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DADODICE: An interactive installation to support learning

Selene Uras[1*], Massimo Deriu[1], Daniele Ardu[1] and Gavino Paddeu[1]

[1] Center for Advanced Research in Sardinia CRS4,
Pula
(Italy)

ABSTRACT

In smart technological solutions, interactive installations, multi-touch surfaces are all around us nowadays. In particular, pupils, who are digital native, are keen on these devices. So the adoption of these smart technologies could be an interesting approach to capture their attention. DADODICE (DD), our latest interactive installation, takes advantage of this trend. DD, in fact, is especially thought for pupils, the main target of Sardegna in Miniatura, an amusement park located in Sardinia. Pupils visit the park in small groups so we developed a collaborative installation to allow visitors to interact and benefit from the various contents simultaneously. DD aims to combine both learning (detailed explanations concerning the different renewable energies investigated and used in our region) and amusing contents, utilizing as much as possible invisible technological solutions. The installation is powered by xPlaces, the software framework we develop. We report here some preliminary results of an ongoing research field, which seem to suggest that there are peculiar behavioural patterns in interacting with the installation, various interaction modalities and different perceptions of the installation (toy-like versus highly technological) depending on the age (adults, adolescents and children).

Keywords: *User-centred design, interaction styles, interactive systems, computer uses in education.*

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1. Introduction

Today's pupils are born using a wide variety of technological devices. Their relationship with technology is natural. In the last decade, schools have been introducing and reinventing learning tools and models. Terms as interactive boards, web platform, collaborative learning community, blended learning are well representative of the pedagogic interactivity (Smith, Higgins, Wall & Miller, 2005).

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* Corresponding Author:
Selene Uras
CRS4, Center for Advanced Research in Sardinia, Pula, Italy
E-mail: selene@crs4.it

Moreover, in literature we can find a wide variety of research investigating this phenomenon by various points of view. Hesseny (Hennessy, Deaney, Ruthven & Winterbottom, 2007), for instance, talking about the interactive blackboards, underlines the improvement in exchanging feedback and ideas, using verbal, graphical and other ways of communicating; furthermore, there are also the possibility to communicate simultaneously both with teacher and peers and the shared and collaborative knowledge. Mortimer and Scott (2003) underline the intrinsic sharing of these devices because they simplify the way of posing questions, discussing scientific and naïve ideas between teacher and students. Other authors (Denvir and Askew, 2001; Smith, Hardman, & Higgins, 2006; Tanner, Jones, Kennewell & Beauchamp, 2005) emphasize the new strategic thinking approach due to the adoption of interactive technologies.

Moreover, previous studies have shown that "the process of learning in museums seems to be more likely related to the possibility of directly interacting with objects" (Ciolfi, Bannon & Fernström, 2001), that children enjoy particularly hands-on exhibits allowing bodily interaction underling that the main aim of museums is to educate and form the visitors (Hornecker & Stifter, 2006).

In addition, we were also interested in groups because our exhibition visit is organized for small groups up to twenty people, and researches have found that there are relevant differences between people visiting an exhibition alone or in group (Aoki, Grinter, Hurst, Szymanski, Thornton, Woodruff, 2002; Grinter & Palen, 2002;).

Concerning tangible learning systems, Price, Sheridan and Falcao (2010) asserted "little work has focused on movement and action in learning contexts, and how design influences the kinds of learning opportunities engendered." The same aspect is treated by Rick, Francois, Fields, Fleck, Yuill and Carr (2010), in fact, they mention a series of authors using tangible user interface to enhance creativity, interaction and learning stimulating simultaneously various senses, such as hearing, sight and touch. But they also underline that " while there is growing interest, little has been written about design methods for developing interactive-tabletop applications for children". So, in this paper we want to focus the attention on the experience and the process allowing us to set up DADODICE. We believe that our experience we will help other multidisciplinary team working all together for the first time to develop their own methodology in order to create and design interactive installations thought to educate pupils and to organize the huge number of inputs coming from the whole team.

This paper is organized as follows: firstly we present the challenging idea that has driven our multidisciplinary team collaboration, secondly we describe the design and development process of each single component of the installation, thirdly the field research we are still conducting, fourthly some (partial) results, the important lesson learnt and finally we draw our conclusions.

