

# INCLUSIVE DESIGN AS THE CENTER OF THE LEARNING PROCESS

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## Abstract

The Cultural Interpretation sector related to architectural heritage comprises a field of applied research, with a major impact on the development and availability of specifically adapted and inclusive resources. Nowadays, smart and sustainable development are common goals of mankind. That includes the social participation of people in learning and leisure. This paper shows an approach to the design of in-situ learning experiences. This study was carried out by a multidisciplinary team of researchers at the Universitat Politècnica de València (Spain). The goals are to increase the use of learning artifacts and to improve the user experience as well. Inclusive design offers choice where a single design solution cannot accommodate all users. The case of an informative solution for interpretation and learning of the Central Market of Valencia is explained. The main difficulty is the simultaneous use of the site as a commercial spot and a tourist attraction. Segmentation, technical options, and creativity are mixed.

Keywords: Innovation, Cultural heritage, Design Process.

## 1 INTRODUCTION

A research is carried out by a multidisciplinary team of the Universitat Politècnica de València (Spain) based on the idea of developing a universal learning object to be used in heritage interpretation. The goal is the design of a learning object which can be accessed in different ways, and also contains built-in opportunities to experiment with the contents, both natural and cultural heritage. The team aim to create something new, by the combination of existing concepts and adapting some products to another function [1]. These learning objects are supported in drawings, graphics, and other elements that provide a variety of experiences by demand of the customers, following their possibilities and motivation and improving the understanding of the topic presented, as an indispensable contribution to today's educational panorama [2].

These objects are universal, but match specially with tourism, heritage fans and, specially, education sector. The formal education in Comunitat Valenciana is based in approximately 3700 educational centers, but the continuous evolution of uLearning (ubiquitous learning) and pLearning (pervasive learning) are based in the evolution of the personal devices, each time with more capabilities. That makes more dynamic the learning, changing the roles of students and teachers, breaking the barriers space-time and smoothing the division virtual-real. The utopian knowledge society is based on a lifelong learner who, paradoxically, don't know the relevant knowledge or skill for the future [3].

Information and communication technologies (ICTs) can facilitate learning, but a proper promotion of flexible learning environments is the way to improve people opportunities [4], [5]. In the last few years, hardware and software have been developed with enough power to create proper augmented reality apps for mobile platforms. Some research is done to elucidate if these apps are useful to improve cognitive skills [6].

With the background of Dunn [7] and Kolb [8] learning models, the research team supports the idea that the learning by making and the diversity of elements facilitate the process of linking instructional activities to individual learning styles, thereby increasing the learner's ability to acquire and retain knowledge. Both specific and general skills are developed by frequent practice and exercise in specific domains. Skills are what any student would be desired regardless of subject matter or discipline, and are teachable and learnable. General abilities are the flexible, fluid capacities developed by and used in learning something new. Different people in different situations haven't the same understanding of the concept. Sometimes is not separable from the knowledge or skills of particular performances or domains. This could mean that a student's ability to display a generic skill in a particular context could, in part, be determined by familiarity with the context. Learning involves an individual engaging in tasks that are similar to those of an expert in the area being learned. Also, learning includes an understanding of how experts think about tasks while performing tasks [9].

This approach is vital in the new learning context offered by information technologies and also concerning the manipulation and accessibility options which these new forms of knowledge can provide. As a consequence, it is easier for individuals to develop their digital abilities and, also, to be more aware of their possibilities for learning autonomously [10], [11]. The widespread use of different technologies is causing a significant impact on educational contexts and is giving a new technological approach for teaching and learning that opens extensive opportunities for inclusion and accessibility in both, traditional and distance education. Furthermore, the implementation of new technologies in different contexts (e.g. museums, exhibitions, classrooms, home) has also promoted a change in the use of the tools making it easier for individuals to develop their digital abilities [12].

It is essential to think about the many possible user group scenarios to design combining stimuli when interpreting heritage sites. Generally, there is no available comprehensive service for educational purposes including accessibility aspects. Furthermore, the capacities of the senses of hearing and touch are minimal compared to that of the visual channel for a human [13].

