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Scenarios for active learning in smart territories

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Abstract. This work is intended to foster a "quantum leap" in the reflection on learning in smart cities/territories. We try to move from a vision according to which *education* is identified with "infrastructures and services" needed to sustain the smart city "organism" (due also to the social capital that it may produce) toward a "new" vision that recovers the founding role of the educative processes, through which the relationships between persons and inhabited territories are continuously reshaped. According to that we present: a) a strategic and methodological approach focused on *museal field* and *narrative* as key elements of future "learning from smart cities"; b) a model of an advanced integrated technological environment (mobile, web, internet of things) designed to support such an approach. The need for a different approach to the monitoring of complex learning experiences is also underlined.

Keywords: smart city, smart education, cultural heritage, museal field, experience monitoring

1 Introduction to smart cities and education

During the past years emerged and acquired an increasingly relevance the concept of *smart city* that characterizes itself, with respect to other definitions used in the past, by the focus on sustainable use of environmental resources aimed at preserving and improving the well being of society. Another element that strongly characterize smart cities is the relevance assumed by the environmental and intellectual/social capitals, which are considered as important as hard infrastructures (physical capital). In this context, Information and Communication Technologies (ICTs) are considered essential components of an indispensable infrastructural backbone able to influence all our behaviors and support the improvement of all key factors that contribute to the development of a sustainable economy: mobility, environment, people, quality of life and governance. It is no by coincidence that the attention of the policy-makers and, as well, of European and national programs devoted to applied research are focusing increasingly on ICT supporting the development and integration of all factors that may contribute to the regional competitiveness [1]. No doubt that among the consequences of such attention there is an acceleration in supporting the integration

and embedding of ICT within physical environments to realize what has been defined the "everyware" [2].

In this context, despite of its inclusion among the indicators of the quality of life, *education* is considered primarily as a mean to educate labor force and to renew/improve their life-long skills. In fact, in the ranking scheme [3] developed to evaluate the European medium-size smart cities, education although listed among the factors contributing to the smart living is considered only in terms of education facilities. Education is also considered (as a "side effect" however), as a factor able to stem and reduce the digital divide, favor the e-inclusion and foster citizens to learn how to learn and innovate, also for the purpose of increasing the level of participation to the governance.

To conclude this short introduction we would like also to highlight that among the factors contributing to the smart living the ranking scheme includes also the tourist attractiveness, a factor of great relevance to many territories with established historical background (like most of the European ones). However the interplay between tourist attractiveness, education and other possible related factors, such as cultural initiatives, is never considered explicitly. The aim of this contribution, thus, is to foster a reflection on how the interplay among the downing age of the ubiquitous computing combined with factors contributing to the living quality, like our cultural heritage, could lead to learn in a smarter, more direct and active way, favoring a more intimate contact with the cultural stratifications characterizing our territories and cities.

In the following we first describe our vision and strategy, and then a technological environment designed to sustain them. To conclude, we propose few considerations on the need to change the approach to complex experience monitoring.

2 The state of art

Nowadays a sort of invisible barrier separates the urban context (with its living streams of activities) and the content preserved by the typical “accumulation points” of our Cultural Heritage (museums, interiors of historic buildings and churches), CH. Many pieces of our CH, unfortunately, live an isolated existence, preserved in their "caskets", far away of living context, and are no longer able to narrate their story and meanings to people (apart from few experts) and to stimulate “living” contacts (apart through the storytellings “accompanying” spatially localized guided tours). We are deeply convinced that their virtual re-contextualization within the "fabric" of cities, villages and territories, where possible, could foster a more intimate contact with the narration of "our memory", as tourists, as citizens and, overall, as potential learners. A large number of European cities and villages, in fact, could be considered veritable “open libraries” containing a huge number of "texts" (buildings, artworks, etc.), but, often, we are not any longer able to read them, due basically to the huge effort needed to master again all their symbolic meanings and to relocate them in their historical contexts.