2. DADODICE an interactive installation to support learning

Csikszentmihalyi and Hermanson (1995) asserted "One often meets successful adults professionals or scientist who recall that their life-long vocational interest was first sparked (as a child) by a museum" (pp. 34–37 and 59–61). We remind this assertion for creating something enjoyable and easily usable.

Starting from this premise, what our team mostly desired was to create an experience that allows young visitors to be trained and have fun at the same time, because very often children and adolescents are disappointed about not have fun in traditional exhibitions (Hornecker & Stifter, 2006).

Then, we started to work as a multidisciplinary team, sharing our background, exchanging information, giving constant feedback and frequently meeting to arrive at DADODICE creation.

DADODICE is an interactive installation powered by xPlaces framework (Deriu, Paddeu & Soro, 2010) and DADODICE is a step of the exhibition ”Terra difendiamola con energia”, concerning renewable energy fonts. Other steps of the exhibition are a video installation showing the passage from the traditional sources of energy to the renewable ones, solar powered toy cars, plants (rape, sunflower and corn) from which it is possible obtaining energy, a vertical paddle wheel and, in another geode appositely dedicated, the biosphere, an amazing setting with butterflies and tropical plants.

Figure 1. DADODICE evolution: from the first prototype to the final result.

This installation is composed by a round Plexiglas table, two web-cams (the plane of the table is opaque and the web-cams are hidden behind) a TV screen, a set of lights and a textile dice (shown in Fig.1), without any technology inside, as it is shown in the rough scheme in Fig.2.

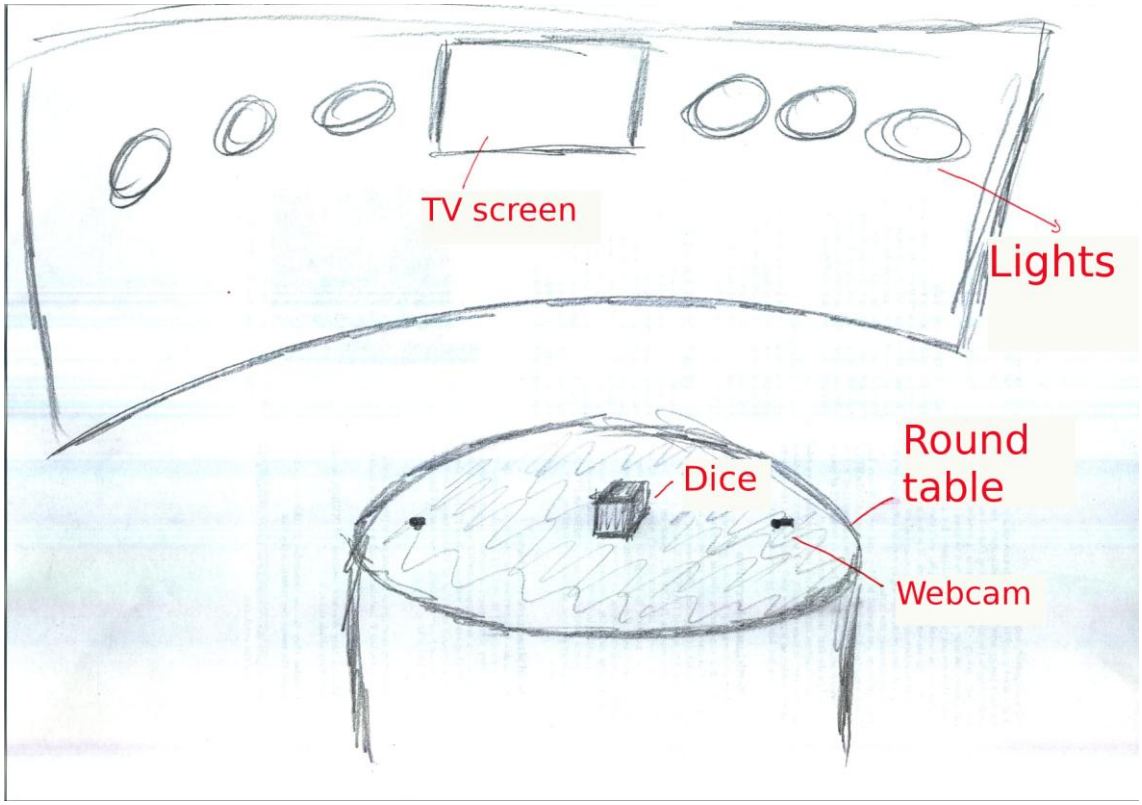

Figure 2. A scheme representing the installation.