## 1.1 Inclusive design

The term inclusive design was coined by Ronald L. Mace in 1973 in the first building code for accessibility in USA. The term was defined as: "the design of products and environments to be usable to the greatest extent possible by people of all ages and abilities" [14]. For instance, the heritage sites will be accessible, usable and inclusive for all. The Principles of Universal Design were established in 1997 by a working group of architects, product designers, engineers and environmental design researchers, led by Ronald L. Mace, in the Center for Universal Design at North Carolina State University [15]. These principles are: Equitable use, Flexibility in use, Simple and intuitive use, Perceptible information, Tolerance for error, Low physical effort, Size and Space for Approach and use.

To detect the difficulties faced by users of wheelchairs, people with crutches and those with visual or hearing deficiencies, ergonomics is very important, but it has to take into account the different necessities for people with different capacities. That is, an inclusive accessibility should be proposed, implicit, not explicit, that is not perceived, thus no one feels different or "out of place". Some examples of deficiencies detected related to accessibility were the steps, the narrow corridors, the chairs or the poor lighting system [16].

The usability is the extent to which a product can be used by specified users to achieve specified goals effectively, efficiently and with satisfaction in a specified context of use. The usability of a system is based on the identification and placement of their components. A clear and simple layout will probably have the right impact on the user. How we move around is defined for the way-finding [16] provided for a specific environment.

From the point of view of website accessibility, it will be essential to make it understandable, usable and practical for all users, which is not an easy task. The guidelines adopted as an International Organization for Standardization (ISO) standard, have been updated by the World Wide Web Consortium (W3C) (Web Content Accessibility Guidelines (WCAG) [17].

## 2 METHODOLOGY

This is a work in progress that intends to provide a design solution to the interface of a learning platform based on the use of different technologies and tools. The site will allow to create and experience tangible models, compositions and resources related to Central Market of Valencia. No other learning platform has been found to solve this hands-on approach.

The expected results are in line with the existence of an interaction between emotion and learning. The claim of situated learning, supported by research, is that people are more inclined to learn by actively participating in the learning experience. Situated learning essentially is a matter of creating meaning from the real activities of daily living where learning occurs relative to the teaching environment [18].

It's understandable that strategies and pedagogical model focused progressively in three big interdependent aims: to transcend the traditional teaching practices centered on the exhibition of fragmented information; to consider the skills development a better achievement than the knowledge acquisition; and to stimulate the capacity of students to anticipate, formulate and impact about the issues of a society with increasing inequality, lability and uncertainty. Both the purpose and contemporary pedagogical criteria refer to social context and imply, in some extent, the situated learning. On the other hand, The creativity of initiatives overcome planning. Conventional things contribute to mixing no formal

knowledge, academic and arts. We use the existing information, memories, connections, skills, tools, as the baseline to the new [19]. Creativity is a collective phenomenon, a constructive set of experiments and relationships including the individual singularities [20].

The team believes in the impact of positive reaction on individual engagement and multidimensional constructs. It is also expected that this "Learning Object" may be useful to connect different subjects or courses which are often isolated in education programs at school (arts, technology, history, etc.). The variety of activities involved can be seen as a means to create a flow situation when using this learning module. The idea is to increase the learner's participation (not a mere involvement) in design activities and decisions, combining experiences and resources.

Two different approach were used. The expert designers and the situational learning. The expert designers approach was based on previous experience of the research team both in methodology in general [21] and in the Mercado Central as a singular heritage site in particular [22]. All the activities proposed have been developed/applied previously by the authors of this paper. Similar elements have been applied in other areas, such as 3D maps, tactile models, and distributed learning object repositories. This experience is an advantage for the implementation of the proposed architecture for the case of this Universal Learning Object in an accessible website.

