UNIVERSITY OF TRENTO - Italy
Department of Psychology
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Master's Degree in Cognitive Science

Participatory Design of a Mobile Application with and for Children: A Case Study in the Tourism Sector

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Thank you!

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1 INTRODUCTION

Interaction design is "the practice of designing interactive digital products, environments, systems, and services" (Cooper, 2007). Certain basic principles of cognitive psychology provide grounding for interaction design. Some of these include mental models, mapping, interface metaphors, and affordances (Norman, 2002). Ergonomics also plays a role in grounding some assumptions in interaction design, including anthropometry, kinesiology, physiology, and psychology as they relate to human behavior in the designed environment. Psychology plays a role in interaction design by allowing designs to be in accordance with how people perceive, analyze and assimilate data. The many insights of cognitive science continue to improve the methodologies of interaction design, which was the main approach employed in this research.

1.1 TRENTOUR PROJECT

This research was done under the TrenTour project in the Trentino-Alto Adige region of Italy. TrenTour is a pre-commercial procurement project funded by Trento Rise and is a collaboration between the University of Trento, Trento Rise, and a pool of Italian companies (GH, LiberoLogico, SAYservice, Pervoice and Clesius) led by a company called Engineering. The main objective of the project is to enable a new generation of services with high added value which can enhance the experience of tourists, not only during the holidays but also before and after the actual travel to the Trentino territory, in Italy.

1.2 THE RESEARCH

My research project focused on designing a mobile application for older elementary-school-aged children as tourists. The particular task in the TrenTour project that I worked on was the "Focus on Digital Natives."

> "The Focus on Digital Natives task specializes the knowledge derived two preceding tasks: *The definition of the methodological framework for the analysis of the tourist experience* and *The analysis of the*

behaviors, motivations, and attitudes of the tourist to people under 14 years of age, considering diverse contexts such as family vacations, school trips and group vacations. As opposed to the existing offering, where the emphasis is essentially on the adult as a mediator of the decision and user of the technology, we propose involving the child directly, studying their needs and desires. In particular, we will concentrate on games and play as pedagogical instruments for the communication of the history and geographical characteristics of the territory."

-Author's translation of TRENTOUR Technical Proposal (Internal Document)

In order to deal with this task, I needed to find out what design aspects were most appropriate for this young user group in this setting. First I had to conduct some user research to better understand the child's experience as a tourist and children's interactions between each other, their surroundings, and a smartphone application. In order to do this I concentrated on answering the following question:

1. How would children respond to the introduction of a mobile application on a trip?

If I found that children responded positively to the introduction of a smartphone application on a trip, it would imply that there is potential for such an application for children of this age group. Such a confirmation from the user research would justify building the application and would allow me to start focusing on the other important objective of the task: the emphasis on games and play as a pedagogical instrument. This became the second focal point of the project:

2. What game-like and playful learning elements of pedagogical mobile applications do children consider fun that are also are age-appropriate?

I strove to comprehend the child's tourism needs and limitations and what game-like application desires they had in order to derive some design requirements and suggestions for a tourism application for older elementary-school-aged children.

1.2.1 METHODS

I endeavored to answer these questions by studying how 19 nine and ten year-old children responded to the introduction of a smartphone application prototype on a museum field trip, as well as what game-like and playful learning elements they consider fun and are appropriate for their age. I had a diary-like smartphone application, called LifeLog, adapted so that it could photograph and record other media in a quick and easy way. I then observed the children using this prototype while on a school trip to an art museum, where I strove to decipher the complex interactions between the children, their surroundings, and the smartphone application. In order to comprehend how to best use play and games as pedagogical instruments, I actively involved the children in the creation process of playful and game-like educational aspects of a smartphone application through participatory

design and later conducted user evaluation of four mobile game application scenarios. Designing *with* children in addition to designing *for* children allowed me to come up with design suggestions that met the needs, desires, and limitations of this unique user group.

I used the ethnographic observation method to effectively observe the children on the trip. I then analyzed the photographs that they had taken using thematic analysis.

I compared the observations of the children's behavior during the case study, as well as the results from my analysis of the photographs the children had taken, to the recent model of the Mobile Tourist Experience for adults described by Wang and colleagues (2012).

I also analyzed mobile applications that already exist in the area of tourism for children.

In attempting to understand the capabilities and desires of the children regarding game-like learning aspects of the application, I used participatory design techniques to involve them in the process. I had the children brainstorm in small groups. Then I elaborated their ideas together with six other designers in a designer workshop. After that, we presented the ideas to the children for a user evaluation of four game-like educational scenarios. From the user evaluation, we received suggestions for the improvement of the application scenarios and I grouped them according to the motivations I perceived behind them.

The following main challenges of mobile technology design for children were formulated in an influential work by Rogers and Price (2009): avoiding information overload, preventing distraction from the ongoing physical activity, and constraining design to promote interaction between children and cooperative working. I used them as criteria for validating the results.

1.2.2 RESULTS

The ethnographic observations as well as an analysis of the photographs taken by the children confirmed that their use of the travel-diary application prototype, in this particular context, mitigated the aforementioned challenges of mobile technology design for children. The introduction of LifeLog did not overload the children with information. Moreover, its introduction actually fostered new types of interactions and conversations and did not entirely distract the children from the museum's exhibits. The patterns that emerged from thematic analysis of the photographs the children had taken supported my observations of their behavior and highlighted the rivalry between extrinsically-directed and intrinsically-directed attention. In the analysis, I presumed that the subjects of the children's photos were the focus of their attention and interest.

In comparing my results to Wang and colleagues' model of the Mobile Tourist Experience, I found that my observations and results analysis supported their model even though our users were outside of the scope of the original model. It seems that the actions the children performed on the trip to the museum and the behaviors they exhibited are similar to the interactions Wang and colleagues describe in adults having a mobile tourist experience. I found that with the exception of a slight modification of the anticipatory phase, their model can be extended to include children, at the very least in a situation where they go to visit a museum.

The case study utilized user research methods to gather information about whether there is potential for a tourism application for children. I found that both the thematic analysis and the ethnographic observations were successful in providing insight into the question regarding how children respond to the introduction of a mobile application on a trip. The results from the case study seem to suggest that introducing an application similar to LifeLog for nine and ten-year-olds would enhance their tourist experience in the Trentino territory of Italy.

After the user research I conducted confirmed that there is potential for the application, I moved to the next phase of the research and studied applying game-like learning aspects to a new tourism application for children. Having used an application prototype during the case study allowed me to analyze its use with older elementary-school-aged children and enabled me to form a comprehensive list of design requirements for improving and adapting travel-diary applications for young users from my observations and the children's direct feedback.

Using the information from the participatory design and designer workshop sessions, I created and then presented storyboard scenarios to the children for user evaluation. I structured their suggestions for improvement according to Malone and Lepper's (1987) taxonomy of intrinsic motivations for learning. This allowed me to formulate a comprehensive list of general design suggestions for adding game-like aspects to an educational tourism application for older elementary-school-aged children.

1.3 ORGANIZATION

This thesis is divided into six chapters. Following the introduction, Chapter 2 provides an overview of the literature on children and tourism as well as mobile learning. It includes a section on the Android applications currently available for children as tourists. Chapter 2 also discusses Interaction Design, the approaches used in the research, as well as some more specific methods. Chapter 3 recounts the museum visit case study and Chapter 4 presents and discusses the results. Chapter 5 is broken down into three parts, presenting methods and discussing results for each of the separate design sessions; the first study discusses the first follow-up visit to the children's classroom, the second study recounts a designer workshop, and the third study tells of the second follow-up visit. Chapter 6 closes the project with a comprehensive final discussion, suggestions for future work, and a conclusion.

2 LITERATURE REVIEW

This chapter presents an overview of the literature on children and tourism as well as mobile learning. It includes a section on the Android applications currently available for children as tourists. This chapter also discusses approaches and methods from the field of interaction design that were utilized in this project.

2.1 CHILDREN AND TOURISM

The tourist experience began to be an area of study around fifty years ago. It is continuing to evolve through the application of technology. The tourist experience can be represented as a process divided through three phases defined as pre-trip, trip and post-trip (Stewart & Vogt, 1999; Cox et al., 2009). Pre-trip starts with anticipation, then planning and travel to a place. The trip is everything that happens between the travel to a place and the start of the return trip home. The post-trip includes the return back, and recollection of the experience.

Family tourism is an important source of income for many locations and travel agencies. The decision making power in a family on vacation is not always crystal clear. In fact, children can influence the behavior of tourist parties either through their physical needs or through their capability of negotiate (Thornton, 1997).

Tourism agencies have studied how to market most effectively to families, and which adults are the main decisions makers in planning vacations. However, there is very little research done on the family holiday that examines the experience as a whole.

In one pertinent work, Gram (2006) studied family tourism to find out what really makes a “good experience” and “good moments” (p.1). The good moments are perceived to be moments where all family members are content and happy. They contain no nagging or sulking, and happen in situations where the children are absorbed by activities, that are not necessarily with their parents (Gram 2006).

Understanding what makes for a good family tourist experience is pivotal to designing a successful application for children who so often travel with their families. Cullingford (1995) found that young children are an important factor in the choice of tourist destination at certain stages in the family life cycle. Their views of their experiences are significant, as they are future tourists, and as a potentially important influence on decisions made during a holiday.

A relevant study in the field was done by Hilbrecht et al. who analyzed school-age children's perspectives in family holidays from interviews of 24 children from 15 different families, where three main themes emerged (2008). The first was a focus on having fun as an important vacation goal. The second was that newness and familiarity, conveyed the importance of adventure however they had to happen in a secure and stable social environment. The third theme was the importance of social connections to which reaffirmed and strengthen relationships with family and friends. Hilbrecht (2008) found that children's experiences did not fit neatly into previously established family leisure models. This finding reinforces the importance of considering all family members' perspectives in future research.

To the best of my knowledge, there has been little to no research done on children and mobile tourism. This research project hopes to be one of the pioneering studies in this nascent field. An essential aspect of the project is to teach children things about the Trentino region. It is important to consider what we can learn from fields of children's learning and m-learning (learning facilitated by the use of a mobile device).

2.1.1 THE MOBILE TOURIST EXPERIENCE

Smart mobile devices are changing the face of the tourism industry. Wang et al. (2012) provides an interesting model (Figure 2.1) based on the work of O'Leary, et al., (2006) to understand how smartphones mediate the tourist experience. Wang et al.'s model is structured similarly to Stewart et al. and Cox et al.'s model described earlier; it contains an anticipatory phase (the preparation for the trip), an experiential phase (when the tourist has new experiences during the trip) and a reflective phase (after the end of the trip). The smartphone can change the organization of activities and the emotions that a tourist has during the holiday, and therefore influence the whole tourist experience. The smart-phone can also change the way of meeting social/functional information needs, and the perception of novelty and pleasure (Figure 2.1).

One example of a mobile tourism application is a multi-dimensional interactive city exploration edutainment game through mixed reality. It was created for adults by Herbst and colleagues (2008) using a head-worn optical see-through display and a GPS device. The system had a unique, interactive, non-linear time scale where users could choose to see images from more than one time period at any moment in the game; thereby learning about history of the city in an interactive way (Herbst et al., 2008).

In 2002, Hsi tested how adult users responded to a mobile web resource designed to improve and transform user experiences in a hands-on museum. Several recurring issues and themes emerged from the interviews, such as users' sense of isolation and how the device inspired motivation in new ways of thinking.

She also found a variety of visitor types, some preferring being directed versus discovering on their own.

Children have not yet been studied with regards to the mobile tourist experience. In seeking to expand this new topic, it is important to study research children and mobile use, which usually takes the form of mobile learning.

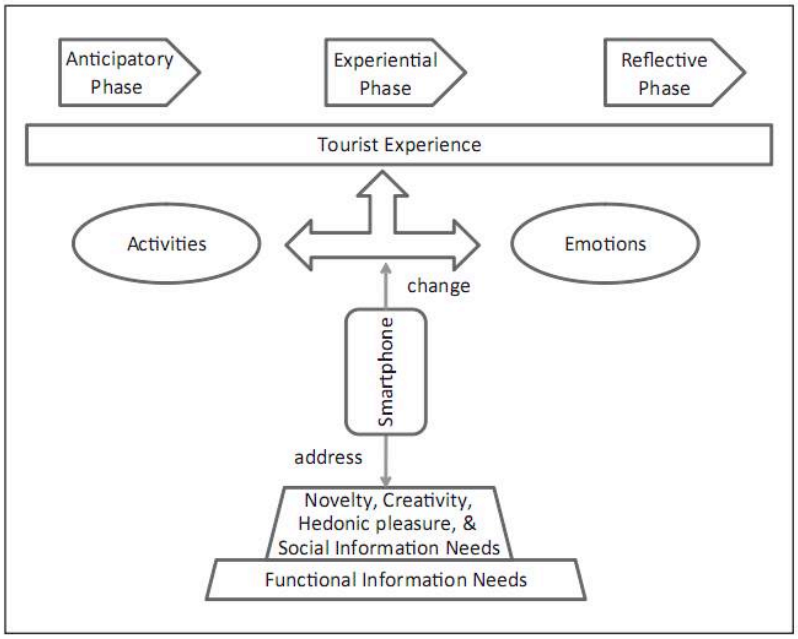


Figure 2.1: Mediation mechanisms of smartphones in the tourist experience (Wang et al., 2012; p.3).