The main target of our installation consists in pupils visiting the amusement park with their teachers. Basing on the park employer experience, we know that all the classes study the theme of the exhibition before coming to the park. In that way, the visit becomes another way to learn.

The creation of such a challenging installation required a proper skilled team able to transform ideas and needs in something fun and special, easy to use, highly technological but not engineering (Barab & Squire, 2004) at all.

3. A multidisciplinary team

It was appositely created an enlarged team (partially shown in Fig.3) comprehending three various groups: a Laboratory studying Human Computer Interaction (Lab OMC[1], our lab), an organization involved in promoting scientific culture (Laboratorio Scienza, LS) which was responsible for contents, and the client, Sardegna in Miniatura (SM), an amusement park situated in Tuili in Sardinia.

We firstly were contacted by LS since they have been charged by SM (the client) the exhibition "Terra difendiamola con energia", concerning alternative energies fonts.

Both LS and SM used to work altogether to previous exhibitions but for the last one they were looking for something more appealing, more technologically oriented but easy to use for all visitors.

In Lab OMC we study and evaluate technological solutions to facilitate people activities and enjoyment in different daily scenarios, such as museums, houses and offices. Our final aim is that people can enjoy their experiences and reach their goals without putting effort in learning to use technological goods, utilizing a methodology on the basis of people needs, desires and expectations. Goods and installations are designed basing on their final utilization, following Interaction Design (IxD) approach and focusing on two main areas: Open Media centre (entertainment, home automation...) and Touch, Multi-touch and Tangible User Interfaces technologies.

Figure 3. The multidisciplinary team at work.

[1] http://labomc.it

All of us have been chosen basing on our curricula in order to create a differentiated team adopting Interaction Design (IxD) approach because "The development of each product engenders its own unique process. In an emerging profession like ours, we can all profit from sharing this knowledge" (Alben, 1996). There are a physicist (the coordinator), three information scientists (one researcher and two junior collaborators), one computer engineering (the other researcher), one computer scientist (the third junior collaborator) an interaction designer (both a psychologist and a computer scientist, the fourth junior collaborator).

LS is an organization composed by five members and various collaborators. All of them have been working in scientific promulgation for a long time.

SM amusing park is located in Tuili. There are different miniatures such as Sardinia small countries, the Beagle inserted in Darwin exhibition, a nuragic village; furthermore, there are also the planetarium and a new exhibition every two years.

SM target is mainly composed by Sardinian students of various school ranking, so the aim of each exhibition consists in intriguing students in scientific matters.

In developing DADODICE installation we met different people working at SM. Firstly we met the employer who is also the creator of each exhibition, secondly we met the person in charge of park booking, then the guides and park maintainers. In peculiar stages we also involved a designer, table and dice producers.

3.1 Working in a multidisciplinary team

Our first meeting was organized in our Lab in order to allow LS and SM to better know our installations because we work with prototypes.

Their attention was promptly captured by LightCube (Deriu, Paddeu & Soro, 2010), a cubic tangible user interface developed for one-handed control of domotics appliances in a home environment. It is a handy plastic cube, just big enough to contain a wireless sensor system, an embedded PIC microprocessor and a three orthogonal axis acceleration sensor. The system is networked with the environment with a unreliable RF communication channel (ZigBee). The data sets we used for classification were gathered with the three orthogonal axis acceleration sensor. The sensor readings are transferred via ZigBee (ZigbeeAlliance[2]) to the actuators present into the eXtended Place. By performing gestures, the user controls a set of lights, each face of the cube is related to a specific lights scenario, when the face is up the scenario is loaded by the framework.

[2] [2] http://www.zigbee.org/.

SM and LM were fascinated by the idea of having a device intuitive to use, characterized by a fashionable design and without any visible wire. So, starting from concepts such as "fun to use", we proposed to create their own installation combining a disposal similar to Lightcube combined with a table.

