Discovery and Involvement for an Efficient *Universal Learning Object* Interface

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***Abstract*— This paper presents a work in progress whose objective is to develop design criteria for the interface of a *Universal Learning Object*, based on an open, free web service. The main purpose of this website is to display different technologies and techniques for discovery learning about architecture and heritage sites. It is central to consider usability and accessibility factors so that this website can target a wide diversity of users. Previously, criteria about the learning method were established. The contents to provide a hands-on pedagogical framework were also defined using 3D production and representation tools. This short paper presents the part of the project pertaining to the definition of a graphic interface for this website, which has to combine contents based on the use of tools and technologies, such as 3D printing or Laser cutting. The main result of the project will be an efficient set of learning tools for learning by making, reaching success through involvement.**

Keywords-Accessibility; Interaction; Requirements; Tools; Usability; Graphic design.

I. INTRODUCTION

Technologies reshape the way we learn and, even more, the societal motivation about learning experiences. The new learning trends are disruptive [1][2] as they increase the diversity and the development of new learning tools and scenarios to learn, and they are faced with the challenge to prove their worth. Massive open online courses (MOOCs) are playing a remarkable role in the autonomous and online learning [3].

The new learning experiences are learner-centered and take on the challenge of participatory design involving different areas (workplace, schools, home, leisure, etc.) and targets. Also, some changes are reducing certain people skills (for instance time management, patience and memory) as dependency on technology increases. Accordingly, several issues regarding participatory design have been explored [4], including the influence of technology on people and the impact of people on technology, the interest in the continuous development of technology, the consequences on wealth and job conditions, and human learning. Some theories support active and efficient participation in the development of learning resources and materials. This is a way to emphasize knowledge acquisition and the relevance of the process, like the multidisciplinary and collaborative work itself.

Some of the most promising technologies since the nineties are Virtual Reality and Augmented Reality (AR/VR), which, combined, produce what is called Mixed Reality (MR) [4]. Both are used frequently nowadays in training simulations, branching scenarios, and serious games. Augmented Reality (AR) focuses on the intersection between two realities and is characterized by the combination of real and virtual elements in an interactive and simultaneous space and time [5]. The use of these technological systems is an established trend in the case of cultural heritage and museums. Displaying historical reconstructions that are impossible to visit, showing their historical timeline and other graphic reconstruction projects aimed at teaching are some examples of its better-known applications [6].

Other platforms promote autonomous and online learning, including various resources and themes. For instance, Khan Academy produces short lessons in the form of YouTube videos, supplementary practice exercises, and materials for educators. All resources are available to the website users and become a set of online tools that help to learn. It has an inviting layout with clear categories for different elements and users. Another kind of learning website is Wolfram Alpha, an online service that answers factual queries directly by computing the answer from externally sourced data. It covers a wide range of topics with minimalistic interface design, and it takes a step further in technical computing systems and encyclopedias [7][8].

A different example of an interface is the National Aeronautics and Space Administration (NASA) education website, very focused on the robust content and the quality of the science, technology, engineering, and mathematics (STEM) learning proposal. The amount of information overwhelms the reader and the layout is cluttered. Navigation is confusing and the black color (space) is not helpful [9].

Pappas [10] has recently published wise and concise guidelines for developing experiential knowledge and learning resources with AR/VR technologies, to make learning more productive, innovative and fun. They are: Understand your target audience to satisfy their needs; Design a memorable story (hypothetical situation or real-life experience) that addresses their concerns and their needs; Present solutions in an effective way; Develop an AR/VR experience by keeping detailed and well-planned product documentation; Care about the post-production stage reusable and adaptable, and arrange the essential minimum equipment to support the e-learning resources (workstations, head-mounted displays, mobile devices, visual and audio.
Although it is a time-consuming development with a costly investment, an online learning object has the potential to boost the learning return on investment (ROI) with more flexibility. Moreover, gaining expertise in this field can now help and in the future of technical tasks and deliverables, especially when using alternate technologies wisely and seamlessly integrating them into the course/web design.
This paper is structured as follow. Section II presents the background of the project. Section III describes usability and accessibility approaches for the website's interaction, some

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research on way-finding and graphic communication. It helps to understand the way we see and organize our perception to answer to the stimuli. Section IV describes the basic proposed definition of a standard interface with the conceptual design of the starting wireframes. In the final section, some conclusions and further work are presented.