2.2 CHILDREN AND MOBILE LEARNING

Mobile technology is transforming the way children learn in the 21st century. Every year, advances are made that embed technology ever more closely into our lives because of their low cost, accessibility, flexibility, and portability (Dede, 2004). These devices have the ability to influence how children interact with the world, each other, and even how they act in general.

Outside the classroom is a prime place to take advantage of mobile learning, and it's becoming ever easier through increased internet coverage. The novel processes of m-learning can be engaging and motivational. They can stimulate students to participate more actively in the activity at hand; facilitating social and cognitive processes (Rogers and Price, 2009). Mobile technology provides new ways of managing information and information flow while allowing ideas and knowledge of ongoing physical activities to be better integrated. It can help children by providing opportunities for making important connections (Rogers and Price 2009). It can allow children to not have to "hold back" from pursuing further thinking or inquiry until they have returned to the classroom. Bringing certain kinds of relevant information to the center of children's attention at critical moments, can allow them to reformulate inquiries (Rogers and Price, 2009).

Creating technology for children can be accomplished very well through the methods of interaction design. There are many challenges to doing it right. Rogers

and Price describe the three main challenges of mobile technology design for children:

1. Avoiding information overload

2. Preventing distraction from the ongoing physical activity

3. Constraining design to promote cooperative working and interaction between children

There have been quite a few scientific research projects which have looked at the topics of mobile learning, children, and specific activities outside of the classroom. Many have documented their findings and some have evaluated their methods compared to more traditional ones. All of these projects are aimed at increasing knowledge.

2.2.1 STATE OF THE ART

The following projects are some examples of the state-of-the-art in mobile technology design for children. Many of the projects focus on m-learning (learning using a mobile device) as one of the main goals.

The Ambient Wood project is a prime example of students integrating different kinds of information together and learning through mobile technology while on a field-trip. In 2003, Randell and colleagues designed a hands-on outing to a forest where 10-year-old children worked in pairs and interacted through the mobile devices with a real adult that asked them thought-provoking questions at appropriate moments. They could also measure certain elements and make predictions about the various trees' and plants' current and future growing conditions. The children enjoyed this new approach and remained engaged during the entire duration of field trip.

A similar idea was created by Ardito and colleagues in 2009; an m-learning game called Explore! which is scalable and applicable to archeological parks. This m-learning system implements an excursion-game technique to help middle school students (ages 11 through 13) acquire historic knowledge while playing the game in an archaeological park. The system was tested with children and had positive results in engagement in the physical activity compared with a paper prototype. The project saw increased collaboration within the small groups (four children each) but low interaction between groups of children.

Anderson et al. (2002) studied the nature of young children's learning through museum experiences. They found that museum-based exhibits, play, and story, provide greater impact and meaning than exhibits and experiences which are decontextualized in nature.

Zydeco is a mobile system that increased interest in scientific inquiry outside the classroom (compared to paper worksheets). It was developed to support nomadic inquiry of middle-school students by enabling the collection and annotation of multimodal data (photographs and audio notes) (Cahill et al., 2012). In comparing the behaviors of the students using Zydeco with those of students using paper worksheets while performing inquiry in the museum, they found that the Zydeco

system “increased active sociocultural engagement but both the worksheets and the system engendered heads-down behavior”. They also found that students using the Zydeco program spent an average of 25 seconds longer at each exhibit than students using paper worksheets.

Nousiainen and colleagues (2012) presented a participatory workshop on a game-like mobile tool to support children aged 9-10 on zoo visits. They held a participatory design workshop for the children, allowing the children to use many means of expression (writings, drawings, comic strips). They analyzed the methods for consistency and creativity and found that one method was not more productive than another. This study stressed allowing children to express themselves in the way that comes most naturally to them.

Here I have discussed a few recent research studies in the field. Next I will mention the available tourist applications designed for children.

2.2.2 AVAILABLE APPLICATIONS

I searched for applications on the Google Play Store (the application market for the Android operating system) in English. There were only two tourism applications designed for children to use on their own.

Figure 3.1 Washington DC Guide…For Kids! (5 images from Google Play Store)

The first application is based on tourism applications for adults and is called “Washington DC Guide…For Kids!” The application is one of a series made by GoTrexx, Inc., which makes similar applications (with the same interface) for four other cities in the United States. It has had 100-500 downloads. It can be found in the Travel & Local category. It has three sections (Figure 3.1, first image): “Places to see” describes points of interest in the area (Figure 3.1, second image) “Fun facts,” is a list of interesting facts about the geographical area (Figure 3.1, third image), and “Postcards” a fun way to integrate your photos into Washington DC (Figure 3.1, fourth and fifth images)

The other application was structured as a treasure hunt which also sends you GPS-located push notifications in order to explore some monuments (Figure 3.2). The application claims to also involve augmented reality, itineraries, personalization with your own pictures, comics, revealing vanished monuments, postcard from virtual to real. It is called “Brad in Paris” and is also one of a series. Its developer is Monument Tracker and has such an application for five cities in Europe and the United States. This application has also had 100-500 downloads.

The design of mobile applications like these can come about in many different ways. A popular approach is to apply the methodologies of the field of interaction design.

Figure 3.2 “Brad in Paris” application, sample screens

2.3 INTERACTION DESIGN

User-experience design (UXD), is a field that almost completely encompasses that of interaction design (Figure 2.2). It focuses on creating and shaping an experience through a device (Hassenzahl, 2011). UXD evaluates designs in terms of usability and affective influence.

Lowgren (2008) defined interaction design (IxD) as being “about shaping digital things for people’s use” (p.1). It is an inter-disciplinary field, and overlaps with that of human-computer interaction (HCI) and many other fields (Figure 2.2). IxD has an interest in form but its main focus is on behavior (Saffer, 2010). This field is heavily concentrated on satisfying the needs and desires of the majority of people who will use the product. One must truly understand the goals of a user (both personal and objective) in order to solve the problem in the best way possible. Creating digital things for people to use can be done by developing an idea while sitting at a desk the whole time, or by putting oneself in the shoes (and the environment) of your potential end-users. The latter is called user-centered design (UCD) and can be implemented through various techniques including ones which directly involve the user. Techniques utilized to identify the motivations, needs, and behavior of end users are called user research and vary from participatory design to ethnographic observation and user evaluation.

2.3.1 METHODS

- PARTICIPATORY DESIGN

We can learn a lot about what our users like, expect, and want through participatory design. Participatory design is a technique used in user-centered design which attempts to actively involve end users in the design process. Once called cooperative design, it is an iterative design process that attempts to distill user needs through focus groups, brainstorming sessions, and frequent end-user review

(Kuniavsky, 2003). Its strength is that it will create solid solutions to the functional needs of users while its main weakness is that users who participate might start to think like the designers; in addition, the users are sometimes not representative of the real user population (Kuniavsky, 2003). These methods developed have not changed drastically in many years and are quite accepted by the interaction design community; however, they have been developed primarily for working with adults and need to be adjusted for being effective children.

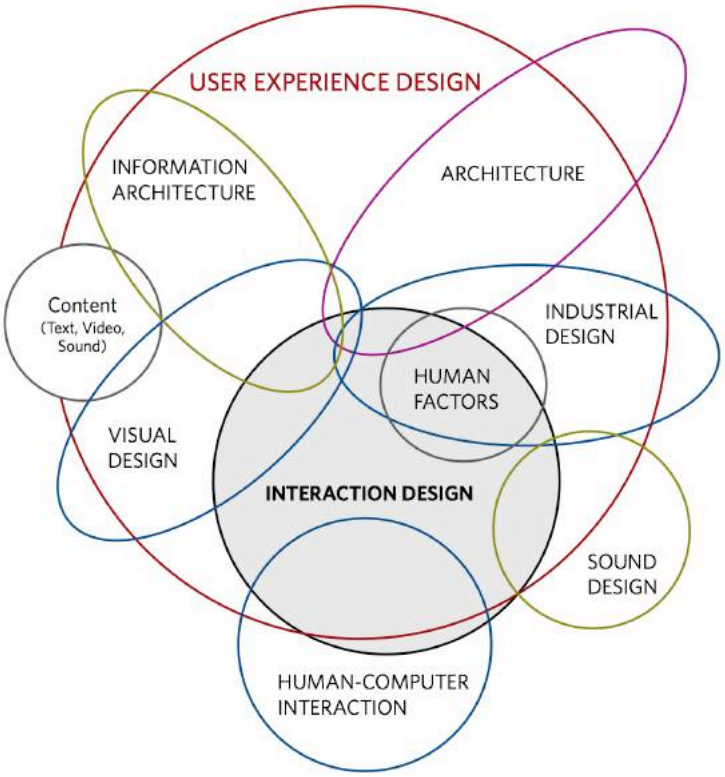


Figure 2.2: Interaction design is an inter-disciplinary field (from Saffer, 2010).

- PARTICIPATORY DESIGN WITH CHILDREN

In order to create successful technologies, we need to know our user. In 1977, R. Berman said “As obvious as this may seem, we as designers of new technologies for children, sometimes forget that young people are not ‘just short adults’ but an entirely different user population with their own culture, norms, and complexities” (as quoted in Druin, 2002, p.1). Children are different from adults in many ways; Piaget explained that it is more difficult for young children to verbalize a thought, especially when it concerns abstract concepts and actions (Piaget, 1971; Piaget, 1973). In a fundamental work on the topic, Druin (2002) provides guidelines for adapting participatory design techniques to working with children. The roles are used by researchers to try to understand the influence that existing technologies have on child users, so that new technologies can be made, older ones changed, or future educational environments improved (Druin, 2002). These roles do not necessarily differ from those of adult users but the methods, context, and challenges of involving

children can be different (Druin, 2002). Each of the roles have clear differences; however, each role includes aspects of those roles that historically have come before it (Figure 2.2). The first role identified is called the *user*; here adults observe while children use technology . A child can also test technology prototypes in the role of *tester* (Druin, 2002). When researchers ask children for their opinions, children are *informants*; this can happen at any stage of the development process (Druin, 2002). In the fourth role, children are equal stakeholders in the design process as *design partners* for the whole experience (Druin, 2002). As mentioned previously, each role includes aspects of the roles that come before it; for example, in the role of informant, children may be asked to test certain prototypes (as a tester), as well as be observed with competing software (as a user) (Druin, 2002).

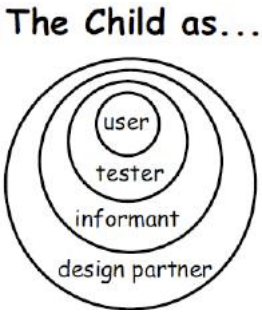


Figure 2.2: The four roles children might have in the design process for new technologies
(from Druin 2002)

One important consideration of working with children is that much of what they say needs to be interpreted within the context of concrete experiences (Druin, 1999). This interpretation can depend somewhat on the method(s) used in the study.

There are many different tools used in participatory design, such as semi-structured interviews, focus groups, brainstorming sessions, design workshops, and user testing; these are all techniques that we used during the follow-up visits.

-ETHNOGRAPHIC OBSERVATION

Ethnographic observation is a standard technique for data collection in the early stages of designing technology for a specific target audience (Cooper 2007). It can help one understand their user's needs and desires as well as to make sense of the typical behaviors of individuals and interactions within groups. While conducting an ethnographic study, researchers can be simple observers or an active participants of the event, but cannot attempt to change the happenings around them.

Once the ethnographic study was completed, and the children had captured much media, I analyzed the photographs that the children took using the thematic analysis method of qualitative analysis.

- THEMATIC ANALYSIS

The most common form of analysis in qualitative research is thematic analysis (Guest, 2012). This approach focuses on inspecting and recording patterns within data. The patterns across data sets are also known as "themes," are important to the description of a phenomenon, and are associated to a specific research question (Daly et al, 1997). Most researchers consider thematic analysis to be a useful method in capturing the intricacies of meaning within a data set (Guest, 2012).