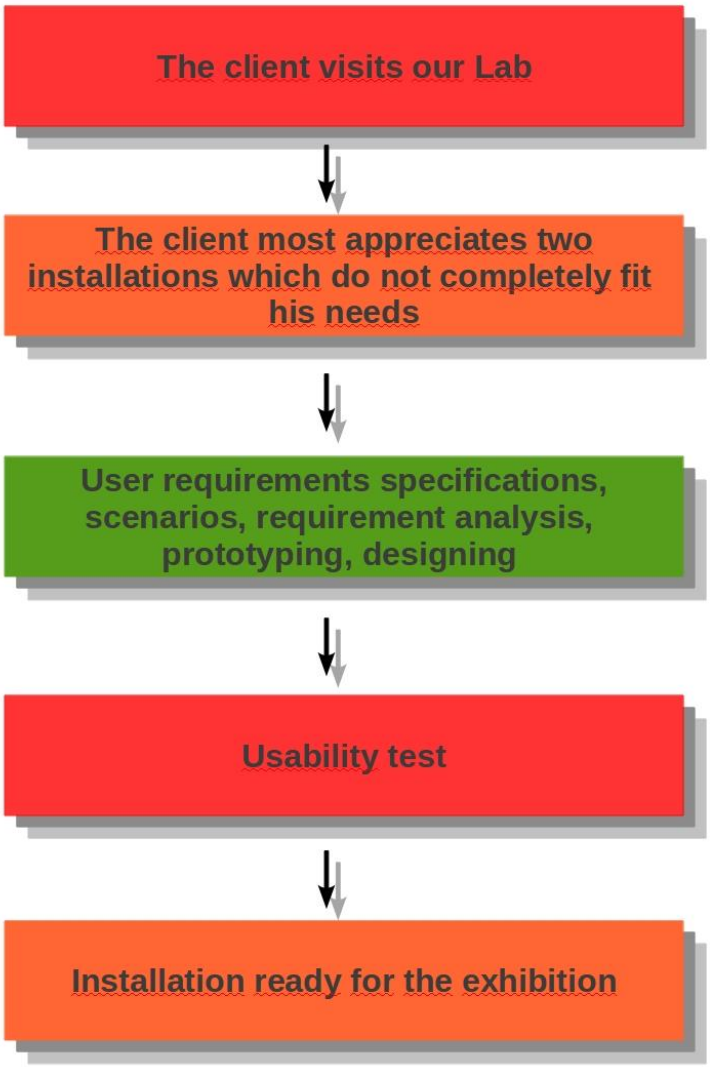

Figure 4. Different phases of the design of DADODICE.

Our idea was that playing might support the learning process, and the installation should have been used and perceived as a toy. One important constraint was that the installation should be utilized by twenty people simultaneously so the cube, a dice in this case, should have an excellent resistance to shock, and should have to be free of

maintenance. These are the reasons why we have not chosen a solution based on embedded PIC microprocessor.

3.2 Designing DADODICE

We started utilizing the character profile tools (Courage & Baxter, 2004) for creating a shared knowledge about the users, their characteristics and habits.

Although the amusing park is also frequented by occasional adults visitors, more and more visitors consist in pupils, so we get to the conclusion to focus our project especially on their needs.

As previously said, our aim was to create an installation promoting learning and fun at the same time while we needed also to pay attention to client requests. So in recreating LightCube, we decided to keep as the only bond the dice shape and its property in controlling a series of lamps but utilizing a different kind of controller.

We decided to create a round table in order to facilitate participation, knowledge sharing, information flow among visitors and symmetry in viewing, as suggested by previous studies (Jordà, Geiger, Alonso, & Kaltenbrunner, 2007; Shen, Lesh & Vernier, 2003).

We referred to Italians height statistics to find the mean height of our visitors. Therefore, it was established that the ideal height of the table was 70 cm, while the diameter was 150 cm in order to allow visitors (big groups visiting the park are divided in small groups up to twenty people) to stay comfortably around the table.

We were conscious that it was not possible to utilize the same technological solution adopted in LightCube; in fact, DADODICE was appositely shaped as a dice to be considered both a device and a game. Moreover, we thought that people would play with the dice throwing it and, for that reason, a fundamental requirement consisted in not to insert any disposal or whatever inside the dice. The dice became soft and made of fabric, as a children toy.

