2\textsuperscript{nd} International Congress on Digital Heritage
2015

federating the

21\textsuperscript{th} International Conference on Virtual Systems and Multimedia (VSMM)
13\textsuperscript{th} EUROGRAPHICS Workshop on Graphics and Cultural Heritage (GCH)

plus Special Sessions from

CIPA ICOMOS/ISPRS Special Heritage Documentation Worshkhop
CAA Fall Symposium
7\textsuperscript{th}International Meeting Arqueológica 2.0
Space2Place
ArcheoVirtual
ICOMOS Digital Interpretation Panel
and International Projects

Volume 1/2

Editors
Gabriele Guidi
Juan Carlos Torres
Fabio Remondino

Roberto Scopigno
Holger Graf
Pere Brunet
Preface

These two volumes contain the papers presented at Digital Heritage 2015, Granada (Spain), Sept. 28th – Oct. 2nd. This is the second edition of a multidisciplinary and federated event, aimed at gathering in a single location multiple communities working on the application of digital technology to the documentation, conservation, exhibition, and understanding of humanity’s shared past.

Following the approach developed in 2013, the scientific program has been selected through a single call for papers and a single review process, endorsed by all of the federated events. The scientific papers included in these proceedings are the result of a complex process that involved the conference chairs, scientific reviewers, and the conference management staff.

The call of paper was structured by the IPC Chairs by setting up five thematic themes:

- Digitization and Acquisition
- Computer Graphics and Interaction
- Analysis and Interpretation
- Theory, Methodologies, Preservation and Standards
- Digital Heritage Projects and Application

For each of these Themes, we selected a Theme Chair and solicited Full Papers, Short Papers, and Works-In-Progress contributions.

The response from the community was strong: we received a total of 359 submissions (126 full papers, 160 short papers and 73 works-in-progress). All these submissions were reviewed by members of the International Program Committee, 168 experts from across the heritage and technology spectra. These experts contributed 760 double-blind peer reviews. We assigned each full/short submission to three reviewers, aiming to have at least two reviews finalized in the conference.
management system. Both, the IPC Chairs and the Theme Chairs, did their best in assigning reviews to the IPC members most knowledgeable on a specific topic, shepherding the process, replacing reviewers when needed, and completing many reviews themselves to decide on papers with conflicting assessments. The result of this review process was the acceptance of 52 full papers, 155 Short papers, and 63 Works-in-Progress, of which 156 will be presented orally and 114 as posters.

Since the exchange of ideas, debate, and discussion with colleagues is an important component of scientific communication, our week-long program has been supplemented with time for networking, sharing of local culture and gastronomy, plus an array of cultural visits around the region.

Such an event would not have been possible without the generous contributions and support of many colleagues and partners. We warmly thank the conference General Chairs, the local organizers and all the reviewers who helped to select the papers for the proceedings.

In closing, we thank all of you: the attendees of the Digital Heritage 2015 conference and the many other people who will read these proceedings in the future. We are proud to present you these two volumes and to welcome you to Granada and to the second International Congress on Digital Heritage. We wish you an enriching, stimulating, and enjoyable week of discovery.

On behalf of the International Program Committee and the Theme Chairs, Granada, Sept. 28, 2015
Volume 1

Theme 1 - Digitization And Acquisition

Challenging Items & Materials, Methodologies

Full Papers  Short Papers  Works in Progress

Theme 2 - Computer Graphics And Interaction

Rendering, Virtual CH & Advanced Interfaces

Full Papers  Short Papers  Works in Progress

Volume 2
Theme 3 - Analysis And Interpretation

Interpretation, Understanding & Methodologies

Full Papers  Short Papers  Works in Progress

Theme 4 - Theory Methodologies Preservation And Standards

Archiving, Metadata, Ontologies, Preservation and Architectures

Full Papers  Short Papers  Works in Progress

Theme 5 - Digital Heritage Projects And Applications

Storytelling, Virtual Exhibitions, Interactive Presentations

Full Papers  Short Papers  Works in Progress

Copyright ©2015 by IEEE

Copyright and Reprint Permission:
Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923. For reprint or republication permission, email to IEEE Copyrights Manager at pubs-permissions@ieee.org. All rights reserved.
Congress Committee of DigitalHeritage 2015