Thematic analysis is designed to construct theories that are grounded in the

data themselves (Charmaz, 2006). According to Braun & Clarke (2006), this process of data analysis can occur in two main ways—inductively (also known as bottom-up) or deductively (also called theoretical, or top-down). Using the inductive approach implies that assumptions are data-driven --one does not try to fit the data into a pre-existing model or frame during coding. This is a merit because it allows one to be less subjective in their expectations, seeing more possible interpretations of the data but is also a defect because a researcher can never completely free themselves of their theoretical commitments. The deductive approach, on the other hand, is driven by the researcher's interest in the area. It begins with some hypothesis about the data and tests for fit. It can provide a more detailed analysis of certain aspects of the data but may miss some big ideas if they had not been previously thought of. Regardless of the approach taken, the analytic process should involve a progression that goes from description, (organizing the data in order to show patterns, as well as summarizing) to interpretation, where there is an explicit attempt to theorize the significance of the patterns along with their broader meanings and implications (Patton, 1990 as cited in Braun & Clarke, 2006).

The thematic analysis process individuates important patterns in the data by coding and interpreting the codes. The coding process is divided into six phases: familiarization with data, generating initial codes, searching for themes among codes, reviewing themes, defining and naming themes, and producing the final report.

It is also possible to combine the two different methods into a hybrid approach. The merits of using a hybrid approach are that one gets the best of both worlds; an in-depth analysis of certain data-driven assumptions.

This was some background information on two interaction design methodologies, next I will talk about a user evaluation technique called storyboard.

- STORYBOARDS

Storyboards are used for user evaluations to present and describe interactive events in a written and visual form. This is a great method to use with children for user testing because storyboards and other formats are so similar to comic strips and are structurally familiar to children (Hall et al., 2004). Storyboards also allow a relatively simple representation of temporal and spatial elements, which is helpful in presenting ideas to children (Hart, 1997).

In addition to the methodology used in design, it is important to consider the context within which an application is designed.

2.4 CONCLUSION

The projects we have cited so far do a good job of addressing the aforementioned issues, but none of them attends to the particularities of our work: the unique combination of children, mobile application design, m-learning, and tourism. Despite the many experiments and studies mentioned above, there is still a lot of room for understanding how to better explore the link between children and tourism. Several of the above studies suffer from a positivistic perspective where they expect the technology to help; however, this should not be taken for granted. Additional user

studies and further investigation into the reality of the situation are needed to better understand the link between tourism and children. A child could potentially spend much time “traveling” if one includes school field trips in addition to family vacations. The child has been mostly neglected as an important decision maker on family holidays. Studying the connection between tourism and children can help in understanding how to enhance children’s tourist experiences, possibly allowing all members of the family who brings their children on vacation a more pleasant experience.

Various methodologies may be applied in studying this field. I have explained some of them in this chapter. Next I will describe how these methods were used in the museum visit case study that was conducted as the first part of the research.

3 MUSEUM VISIT CASE STUDY

This chapter explains the methodology used while accompanying the children on the field trip.

By going with the children on a visit to the Casa Depero Museum and introducing a smartphone application prototype into the equation, I hoped to gain some insight into the first main question: “How do children respond to a mobile application prototype designed for capturing their experiences on a school trip to a museum?” Therefore, I structured the goals of the trip to Casa Depero Museum while using LifeLog as specific questions:

1.Does the application distract the children from the physical surroundings? That is, do the children pay minimal attention to the artwork and other aspects of the museum?

2.Was there any appropriation of the device? That is, did the children make the application or device their own through physical or virtual means?

3.Does our application cause isolation? That is, do the children interact with each other minimally and pay more attention to their smartphone?

4.What kinds of things interest children the most on a trip like this?

5.What are the needs of 9-10 year-old children in the functionality of mobile applications? That is, are they able to use the application as it was intended to be used?

3.1 PARTICIPANTS

We conducted a case study with the IV B class of the Elementary School R. Sanzio (Trento, Italy). The children were between nine and ten years of age, and there were also two adult teachers who also participated in the experience. Of the 19 children in the class, there were 11 boys, 8 girls. Everyone in the class speaks both English and Italian; the class follows a bilingual teaching system, spending 20 hours a week being taught in English and 10 hours per week in Italian. We decided to work with this particular class for three reasons: they are a bilingual group (the application prototype was in English), we had a indirect connection with the teachers (through one of the members of the project), and because of their age. Children at this age make some of the most effective prototyping partners because of their self-reflective and verbal skills are developed enough to discuss their thoughts (Druin et al., 1999). Children aged 7-10 can understand abstract ideas like that of designing something with low-tech prototyping tools which will later be turned into a technology; and at the same time, these children are not too heavily burdened with pre-conceived notions of the way things "are supposed to be"; often seen in children older than 10 (Druin et al., 1999).

3.2 MATERIALS

The smartphone application prototype that was used in the case study was called LifeLog. It was designed and created for the SmartCampus project; another research project at the University of Trento. LifeLog had originally been made for university students to connect with each other by sharing contents inside the application. A version of the application has been released to 200-300 University of Trento students but has not yet been integrated into the university's social network. In addition, LifeLog, as intended for university students, is still in the initial stages of development, so it did not have many complicated features.

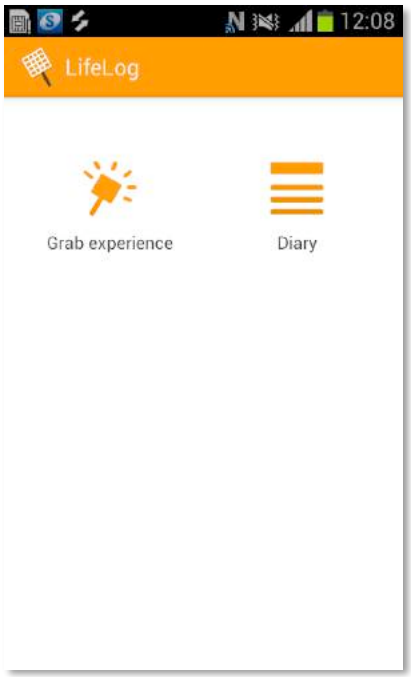
The LifeLog application does not automatically capture photos. Instead, it is more similar to a smartphone diary application allowing one to record their experiences through different multimedia and add text. The multimedia are organized into so called "diary entries."

This diary-like tool was ideal because, when used for travel, it became a way to record one's adventure and the unique way that one experienced it. The entirety of the diary entries could be considered a story. The parts of the experience that are captured, as well as those that are left out, create a story that can be reviewed --or retold-- after the adventure has ended.

We needed to simplify it for the appropriate age-level of the children who we wanted to use it with. With the interface already being clean and simple, my main goal was to simply get rid of all functions that were not strictly necessary.

I requested the developers to make certain changes to simplify the application. The following changes were made:

- We removed options to organize diary entries into folders and to search by entry title to simplify the interface.



-We removed options to add photos and videos from the gallery as well as places near the user to simplify the interface.

-We moved the “Done” button (which signals to the program to save the entry) to the bottom of the diary entry to make sure the children would not miss it. We removed the obligation to give a text title to every entry; to speed up the diary entry making process.

-We asked that a bug which caused information loss when the back button was pressed before the save button be fixed. Instead, the user was prompted with an “are you sure you want to leave this screen?” pop-up message.

Figure 3.1: Home page of the LifeLog application prototype

- We removed the menu inside the application. It was mostly for organizing diary entries, and since we would be testing the app only for a few hours, this would be an unnecessary complication for the children.

- We asked the Diary be organized by hour instead of by day. This would suit our short trip better and allow the children to browse their diary easier.

The resulting interface was clean and simple (Figure 3.1 and 3.2). I used the same name for this new prototype: LifeLog.

We had access to two different Android smartphones that we could give to the students, so we tested them with one student from the class for one hour in order to decide which phone to use. The child found that the smaller Sony Xperia U was easier to hold and fit into pockets nicely. However, he preferred the Samsung Galaxy SII overall because of its larger screen, larger keypad for typing, and general visual appeal. Since the trip would be relatively short, we decided that the ease-of-use of the keypad and the larger screen were the most important factors so we chose to use the Samsung Galaxy SII. It ran the most recent Android operating system at the time --Android 4.0. Two of my fellow researchers and I pre-installed the LifeLog application onto each smartphone so they were ready for the children to use.

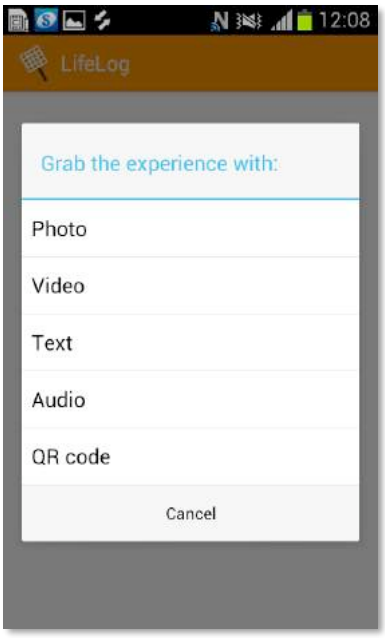


Figure 3.2: LifeLog prototype’s menu for “grabbing an experience”

To use LifeLog, one starts at the main menu (Figure 3.2) and chooses one of the ways to grab (capture) the experience. Once the experience is grabbed, they can add a text title or text description using the keyboard input if they so desire. There is a menu button with the image of a plus sign that allows one to add media to the entry and brings one back to the main menu (Figure 3.2) and the new media you record is added. To complete the entry, one needs to press the “done” button, loacted below all the media recorded inside the entry.

We did not want the children to get distracted by other capabilities of the smartphones. To keep the children from accessing other applications and protect them from possibly finding inappropriate content on the internet, we carefully researched the best free parental protection program. We finally chose an application called Kid’s Place which allows only chosen applications to function on the phone when Kid’s Place was active. The security is ensured by a special pin chosen by the adult and the children cannot not exit the application without it. In addition, Kid’s Place retains its settings even if the phone is restarted. We assigned each phone to a child and pre-labeled them with the children’s names so as to be able to track the phones throughout the duration of the project.

The researchers used pen and paper to take notes as well as a DSLR camera to document the trip.

To analyze the photographs that the children took, I used a qualitative analysis program called NVIVO, version 10.

3.3 PROCEDURE

We accompanied a class of 19 children during a visit to the Casa Depero Museum in Rovereto, TN on March 21, 2013. Before the trip, we presented a written project proposal and received permission from the school teachers and headmaster to run the case study with the class. We also got special permission from the offices of the fine art museum *Museo di arte moderna e contemporanea di Trento e Rovereto* (Museum of modern and contemporary Art of Rovereto and Trento -MaRT) to allow the group to take photos and videos inside the museum since visitors are usually not allowed to photograph or video tape on the premises.

The trip began in the bus station in Trento, Italy. There were five student researchers from Professor Antonella De Angeli’s HCI group including myself, along with our professor, Dr. Antonella De Angeli; all fluent in both Italian and English. We met the teachers and the students and started handing out the phones.

The trip involved taking a bus from Trento to Rovereto (about an hour), walking to the museum (20 minutes), the visit inside the museum (1 hour 30 minutes), lunch in the museum courtyard (30 minutes), the walk back to the bus station (20 minutes), and the bus ride back (1 hour). All together, we were with the kids from 8:00 a.m. until 1:30 p.m..

On the bus ride to the museum, I explained to the children that we wanted them to help us test a new way of experiencing a trip to a museum. I used the metaphor of the cellular phone being an intelligent photo camera where you could write things and record audio and video too. Then I explained in detail how to use the application to create diary entries by going through an example and having the children follow. I explained that to use LifeLog, one needs to:

Go to the main menu and choose the way they want to capture the experience, for example; one can take a picture outside of the bus window. Then add a title and description using the keyboard input if desired. To add media to the entry, click the menu button with the image of a plus sign and once you're back to the main menu, choose one and then record a movie or video media which will be added to the entry. To finish, press the "done" button, which can be found below all the media you recorded.

I purposefully did not explain how to delete an entry because I wanted a complete record of the photographs they took and other media they recorded.

From informal inquiry done on the bus, I found that 17 of the 19 children had used a parents' or a relatives' smartphone in the past.

During the trip to the museum, the children understood how to use LifeLog on the Samsung Galaxy SII. The length of the bus trip allowed plenty of time for the kids to get familiar with the process of recording diary entries and somewhat reduced the "wow factor" --the novelty-- of the devices. The children actively took photos, recorded other media, and even wrote text notes in the diary entries while on the bus and on the walk from the bus stop to the museum.