Technologies supporting a different approach and a more informed contact with such open libraries could be particularly relevant for children who may acquire a greater

awareness about history and meanings hidden behind their mute appearance. People accustomed to deal with teen-agers know very well, in fact, that they learn more by actively playing with video-games based on historical settings that by studying traditional text-books. Too often these latter miss very important ingredients like the power of involve through the narrative, pathos and action and, sometime, even the ability to critically analyze the events to point out parallelisms aimed, for example, to better explain the present.
A new technological infrastructure that could act as a modern "volumen" is needed and its goal should be to foster a more intimate contact with the cultural background of cities/territories and to support living experience characterized by an high level of physical involvement. A kind of involvement very different from staying "glued" to a laptop screen or to a portable playstation. In this way, perhaps, one will succeed also in avoiding that during the visit of an exhibition the greatest attractions for children would be touch-screens instead of exhibited artifacts.

3 The inspiring vision

The key concepts that inspired the design of our technological infrastructure are:
a) *the "museal field"*
proposed already in 1999 by one of the authors [4] to describe the field of force that an accumulation point of our cultural heritage (museum, collection, etc..) could generate around to foster the contact between accumulated contents and individuals. When the interaction takes place exclusively inside the physical location of the Institution responsible for the conservation of our CH, it can be considered a short range one, i.e. an interaction that requires a continuous process of "marketing" to force contacts. The territorial re-contextualization of the contents (albeit in virtual form), instead, could produce an extension of the range of interaction and, thus, an increase of the probability to involve individuals located inside the interaction area - tourists, citizens, all potential learners - even though they may have not planned to visit the museum/collection. Moreover re-contextualization of pieces of the collections - e.g. archaeological and historical artifacts, historical views provided by photographs, prints, paintings, etc. - may promote: i) the mutual amplification of sense, due to the interplay among re-contextualized "objects" and hosting contexts; ii) the design of environments more suitable to foster engaging narrative experience of the "places". In fact, the use of content in virtual form allows for its easy manipulation and, thus, to create more engaging inter-actions for specific targets (e.g. to amplify the ludic dimension [5] of the interaction when children are involved) and stimulate the proactivity of individuals providing them the means to add "sense and meaning".

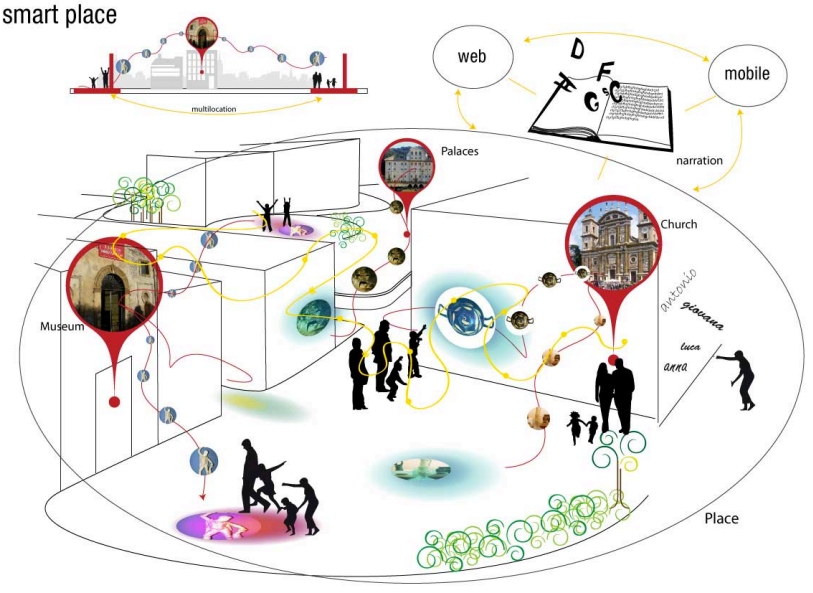

Fig. 1. Sketch of a museal field: a smart physical place always in interaction with the virtual components (web and mobile) of the technological environment.