Honorary Chairs

**Pilar Aranda**  
Chancellor of the University of Granada, Spain

**Federico Mayor**  
Chairman of the Foundation for a Culture of Peace and Former Director-General of UNESCO

**María del Mar Villafranca**  
Director of the Council of the Alhambra and the Generalife, Spain

**Ernesto Páramo**  
Director of the Sciences Park of Granada, Spain

Federated Event Chairs

**Eurographics**  
Dieter Fellner  
Fraunhofer IGD/TU-Darmstadt, Germany

**GCH 2015**  
Lon Addison  
VSMM Society

**VSMM 2015**  
Livio De Luca

**ArcheoVirtual**  
Sofia Pescarin  
CNR – National Research Council, Italy

**2015**  
Alfredo Grande  
SEAV -Spanish Society of Virtual Arch, Spain

**Arqueologica**  
Jose Luis Lerma

**2.0**  
Lisa Fischer  
Jamestown Rediscovery, USA

**CAA2015 Fall Workshop**  
Heather Richards-Rissetto

**ICOMOS/ISPRS**  
Andreas Georgopoulos  
National Technical University of Athens, Greece
Congress Co-Chairs

Livio De Luca  National Center for Scientific Research (CNRS-MAP), France
Lisa Fischer  Jamestown Rediscovery, USA
Victor López-Menchero  Virtual Archaeology International Network, Spain
Juan Carlos Torres  University of Granada, Spain

International Program Chairs

Gabriele Guidi  Polytechnic of Milan, Italy
Roberto Scopigno  CNR, National Research Council, Italy

Theme Chairs

Digitization and Acquisition  Fabio Remondino  Bruno Kessler Foundation, Italy
Computer Graphics and Interaction  Pere Brunet  Polytechnic University of Catalonia
Analysis and Interpretation  Juan Barceló  Autonomous University of Barcelona, Spain
Theory, Methodologies, Preservation and Standards  Luciana Duranti  University of British Columbia, Canada
Digital Heritage Projects and Applications  Susan Hazan  The Israel Museum, Israel

Publication Chair

Holger Graf  Fraunhofer IGD, Germany

CFP & Posters Chair
Holger Graf  Fraunhofer IGD, Germany
Germán Arroyo  University of Granada, Spain

Exhibition Committee

Exhibition Chair  Sofia Pescarin  CNR, National Research Council, Italy
Alfredo Grande  Virtual Archaeology Society, Spain
Pedro Cano Olivares  University of Granada, Spain

Exhibition Board
Daniele Ferdani  CNR, National Research Council, Italy
Enzo D'Annibale  CNR, National Research Council, Italy
Alfonsina Pagano  CNR, National Research Council, Italy
Bruno Fanini  CNR, National Research Council, Italy

Local Organizing Committee

Local Chair  Alfredo Grande  Virtual Archaeology Society, Spain
Juan Carlos Torres  University of Granada, Spain

Local Board  Germán Arroyo  University of Granada, Spain
Pedro Cano  University of Granada, Spain
Alejandro Rodriguez  University of Jaén, Spain
Francisco Feito  Virtual Archaeology Int’l Network, Spain
Lourdes García Ángeles  Virtual Archaeology Int’l Network, Spain
Barahona   Virtual Archaeology Society, Spain
Alejandro   University of Granada, Spain
León
Luis López   University of Granada, Spain
Domingo   University of Granada, Spain
Martín
Matthew   Virtual Archaeology Int’l Network, Spain
Vincent   Spain
Celia Romo   University of Granada, Spain
Vicente del   University of Granada, Spain
Sol