At the museum they were greeted by an Italian guide. Many audio-recoded the explanatory welcome speech and all children took photos as the guide started walking them through the museum. On their tour they stopped two times in different rooms to do short art projects on the floor with the guide. While working on the art projects, the children did not use the phones for the most part (other than audio recording the guide's instructions), but many of them did take photos of their finished work. They took many photos of each other and the museum art as well.

Before going back to the bus stop, the group stopped in the museum's courtyard while the children ate their sack lunches.

Afterwards, the teachers shared their impressions about the trip with us. We also asked the class some questions on the bus ride back to the entire group as a whole:

-Did you like the experience overall?
-Did anyone not like it?
-Was the application easy to use?
-What else would you have liked the application to do?

4 CASE STUDY RESULTS

4.1 DATA ANALYSIS

After the case study, I got together with the other researchers and our professor to review notes and discuss our major observations. The five of us compared our notes and all the results reported below were confirmed by at least a majority of the researchers, if not the entire group. After that, one of the researchers and I downloaded all of the data to our computers and then I tagged all the photos that the children took to see what major themes would emerge.

The children created 11 GB of content, broken up into 1126 media and text files. Of these files, 615 were photographs. I did not include the teachers' data in the analysis. For the purposes of this project, I analyzed all the children's photographs using thematic analysis. All names of study participants reported in this work have been changed to protect identities.

Of the 615 total photos taken, each child took an average of 32 photos (with standard deviation of 14, median 30, and range between 14 and 56). Six photos were extremely blurry or so close-up that the subject was impossible to individuate. I disregarded these photos in my calculations.

In organizing the photos to find patterns (one of the initial stages of coding), I started by generating tagging all objects and people in the photos which fell into the following general category: Photo Content (Artwork, Surroundings, People) (Figure 4.1). I also initially tagged Miscellaneous Photo Attributes (Blurry, Duplicate, and Subject and Place Unclear) but they ended up not being useful to the final analysis. In later iterations of the thematic analysis process, I added the Activity Being Done (by people in the photo) to the Photo Content section. In further iteration, I added a new set of codes that coded the phase of the trip during which the photo was taken, which included photos taken during Travel To Destination, At Destination, and during Travel From Destination (Figure 4.2).

Asking *why* the children were photographing what they were photographing during the coding process helped the data-driven themes start forming. The top-down process of looking for themes related to the challenges of mobile technology design for children (Rogers & Price, 2009) helped create new codes and calculate the occurrences of Extrinsically-Motivated photos, Spontaneous Photos, Isolation (Individual Smartphone Usage), and Participation (Figure 4.5).

Code			Photo sources	Photo References
Art			320	347
	Inside Museum		312	339
		Children's Collective Artwork	27	27
		Child's Own Artwork	43	43
		Depero	247	268
	Outside of Museum		8	8
		Cartoon outside museum	2	2
		Graffiti	4	4
		Statue	2	2
People			223	301
	Activity being done		45	59
		App Usage - Individual	31	32
		Child Reading	2	2
		Child Taking notes	1	1
		Creating Artwork	4	4
		Helping	3	3
		Participating in guided visit	11	11
		Sharing Content	6	6
	Adults		75	79
	Children		151	163
Surroundings			131	141
	Architecture		24	25
	Landscape (Natural)		32	32
	Meal time		5	5
	Miscellaneous Object		31	32
	Monument		18	18
	Shopping and Services		13	13
	Sign - Informational		16	16
Extrinsically Driven Focus			168	170

Figure 4.1 - A breakdown of the Photo Content codes for the photographs the children took during the entire trip. “Code” refers to the code’s name. “Photo sources” refers to the number of photos which had a tag in this code category. “Photo references” refers to the number of times this code was present (more than one code can be present in a single photograph). Every category inherits the count of the sources and references of its sub-categories.

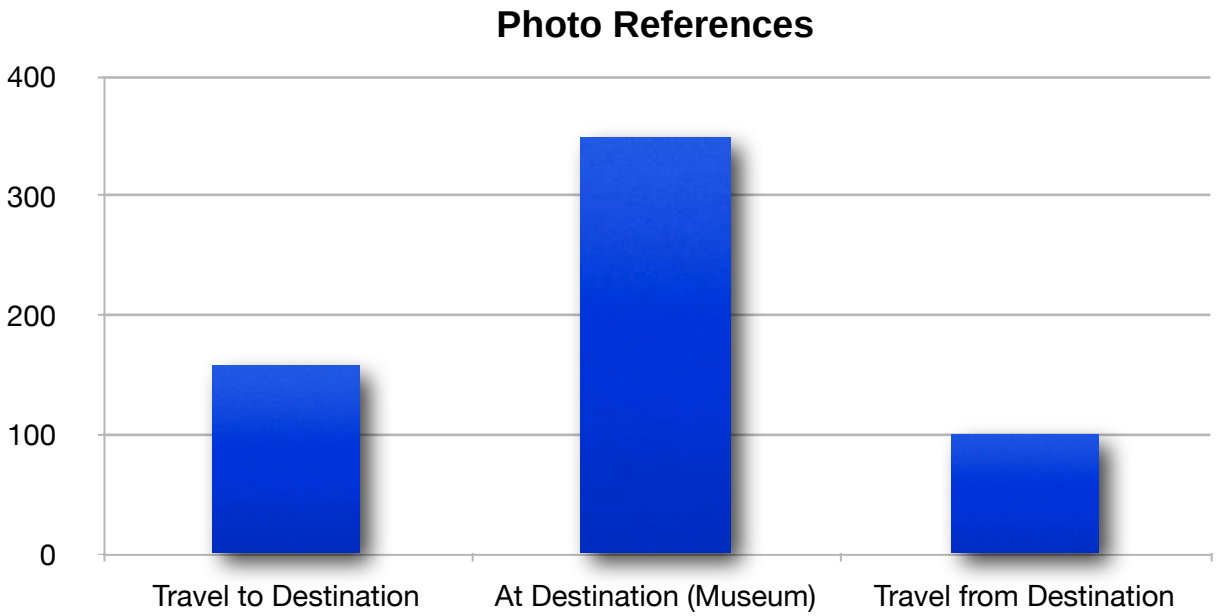


Figure 4.2: Time-course breakdown for number photos taken on the trip by all 19 children. Each of these three phases of the trip took about the same amount of time, approximately 90 minutes.

4.2 THEMATIC ANALYSIS

Qualitative analysis is the approach I took to in order analyze the photographs the children created. I used thematic analysis methodologies, incorporating both a bottom-up (inductive) approach as well as a top-down (deductive) approach. I utilized the challenges of designing mobile technology for children described by Rogers and Price (2009) as general themes with which to start analyzing the data used.

Since the children were blind to our hypothesis they likely photographed things only because they considered them interesting and worth photographing. Therefore, I assumed that the subjects of the children's photos were the focus of their attention and interest.

The major themes that emerged from the data through thematic analysis were engagement, socialization, and the rivalry between extrinsically-directed and intrinsically-directed attention.

✺ ENGAGEMENT

Introducing a smartphone application prototype to a museum field trip for 9-10 year-olds while not drawing too much attention away form the museum might seem like a difficult endeavor. However, the level of the children's engagement inside the museum was high. We observed many children paying close attention to the museum guide (as in Figure 4.3). The majority (77%) of the photos that they took inside the museum were related to the exhibition: either Depero's artwork or

photographs about his history; and an additional 7% were of their surroundings inside the museum (gift shop items, signs, the architecture of the structure, etc) (Figure 4.4). Only 17% of photos were of people (classmates, teachers or researchers). There was also a negligible amount of photos of other visitors (1 out of the 351 photos taken inside the museum) and the visitors were not clearly the focus of the photographs (some popular toys were in the background).

Figure 4.3: Andrea listening to the tour guide after setting his phone to audio-record her speech.

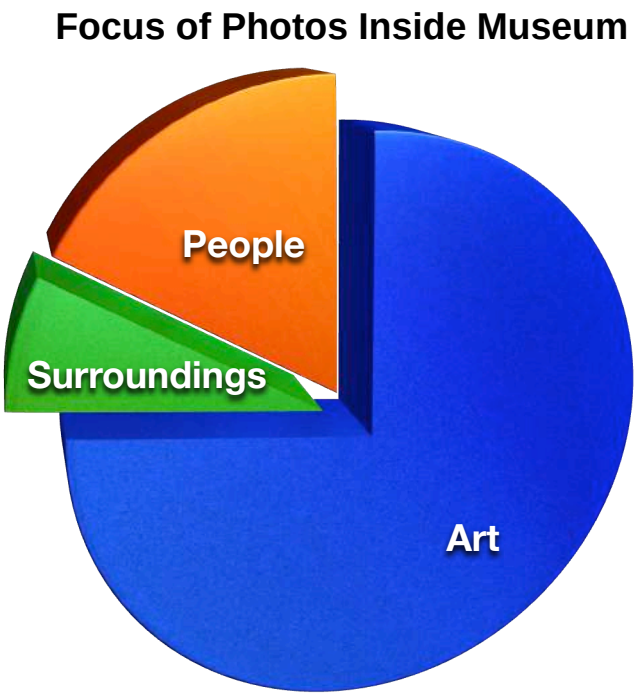


Figure 4.4: Focus of Photos Inside Museum

SOCIALIZATION

According to our observations, the principal activity during the trip was using the mobiles to document the visit. Forty-five percent of the total photos the children took were of others using the prototype (as in Figure 4.9, and Figure 4.5). Which either means they were trying to take photos of another child and the child was busy with the application, or they were attempting to capture the particular action of interacting

with the smartphone. This implies that the kids were particularly interested in taking photos of their classmates, and possibly in taking photos of their classmates using a smartphone.

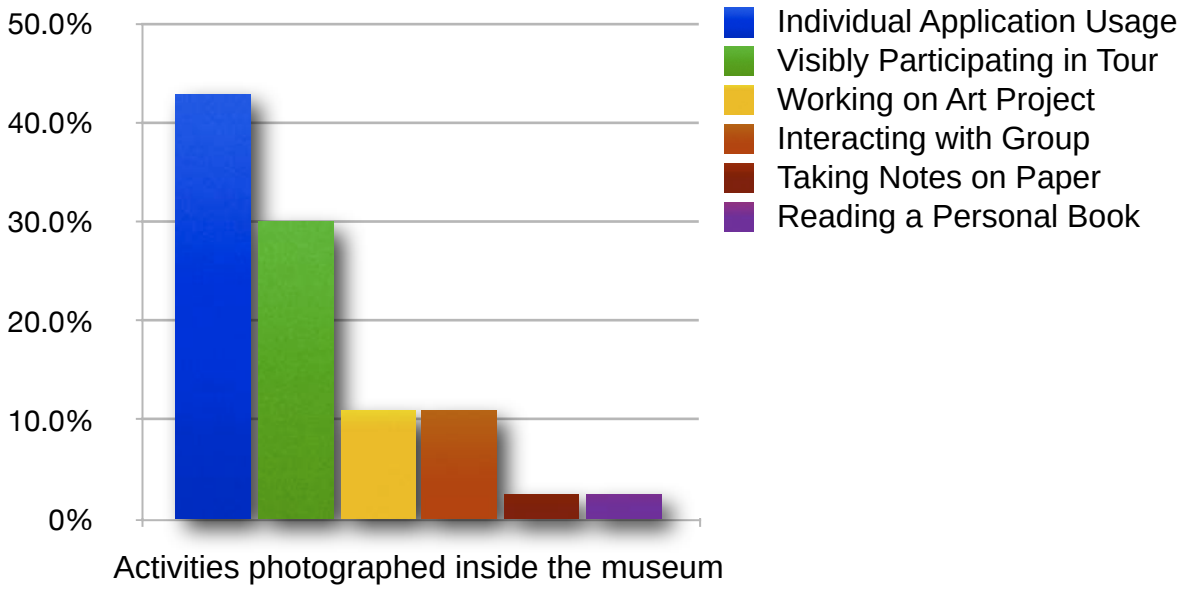


Figure 4.5 Activities photographed inside the museum by percentage. The photos of the group inside the museum can be broken down by the activities they were doing. “Individual Application Usage” was coded as present when there are children in the photo looking down at their device and not visibly socializing with others.

The photos of the group inside the museum can be broken down by the activities that the subjects in the photo were doing. From Figure 4.5 we can see that children were engaged in the what the museum guide was saying. In fact, in almost 30% of the photos taken, the children were paying attention or participating in the tour. In addition, almost 11% of the photos that the children took of each other were of them interacting with other children (as in Figure 4.6). About 3% of the photos were of children taking notes on a pad of paper or looking through a personal comic book during lunch time.

The children even found a way to use the devices to play. They utilied the devices to host a radio show (see Section 4.2, “Appropriation”). In addition, quite a few photos were of children engaging in what might be called a “photo war” where two children take pictures of each other at the same time. We can consider one child as reacting to another who starts to take their photo.