The researchers went on a 'service safari' where they were able to experience first-hand and in situ specific educational scenarios and contexts. After this, interviews with key stakeholders (e.g. users, vendors, managers, tourists, architects) were carried out. The subjective nature in choosing the sample (thus it is not a good representation of the population) is not a constraint, thanks to the purpose of discovery, inspiration, and triangulation of the information [23]. The next step will be to build a prototype of the website, including these activities and tools, to make a research-through-design approach, and to use it. Knowledge will always gain from testing. The designs will be tested with users questionnaires and assessed with the help of experts focus groups.

For the situational learning, an international group of students in the framework of European Project Semester participated. During the first stages of the project, several field trips to markets were completed where students actively observe the environment in an unfamiliar way. Markets are interesting in cultural heritage and tourism as well, beside the most important, the commercial activity. The research focused on the Central Market of Valencia for several factors: a) A high number of potential users; b) Enough early adopters, ready to check novelties; c) An old building still in the same use; d) Architectural and cultural heritage interest; and e) Learning side underdeveloped.

It's crucial that an important cultural sight such as Central Market has different means of communication with its visitor. Conventional tourist information must be combined with new engaging and interactive measures. Feelings of amazement, satisfaction, curiosity, hope, and inquiry are good emotions that facilitate a higher level of learning. A hands-on approach also shows that learning improves when using, creating and manipulating tangible elements, and many subjects in education use commonly tactile models in their teaching [24], [25].

After the research and ideation phases, four goals were established: produce an innovative learning product, adapt it to diverse target groups, test the prototype and visualise the history and culture of Central Market. The final decision was the development of an interactive table. Research on existing products was carried out in order to get an idea of what similar interactive tables and technologies are available on the market. In addition to paying visits to multiple museums and other cultural venues in Valencia to first hand experience of possible solutions, all team members also carried out research on interesting interactive tables and presented the findings and the inspiration drawn from it to the group.

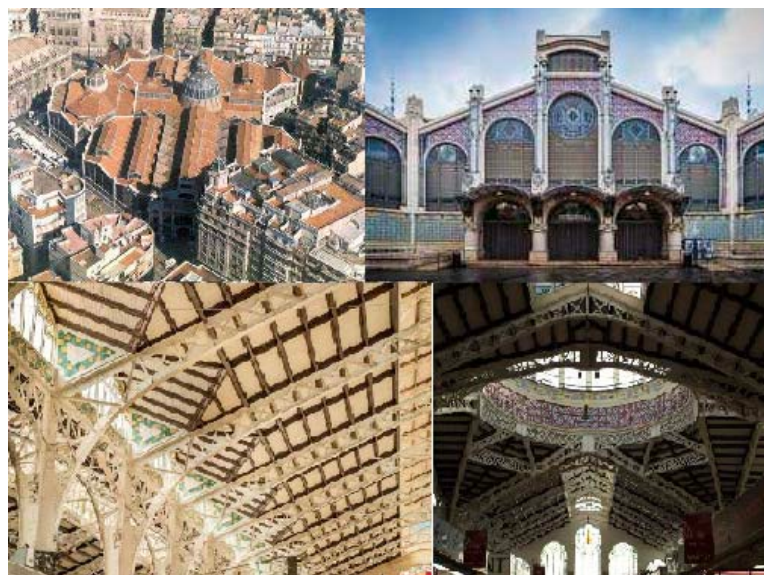
## **2.1 The Central Market of Valencia**

The Central Market of Valencia is one of the oldest fresh food markets still in use in Europe. It is an Art Nouveau built, covered market in the old centre of the city. The building is a reference of trade, architecture and technology of the early XX century. Central Market has 8200 m<sup>2</sup> where operate 274 small traders distributed in ten corridors. As an example of the activity, 48000 kg of fruits are sold daily in 61 fruit stores.

Its architecture doesn't break the aesthetics of the square, where it integrates perfectly with two other important monuments: La Lonja de la Seda and Los Santos Juanes Church. It is the most representative building of Valencia that at the beginning of the twentieth century advances towards technological and mercantile progress. Agricultural production is reflected in the modernist structure of the market and the allegorical ornamentation inside.