**International Program Committee (IPC)**

<table>
<thead>
<tr>
<th>Pierre Alliez</th>
<th>Ana Almagro Vidal</th>
<th>Carlos Andujar</th>
</tr>
</thead>
<tbody>
<tr>
<td>German Arroyo</td>
<td>Norman Badler</td>
<td>Adriana Bandiera</td>
</tr>
<tr>
<td>Adriana Bandiera</td>
<td>Salvatore Barba</td>
<td>Juan Antonio</td>
</tr>
<tr>
<td>Andreas Bienert</td>
<td>Jean-Yves Blaise</td>
<td>Barcelo</td>
</tr>
<tr>
<td>Jean Luc Bodnar</td>
<td>Monica Bordegoni</td>
<td>Luciana Bordoni</td>
</tr>
<tr>
<td>Davide Borra</td>
<td>Betsy Bowers</td>
<td>Michael Brown</td>
</tr>
<tr>
<td>Stefan Bruckner</td>
<td>Pere Brunet</td>
<td>Patrick Calletr</td>
</tr>
<tr>
<td>Marco Callieri</td>
<td>Stefano Campana</td>
<td>Pedro Cano</td>
</tr>
<tr>
<td>Chiara Catalano</td>
<td>Erik Champion</td>
<td>Ray Cheung</td>
</tr>
<tr>
<td>Paolo Cignoni</td>
<td>David Crandall</td>
<td>Adrian Cunningham</td>
</tr>
<tr>
<td>Andrea D'Andrea</td>
<td>Marc Daniel</td>
<td>Livio De Luca</td>
</tr>
<tr>
<td>Olga De Troyer</td>
<td>Matteo Dellepiane</td>
<td>Lily Diaz</td>
</tr>
<tr>
<td>Julie Digne</td>
<td>Anastasios Doulamis</td>
<td>Pierre Drap</td>
</tr>
<tr>
<td>Luciana Duranti</td>
<td>Maria Economou</td>
<td>Stephen Fai</td>
</tr>
<tr>
<td>Bianca Falcidieno</td>
<td>Mercedes Farjas</td>
<td>Mohamed Farouk</td>
</tr>
<tr>
<td>Isabelle Fasse</td>
<td>Jean-Dominique</td>
<td>Francisco Feito</td>
</tr>
<tr>
<td>Francesco Ferrise</td>
<td>Favreau</td>
<td>Julian Flores</td>
</tr>
<tr>
<td>Mariano Flores-Gutiérrez</td>
<td>Lisa Fischer</td>
<td>Maurizio Forte</td>
</tr>
<tr>
<td>Christoph Franzen</td>
<td>Jakub Flotyński</td>
<td>Francesco</td>
</tr>
<tr>
<td>Name</td>
<td>Name</td>
<td>Name</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Fabio Ganovelli</td>
<td>Andreas Georgopoulos</td>
<td>Gabellone</td>
</tr>
<tr>
<td>Jeffrey Glover</td>
<td>Enrico Gobbetti</td>
<td>Gesquiere Gilles</td>
</tr>
<tr>
<td>Pascual Gonzalez</td>
<td>Holger Graf</td>
<td>Sanjay Goel</td>
</tr>
<tr>
<td>Franco Guena</td>
<td>Antonella Guidazzoli</td>
<td>Pierre Grussenmeyer</td>
</tr>
<tr>
<td>Gilles Halin</td>
<td>Carlo Harvey</td>
<td>Gabriele Guidi</td>
</tr>
<tr>
<td>Martine Herpers</td>
<td>Mona Hessn</td>
<td>Luis Hernandez</td>
</tr>
<tr>
<td>Katsushi Ikeuchi</td>
<td>Kevin Jacquot</td>
<td>Zha Hongbin</td>
</tr>
<tr>
<td>Yvonne Jung</td>
<td>Jaime Kaminski</td>
<td>Elizabeth Jerem</td>
</tr>
<tr>
<td>Vassilis Kilikoglou</td>
<td>Min H. Kim</td>
<td>Martin Kampel</td>
</tr>
<tr>
<td>Harald Kraemer</td>
<td>Arjan Kuijper</td>
<td>Reinhard Klein</td>
</tr>
<tr>
<td>Hasan Lee</td>
<td>Alejandro León</td>
<td>Florent Lafarge</td>
</tr>
<tr>
<td>José Luis Lerma</td>
<td>Fotis Liarokapis</td>
<td>Nicola Lercari</td>
</tr>
<tr>
<td>Ioannis Liritzis</td>
<td>Paolo Liverani</td>
<td>Maria Chiara Liguori</td>
</tr>
<tr>
<td>Genevieve Lucet</td>
<td>Ricardo Marroquim</td>
<td>Victor López-Mencher</td>
</tr>
<tr>
<td>Fabio Marton</td>
<td>Herbert Maschner</td>
<td></td>
</tr>
<tr>
<td>Luis Matey</td>
<td>Javier Melero</td>
<td></td>
</tr>
<tr>
<td>Chris Michaels</td>
<td>Michela Mortara</td>
<td></td>
</tr>
<tr>
<td>Erica Nocerino</td>
<td>Michela Ott</td>
<td></td>
</tr>
<tr>
<td>Gianpaulo Palma</td>
<td>Augusto Palombini</td>
<td></td>
</tr>
<tr>
<td>George Papagiannakis</td>
<td>Gustavo A. Patow</td>
<td></td>
</tr>
<tr>
<td>Francisco Jose Perales</td>
<td>Jean-Philippe Pernot</td>
<td></td>
</tr>
<tr>
<td>Denis Pitzalis</td>
<td>Daniel Pletinckx</td>
<td></td>
</tr>
<tr>
<td>Dominic Powlesland</td>
<td>William Puech</td>
<td></td>
</tr>
<tr>
<td>Adam Rabinowitz</td>
<td>Romain Raffin</td>
<td></td>
</tr>
<tr>
<td>Fabio Remondino</td>
<td>Patrick Reuter</td>
<td></td>
</tr>
<tr>
<td>Karina Rodriguez</td>
<td>Juan Antonio Rodriguez Aguilar</td>
<td>Pablo Rodriguez-Navarro</td>
</tr>
<tr>
<td>Seamus Ross</td>
<td>Maria Roussou</td>
<td>Holly Rushmeier</td>
</tr>
<tr>
<td>Michele Russo</td>
<td>Robert Sablatnig</td>
<td>Donald Sanders</td>
</tr>
<tr>
<td>Pedro Santos</td>
<td>Raffaella Santucci</td>
<td>Martin Sauerbier</td>
</tr>
<tr>
<td>Pasquale Savino</td>
<td>Roberto Scopigno</td>
<td>Rafael Segura</td>
</tr>
<tr>
<td>Susan Shazan</td>
<td>Francesco Soldovieri</td>
<td>Michela Spagnuolo</td>
</tr>
<tr>
<td>Hrvoje Stancic</td>
<td>Stephen Stead</td>
<td>Andre Stork</td>
</tr>
<tr>
<td>Maria Theodoridou</td>
<td>Harold Thwaites</td>
<td>Corey Toler-Franklin</td>
</tr>
</tbody>
</table>
Playing Design
Mobile Serious Games to Valorize Design Culture in the Urban Space