Figure 4.6: Carlo, Elena, and Chiara reviewing or using LifeLog in the museum together

✺ *EXTRINSICALLY-MOTIVATED ATTENTION*

Thirty-four percent of the all photos taken inside the museum were of objects that the guide had pointed out. I called this type of photo with the new term: *extrinsically-motivated*. These are photos of objects towards which the children's attention had been purposefully directed by an outside source; in this case it was the tour guide, and sometimes the teachers (as in Figure 4.7). This implies that their attention was also extrinsically directed in these moments. Outside the museum, the rate was 19%. This suggests that their attention was guided at moments by the same adults.

Figure 4.7: Taking photos of a work described by the tour guide

✺ *INTRINSICALLY-MOTIVATED ATTENTION*

The other type of photo taken by the children in the museum was what I termed *intrinsically-motivated,* or the *spontaneous* photo --66% in the museum. Here children photographed things that attracted their attention, regardless of adult direction or approval (Figure 4.8). This suggests that their attention was intrinsically-motivated at these times. An interesting occurrence that we did not anticipate was that many children took photos of the same *spontaneous* objects; even though their attention was not explicitly directed there by anyone official or older.

Figure 4.8: An artwork near the gift shop. Photographed by five children

Figure 4.9: Stefano using LifeLog on his own

4.3 DISCUSSION

The reason for conducting user research through a case study was to see whether there was potential for a children's tourism application. The observations from the ethnographic study confirmed the data from the thematic analysis. Both the thematic analysis and the ethnographic observations were successful in providing insight into the questions this project asked.

- DISTRACTION FROM PHYSICAL SURROUNDINGS

In the first question of the case study goals, I wondered whether LifeLog might distract the students from the physical surroundings of the city, museum, and artwork. On the contrary, we found that children paid attention to the actual artwork. Our observation notes pointed towards the children having been engaged in the tour-guide's speeches (as in Figure 4.10, and Figure 4.5) and interested in the museum surroundings in general. The fact that the children took many extrinsically-motivated photos shows that the children were interested in what the guide was telling them. They were responding to direction. This shows that it is possible for children's attention to be directed a context similar to this one.

- APPROPRIATION

The second question asked if the children would appropriate LifeLog as uniquely theirs. In addition to the appropriation that one would expect from a diary-like application, there was a particularly fascinating and novel example of appropriation during the trip. The children used the audio recording functionality to host a personal radio program. For example, one child interviewed one of her teachers while on the bus to the museum:

Figure 4.10: The tour guide talking to the children

Alessandra: “This is *Radio Alessandra*, and here today we have Teacher Sam! Tell us something, Teacher Sam!”

Alessandra holds the smartphone/microphone up to Teacher Sam to speak into.

Soon everyone was hosting their own radio show and interviewing their classmates. Children also expressed interest in running their radio programs together with others and spent time searching for co-hosts among their classmates on the bus.

The fact that the children did not simply interview each other or record personal voice notes but became hosts of their invented radio stations points to a high degree of appropriation. The children appropriated the phone and the application by making it uniquely theirs.

- ADDRESSING ISOLATION

Before the trip started, we asked ourselves whether introducing the LifeLog application prototype on a visit to a museum would cause isolation in the children; most likely expressed by decreased interaction with fellow classmates and teachers. We observed them sharing their photos and videos with one another (Figure 4.11) and one could frequently catch them playfully photographing one another as the one photographed the other. From the data we saw that the children spent about 45% of their time taking photos of their classmates where their classmates were using the device without interaction with others (Figure 4.5). However, a majority of the photos (55%) included some socialization with others, with children visibly participating in the guided tour, making art, taking notes, or reading a personal comic book together with friends. Inside the museum, 84% of the photos taken were of the exhibit or the surroundings inside the museum (architecture, gift shop, courtyard, etc.) (Figure 4.2). In addition, through the personalized radio show, the children appropriated the devices and created a completely new and unexpected way of interacting and playing with others.

There were many spontaneous photos taken (66% of the photos inside the museum, 81% outside the museum) but not all seemingly individual usage happened in a vacuum. We observed that the children’s attention was often directed by the other students. Children closely watched each other and took photos of the same “spontaneous” items; basically copying each other.

The conversations we heard among the children often centered around the new devices (as in Figure 4.12).

Figure 4.11 - Maria and Massimo interacting while using LifeLog.

- CHILDREN'S INTERESTS ON A TRIP

In seeking to discover more about children's general interests on a trip, I analyzed the how many photos were taken on the different phases of the trip. There were 351 photos taken inside the museum (57%), 158 on travel to the destination (26%), and 100 during travel from the destination, (16%) (Figure 4.2). Inside the museum the children were interested in what the tour guide had to say and the art she pointed out. Thirty-four percent of the photographs inside the museum were of artwork that the guide had directly mentioned. The most popular work, a huge colorful tapestry, was photographed by 16 different children.

Figure 4.12: Maria, Rosa, Chiara, and Elena interacting in a group while using LifeLog

- TIME-COURSE BREAKDOWN

Children took the most pictures at the museum; these photos were of art, their classmates, the teachers, and their own artwork. Children took fewer photos while traveling to the destination, and yet fewer ones on the return trip. Each of these three phases took the same amount of time, about 90 minutes.

The differences in the quantity of photos is consistent with the theory of tourism which breaks the tourist experience into three stages: anticipatory, experiential, and reflective (Wang et al., 2012).

In our study we can see that the children were excited to begin the trip and took many photos during their transportation to the museum. The elevated number of photos in this phase might also be related to the "wow factor" of the smartphones; the fact that they had just received the smartphones might have made the children more excited about and willing to take photos.

The high number of snapshots taken at the destination is consistent with the general idea that the location goal of the trip is also where people want to record the most memories.

The lowest number of photos was taken on the way back from the museum. This moment during the trip can be considered the reflective phase of mobile tourism. In fact, we noticed that many children spent some time on the bus trip back looking at the photos and media they had created. We also observed that the children most actively used the voice recoding functionality on the trip home; interviewing each other and the researchers about

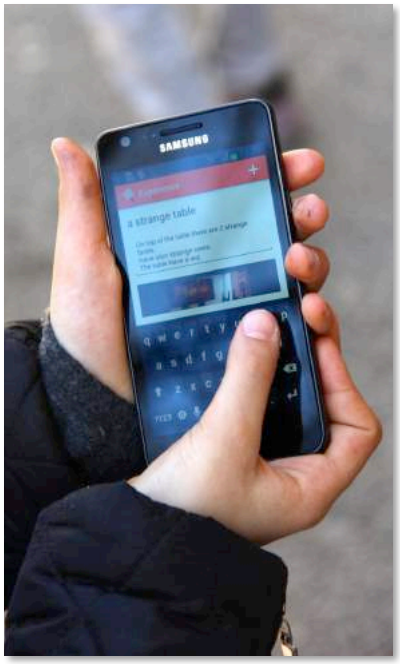
Figure 4.13: Maria, Lisa, and Roberto "hosting" a researcher on their radio shows on the way back

things unrelated to the trip (Figure 4.13). It can be inferred from the time-course breakdown that the movement from being interested in everything in one's surroundings (during the anticipatory phase / travel to the destination) turns into to wanting to socialize and play (during the reflective phase / travel from the destination) which is characterized by the drop in photographs taken on the trip home.

-MOBILE FUNCTIONALITY NEEDS

The children were able to navigate the smartphones and used the application in the way we had planned for them to use it. They used it to record things; they recorded the art exhibit, their surroundings, the art they created, and even took photos of the class' collective artwork. The children used all available functionality of the application, even text (Figure 4.14) and audio-recording. They understood how to make new diary entries and save memories.

There was one smartphone which had problems. We believe it was the phone rather than LifeLog because it was extremely hot to the touch. Shortly after leaving the museum the child discovered that all of his memories were no longer there. This was quite traumatic for him. An analysis of the application on the phone showed that it was working regularly at times, so we were not able to understand exactly what caused the problem.



The children had a problem understanding that elements had to be separated into different diary entries, otherwise everything would end up in the same entry. However, this is a problem that one of the teachers had as well. The teacher owns an iPhone and was not familiar with the Android operating system. The problem was probably not an inherent to the application; it might have occurred because of the lack of familiarity of some of the users with the Android system or because the explanation at the start of the trip did not emphasize this aspect enough.

Figure 4.14: A child entering text for a diary entry in LifeLog

4.4 IMPRESSIONS AND FEEDBACK

The children liked the experience and were excited to participate in future studies. They continuously asked when we would come back. While talking to the kids after the museum trip, we found that they were generally happy about the new experience. None of the children expressed any negative feedback about the trip.

From our questions in the informal setting of the bus trip back to Trento; we received very positive feedback. A majority of the children said they enjoyed the experience and none said that they had not. The researchers and I tried our best to

get candid criticism of the prototype as well. From the same bus setting, we gathered that there is a need to include some game aspects in the application. The children also wanted to have some editing tools for the photos like Instagram. In addition, the children mentioned that they would like to be able to scan QR Codes (Quick Response Codes; barcodes that are optically machine-readable labels that are attached to an item and that records information related to that item) --this was one of the functionalities disabled, but still visible in one of the menus.

From our ad-hoc conversations with the teachers, it turns out that in their opinion the application kept the children much more focused on the activity at hand. In addition, the teachers appreciated that the children spent much less time distracting each other. The teachers were highly positive about the whole experience and encouraged us to continue similar endeavors in the future. They were cooperative about setting up the follow-up sessions.

5 FROM IDEATION TO USER EVALUATION

This chapter is broken down into three parts, presenting methods and discussing results for each of the separate design sessions; the first study discusses the first follow-up visit to the children's classroom, the second study recounts a designer workshop, and the third study tells of the second follow-up visit to the school.

5.1 FIRST FOLLOW-UP VISIT

The first follow-up visit was done a few weeks after the trip to the museum. We took advantage of this time to run a participatory design session with the children.

Throughout this part of the research project, we wanted to further our understanding of the second research question: What game-like and playful learning elements of pedagogical mobile applications do they consider fun and are also are age-appropriate? The goals of this part of the study were posed as the following questions:

1.Would the children change the current prototype? If so how?

2.What novel ideas would the children come up with?

- PARTICIPANTS

At the first follow-up visit, 18 of the 19 children were present; one female was home sick.

- MATERIALS

We gave the Samsung Galaxy SII smartphones back to the children, being careful to give the right phone to its previous owner. We also handed out earphones to each child. The phones still had the parental protection “Kid’s Place” activated so the children could not access other capabilities of the phone.

The children used their own paper and writing/drawing utensils for the brainstorming part of the visit.

- PROCEDURE

This time there were three researchers and the professor. We asked the children as well as the teachers to review all their media files and choose three which best represented the trip. We employed a metaphor of using these three memories to explain the experience to someone who was not on the trip. We asked the children to use the headphones to listen to the audio and watch the video. They were to put the word “Star” next to the title in the appropriate diary entry, indicating which media file (audio, video or photograph) they selected. We told them that we would create a souvenir for the class using these memories.

Each researcher interviewed four children as to why they chose those particular memories. We asked each child to bring up each diary entry and asked why they chose it.

We asked the group the following questions as a whole and they raised their hands to share their thoughts.

-What do they want to do with the memories they created?
-What would they change in LifeLog?
-Did they like the experience in general?

Then we asked the teachers to arrange them into groups of four and asked them to work together to design an application for tourism for the future. We asked them to draw or write their ideas (either in Italian or English) on a paper that we could collect at the end. They had 20 minutes to do this part. During the free brainstorm/design session, we all walked around, listening to ideas and directing the children very gently to keep them on topic. We tried not expressing any opinions about the works so as not to influence the brainstorming session.

5.1.1 RESULTS

After the first follow-up visit, we discovered the children’s favorite memories and saw the ideas that they had come up with in small groups. We analyzed these and found some trends.

- STARRED MEMORIES

The children present and the teachers choose three memories that best represented the trip for them (as in Figure 5.1).

One of my fellow researchers created a souvenir for the children in the form of a DVD with an offline website where they could view the three starred memories of the entire classmates. We had previously selected some memories at random for the girl who was absent during the follow-up visit.

Figure 5.1: Example of “starred” photo of a colorful tapestry in the museum

- FOLLOW-UP QUESTIONS

The children emphasized wanting to have something tangible to keep after the trip. One girl said that she would like to print out the photos and put them in a box under her bed to take out and look at when she was sad.

A summary of changes they mentioned wanting like to see in LifeLog follows:

- Content visibility

When in the main view of all diary entries, it is impossible to see what kind of media is inside and how many of each media there are.

