Evaluation of User Engagement and Message Comprehension in a Pervasive Software Installation

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***Abstract*—The goal of this work is to explore the relationship between pervasive software and user engagement towards environmental issues. We study this relationship in the context of an art installation that concerns the water cycle in nature. The research question is: How can we design and evaluate software that becomes a medium to engage and inform the user? We have gathered empirical data during a two days exhibition of two versions of a pervasive art installation by: observations, questionnaires, and input logs. Data analysis reveals that the art installation engaged users, with focus on young children, and communicated the intended message. The results are organized according to five important factors for developing and evaluating interacting art installations. These are: 1) data collection method; 2) user interaction; 3) social interaction; 4) issues about children; 5) message comprehension. We suggest that these factors can inform engineering practices for engaging software like video-games.**

***Keywords*-Social engagement; pervasive software; art installation; interactivity; evaluation**

I. INTRODUCTION

Social engagement enabled through software solutions has in the last few years proved to change the way the political and democratic world works. In particular, software based engagement towards clean technology has been addressed [1]. In this work, we explore interactive installation art as a medium to convey a message about environmental issues.

Interactive art installations [2] [3] [4] [5] [6] [7] [8] have resemblance to both traditional art pieces and computer games. They are usually placed in public space where spectators can enjoy them. As for computer games, installation elements have the ability to change, usually triggered by interaction with spectators or other environmental factors. Interactivity is usually the key for the artwork to communicate its artistic message. Often spectators themselves become a part of the installation through interaction. While traditional art pieces are usually forbidden to touch, interactive art adds to the mental activity a haptic dimension. Visitor are not only allowed, but required to interact with the art work. Artists usually want to deliver a message through their artwork, to stimulate thoughts, reflections, and emotions. In interactive art installations, the physical part of the installation is part of the artwork. To get the user to interact with the installation, the physical appearance needs to both engage and evoke the user's curiosity and attention.

Our work is contextualized in the cooperation with Liv Arnesen Foundation (LAF), which focuses on water challenge with the ambitious goal of involving 50 million children and young adults. In this context we have developed an interactive art installation whose goal is to make children aware of the balance of water in nature. The research question that shapes this work is: How can we design and evaluate software that becomes a medium to engage and inform the user?

II. WATER ME

The goal of the interactive art installation is to make children aware of the balance of water in nature. The artistic concept of the installation is simple and should be understood by pre-school children: the flowers thrive or vanish depending on the amount of water they receive. The installation visualizes a stream of water and flowers that grow and wither in real-time.

The development process of the installation included: 1) development of an installation based on physical buttons and projections (see Figure 1); 2) development of a new physical installation based on a touch screen, by reusing and modifying the same software in a way it is able to function with different input devices (see Figure 2). For the button and projection based installation, the user controls the water flow through physical buttons and the output is projected on a wall. For the touch screen installation, the screen is both input and output. The software application has been developed in Visual Studio.

The button and projection installation consists of a wooden box that houses a projector, a laptop with the running application, a power supply, and three buttons. The three buttons control the flow of water where the upper button increases the amount of water, the bottom one decreases the amount of water and the middle one restores the amount of water to a predefined "balance". The buttons are made by connecting three arcade buttons to a microcontroller with a built-in USB module that is connected to the laptop. The touch screen installation consists of a touch screen, a laptop and a power supply housed in a wooden casing. The touch screen is a single-point touch screen based on infrared technology.

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Figure 1. Button and Projection based installation: a girl interacts with the projection

The two installations were placed in the public space as part of an exhibition held on the 24th and 25th of September 2011 during the Norwegian Science Week (Forskningsdagene) at NTNU's Science museum.

III. Evaluation

To evaluate how users perceived the art installations, we have collected data through three methods: observations, questionnaires, and input logging. For each method, we give a concise explanation of research design choices and a presentation of the collected data. An extensive presentation is given in [11].

A. Observations

Research design: We have employed "shadowing", also known as direct observation, supported by pictures, videos, and notes.

Collected data: 17 pictures (permission has been obtained to take and use the photos/videos for this article), notes, and four videos.