Mauro Ceconello, Alessandra Spagnoli, Davide Spallazzo, Umberto Tolino
Department of Design
Politecnico di Milano
Milan, Italy
mauro.ceconello@polimi.it

Abstract—The paper frames, describes and analyses the Play Design! Project, a set of mobile location-based urban games to divulge and teach design culture. Aim of the project was to promote the culture of design among high school students through the use of mobile gaming, providing an informal and enjoyable way of learning, valorizing and contextualizing Italian and Milanese design across the city. Design is here intended as heritage to be recognized and valorized in the center of Milan providing not only information on iconic industrial design products, showrooms and studios but also contextualizing them into the historical evolution of the Italian design.

Index Terms—Serious game, mobile technology, location based game, design, urban space, informal learning.

I. INTRODUCTION

The paper frames, describes and analyses an applied research project — Play Design! — whose aim was to create a location-based serious game for mobile devices with the purpose of promoting and spreading the culture of design, offering fun and an informal way of learning. The audience of the project are students attending the final years of high school, interested in design related issues at large that can be considered prospective students of design, art or architecture.

Play Design! project led to the development of two mobile games: the first — D.Hunt, Design Hunt — is a mobile treasure hunt that allows users to discover some of the most relevant places and icons of Milanese design following the trail of the Zizi monkey (the award-winning toy designed by Bruno Munari). The second game — D.Learn, Design Learn — is a role-play mobile game that involves four teams of three participants each, pretending to be design studios struggling to achieve the renowned Italian prize for Design, the Compasso d’Oro (the Golden Compass).

II. DESIGN OF THE GAMES

The term serious game [1,2] identifies those games that have “a learning model embedded, the content is integrated into the game, so learning is intrinsic to play” [2, p. 27] and, among them, mobile serious games add the possibility of being surrounded by the real world, enabling authentic experiences that keep the contact with the environment [3].

Not by chance the employment of mobile gaming for learning purposes in informal contexts and in particular for cultural heritage valorization has a quite established tradition that dates back to the first years of the 2000s as documented in [4] that selects and analyses fourteen projects that employed mobile supported serious games to valorize cultural assets.