The market's dome is made of iron, crystal and ceramics and stands around 30 meters tall. An iron structure was preferred over a wooden one due to health and security reasons. These materials play a large part in the general perception of the market as visitors quickly notice the colourful tiles and the giant stained-glass windows as well as the beautifully coloured natural light which illuminates the market hall and contributes to the overall ambience of the market. The cupolas, of iron, glass and ceramics and the vanes that crown them -the parrot and the fish- are integrated to a landscape panorama of towers and bellies eminently Valencian.

The distribution of the interior is rationalist, so the stalls are located along a series of rectilinear streets crossed by two broad pathways. It was conceived for 959 positions, destined in the general zone to high shops closed for butcher's shop, corner shop and ironware; low stalls for potatoes, legumes, vegetables, fruits and hen; high-open shops for sale bread, poultry, meat and hunting meat; and, in the fish shop, high shops for sale of salt and offal, and low stalls for fish. The two pavilions that flank the main access are built entirely in brick seen, with applications of stone and decorated ceramics, while the annexed building of Deputy mayor follows the construction of influence Noucentista and remains topped by turrets crowned by small semi-spherical domes. Fig. 1 displays different views of the Central Market.



*Figure 1. Different views of the Central Market of Valencia.*

### **3 RESULTS**

The results document the findings collected from education sector and about the Central Market. That includes information from surveys, the project briefs and decisions and the corresponding preliminary prototypes. The stakeholders who participated in interviews were members of the target population that meet specific practical criteria, such as easy accessibility, geographical proximity, availability at a given time, and the willingness to take part in the study.

Regarding the education sector, a sample survey was conducted with 147 responses [5]. Teachers use frequently email, social networks, search engines, and digital media. They commonly (95%) apply ICTs for teaching practices (preparation of lessons and materials, direct use of specialized sites of sciences, blended use of repositories, blogs, mobile apps, etc.). They consider that students manage technological gadgets fluently and, despite teachers positively view rendering technologies and new realities, the level of using these technologies is low. The opinions of teachers on the characteristics of emerging representation technologies is very positive, based on how visual and diverse they are. A high percentage find a pedagogical added value because are agile and facilitate desktop publishing. Some beneficial aspects are to allow the experimentation of inaccessible situations, the visualization of hidden things and the novelty as a way of approximation to digital natives. The awareness of the creation in new formats can impact on comprehension and motivation of the learners. Teachers identify the resources as the main potential barrier of use of emerging representation technologies for the introduction of new formats, but they are open to sharing materials and experience beyond their own subject.

Accordingly with published records about Central Market [26] and personal interviews of the managers, 20% of the buyers in Central Market are coming from walking distance, 55% from farer districts of the city and 25% are not from Valencia. Two thirds of the visitors of the market are tourist and the other third are locals, most of them are regular shoppers, i.e. one a week or more.

In order to get an overview of visitors interest, a preliminary in situ field survey was done with forty people. A majority of the visitors are interested in receiving more information about the Central Market. 55% in the case of history and 60% about the architecture. 20% of the people need better guidance through the market. 15% reported lot of difficulties to find what are they looking for, and 55% don't know ordering on line is possible. A second survey was done to discover basic preferences to a potential personal heritage interpretation tool. 29% like traditional brochures, but the majority prefer audiovisual tools and interactive quiz. 60% of the people prefer to have only touch screens. One third prefer a combination of touch screens and buttons. This last option is preferred for elderly people. Regarding learning about architecture, most interested issue are style and history. The construction and the materials seems interesting for 31% and 12%, respectively. 80% of the respondents preferred the placement of this tool at or close to Central Market. Half of visitors related they want to experience the market, and two thirds would use the phone in combination with an interactive table.

These activities grounded the context for the next steps: make a list of requirements for interactive table, design the different elements, build the prototype, test and exhibit for feedback. Fig 2. shows some visual examples of the requirements for the interactive table.