User interaction: Visitors were mainly parents with children 3-7 years old. A common observed scenario was that visitors tried the touch screen installation first, as this was more near to the entrance. Some visitors tried the touch screen installation, and wondered if they could affect the projection from the button-based installation by playing on the touch screen. Most of the people stood and watched the installations as they would watch an art piece at a museum, reacting with surprise when being told that they could interact with them. Many visitors were afraid to use the buttons on the button and projection based installation.

Social interaction: The parents showed a bit of interest at first, often followed by showing their children how they could interact with the installation, and then most of them enjoyed playing with it together.

Figure 2. Touch screen installation: a girl interacts with the screen

A common scenario among young siblings/friends was that if one sibling/friend tried out one installation before the other, they often explained what they had learned to the other one. Quotes like "No, you need to do it like this!" and "Be careful with the water, or the flowers will die!" were heard and written down as notes while observing the two siblings playing on the touch screen installation. These two siblings played together for a while, and younger boy was eager to inform her sister what she could do with the installation. This is a good example on how these kind of installations may be effective in teaching, as the youth were eager to teach their siblings, friends or even parents "how it should be done" or what they should do to succeed. Small children who tried out an installation were usually eager to tell their parents what they had learned while using the installation, often while doing actions that underlined their statements. Many visitors also used the installations to teach their children about how important it is for flowers to have access to water.

Children: Usually the children ran into the room, looked around and went on to explore the installations. The children were by far the most engaged users of the installations. Both young boys and girls seemed to enjoy the installations equally much, but older boys showed signs that they thought it was too childish or too "girly".

Most children tried to directly interact with the projection. Many of the young visitors went straight to the wall and began touching it, expecting it to change accordingly. A good example of this behavior was a young girl that basically tried to climb into the projection (Figure 1). When children understood that they could interact with the button-based installation, they showed a lot of eagerness and joy playing with it too. Some children also tried to interact with the button based installation in other ways, and even if it did not affect the installation, they still enjoyed playing with it in their own way. More than one young boy set the water flow to the maximum amount, and expressed that it was cool to drown all the flowers. Older girls did not seem to mind the childishness, and were eager to try out the installations.

One young boy was afraid to push the buttons even after he was told that he could press them (first by the researcher and then his parents). After questioning his parents about this

behavior, they explained that he had been told all his life that he should not touch things (and especially not buttons) that he did not know or what it could lead to. He was therefore very afraid to cause problems when pushing the buttons. There is probably a bigger fear of pushing physical buttons than interacting directly with a screen, as buttons pose as far more ”physical” a screen does.

Message comprehension: Video recordings show a young girl who expresses joy playing directly with the projection, even though she could not directly interact with it. She made up a game on her own where she tried to take a shower from the projected stream of water, running after it as it oscillated from side to side, uttering things like: ”I’m taking a shower now, and I’m getting wet!” Many users showed feelings of empathy when watering the flowers, and tried hard to keep them alive.

B. Questionnaires

Research Design: We have reused the Questionnaire for User Interaction Satisfaction (QUIS), the System Usability Scale (SUS) [9] and the EGameFlow Questionnaire [10] as base line to design our questions. EGameFlow is a scale to measure the enjoyment in educational games. We added some questions specific to the installation, one the question is: ”What do you think is the artistic message for this installation?” Another full text question is: ”Can you image this installation in other settings? Where would that be?”

Collected Data: 18 persons answered the questionnaire, but not all questions were answered by all respondents. The visitors that answered the questionnaire were mostly parents and students. Some parents also answered on behalf of their child. 50% of the answers were from women. The questionnaires were all anonymous, i.e. you could not trace the answers back to a specific person.

User interaction: Most visitors answered that the installations were easy to use. When it came to the immersion scale questions from EGameFlow, people had some mixed answers, but most of the answers were tilted more against ”strongly agree” than ”strongly disagree”. The immersion statement that overall had the most agreeing answers was ”I feel viscerally involved in the installation”. The average answer for this statement was 4 out of 5, where 5 stands for ”I strongly agree”.

To the question: ”Can you image this installation in other settings? Where would that be?” Most of the answers were oriented towards teaching and usage in schools. Others answered that they imagined the installations in public spaces like shopping streets, airports, bus stops, waiting rooms and museums or other places were families spend their time.

Message comprehension: The most interesting result from the questionnaire was from the full text questions. One of the questions was: ”What do you think is the artistic message for this installation?” Many answers are of the kind ”climate changes”, ”the balance between life and death”, ”water is important” or ”plants need the right amount of water”. Interesting answers are ”empathy, learn to value life even though it’s in an electronic form” and ”learning about how water affects its surroundings”.