All these projects have in common the exploitation of the teaching capabilities of mobile games, providing highly localized and lightly augmented games.

The project Play Design! fits in this strand and aims to promote and spread the culture of Italian design among teenagers who have expressed interest in design related issues. To achieve this purpose, design can be presented from two points of view: on the one hand design can be seen as cultural heritage, favored witness of the industrial production and of the creative thought of the past, and on the other design is seen as a discipline that can be taught in schools and universities. Two different approaches that, despite unified by a shared culture made of objects, stories, characters and places, must be coped with different strategies.

Looking at design as a heritage to be recognized and valorized in the city means indeed providing not only information on single industrial design products but also contextualizing them into the historical evolution of Italian design. On the other hand dealing with design as a discipline means providing information on the production but also on the entire design system and its characteristics as well as on the daily work of a designer. The choice of following both the approaches required two different strategies that were translated in the project into two different games.

D.Hunt, the first game, looks indeed at design as heritage and aims to make young students aware of the design essentials, the most renowned products, designers and brands that became in the years iconic of the Italian design and that are conserved and exposed in the major design museums across the world. On the contrary D.Learn, the second game, embraces a didactic approach and aims at disclosing the complexity of the discipline, made of different sub-disciplines (eg. product, fashion, interior and communication design) and characterized by teamwork.

The two games subtend also a slightly different target audience, being that of D.Hunt interested in basic information about design, provided in an engaging manner, and that of
D.Learn already interested in the discipline and keen to improve their knowledge in the field. For these reasons they differ also in the game genre. D.Hunt is designed as a treasure hunt because this genre seemed to best fit with the aims of the game, that is providing simple information in an involving way: a well defined sequence of hints to be discovered, within a narrative structure, allows indeed to provide players with small pieces of information and to keep their attention alive.

D.Learn is instead designed looking at the world of role-play games, in order to enable more sophisticated game dynamics and to create different roles corresponding to specializations within the design discipline.

The games were not created from scratch by coding a new app but exploited a platform specifically designed to support mobile learning in informal contexts — Mobile Learning Academy — that gathers several universities and institutions and allows to create location-based games with no coding skills. The choice of using an off-the-shelf solution and to adapt it to the requirements of the projects was in part due to limited resources allocated to the project but also justified by the final goal of the project itself, that was not the creation of an innovative app for mobile gaming but the testing of the potentials of location-based games to valorize design.

III. HOW THE GAMES WORK

D.Hunt is an urban mobile game that follows the rules of a geo-located treasure hunt. It’s designed for a single user that, playing the role of a detective designer, has the task to go searching for the famous Zizi monkey, that pretends to have been kidnapped. Aim of the game is to follow the traces left by the mischievous monkey using the mobile application, walking through locations that are iconic of Milanese design and, at the same time, answering questions on the matter. Players acquire knowledge through a sequential order of hints and parts of a storyline: only after visiting the right place and solving the clue, the following location is indeed disclosed. To start the game the user has to reach, equipped with his mobile device, the Bruno Munari Association in the center of Milan; once the player is located through the GPS, the smartphone starts the game and provides the first hint.

The player needs answering questions correctly, walking in the streets of Milan to discover institutions, showrooms, public places and locations that made the history of Italian and Milanese design.

A path connecting fourteen selected locations was created through the streets of downtown Milan: each place is associated with a question or a hint related to the world of design and strongly connected to the place itself (Fig. 1).

The questions deal with themes related to the history of Italian design, design icons (mainly products, interior and graphic design) and famous designers.

The level of difficulty of the questions is medium-low to meet a young audience interested in design related issues but who is not strictly specialized: the help provided, in the form of detailed descriptions or images, allows the player to guess the correct information without knowing the specific topic. Each task is then assigned with a score and at the end of the game, the user is associated with a particular profile based on the achieved score.

Some hints are provided as audio tracks that simulating a radio broadcast allow players to listen to excerpts of design history. The speaker’s voice is partly disturbed by the voice of the little Zizi monkey that seems to intrude in the transmission, suggesting the user-detective the next place to reach. This radio show represents a complementary story to the main storyline and it has the dual purpose of linking different places and offering a different channel of learning: a traditional approach but conveyed through an unconventional and experiential way.