 Audio-Visual	 Video, AR
 Educational	 Text, Quiz, Interactive Timeline
 High accessibility	 QR
 Blind friendly	 Audio, 3D Model, Braille, tangible tile
 *Wheelchair friendly	 Ramp, height 1.1 cm, tilted displays
 Kid friendly	 Height 1.1 cm, visual, tilted displays

Figure 2. Extract of the conceptual (left side) and functional (right side) requirement for the interactive table.

Fig. 3 displays the 3D printed model of islands and corridors of the Central Market of Valencia. This model will be located on the of the prototype as a centrepiece. The real table include some informative LED. Visual impaired people can also access through tactile relief (see fig. 4) and surfaces to some relevant examples of market tiles and Braille writing. The table include five panels surrounding the centrepiece. The two focused on tactile mentioned above, one devoted to architecture both general info and some details, another one in history thanks to a time line with assorted extra information and a multi-purpose panel. The multi-purpose panel provide, eventually, food information, general information&fun facts, a Central Market quiz and advertisement options. After evaluation of different shapes, the Concept Polygon was the preferred one. This option combined space economy and novelty. Fig. 5 shows the Concept Polygon shape (sketch on the left side), the framework combined with an aerial view (picture on the centre) of the market and a picture of the first prototype exhibited (right side).



Figure 3. 3D printed model of islands and corridors of the Central Market of Valencia.



Figure 4. 3D printed models of Central Market tiles for tactile interpretation.



Figure 5. Concept Polygon shape for interactive table. CAD sketch (left side), aerial view with superimposed frame (centre) and a picture of the first prototype exhibited (right side).

After the construction of the prototype 1:550 scale, some presentations and exhibitions were done, in order to get appropriate feedback (see Fig. 6) and to foster innovation [27].

#### 4 CONCLUSIONS

In this paper we have introduced the concept of inclusive design as the centre of the learning process, which is targeted to different learners and educators, enhancing the contents with new techniques and technologies to create new resources as usable as possible. This can have a simultaneous effect on

users and in facilitators (e.g guides and teachers). The hands-on perspective arouses self-editing, active participation in learning, and interpretation. Emerging representation technologies are a trend, proper experimentation could lead to a better combination of physical and virtual models. Persuasiveness is enhanced via triangulated consensus (when consensus is present) and via transparency (especially when perspectives are in conflict), and both of these are consequences of involving more than one model to explore a building.



Figure 6. EPS Team explaining their ideas in CIM de Benimaclet Exhibition.

The research has shown, on one hand, an improved vision of the interest of learners in pre-visit and post-visit scenarios to heritage sites and, on the other hand, a better understanding of the inclusive design interpretation from different stakeholders. This information will enable the designers of the learning object to maintain focus during the ideation and development phases.

In the education sector, the proposal is a user-friendly scenario for new experiences and self-editing. Most of the teachers are open to sharing resources and knowledge and are ready for permanent learning. Preliminary results indicate that the early adopters will be from visual arts, software and, to less extent, humanities and science.

Regarding the results of the surveys and the interviews of the Central Market, make sense pay an effort on informative issues. Both from the cultural point of view, and from the shopping experience point of view. The set of products designed propose the user a “learning by doing” approach, to create shapes producing simple elements, which allows informal learning about this the Central Market in Valencia, *in situ* and pre-post use as well. Using and blending technologies available nowadays it is possible to create different models that, not only can be built and touched but also convey a range of spatial concepts, proportions, and wayfinding information.

In a few days after the preparation of this paper, the 1:1 scale prototype of the interactive will be exhibited internationally in an academic context to test the concept and the capabilities. Immediately after, all the products will be presented to ONCE (Organización Nacional de Ciegos Españoles), the biggest Spanish player on inclusive design ([www.once.es/otras-webs/english](http://www.once.es/otras-webs/english)).

As future prospects, the documents will be located in a website (<http://indico.ishobox.es/>) with a further development of the specifications for each model or content explaining the technology and the building process and providing the files in an open source. This website will include all the models prepared, landscape, sections and blueprints of different views, to make understandable the main features of the Market, with the different supports or stimuli, plus a virtual 360 visit of the Central Market (already recorded).

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