In that way, the dice is inserted in a well-known behavioural pattern: people have previous experience in utilizing a dice so they can use it also in a different context, creating a new experience and way of interacting. The collective experience is promoted also by the shape of the table, which allows collaboration among peer. DADODICE designing phase are represented in Fig. 4.

As said before, DD is powered by Xplaces[3], a software framework designed to help developers in the creation, from design to testing, of collaborative applications for

[3] http://xplaces.crs4.it/doku.php

technology-enriched places. Technically XPlaces is a message-oriented middle-ware written in ISO C++ based on Linux distribution. Its main components are Box, Board and Device. More specifically a Device could be a Sensor, a Viewer or an Actuator. The idiosyncrasies of sensors and devices are hidden by software abstractions, and a simple but functional distributed event system allows the creation of complex interactive applications. DADODICE is one of these applications. The programmer writes high level application logic, while the burden of sensor discovery, calibration, geometrical transformations, adaptation to environment conditions (a known issue of computer vision based sensors, etc.) are hidden within the framework. The main purpose is the design and the development of interactive living/working environment, provided with integrated information and communication technology to best satisfy people needs, thanks to an active and no-invasive synchronised orchestration.

In choosing the installation, we wanted to underline both is learning power and its toy like qualities. So, we use a word-game. In fact, in Italian “dado” means “dice” and “dice” means “tells”. The name of the installation becomes then auto-explicative meaning “the dice tells”.

3.3 DADODICE: How it works

It is composed by a round Plexiglas table, two web-cams, a set of coloured lamps in six different boxes, a TV screen and a textile dice, without any technology inside. Throwing the dice on the table the xPlaces framework recognizes the face and, simultaneously, loads a movie on the TV screen and lights up a transparent box with a representation of the related renewable energy inside.

As shown in Fig.1, each face of the dice bears a visual tag that encodes the renewable energy showed by the image. The plane of the table is opaque, and two webcams are hidden behind, so that each camera frames a portion of the surface. Two webcams are needed in order to cover all the area of the table, which is 150 cm in diameter. Moreover, since the table is just 70 cm height, we had had the problem to improve the deep of the field, easily solved positioning a mirror to the bottom and pointing the cameras to it.

The recognition of such tags is performed by means of the reacTIVision framework (Kaltenbrunner & Bencina, 2007), which is capable of distinguishing several hundred different tags, their position in the frame and rotation on the plane.

4. The field research

The exhibition "Terra difendiamola con energia" has been started for two months and we are spending entire weeks in the amusement park, participating to visits and working with park employees.

It is a good policy of the park to provide a plan of the day for each group, combining self-managed, theoretical (such as listening to the guide explanation) and practical activity. Our installation is considered a practical activity because visitors are free to move and play with their companions.

We are now conducting a field research to analyse how people interact with our installation, whether it is enjoyable and pupils can learn in a easier way. We are also interested in the exhibition collaborative space so we are paying attention to visitors and guide position around the table.

There is a sign at the entrance of the park informing visitors that a research is being conducted and it could be possible, if they agree, to be interviewed and exchange opinions with researchers. The focus of the research is appositely not mentioned to avoid to influence participants.

We have been adopting a field research approach, which consists of various measures, in order to involve all the relevant organizational actors:

- participant observation conducted following all the exhibition with visitors, as if we were ”common” visitors
- semi-structured interviews administered to visitors, divided in small groups up to 5 people, as soon as they finished the visit
- informal speech with park guides in order to collect their impressions, feedback and to understand whether there were recurrent questions or behaviours

4.1 Participant observation

We are now conducting our observations inserted in the group of visitors, as if we were common visitors as well. We always assume the same position around the installation, avoiding to introduce a further font of error. To better analyse group behaviour we prepared an observation grid considering visitors questions and all the behaviour carried out, as shown in Tab.1.

Sex & age	Asking for explanation	Complaining	Involving other people	Playing alone/in group
M 12	X	X	V	a
F 12	X	V	X	X
F14	X	X	V	g
F 13	X	X	V	a, g

Table 1. The observation grid (a red “X” means absence of the phenomenon, a green “V” means adopted behavior, an “a” means alone and a “g” in group).