The narrative register is strongly characterized by the choice of Zizi as the virtual leader of the treasure hunt: the monkey plays as a real character that interacts with the user asking questions and leaving clues on his path. At the same time the language and the tone with which the story is presented, from rules description to the questions, are extremely friendly and informal.

D.Learn is a role-play game involving different teams: the participants, divided into four teams corresponding to the four degree courses offered by the School of Design at the Politecnico di Milano, confront each other on specific paths throughout the streets of downtown Milan, answering questions, challenging and trying to prevail one on the other reaching the highest score.

Each team therefore plays interpreting one of these four roles in order to complete its mission by collecting points, achieved answering questions correctly, and skills, gained crossing reward places and challenging other teams.

Unlike the first game, D.Learn requires the participation of different teams (from two to four) of three players each: the game session must start at the same time, and it lasts for one hour and a half. Upon registration to the game, which is done through the website, players meet in Piazza Duomo, in the city center, to receive the game kit and all the instructions.

Each member of the team must fulfill one of three different roles within the team: one player has to identify, through his smartphone, the correct location of the points of interest, to control the position of the other teams and then to interact with the device; a second one, equipped with a paper map of the center of Milan, has to plan the team’s activity and the game strategy according to the score and to the location of each question; the third player is provided with a card deck useful to answer quizzes correctly and to solve the final riddle.

![Fig. 1. Screenshots of D.Hunt showing the interface.](image-url)
As it happens in \textit{D.Hunt}, there is always a strong relationship between the PoIs in which the players are and the topic of the quiz: showrooms, hotels, museums, graphics, urban indoor and outdoor represent the perfect setting to invite players to recognize and appreciate the presence of modern and contemporary design in the city of Milan.

In addition to the quizzes there are also reward points that could be gained in special locations where users acquire information on important brands, products, designers, interior projects, graphics, or simply a curiosity.

The teams have the chance to meet and clash in their moving inside the gaming area and to activate score stealing challenges: every time a team faces another, a challenge begins and the team with more skills steals points from its opponent. Consequently, each team is stimulated to reach the largest number of PoIs, gaining scores and skills by answering questions correctly. They can strategically choose a route to avoid or favor the challenge with other teams before heading towards the final meeting point (Piazza dei Mercanti) for the last challenge and to conclude the game session. Once players reach the last PoI the final question appears on their smartphone providing them with a code to be decrypted: the cards and the paper map are crucial to get the final answer.

Unlike the first game, in this case the digital interaction with the mobile device was integrated with analogical tools (Fig. 2), a map showing the points of interest and a card deck with hints, in order to foster a richer interaction among players and between players and devices, in a continuous dialogue between digital and physical.

\section*{IV. Launch, Tests and Game Sessions}

The game \textit{D.Hunt, Design Hunt} was launched and publicly disclosed on February 2014 at the Open Day of Politecnico di Milano, an open doors day dedicated to the undergraduate courses: an excellent opportunity because both the games and the event were designed for high school students.

The launch of the game \textit{D.Learn, Design Adventure} required instead the involvement of the Student Orientation Service of the School of Design, which contributed to the promotion and dissemination of the game and to gather students interested in the taking part to the activity.

Thanks to a previous registration of the participants, the research team organized game sessions involving groups of students from different high schools.

The two games are currently documented on the project website and they are accessible from the free app \textit{Mobile Learning Academy} for iOS and Android. While \textit{D.Hunt}, according to its characteristic of individual mobile game, is available to anyone interested in experiencing a playful and interactive approach to design related content, \textit{D.Learn}, since it’s a role playing game that provides team interaction, remains focused on an audience of possible prospective students of Politecnico and need to be organized through special game sessions.

Before the launch, the games undergone an iterative process of test and correction, conducted at first by the research team and later with a sample of final users in order to identify and fix major problems and to fine tune the games. The choice of an off-the-shelf solution for the digital part of the games avoided time-consuming tests on its basic functionalities and allowed to focus on contents and on the user experience.

Since the launch of the two games in 2014 \textit{D.Hunt} has been played about a hundred times by single players without the supervision of the research team and it was therefore difficult to have from them first hand and significant feedback, beyond the rating (from one to five stars) and simple comments.

The different modalities for the game \textit{D.Learn} allowed instead to get relevant feedback from users, despite the number of played sessions was significantly lower.