II. BACKGROUND OF THE PROJECT

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. In other words, the objective 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 aim is the creation of something new, by the combination of existing concepts and adapting some products to another function.

The proposed design wants to achieve a relevant combination of three merging technological areas, implying disrupting innovation.

First, the development of an open digital platform with virtual elements related to a site or building. The free access to online contents is more innovative than the learning platform itself. This is a crucial point for an ideal integration into different systems and contexts of active learning, e.g. educational centers, cultural interpretation sites, and informal learning.

Second, the use of augmented and virtual reality, both in a real expansion, and the inclusion of digital 3D models in specialized 3D repositories free of charge, in virtual classrooms, or online repositories [11]. Based on graphic representations, this project intends to create new supports and tools, which trigger new relationship models fostering reality and knowledge. These "models" must be researched in the immediate future, as they are new means of communication, for the purpose they symbolize. Simultaneously, these now available means and technologies facilitate an increase in accessibility and interaction with multiple contents within the cultural and heritage scope. Numerous recent studies have identified the benefits of using mixed reality in applications and the gamification principles (use of game design elements in non-game contexts and activities.) This is the central focus of many creative industries, resulting in a new breed of smart education and heritage applications [12]. At the same time, we are witnessing the introduction of (purely virtual) 3D into the consumer market as well, namely stereoscopic television screens, photo frames, games, and tablets.

Third, the assumption of the maker culture (or subculture) as a technology-based extension of *do it yourself* (DIY) culture, with elements of the hacker perspective. Additive and subtractive manufacturing production tools (especially laser cutting) facilitate creating new devices, as well as tinkering with existing ones. That means new opportunities for new teaching practices in a range of subjects and educational settings, from primary education to interpretation and to higher education [13]. There is a fast-growing community of people who use *Rapid Prototyping* to produce things in small numbers at home, using peer-to-peer networks to exchange their prototypes and designs. 3D Printing would provide a more holistic appreciation of the produced objects, but it requires the development of basic guidelines of the 3D offered for printing.

Figure 1 is a generic visual organizer of the learning object contents. The center is the focus (a specific heritage

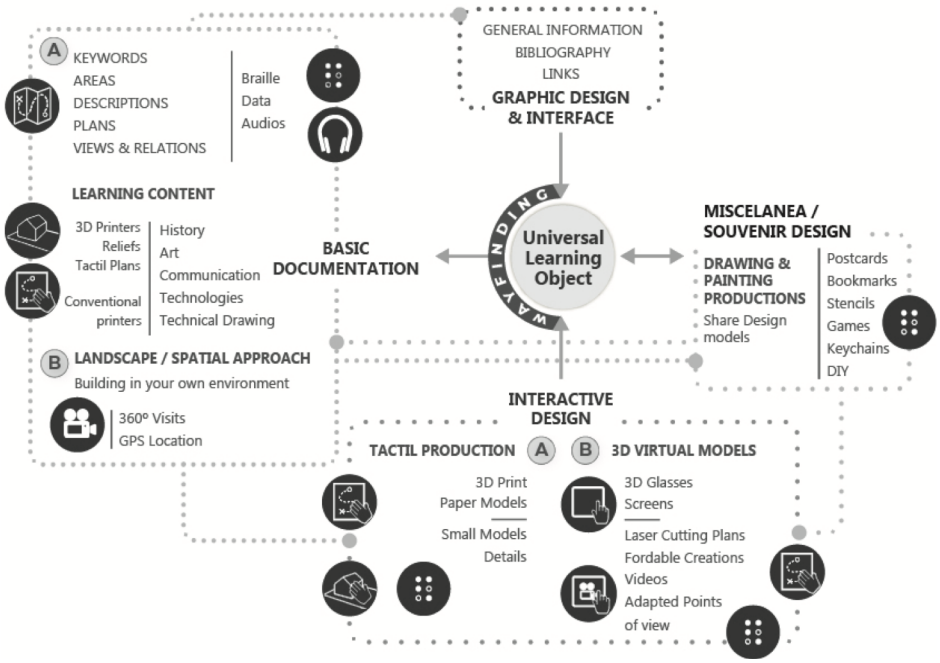

Figure 1. Architecture accessibility contents diagram.

site), and a set of structured resources support comprehension and help understand the rhetoric, where *way-finding* is a primary element. This visual organizer displays the functional elements potentially used. This is interesting because it helps to overcome the challenge of making multidimensional learning formats compatible. This combination of adaptable stimuli facilitates multiple approaches to the educational contents which it offers.