- Photo printing

The children wanted the device to easily connect to something that can somehow print the memories. They referred to the quick process of printing from a USB key. I suspect that this is related to their age. They are at an age where they do not have a smartphone, so any media taken would be saved on their parents’ devices where they might not have access to it whenever they wanted. It would be interesting to see if older children were as concerned with printing the photos as this age-group.

- Auto save and simple deletion

The save button was moved out of view when the phone was turned in landscape mode. This caused a few of the children to lose data they had created. They wanted the application to not allow this. They also wanted a quick and simple way to delete something they had recorded.

- Special effects

Personalizing photos through filters was a commonly requested improvement. I suspect that because of the nature of the trip, a guided tour along with all of one's school friends, children did not want to have exactly the same photos of the same things. Adding filters would have increased the appropriation of the photographs. In addition, it could a silly and playful aspect that would keep the kids interested both during the trip and afterwards when reviewing the photos.

-Media review

The children spent time reviewing the content they had created. They mentioned wanting something like an auto slide show for review.

- BRAINSTORMING ARTIFACTS

The children came up with some technologies that are similar to many things that already exist that they may have seen or heard people talk about (for example, glasses that take photos for you (ie: Google Glass)). A few groups wanted the phone to bring the things you drew into real life (ie: a 3D Printer) (figure 5.2). A popular request was that of time travel and many talked about a robot that did your homework, made you pizza, and brushed your teeth.

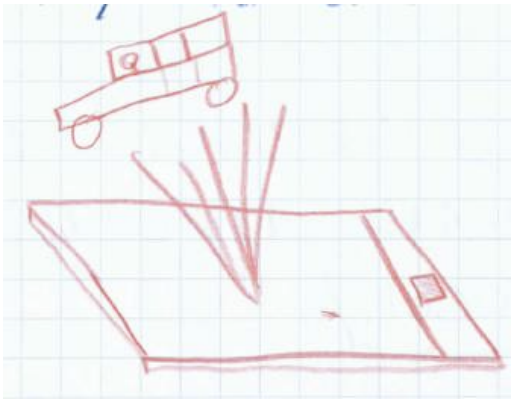


Figure 5.2: Children's brainstorm: A smartphone where when draw something, it becomes real and you can play with it or use it; like a car.

5.2 DESIGNER WORKSHOP

In this part of the research project, we wanted to further our understanding of the second research question: "What game elements are appropriate for and considered fun by nine and ten year olds?" We approached the problem from the point-of-view of interaction designers.

- PARTICIPANTS

I gathered six people together from Professor De Angeli's Human Computer Interaction (HCI) group for an hour-long design workshop; to brainstorm game ideas for the children. The participants were HCI researchers, interaction designers, graphic designers, and HCI students working on their PhD or Master degrees. There were three females and the average age of the group was 32.

- MATERIALS

Other than the powerpoint presentation I made to introduce our work on the project so far, we also used post-it notes, markers, poster boards to put the notes up on and tape to attach the posters to the wall.

To present the ideas to the children, a of mine and I created storyboards using the free online software program called for creating comics called Pixton (www.pixton.com).

- PROCEDURE

First I summarized what we had done with the children so far (museum trip and first follow-up visit). We discussed and looked at scans of the brainstorming artwork that the children had made at the first follow-up visit as well as our preliminary findings about the features of LifeLog that the children had wanted to improve as our starting point. From here, I presented the problem statement: “We will concentrate on the game as a teaching instrument for the communication of the territory’s history and geographical characteristics.” The vision statement was the following: “The game aspects of the TrenTour smartphone application will facilitate learning and communicate the history and geographical characteristics of the territory.”

Then I presented four scenarios. All the scenarios had characters who used a a mobile application in different places in the region, in different contexts, and at different phases of their trips. The scenarios presented were the following:

1. Giulia is 9 years old. Her family lives in Brescia. They are going to visit Trento for a week. Her dad opens the app, and turns on some specific aspect of it and lets Giulia use the TrenTour app to explore things about their future destination.

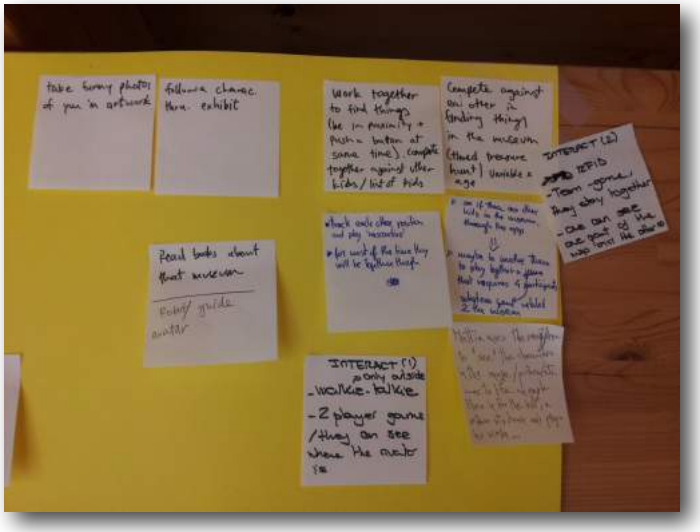
2. Mattia, age 9 and his brother, Marco, aged 7 and their family are coming to visit Rovereto from Bologna. They want to see all the museums. the parents give the two kids smartphones. They use the app while inside the museum.

3. Anna is 9 years old. She and her family are from Trieste and are going to Val dei Mo’cheni to visit some friends and they will go hiking around the area. Anna is allowed to use the app on their walk in the mountains (~3 hours).

4. Martina is 9 years old. Her elementary school class is going on a trip to a museum in the Val dei Mo’cheni. They will take the bus there from Trento. Martina has a smartphone with the TrenTour app. She uses it somewhat on the bus trip to the museum, a little bit inside the museum, and mostly uses it afterwards on the bus trip back to the school.

To stimulate discussion about the scenarios and brainstorming of ideas, I asked two questions after presenting each scenario: “What does the character do?” and “What do they learn?”

Each member wrote down game ideas for each scenario on their pad of post-it notes. After each scenario, we shared the ideas we had and discussed them. We put all the post-its up on different posters for each scenario. Once we were done with all the scenarios, we went back through them and chose all the ones we thought were good ideas for each scenario; this narrowed down the ideas by about two-thirds to 18 ideas.



I structured the 18 ideas into the most scalable (since TrenTour must work for the entire territory of Trentino) and what seemed the most playful and fun (Figure 5.3). Then with my advisor and co-advisor, I chose the top four applications to develop. To present the ideas we had come up and gather feedback from the children, I used storyboards.

Figure 5.3: Top game ideas that are scalable and playful/fun from workshop.

5.2.1 RESULTS

After choosing four applications that had a good balance of scalability, fun, and variety, we expanded on them by creating scenarios. We presented the scenarios for user evaluation using storyboards (Appendix A).

1.Nature Scenes - Capture Clues and Identify

This application is meant to be used while exploring Trentino's more remote areas, possibly while in the countryside, hiking or nordic walking. This application can be used to identify things in nature. In the storyboard, it connects a photograph taken of the feces of an unknown animal to the animal that made them and provides further information about the animal.

2.City-center Treasure Hunt

This application consisted of a treasure hunt which takes place in a city center. It poses objectives to find and photograph certain objects around the city that might be interesting to tourists (monuments, landmarks, animals), and provides more information about these targets.

3.City-specific Memory Game & Capture *in situ* (Figure 5.1)

This application employs a metaphor for the classic children's memory game using images of typical objects from the territory. It is meant to be played during the anticipatory phase of the tourist experience (Wang et al., 2012), before the departure for the destination. Then, while on the trip, the application connects what was

previously discovered about the territory in the game with the photographs taken in real time.

4.Serendipitous Background Tour Guide

The application runs in background and push notifications popped up whenever you are near a point of interest (POI) with information about the POI. In the storyboard, one can see a child passes by a building where Mozart gave one of his first concerts in Italy and the child gets a notification which informs her of this fact and lets her listen to a composition of Mozart's from the relevant year.

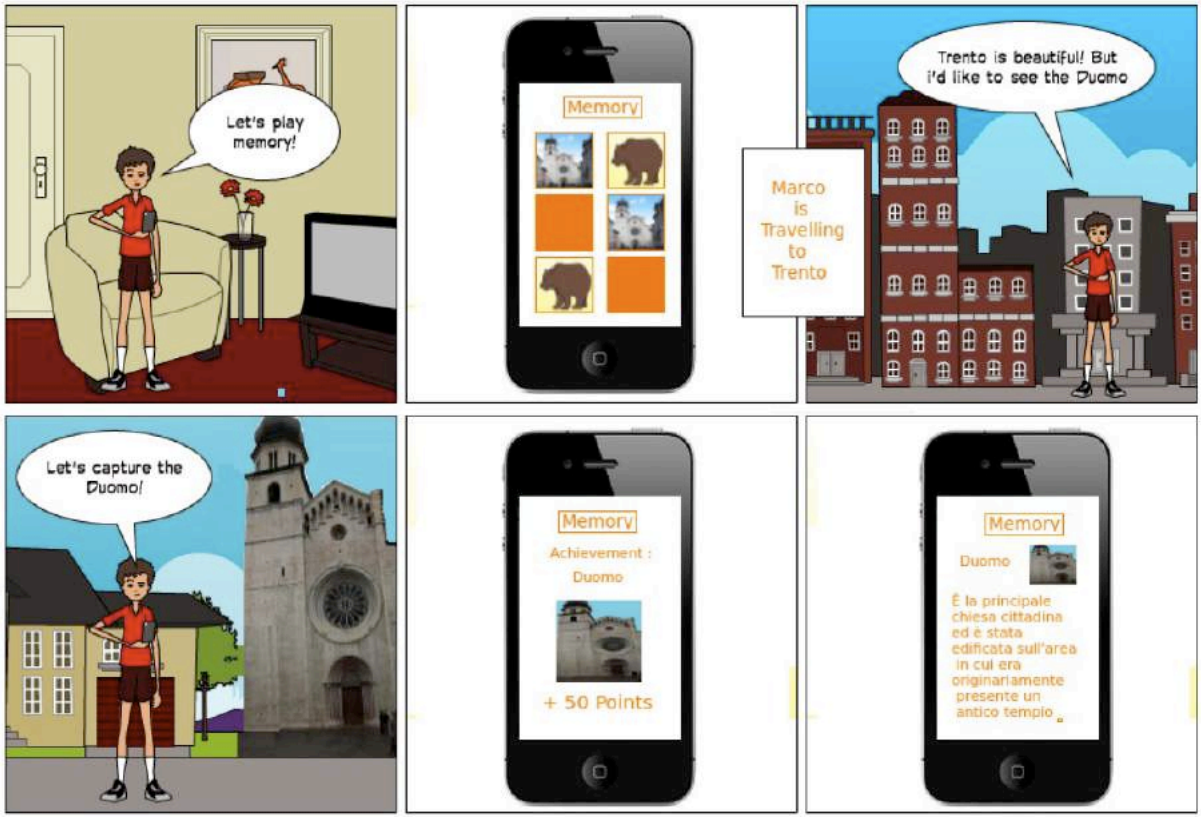


Figure 5.1: storyboard example of "City-specific Memory Game & Capture *in situ."* Marco's parents are going to go visit Trento soon, so they let Marco play this game to get familiar with aspects of the city before they get there. In square 1 Marco decides to play the game. In square 2, we see the interface Marco sees. Then we understand that Marco is going to Trento. in Question 3, Marco decides to look for the Duomo church because he remembered it form the game. When he sees it in square 4, he takes a picture of it and in square 5 we see his mobile which awards him points for taking a photo of something he had previously matched in the memory game. In square 6 it shows him more information about the Duomo church as well.

5.3 USER EVALUATION

Throughout this part of the research project, we wanted to further our understanding of the second research question which asked what game-like and playful learning elements of pedagogical mobile applications do they consider fun and are also are age-appropriate. Using user evaluation allowed me to understand the children's desires and preferences by looking at their reactions, feedback, and suggestions for

improvement.

-PARTICIPANTS

At the second visit, all 19 children were present.

-MATERIALS

During the second visit we did not give the phones back to the children. We printed the storyboards with colored ink on A4 paper. There were two storyboards per group for each scenario --one was in English and the other in Italian. Once we read the storyboards we then asked the group of children a set of semi-structured questions about the storyboards. Each group used a smartphone to audio record the group conversations. The questions based our inquiries on were the following:

1.What do you think?
2.Would it be fun?
3.Would you do this activity?
4.What can you do with it?
5.What can you learn from it?
6.Which parts are fun?
7.Which parts are boring?
8.How would you change it?