b) *the support to narration*

from early childhood we develop our knowledge of the world also through multiple forms of storytelling, the most important of which is the tale. In adulthood, then, narrative not only still represent an interesting way to learn (just think of the successful emissions on scientific subjects, history and art based on narration, or to school and university lessons characterized by a strong narrative content and a high dose of pathos) but also a "pause" that, thanks to the “temporary suspension of reality” allows us to live highly engaging experiences. Novels, films, theater, radio and television, in fact, although along different paths, allow to satisfy individual needs and expectations. Beside these form of narratives, that we might be considered as "traditional and passive", nowadays we have to considered also less traditional ones like the multiverse narratives typical of video games, that actively involve individuals in the construction of the plots. Such active participation satisfies one of humanity's basic needs: feel oneself active protagonist of the story within which one is embedded [6,7]. The need to feel protagonist and, at the same time, to share with others their own experiences emerge also from the narrative of travel. Just think to the huge number of people that spend time in reconstructing the memory of travels through the editing of movies or by assembling slide shows; activities now available to everybody thanks to the large diffusion of increasingly powerful laptops and network connections

4 The technological environment:

Technology enhanced learning experiences from our cultural background requires, thus, the integration of many technologies and infrastructures: web, mobile and smart spaces (Internet of Things, IoT, and Points of Interaction, i.e. PoInts, based on multimodal and natural interactions). No more than five-ten years ago the idea of such integration was still considered a far possibility, today, thanks to the recent technological developments, it has become a viable reality.

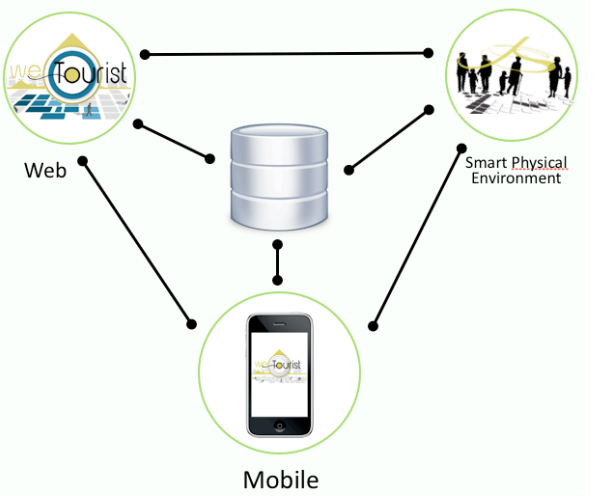

Fig. 2. All components of the technological environment sharing the same database

The modular and scalable web component of the technological environment, currently still under development, has been design to support a generic tourist experience. The portal consists of three areas intended to assist people during the three phases of a territorial experience: "before", "during", "after". Each area can accommodate modules/functionalities specifically designed to assist the person in a given phase of the experience. The modular organization of the portal allows to integrate, as "plug-ins", services and modules developed by third parties, either free or vendors. Appropriate API, some of which are already available, will enable interoperability and data exchange with other infrastructure/platform: e.g. applications for Android and iPhone, or wearable enhanced fabrics and tools.
For example, we have realized an app for iPhone (see fig. 4) offering narrative paths that may develop either in space (territorial paths) or in time (event paths). Paths are composed by Points of Interest (PoIs): the associated content can be inserted and upgraded anytime through a dedicated web editor. New PoIs and Paths can be added ad any time and, in close future, users could contribute actively to their development (stratification of tales and experiences). Learners could upload the paths of their interest, follow a narration and jump from one to another at crossing points.

Fig. 3. Screenshot of the web portal home page: before the experience

Fig. 4. Flow diagram of the iPhone app

Fig. 1 offers a sketch of the enhanced physical component of the technological environment, a Museal Field: i.e. a portion of village/city, within which are embedded installations allowing for a smart interaction among persons, museums' content and physical elements of the place. In the case of "K12", such smart places may include

educative games, applications that allow to leave the signature of her/his own passage, to produce collaborative narrations, to creatively redefine the meaning of the Museums' content, etc. The augmented and sensitive physical environment is made of PoInts connected among them, possibly able to interact with the integrated virtual environment (web and/or mobile). Thanks to such level of integration smart physical environments will allow to play and learn in multi-user modality, being people physically or virtually delocalized (i.e. active in other smart physical environments, or in other virtual environments).