Some experimentation will be necessary to test the quality of the results, the autonomy of the users and the impact on learning. The designs will be tested with user's questionnaires and assessed with the help of experts focus groups. The big point is how to combine activities and specific technologies to obtain tangible outcomes and other exploratory representations. To solve this question, this paper presents a work in progress whose goal is to develop a very intuitive Universal Learning Object website interface for autonomous, varied experiences for a Hands-on approach to knowledge.

III. USABILITY AND ACCESSIBILITY CRITERIA

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 [14] 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 [15], have been updated by the World Wide Web Consortium (W3C) (Web Content Accessibility Guidelines (WCAG) [16] establishing success criteria to be satisfied by web applications or websites. To quantify the accessibility of a website, a standard has been created based on three levels of compliance connected to a list of criteria [17].

Following these criteria, the success of websites can be verified online using evaluation tools. In general, these online evaluation tools are web applications that allow the user to enter the uniform resource locator (URL) of the website to be tested, in order to obtain an assessment report, which includes the verified accessibility requirements, those which are not verified (requiring manual assessment), errors found, and warnings. However, not all the tools have the same way of making available the execution of different activities and of getting particular results. The design of this website interface has to address this.

The aim of this "learning object" is to encourage the general public to approach knowledge for building things and resources, and determining which are better suited to them.

The design and development of this interface to explain a topic should reasonably accommodate a broad range of diverse users, favoring levels of appropriate training, including individuals with disabilities. The design will benefit people with low literacy and new and infrequent users. Following this idea, a preliminary scheme with four phases is proposed (Figure 2), where each tool is independent of the rest, allowing the use of its deliverables and actions separately. A previous phase of general information acts as a door for the other three described below.

Increasingly, more people in society are using and participating via keyboards, screens, telephone handsets, smart cards, etc., so it is possible to communicate efficiently. Young people, people with good manual dexterity, good

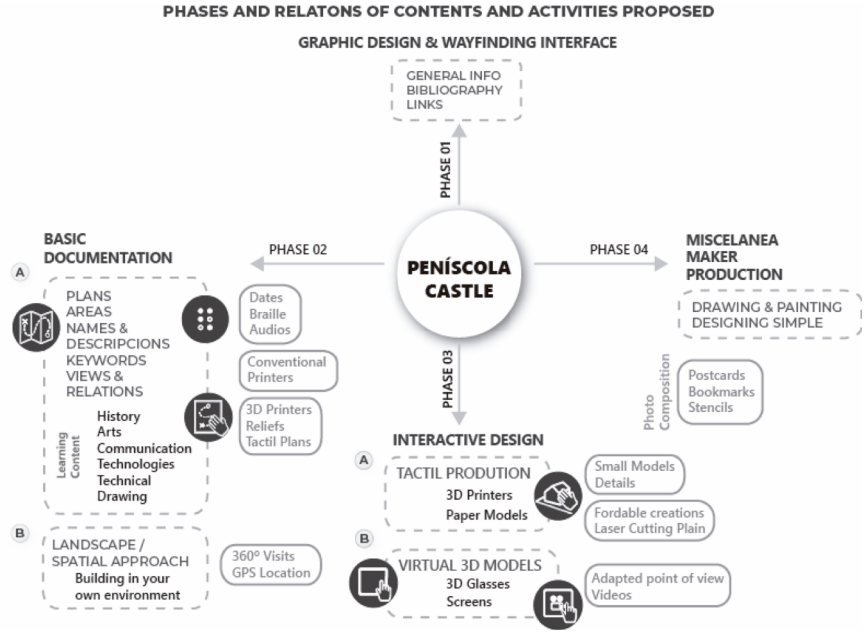

Figure 2. Four phases preliminary scheme.

eyesight and good hearing are daily users of many interfaces. However, for people who have any disability, including dyslexia and other mental limitations, access to this sort of information may not only be difficult, but impossible [18]. As providers of a free system, in order to make significant progress in accessibility, we will need to adopt a 'design-for-all' perspective. Also, it will be necessary to build the prototype to pilot the different utilities with different groups of users.