-PROCEDURE

There were four researchers present. We presented each of the children and the teachers with the souvenir DVDs which contained their favorite (“starred”) memories. It contained an offline website that one of my fellow researchers created with the children’s starred memories along with scans of the artwork they had made at the museum.

We asked the teachers to break the children up into groups of five; one researcher was assigned to each group. Then we presented the storyboards we had created. We made sure that each researcher presented the ideas in a different order to avoid any bias from the children. The storyboards explained the functionality of various game-like elements of the pedagogical mobile application scenarios I had created.

After explaining each storyboard to their group, each researcher asked the semi-structured questions. We were careful to observe their reactions, and note their feedback and suggestions for improvement.

In analyzing the children’s desires and preferences by looking at their reactions, feedback, and suggestions, I noticed that there were various types of motivations behind them. The motivations for the children’s suggestions seemed to fit into Malone and Lepper’s (1987) framework for intrinsic motivations for learning therefore, I grouped the children’s desires and preferences in this way.

5.3.1 RESULTS

Malone and Lepper (1987) created a taxonomy of intrinsic motivations for learning by studying games with ten and eleven year-olds. They observed that that games seem to strongly motivate players to engage in problem solving and critical thinking. While analyzing the children's desires and preferences by looking at their reactions, feedback, and suggestions for improvement, I noticed that there were various types of motivations behind them. The motivations for the children's suggestions seemed to fit into Malone and Lepper's (1987) framework of intrinsic motivations for learning.

According to Malone and Lepper (1987) there are three interpersonal intrinsic motivating factors: cooperation, competition, recognition. In my studies, by analyzing the suggestions and feedback for improvement that the children gave during the user evaluation of the storyboard scenarios, I was able to identify a relatively strong the presence of all three of these motivations.

-Cooperation

The children often mentioned wanting to play with the other children in whatever area they might find themselves in. They wanted to find new friends in order to work together towards a common task (i.e. like in the treasure hunt scenario). Moreover, a few children were adamant about the games being strictly collaborative.

-Competition

There were other children who stressed competition. They thought that the best way to implement the treasure hunt application would be through timed races with others.

-Recognition

The children often talked about prizes. One child even mentioned that he would want to know what the prize was before starting the game because this information was crucial to his decision of whether he would play the mobile application game. The children did not mention whether they meant virtual or tangible prizes, but either one might suffice if implemented in the right way.

There are four individual intrinsic motivating factors described by Malone and Lepper (1987): Challenge, Curiosity, Control, and Fantasy. I found that Control and Fantasy were strongly reflected in the children's suggestions. However, the Curiosity and Challenge factors was somewhat present.

-Control

A few children mentioned that the activities should be carried out in smaller spaces rather than in the whole city. For example, the children preferred to have a small treasure hunt in a public square rather than one around the whole city. Some level of independence from their parents could be gained if children were able to run around a square using the application and discovering new things, all the while staying under the watchful eyes of their parents. Moreover, safe, open spaces like squares could, allow for a higher degree of control over conducting the application's educational game activity.

-Fantasy

One child mentioned creating his own quest or treasure hunt. While the idea only emerged in one group, it is an important example of the desire for storytelling. In Anderson and colleagues' (2002) research, the retention and recall of newly learned information was increased when the experiences were elaborated through storytelling and play. Creating stories can be related to Malone and Lepper's Fantasy feature as they both involve using one's imagination extensively.

Another example of this feature occurred when one group of children decided that the City-center Treasure Hunt application scenario was too boring, and invented an under-the-sea virtual reality version. They suggested being able to see how the city would look like underwater, collect flags around the area and even elaborated that they wanted to be able to punch sharks to gain bonuses.

-Curiosity

The children gave positive feedback about the Serendipitous Background Tour Guide scenario. They seemed interested in the the idea of learning in this multimodal way and mentioned wanting every notification to contain every possible media format available. Some children then continued proposing this last suggestion for some of the application scenarios presented thereafter.

-Challenge

There was one suggestion for improvement that involved personal challenge. One child elaborated on the types of challenges they wanted to find in the Treasure Hunt, suggesting that the challenges should be presented in the form of riddles.

Thus, the children's motivations that I saw as being behind their suggestions for improvement fit fairly well into Malone and Lepper's taxonomy for intrinsic motivations. All motivating features were present in both the interpersonal and individual categories, even if the Curiosity and Challenge features were less represented than the others. Overall, the success of using Malone and Lepper's framework to classify the children's suggestions indicates a possible a link with the research field of motivation in learning.

6 GENERAL DISCUSSION

The research done in this study enabled me to derive some requirements and suggestions for how to design a mobile tourism application for older elementary-school-aged children. I started by asking how children would respond to the introduction of a travel-diary mobile application prototype (LifeLog) on a school museum trip and how they would impact its design when given a real chance.

Wang and colleagues' (2012) aforementioned model (Figure 2.1) describes the adult mobile tourist experience as having three phases called anticipatory, experiential, and reflective. The children's collective mobile tourist experience on the school museum trip could also be modeled similarly. According to my observations in the case study, the phases of the children's experience as well as the children's interactions with the smartphone are comparable to the model created for adult tourists. In Wang and colleagues' model, the anticipatory phase involves the preparation for the trip. This phase is slightly different for children because they do not have the capacity nor the tools to anticipate a trip in the same way as adults; for example, children usually do not research the destination on internet, nor do they create an itinerary. However, the children can anticipate the trip emotionally; for example, by looking forward to it, as seemed to be the case on our museum trip. This is confirmed by behaviors observed on the bus ride and while walking to the museum where the children seemed excited about the new type of experience and took almost twice as many photos on the bus traveling to the destination as on the trip back. In Wang and colleagues' model, the experiential phase occurs at the destination when the tourist has experiences during the trip. For the children, the experiential phase happened inside the museum, where they were seen to be actively participating in the guided tour. This is also confirmed by my analysis, which showed that the majority of the photographs they took inside the museum was of artwork and things related to the exhibit. Wang and colleagues describe the reflective phase as happening after the end of the trip. After visiting the museum, we observed an increase in socialization where some of the children's conversations turned to

talking about the trip. One child was even overheard interviewing one of her teachers about the trip on the bus trip back and recording the interview using LifeLog. While on the bus back, many children reviewed the media they had taken during the trip and we saw them showing photos or videos to each other that they had taken previously. Wang and colleagues state that the smartphone can change the organization of activities and the emotions that a tourist has during the holiday, and therefore influence the whole tourist experience. They say that the smart-phone can also change the way of meeting social and functional information needs and the perception of novelty and pleasure. In our case, LifeLog seemed to address the children's needs for novelty, creativity, and pleasure. It also changed their activities by literally transforming how they saw the museum as well as changing how they experienced it. LifeLog did not provide social and functional information but it could have, had it been connected to the internet and incorporated ways of sending the diary entries as well as general tourist information.

Wang and colleagues' model is supported by our observations and results analysis even though our users were outside of the scope of their model. It seems that the actions the children performed and behaviors they exhibited are similar to the interactions Wang and colleagues describe in adults having a mobile tourist experience. With the exception of a slight modification of the anticipatory phase, their model can be extended to include children, at the very least in a situation where they go to visit a museum.

These collective results seem to suggest that introducing an application similar to LifeLog for nine and ten-year-old would improve their tourist experience in the Trentino territory of Italy. The results also helped derive more precise requirements for the design of the such an application and create a list of design suggestions for general tourism applications for children.

6.1 DESIGN SUGGESTIONS

The TrenTour application will be designed for children to use in the Trentino territory. While the case study reported here was conducted inside a museum, the research project aimed at designing an application that is scalable to an entire geographic region.

Observations and data from the case study showed that the museum guide was successful in directing the children's attention to objects in the real world. Therefore, if one wants to steer children's attention to specific areas, it seems that using some type of guide inside the tourism application would be effective in achieving that goal. An anthropomorphic guide would be most similar to the situation we observed but I suspect that any artificial intelligence agent or character on the screen could achieve similar goals.

The children's desires and preferences, gathered from the user evaluation, were clustered according to Malone and Lepper's (1987) taxonomy of intrinsic motivations for learning.

Using the ethnographic observations and results from the user evaluation, I created a list of eight suggestions for the design of a new pedagogical tourism application for older elementary-school-aged children.

- DESIGN SUGGESTIONS FROM ETHNOGRAPHIC OBSERVATIONS

	Design Suggestion #1 - A.I. Guide
Suggestion	To steer children's attention to specific areas around them, a guide should be present accessible from inside the application
Justification	The museum guide in our case study was successful in directing the children's attention to objects in the real world.

- INTERPERSONALLY MOTIVATED DESIGN SUGGESTIONS

	Design Suggestion #2 - Cooperation
Suggestion	It should be possible to play pedagogical games in a cooperative manner. As much as possible, the user's preference should be considered and they should not be forced to compete against others, but have the option of reaching the same goal through cooperative play.
Justification	A few children were adamant about the games being strictly collaborative.

	Design Suggestion#3 - Competition
Suggestion	It should be possible to play pedagogical games in a competitive manner. As much as possible, the user's preference should be considered and they should not be forced to cooperate with others, but have the option of reaching the same goal through competitive play.
Justification	Some children expressed wanting to play competitively.

	Design Suggestion #4 - Recognition
Suggestion	Some type of recognition or prizes should be part of the application. For example, there could be a "high-ranking" list showing successful players. There could also be a possibility of unlocking special "photos" of the area. Unlocking silly riddles with answers could be used as prizes as well.
Justification	The children often talked about wanting prizes for playing.

- INDIVIDUALLY MOTIVATED DESIGN SUGGESTIONS

	Design Suggestion #5 - Control
Suggestion	Some activities (treasure hunts for example) should be planned for small spaces or it should be possible to constrain an activity to a certain, specific location if the user so desired.
Justification	The children wanted the activities to be carried out in spaces smaller than an entire city.

	Design Suggestion #6 - Fantasy
Suggestion	It should be possible to create your own story or quest within the application.
Justification	One child wanted to create his own treasure hunt for others to follow. In addition, Anderson and colleagues (2002) implied that creating stories helped children's recall after a from a trip to a museum. Another child invented a fantasy virtual world through which to view the city which might be more fun for children to use.

	Design Suggestion #7 - Curiosity
Suggestion	Historical and geographic information should be presented in as many media types as possible; including audio and video when feasible.
Justification	Often, when there was talk about presenting information, the children wanted it in every media format available.

	Design Suggestion #8 - Challenge
Suggestion	Applications should be challenging for children, presenting information in
Justification	One child elaborated on the types of challenges they wanted to find in the Treasure Hunt, suggesting that the challenges should be presented in the form of riddles.

6.2 FUNCTIONAL REQUIREMENTS

The feedback that we received during the first follow-up visit as well as during the case study was positive. The children, however, directly requested some changes. These are summarized in following design requirement list:

	Requirement #1 - Content visibility
Requirement	It is necessary to be able to tell the difference between diary entries that have more than just the one instance of media.
Justification	When in the main view of all diary entries, the children were not able to see what type of media is inside and how many media files there are.

	Requirement #2 - Photo printing
Requirement	Print the photographs taken using LifeLog must be made as quick and simple as possible.
Justification	The children wanted the device to easily connect to something that can somehow print the memories.

	Requirement #3 - Auto save and simple deletion
Requirement	The application should ask before exiting when information has been entered or media captured. It should also have an easily accessible way of deleting entries and single media.
Justification	Some of the children to lose data they had created. They wanted the application to not allow this. They also wanted a quick and simple way to delete something they had recorded.

	Requirement #4 - Special effects
Requirement	It should be possible to modify the photos after taking them.
Justification	Personalizing photos through filters was a commonly requested improvement.

	Requirement #5 - Media review
Requirement	It should be possible to review all media, regardless of which diary entry it is in, for example, by creating an automatic slide show.
Justification	The children spent time reviewing the content they had created. They mentioned something like an auto slide show for review.

6.3 FUTURE WORK

The results obtained regarding nine and ten year-olds using a smartphone application prototype on a museum trip are interesting and provide new insights into the design. However, more research would need to be done to extend the application to children of other ages. One of the main limits of the research is that the group was relatively small (19 children) and were observed on one trip.

While the studies conducted were comprehensive, some improvements could be made if one is does something similar in the future. During the case study, I found that when I was explaining how to use LifeLog to create diary entries by going through an example, many of the children were quite excited and did not completely pay attention to the example I was demonstrating. It might have been more useful to print out an instruction sheet for each child so they could go at their own pace.

In the future, it might be interesting to refine some aspects of this project. A more direct measure of learning could be taken by comparing these results to an ethnographic observation of children on a similar trip without smart technology.

