9$), $T = 229.5$, $sig = 0$, $r = -0.60$;

TABLE II.   RESULTS OF SHAPIRO-WILK NORMALITY TEST.

	Pre-Game		Post-Game	
	Statistic	sig	Statistic	sig
Topic 1	0.763	0	0.841	0.002
Topic 2	0.729	0	0.877	0.01
Topic 3	0.846	0.003	0.914	0.057
Topic 4	0.645	0	0.846	0.003
Overall	0.885	0.015	0.976	0.845

TABLE III.   RESULTS OF WILCOXON SIGNED-RANK TEST.

	T	Z value	Sig	Effect Size
Topic 1	136.0	-3.755	0	-0.57
Topic 2	134.5	-2.765	0.006	-0.42
Topic 3	94.0	-2.719	0.007	-0.41
Topic 4	66.0	-3.002	0.003	-0.45
Overall	229.5	-3.970	0	-0.60
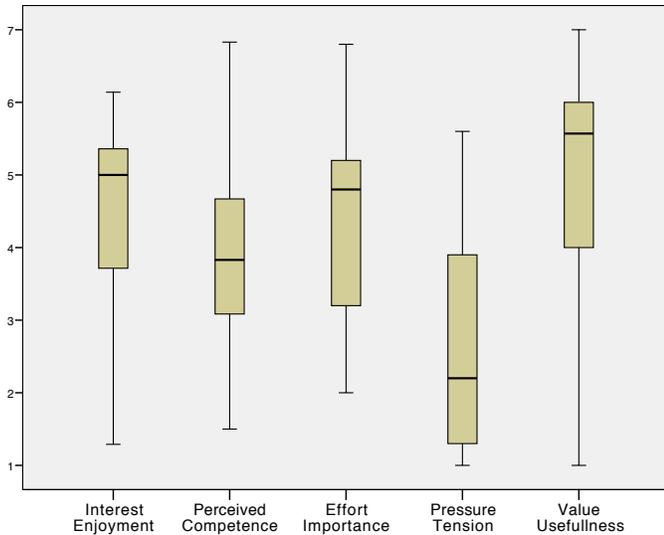
Fig. 6.   Box-and-whisker plot for the IMI data.

E. Game Session Experience

To analyze the impact that *Stop Disasters!* had on participants in terms of game experience, we created a box-and-whisker plot chart for each dimension of the IMI questionnaire. In Figure 6 we may observe that there are no outliers in any of the measured dimensions, meaning that there were no scores that were 3/2 times higher/lower than the respective upper/lower quartiles in any of the analyzed dimensions. However, there are some important differences with regard to the distribution of the answers in the different dimensions which we will analyze individually.

In the Interest/Enjoyment dimension we observe a $Mdn = 5$ meaning that 50% of the participants characterized their interest or enjoyment in the game above 5. Additionally we can see that the upper quartile is small in length (5 to 5.36) meaning that 25% of the participants scored in this narrow band of values. We can also observe that the values below the median are much more disperse than the values above it. This is demonstrated by both the lower quartile (3.71 to 5) and the minimum whisker ($min = 1.29$) being much longer than the upper ones ($max = 6.14$) and spanning between just above 1 and 5. However, the lower quartile is mostly above a score of 4 meaning that 75% of the participants scored from just below 4 to just above 6 in this dimension.

The Perceived Competence dimension is characterized by a small skew towards lower scores with $Mdn = 3.83$ and an upper quartile (3.83 to 4.67) slightly below 5 and a lower quartile (3.08 to 3.83) slightly above 3. This means that 50% of the participants perceived their competence around the neutral value of 4 with a small skew towards lower values. By observing the maximum ($max = 6.83$) and lower ($min =$

1.50) values we may observe that participants' scores spanned for almost the totality of the scale even though the lowest participant score is further from the minimum possible score than the maximum participant score is from the maximum possible score. As a consequence, values above the median are more disperse than the values below it.

In the Effort/Importance dimension we observe a $Mdn = 4.80$ with 50% of the participants' scores corresponding to the upper quartile (4.80 to 5.20) and lower quartile (3.20 and 4.80) between 3.20 and 4.80. This shows that, as in the case of the perceived competence, 50% of the participants' perceived effort/importance regarding the game session is close a neutral value. However, contrarily to the perceived competence, there is a strong skew of the median towards the upper values. As a consequence we can also observe a higher dispersibility of the results in the participants' lower scores, but mostly in the values contained in the quartiles and not for the range of values characterized by the highest score ($max = 6.80$) whisker and the lowest score ($min = 2.00$) whisker.