The data gathered in the first year of life of the games are therefore not so significant if read from a quantitative point of view but informal interviews conducted with the teams after \textit{D.Learn} game sessions as well as the direct observation of players during the sessions underlined some relevant issues about the learning outcomes, the overall enjoyment and the social engagement as well as on the entire experience that are discussed below.

\section*{V. Discussion and Future Works}

Aim of the project was to promote the culture of design among high school students through the use of mobile gaming, providing an informal and enjoying way of learning, valorizing and contextualizing Italian and Milanese design across the city.

As already stated we haven’t got any relevant feedback by \textit{D.Hunt} players but elementary feedbacks provided with a rating from one to five stars and tweet-like comments, despite not completely reliable, underline a quite positive result in terms of overall enjoyment. Informal interviews with \textit{D.Learn} players after the game sessions and direct observation of users allow instead arising some relevant issues and proposing topics of discussion. A very first point regards the learning outcomes achieved by playing the game: several young players reported an increased knowledge on design related issues and an overall appreciation of the experience played across the streets of downtown Milan, with contextual contents provided in places meaningful for design.

![](image)

\textbf{Fig. 2.} The game kit including a smartphone, the paper map and a card deck.
The active exploration of the city enabled by location-based game dynamics has been pointed by several players as an added value and the observation of the activity confirmed this result: by looking for hints and defining the strategy on the map, the city was observed in a more active way and players easily built a new personal geography and orientation system, overlaying the actual city with that of the game, thus expanding the classical game environment into the physical world [3].

The combination of contextual information provided in meaningful places for Italian design together with questions supported by images and by hints, to be discovered in the cards provided at the beginning of the game, resulted to be an efficient way to stimulate users’ active involvement and to foster learning. It’s not surprising that mobile urban experiences designed as role-playing games have great potentials for learning [5,6], because they match a well designed narration with social collaboration and competition, and location based games in general can strongly enhance learning, and in particular social, experiential and situated learning, because they exploit three different sources of information: the physical space, the digital space and the mind of the users [7].

The good results achieved in D.Learn in terms of social engagement and involvement in the activity can also be explained with the choice of mixing digital contents and physical tools that must be used together in order to progress in the game. The forced exchange of information among the team members facilitated indeed discussion on the topics and a shared understanding as well as the reinforcement of the team spirit: sharing experiences, skills and resources both face-to-face and through digital devices, players engage in a common learning process. Furthermore physical tools are also helpful to maintain the contact with reality, a relevant aspect if the aim of the project is to stimulate active involvement and exploration of the urban space. The three efforts suggested by McGonigal [8] to achieve collaboration — cooperation, coordination and co-creation — are therefore entrusted in the game to the combined use of digital and physical tools.

Thus the experience matured with D.Learn reinforces the idea that “physicality and materiality is usually more conducive to social enjoyment and sharing” [9] and that a simple mobile app, be it based on a tour or on a game, in a cultural environment can engage visitors utterly with contents but it’s unlikely to engage people with places and other people, going beyond the selfishness of the smartphone monitor. The employment of mobile technology on the one hand is indeed very helpful in offering a location-based service but on the other hand it could hinder social involvement if not correctly employed. The experience matured with previous projects demonstrated indeed that using a smartphone as a unique tool for a visit experience well suits only with a personal experience [10] especially if based on media like video, images and audio. For this reason D.Hunt uses audio contributions sparingly, in order to allow the sharing of the monitor and a social experience while D.Learn introduces two physical tools — paper map and card deck — to avoid the social isolation due to the use of a device and to foster social engagement and collaboration.

The foreseen actions for the project are the organization of new game sessions of both the games in order to collect more reliable and quantifiable data to verify the points described above and, on a general level, a further exploration on the integration of digital and physical tools. The good results achieved in D.Learn in terms of social engagement, collaboration and involvement thanks to the integration of physical tools in the experience, suggests indeed further exploring their employment and the integration between physical and digital, pushing ahead the intertwining between these two worlds for learning purposes.

ACKNOWLEDGMENT

We thank the Department of Design of Politecnico di Milano for the grant, ADI for the patronage, all the design studios and archives that provided images for the games, Orsetta Mangiante and Maria Tasca for the work on graphic design.

REFERENCES