As designers in this "learning object" we should consider cognitive ergonomics [19] in the product-development process. Cognitive ergonomics analyze the interaction of each person with cognitive artifacts (which demand a mental process) taking into account the cumulative effect of expertise.

Some cognitive processes involved in play activities are very similar to those involved in learning: motivation, meaning, repetition, self-regulation and abstract thinking.

Through design, the website will enable the use of a significant amount of easy-to-do activities and a wide range of interactions while allowing the tailoring of the different learning needs. The preliminary wireframe should immediately show the graphic design, which identifies unmistakably the interface. The areas proposed are the following:

Basic Documentation. Different kinds of representations of general information are presented to the user who wants to approach the topic using multiple tools.

Interactive Design. At this level, there are other sorts of representations: virtual models, animations and tangible elements to be produced. Users may perform in different ways, adapting the format of the available means to support their own experience and knowledge.

Miscellanea Maker production. It includes tools that allow the user to personalize designs and produce functional elements about the topic.

IV. Communication in Learning Platforms. Graphic Design and Wayfinding for Tasks and Tools

As explained at the beginning, there is a growing number of online platforms, and the majority of them expose their functionality through graphics and pictograms. Obviously, the tendency is to offer more functionality using technologies through these websites and, as touchscreens become more common, it is essential that they are designed for everyone's ease of use. Also, the information that the tools include in response to the requests will be more accessible for all or for more cases and formats of the results.

The central aspects of the proposed wireframes for the system will be simplicity and the association between pictograms and results. The main characteristic of this interface is the simplicity to find both the available resources and the goal of the proposed activities. This is crucial because the different working elements are interrelated. Each activity implies two approaches: the analogical technique of constructive tasks and the symbolic logic of graphic representations [20].

Since the point is to show relevant architectures, we raised three types of approaches which are essential for a global comprehension: the contextual presentation as part of a particular landscape; the organization as a space to discover by moving around rooms, levels, etc., and the volumes as in a building site. In all cases, for the sake of simplicity, they are presented using pictograms connected with the result to achieve. In a general sense, we are interested in the "quality" of the visual communication and its relationships with the human experiences as explained by the Gestalt Theory [21]. Gestalt, as a "living thinking" discipline, gives us a series of observations located in experiments with human subjects that could have applications in the design of this Learning Object.

Clearly, it is difficult to combine all these ideas and unify the input parameters to create an interface where the tools are part of the content to learn. Participation in the creation of the results or the resources is part of the process, depending on who is the user. Authors of this paper are working on creating a universal interface proposal, using some graphic technologies, and producing a result with a self-descriptive structure, based on one's own experience [6][11].

The solution proposed here is to include in a knowledge base, at each wireframe, the explicit relation accessibility-result (Figure 3), both visual and tactile, based on semantic and iconographic relations, capable of helping to determine the equivalence between possibilities for knowledge.

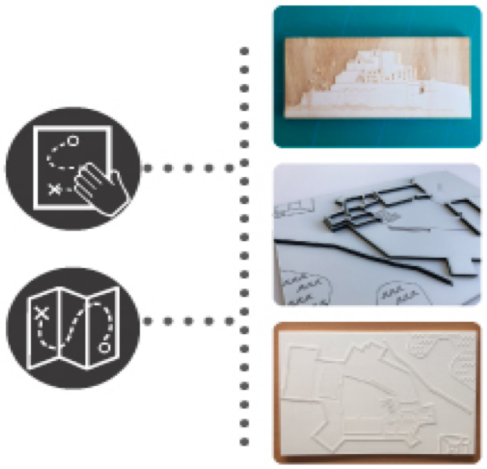

Figure 3. Scheme proposed to develop the wireframe and design of the buttons to establish simple activity-result relations.

Another problem that arises by combining results is the possibility of inconsistencies between the results of different tools for the same accessibility requirement. For example, a tool can determine that the success criterion 1.1.1 is satisfied because all images have alternative text, whereas another more advanced tool could determine that the goal is not satisfied.

V. Conclusions and Further Work

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

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create and experience tangible models, compositions and resources related to a particular topic. No other learning platform has been found to solve this hands-on approach.

The expected results are in line with the previous work by Kort et al. [22], which highlighted the existence of an interaction between emotion and learning. Their claim, supported by research, is that 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.

We believe 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.

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 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.

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