The Pressure/Tension dimension is characterized by a very low $Mdn = 2.20$ and by 50% of the participants that are represented by the upper (2.20 to 3.90) and lower (1.30 to 2.20) quartiles scoring between 1.30 and 3.90. This range of scores is very low and always below 4, meaning that 50% of the participants felt very low or low pressure/tension with a skew of the results towards very low scores. The overall skew towards lower scores is also demonstrated by the minimum whisker ($min = 1$) which corresponds to the lowest score possible. Nonetheless, there are still 25% participants that scored their pressure/tension between just below the neutral score 3.90 and $max = 5.60$.

Finally, the Value/Usefulness is characterized by a high $Mdn = 5.57$ and by 50% of the participants that are represented by the upper (5.57 to 6.00) and lower (4.00 to 5.57) quartiles scoring between 4.00 and 6.00. This range of scores is high, meaning that 50% participants classified the game from slightly to highly valuable/useful with a skew towards high scores. However, this dimension is also characterized by the highest dispersibility in scores when compared to all other IMI dimensions. Clear evidence of this are the participants' maximum ($max = 7$) and minimum ($min = 1$) scores which correspond to the scale's maximum and minimum possible scores. Another example of this is that there are 25% participants who scored between 1 and 4, half of the scale's range of values.

F. Free Comments

At the end of the procedure we let players express any comments and impressions they had in a free text format. Based on these, there were several positive comments regarding diverse aspects of the game such as the overall interface, game concept, enjoyment, the way feedback was given to the player at the end, the informative and instructive nature of the game that was mentioned by a participant as actually creating awareness. Still, the game also received some critique, especially regarding an interface limitation that was detected: some tiles near the map's border were not possible to select. Even though this was not reported as being critical one participant reported it as being frustrating because she was not able to achieve the best result

possible. Additionally, players also made some suggestions such as adding a zoom mechanism and the ability to start the wildfire disasters in a specific region of the map to be able to test their actions in different planned settings instead of the wildfire starting from a random direction.

VI. CONCLUSION

In this work we studied a highly disseminated serious game for social awareness: *Stop Disasters!* a game created by Playerthree in the context of the United Nations International Strategy for Disaster Reduction (UNISDR). The study focused on the impact that the game's wildfire scenario could have on players regarding the awareness created to the issue of wildfires, their prevention and also the preparation of an appropriate reaction.

In our study we found statistical evidence to a positive impact of the serious game in players' awareness to wildfire prevention measures, both at an overall level and in specific topics: vacant land management, inhabited land management, community initiatives/materials and also community mechanisms. It is important to notice that, even though most participants have a nationality from a wildfire prone country they still supported a statistical effect in terms of awareness differences before and after the game session. Additionally, we also studied the game experience and found that for most players it was perceived to be a fun/enjoyable and valuable/useful in a context of low tension/anxiety. However, many players felt that they did not have a high competence in the game and that it required some effort.

Even though the results from this study are very encouraging, the short time span between the pre-game and post-game measures can be pinpointed as a weakness. However, since the objective of the game is to transmit a message and at least make people aware of the wildfire issue we argue that even if players do not memorize or learn all the specific steps or measures presented in the game they still continue to be aware of the issue. This awareness is already an important step towards the inclusion of issue related considerations in future decisions related to wildfires.

Based on our results we provided further evidence to the positive impact that social awareness serious games can have in transmitting messages regarding social relevant issues in an overall positive and engaging experience. In this work we showed that the *Stop Disasters!* serious game can have a positive impact in dealing with wildfires and therefore supports the current trend of increased serious games adoption to get people in contact with important issues and their solutions.

VII. FUTURE WORK

This study provided clues to the positive impact that social awareness serious games can have, but there are two aspects that can be improved in future studies. First, in a future study we would like to use a true experimental design instead of a quasi experimental one. Additionally, we would also like to perform an extended experiment with more participants and with a longer term assessment of the impact that the game has so that we could evaluate longer term effects of the game.

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