We ran our case study in a fine art museum. It would also be interesting to compare this to a case study in a science museum, or a more interactive tourist attraction.

Now that I have shown a possible link between children’s desires for mobile application designs and Malone and Lepper’s (1987) taxonomy for intrinsic motivations, it would be fascinating to apply other theories and methodologies of motivation research to pedagogical mobile application design for children.

6.4 CONCLUSION

In this user research and participatory design study I attempted to derive some suggestions and requirements for the design of a mobile application that enhances the tourist experience for and facilitates learning in older elementary-school-aged children. I studied how 19 nine and ten year-old children responded to the introduction of a smartphone application prototype (LifeLog) on a school field trip, as well as what game-like and playful learning elements are appropriate and fun for them. I observed the children using LifeLog which could photograph and record other media while on a visit to an art museum. I strove to decipher the complex interactions between the children, their surroundings, and a mobile application. In order to comprehend how to best use play and games as pedagogical instruments, I actively involved the children in the creation process of playful and game-like learning aspects of a smartphone application through participatory design and later conducted user evaluation of four mobile educational game application scenarios. Designing *with* children in addition to designing *for* children allowed me to come up with design suggestions that met the needs, desires, and limitations of this unique user group.

The ethnographic observations as well as an analysis of the photographs taken by the children demonstrated that this case study which introduced a travel-diary application prototype on a museum field trip overcame, to a large extent, the three challenges of mobile technology design for children outlined by Rogers and Price (2009). The introduction of LifeLog did not overload them with information. Its introduction actually fostered new types of interactions and conversations and did not entirely distract the children from the museum's exhibits. The patterns that emerged from thematic analysis of the children's photographs supported my observations of their behavior and highlighted the rivalry between extrinsically-directed and intrinsically-directed attention. In the analysis, I presumed that the subjects of the children's photos were the focus of their attention and interest.

The observations from the case study, as well as the analyses of the results from the participatory design and user evaluation sessions, enabled me to form a comprehensive list of suggestions and various requirements for building an application that would improve the tourist experience for nine and ten year-old children.

In regards to children's mobile tourist experience, I showed that; with the exception of a slight modification of the anticipatory phase, Wang and colleagues' (2012) model can be extended to include children, at the very least in a situation where they go to visit a museum on a class field trip.

With regards to the user evaluation, I found that the groupings of the children's desires and preferences seemed to fit into Malone and Lepper's (1987) framework for intrinsic motivations for learning.

This study brought together the research areas of mobile application design, the tourist experience, intrinsic learning motivations, and participatory design with children. In this work, I demonstrated that a travel-diary smartphone application can enrich children's tourist experiences, compared the children's mobile application

learning motivations with Malone and Lepper's established framework, created a list of design suggestions and requirements for a more game-like educational children's tourism application, and compared this study's trip to the currently accepted model of the adult tourist experience, thereby adding to the general understanding of children as tourists and as users of mobile applications.

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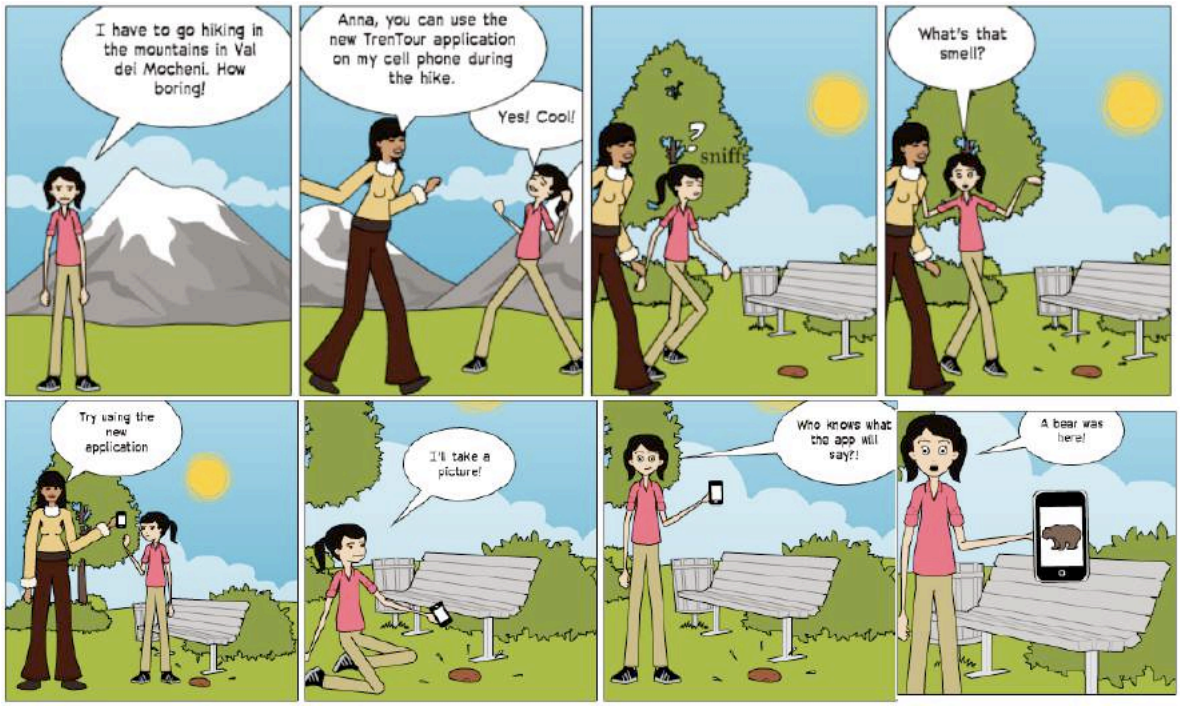
APPENDIX A

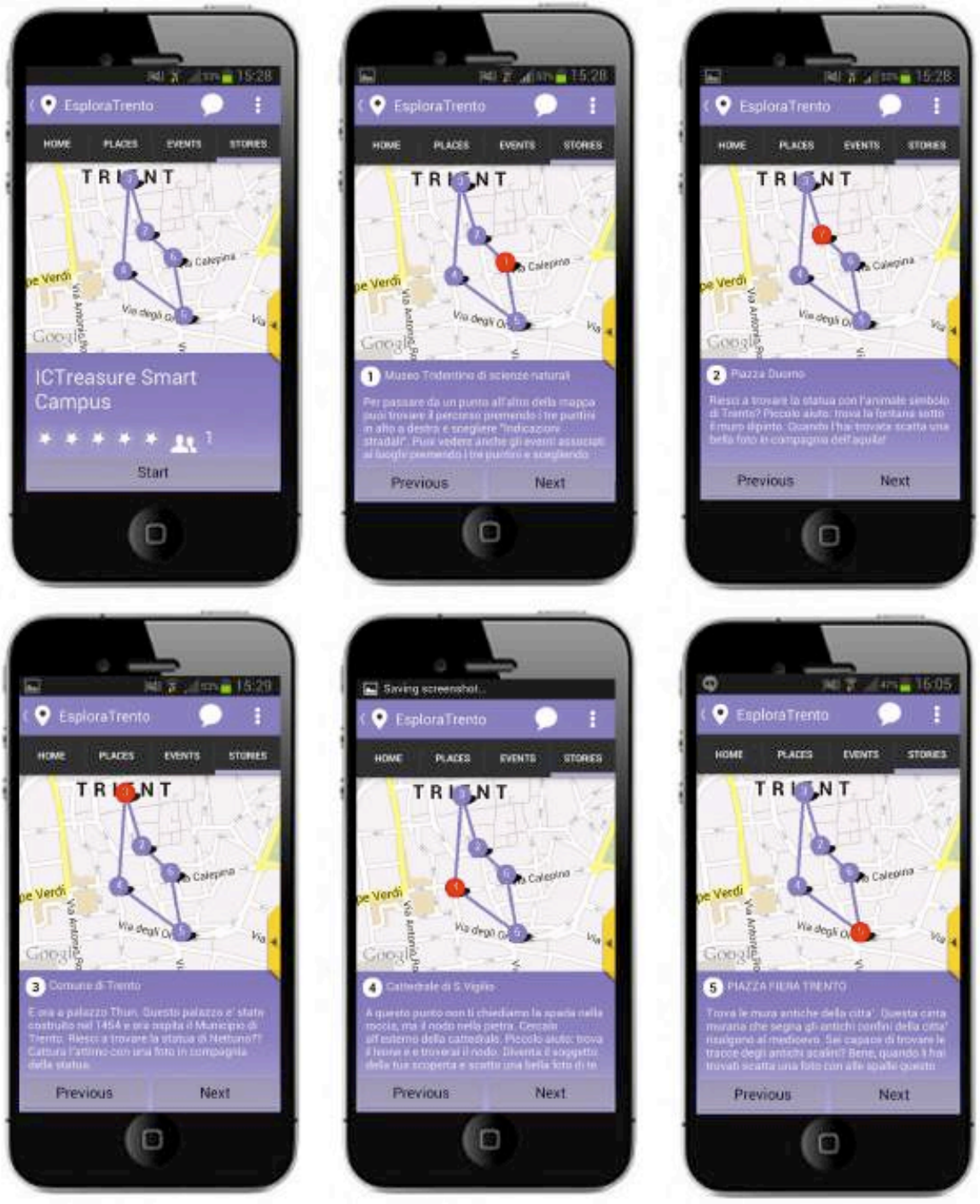
Storyboards

1.Nature Scenes - Capture Clues and Identify

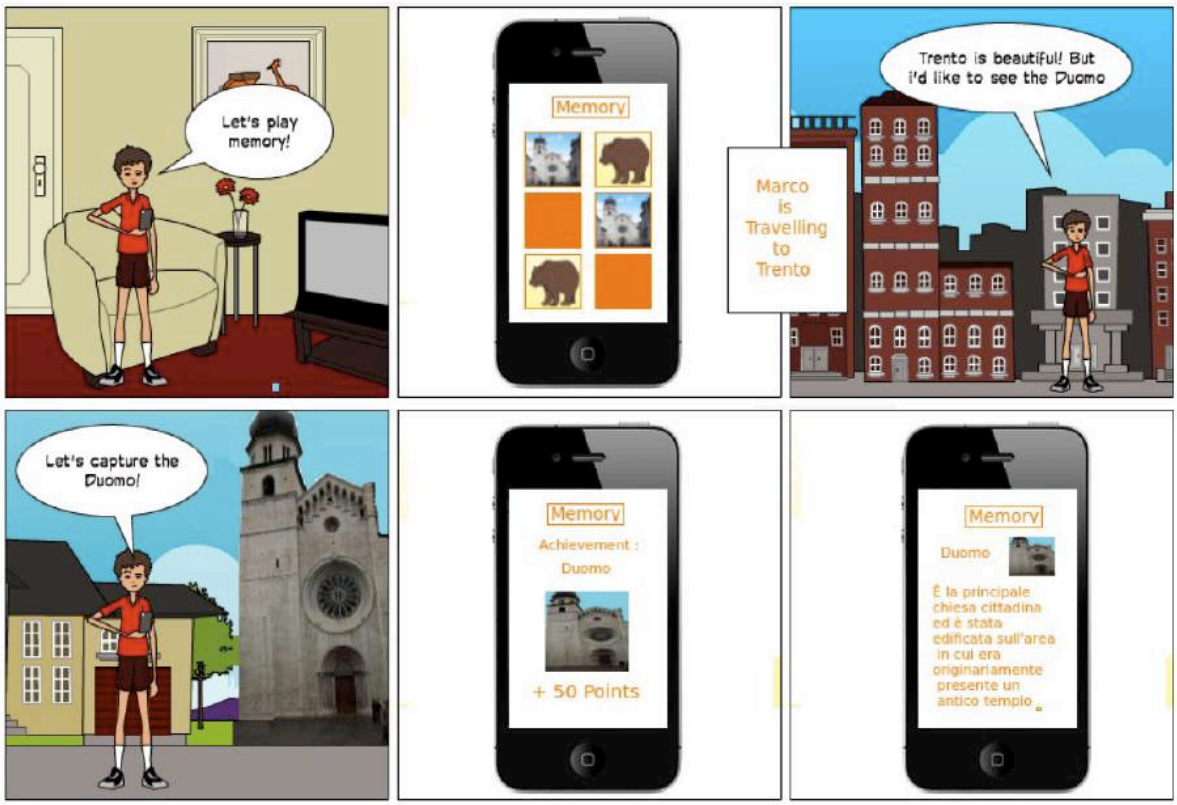


2.1 City center Treasure Hunt (part 1)

2.2 City center Treasure Hunt Prototyped Interfaces (part 2)



3.City-specific Memory Game & Capture *in situ* (Figure 5.1)



4.Serendipitous Background Tour Guide (Italian Version)