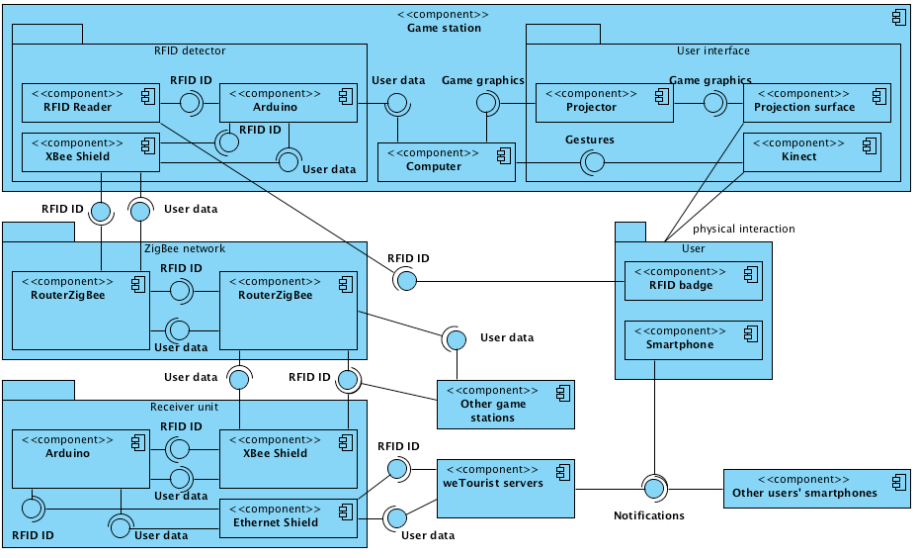

Fig. 5. UML diagram of a typical PoInt

As a first brick toward the construction of the smart physical environment envisaged above, we have designed an infrastructure that allows to identify the player and personalize the experience using RFID/NFC technologies, put in communication the various smart environments via ZigBee and to interact in a natural way, thanks to the integration of Microsoft Kinect sensors (see figure 6).
Figure 6 shows an early prototype of an interactive board to be embedded into the urban environment, featuring several different applications (widgets that can be activated at will using a text file): an art-puzzle based on the image of an archeological remain preserved in a Museum, an art-based pong, various example of interactive digital signage, a light intensity controller, etc.