C. Input Logging

Research Design: We implemented mechanisms for logging input for both installations to collect data about user interaction. The advantage of automatic logging of input is that the user is unaware of being recorded, and it does not influence user experience. We defined a session as a period during which the installation receives input after 20 seconds of inactivity.

Collected Data: Table 1 summarizes the logged input data.

TABLE I. LOGGED INPUT FROM THE TWO INSTALLATIONS.

Buttons	Day 1:	Day 2:
# of button clicks	405	916
Click duration in seconds (total)	938	762
# of sessions	38	47

Touch screen	Day 1:	Day 2:
# of touches	1124	1475
Touch duration in seconds (total)	1915	2378
# of sessions	23	30

User interaction: The touch screen installation was the most used one, both in number of touches and duration in seconds. Out of the two chunks of statistics, the number of touch sessions is the most relevant one. Overall, the touch screen installation got most of the attention.

IV. DISCUSSION

Our data lead to five discussion themes.

1. Data Collection: We have exploited observations, interviews, and automatic logging. The three data sets tell complementary stories. While automatic logging gives a precise picture of how many sessions and how many clicks have been run during the two days, observations have captured knowledge that we had not foreseen, like interaction between users. Interviews are efficient to elicit information about user opinions and feelings.

We have observed the users while the users were aware of being observed (Shadowing). This makes it easier to follow the user in her actions, but the awareness of the presence of the researcher can influence the user behavior and therefore lead to different data (known as the Hawthorne effect). An alternative is ”Fly-on-the- Wall” method, which hides the researcher presence. The subjects of the three data sets are overlapping.

2. User interaction: From the input logs it seems that the touch screen installation was the most popular one, both in time spent on it and the number of physical interactions. But might that be because of people’s familiarity with touch screens? Some users assumed that the button-based installation was connected to the touch screen installation. Other users looked at the projection as a traditional art piece. The users behaved more formally when they interacted with

the button-based installation compared to the touch screen installation.

3. Social interaction: The children were far the most eager users of the installations, but there were also some young adults that enjoyed playing with the touch screen installation, and even organized themselves in a small queue in order to try it out, since the touch screen only supported one user at a time. Children were eager to explain what they had found out to their parents, siblings or friends. The parents often watched their children play and/or played together with them.

4. Children: Before the study, we had a hypothesis that the button-based installation would be more popular among small children than the touch screen installation. We believed that the unusual appearance would appeal more to children. On the other hand, data reveal that some children were in fact a bit afraid of the button-based installation to begin with, and were drawn to the familiar touch screen instead.

5. Message comprehension: People showed signs of empathy and immersion when using the installations. Many wanted to keep the flowers alive, others wanted to get rid of them by pouring too much water on them. Most of the children showed joy. The answers collected from the questionnaires showed that: 1) most of the respondents believed that the artistic message was about balance in life, the importance of water and 2) plants need the right amount of water to live. But some also answered on a philosophical level, like ”empathy for digital life forms”.

The interpretation of the ”artistic message” was different for the two installations. As the button-based installation was decorated with water and ”wise words” about problems related to water, it acted as a whole different medium than the touch screen installation that has no decorations at all. When asked about their interpretation of the artistic message for the button based installation, answers were more focused on ”the balance of water” compared to the touch screen installation that had answers oriented towards the aspects of learning and ”taking care of the flowers”.

Although changing the appearance and presentation of an installation can bring benefits to the communicated message and how users perceive and experience it, it can also change it to something that the artist did not mean. The software creator needs to consider which impact the changes do to the installation and if it is for the better or worse. It makes no sense to change the installation so drastically that it does not fit the message communicated anymore.

V. Conclusions

In conclusion, the reported empirical study indicates that especially children are easily immersed in pervasive software. The higher degree of interactivity in the touch screen installation indicates that it engaged the users more than the button and projection based installation. Therefore, the input style of an art installation affects how the installation is experienced and perceived. Our results can help software creators find better ways of communicating a message to the audience, and can also be applied to other domains, such as video-games and interactive campaigns. In our future work, we plan to reuse the software developed for this installation as well as open software that has been made by other artists to replicate the investigation in different exhibitions.

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