Behaviours and comments not according with grid are anyway collected in another part. Simultaneously, we draw an outline of group disposition (the guide is the darkest character), as it is shown in Fig.5.

Figure 5. Behavioural patterns around the installation.

4.2 Semi-structured interviews

It is not possible to interview one person alone so the interviews are conducted in small (3-5 people) groups. The researcher every time assigns a number to each person and write his/her sex and the approximate age.

Whether arise questions (”What are you interested about?”) during the interview, the research says that all the answer will be solved at the end of the interview itself.

The researcher asks:

1) What they most appreciated in the park

2) What they most like in “Terra difendiamola con energia” exhibition

3) What they think about DD

4.3 Speech with guides

By spending entire days in the amusement park, we had the occasion to talk with the guides, to collect their impressions concerning our installation and the way of people interacting with it.

The guides are six: three work permanently at the park and the other three are available only when the park is quite crowded. They are very differently skilled and all of them have been working in this field for a long time (up to five years).

5. Partial results

At the moment the exhibition has been visited by 1200 people and we have collected comments, behaviour and spatial position of about 200 people (both young and adults).

We can draw here some partial results. We can assert that children are more attracted than adults and adolescents (who, at the moment, seem to perceive the installation as a *childish game*) by DD installation. In fact, pupils usually a bit *rowdy* are willing to play with DD and they love to throw the dice to see the movies concerning various alternative energies, as shown in Fig.6.

Figure 6. Behavioural patterns around the installation.

Children seem to use our installation as if it was a toy (but they refer to DD saying that it is an electronic device). Otherwise adults are curious, they stay around the table after others have gone, then they throw the dice trying to understand how it works. It is unusual that they ask this kind of explanation directly to the guide.

Starting from the first data collection, we think to find relevant differences concerning people of various ages (adults, primary and secondary schools pupils) and their position around the table. There seem to be various behavioural patterns depending on the kind of visitors (pupils versus adults). In any case, guides tend to assume always the same position, but they are also able to change quickly if participants are dizzily arranged in marginal positions.

All the guides believe that DADODICE is helpful in involving all visitors because it simplifies and translates complex concepts stimulating different senses (sight, touch and hearing). All the guides have different explicative styles but all of them adapt the content basing on the target skill and age, on their reactions and also on the time (because of the sun).

6. Lesson learnt

This experience was enormously relevant for our team. In fact, we develop prototypes so we often invite people interested in our activity to visit our Lab.

One of this peculiar visits has allowed us to combine two different prototypes, thought for various scenarios and scopes, in a new installation working with very differently skilled people. We learnt that the more heterogeneously skilled is the team working on a project the more complete is the installation.

As it happens, we would have needed more time to develop our installation and, in particular, to set it in its final destination. In fact, our Lab is the perfect environment where to work: no dust, no insects, no real dazzling light of the sun and the right controller to switch on/off every device. But where DADODICE was really installed there was the combination of all these elements! So we needed to modify our installation in some way and came back various times.

In fact, we have modified some relevant parameters of the two web-cams and implemented a better control concerning lightness and aperture parameters. We have also implemented a feature which allows to put on stand by the two web-cams after

five minutes of idle time. This was due to the risk of overheating the boxes containing the lamps.

However, there is also the positive effect. In fact, there is an intrinsic delay in recognizing the tag. In our Lab we thought that this could be a problem, while we have discovered on the field that this delay allows visitors to turn the face from the table to the wall were the lamps are put. If this operation were synchronous it would be impossible for visitors to play with the dice and see the correspondent light switched on.

7. Conclusion and future works

The data collection is still in progress. At the moment, we are pleased by visitors', clients', guides' and our team's reaction to DADODICE installation. We would like to utilize a similar highly technological and not invasive solution to develop other installations. We are going to collaborate again altogether, starting from the reorganization of the current exhibition. In fact, park employer needs more active and interactive installations to increase visitors' satisfaction. At the moment we have only some partial results but we believe that our next step consists in analyzing how this kind of installations are useful in explaining formative contents and whether these contents are easy to remembered or are too elusive.

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