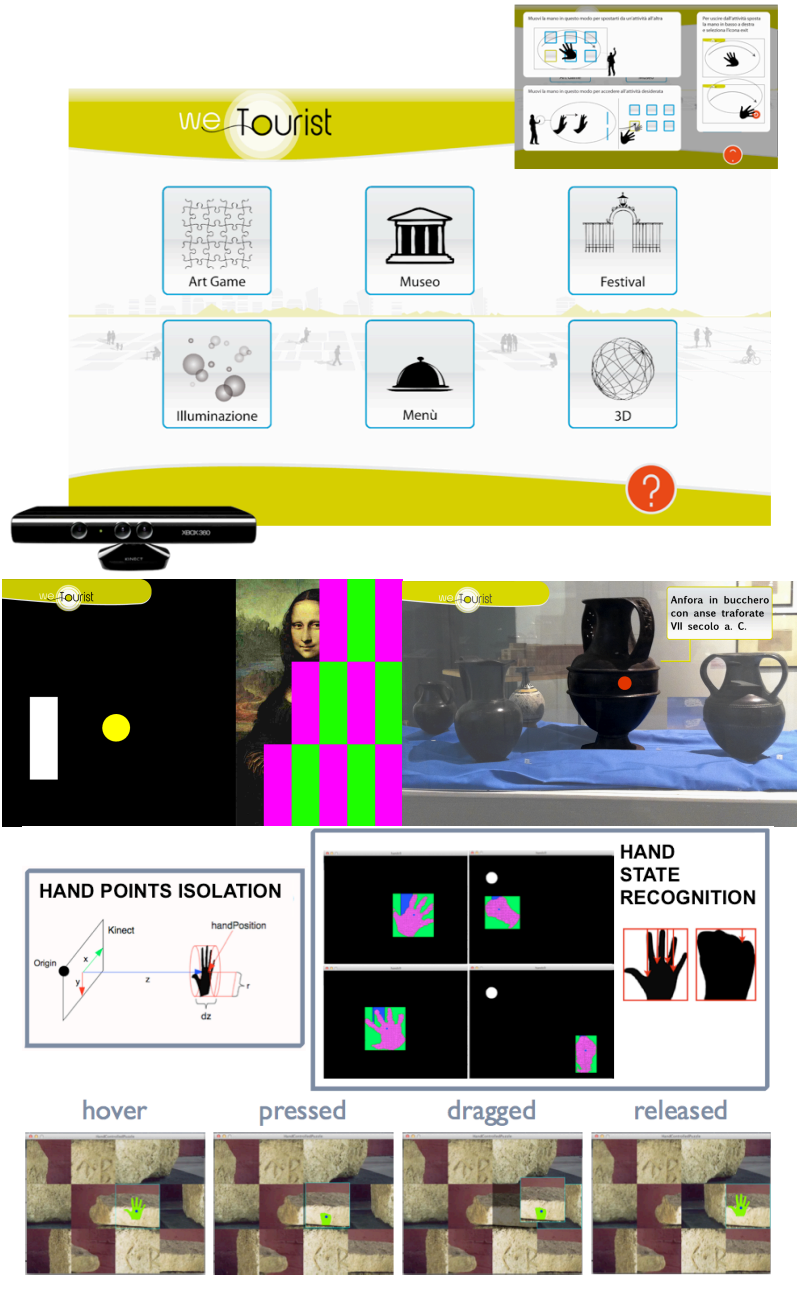

Fig. 6. Prototype of PoInt, Kinect based, containing games and informative widgets. The two interaction strategies adopted are also illustrated.

As far as the interaction design is concerned we used two different approaches:

a) SimpleOpenNI library, and a series of dedicated algorithms, to recognize the position of a hand in the space and its state (open/closed); an appropriate combination of hand states, then, allow us to simulate the four states (functions) of a mouse: hover, pressed, dragged and released (see the case of the art-puzzle)
b) algorithms for the recognition of the hand centroid and an interaction based only on two mouse states: hover and pressed (this latter has been simulated by a movement of the hand towards the screen).
These simple realizations shows how realistic is a scenario based on future embedded smart learning places.

Fig. 7. Views of the augmented backback

To complete the overview on the technical environment we would like to mention also the effort we have been doing in designing possible personal add-ons, like the *smart backpack* shown in figure 7. In the backpack we have embedded an integrated system of detection (photographic images, sounds, temperature, etc..) that, without having to hold any device, allows to record a whole set of signals: the memory of the experience. At present data are recorded in a microSD, in the future we expect the smart backpack to interact with the integrated infrastructure through mobile phones.

5 Experience monitoring and 'evaluation'

All above have hopefully convinced the readers that an active learning “experience” of the territory is a complex process that cannot be assessed any longer in a traditional manner (e.g. exclusively in terms of effectiveness and efficiency). The logical and very concrete consequence is that *deterministic previsions and evaluations should transform into the monitoring of the experience's qualities and into the analysis of the emergences*. It can be done by recording and analyzing traces produced at many different level:
a) those produced by the gestural interaction with the apps embedded in the territory;

b) those derivable from the mobile phone that allow to keep track of the spatial movements performed by the people and of some of their qualities (location, accelerometers, etc..)
c) those produced during the exchange of data (mainly textual ones among members of the community).
To track and analyze the traces of the gestural interaction, we have adapted an application developed few years ago to analyze tracks recorded during eye-tracker measurement sessions [8]. Trials with such application are currently in progress.
In progress is also the development of an application that will allow to analyze data collected through mobile phones. Already active [9] are web applications able to detect social and emotional characteristics of the on-going process by means of social network analysis (SNA) [10] and automatic text analysis (ATA) [11].
All together the above techniques of analysis, and many others under development, could contribute to define the experiential profile of the learner. Of course its derivation is not an easy task and should be based on the definition of a model of the experience [12], to be used as framework of reference.

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