From Formal to Informal 3D Learning. Assesment of Users in the Education

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Abstract. This work is focused on the design of an educational experience involving the implementation of virtual and augmented 3D information in the architectural and urban design precesses. This process has two distinct educational parts: the first within a formal framework (regulated course where the student gets a qualification within their studies), and the second in an informal environment with the end-users feeback. The responses of the end-users are obtained using 3D visualization with mobile devices and in situ assessment using QR codes (Quick-Response) of the proposals. This social interaction contributes indirectly and unconsciously in a crucial training of students, validating environments and real situation proposals and providing them with experiences and professional skills.

Keywords: 3D learning · E-Learning · Formal and informal learning · Urban planning · Educational research

1 Introduction

New technology implementations in the teaching field have been largely extended to all types of levels and educational frameworks. In recent years, in addition to technology use in the classroom, new areas of research are opening to assess and recognize more effective and satisfactory teaching methods, such as: gamification strategies, Project Based Learning (PBL), Scenario Centered Curriculum (SCC), and the recognition of capabilities that provide the non-formal and informal education.

The current paper is based on four main pillars: The first pillar focuses on teaching innovations within different educational frameworks that promote higher motivation and satisfaction in students (especially at High School and University levels). The second pillar concerns how to implement such an innovation; we propose the utilization of different Information Technologies (IT) like Virtual and Augmented Reality (VR/AR), Digital Sketching (DS), and hybrid models, based on which students, as "digital natives", will be more comfortable in the learning experience. The third main idea is to employ a mixed analysis method to obtain the most relevant aspects of the experience that should

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be improved both in future interactions and in any new technological implementations within a teaching framework. And finally, the incorporation and analysis of users informal interaction of the implemented 3D proposal.

These interactions, as it pursues to demonstrate, provide an informal teaching to students, creating a link with formal systems through a central axis: the user and the assessments of both the experiment and its results. These relationships are vital in the field of architecture, where proposals of students and professionals have particular repercussions to the end-users of the proposal.

2 Background

2.1 Informal Education: The Citizenship Background in Architectural Education

The users experience (UX) and the usability have been handled normally as tools for the final product or system [1, 2]. Based on the results that the product obtained of the interaction with end-users, developers get value information. This feedback allows a better adaptation, redesigning and improving a system based on the opinion and typology of the end users. Historically this process has been used in the design of web environments, consumer products such as appliances and all kinds of technology especially those targeted areas such as leisure and social relations [3]. However we can affirm that it has great potential if adapted appropriately to education. As based on the behavior and emotions of end users of a proposal, the designers of the same (students) may improve in future projects.

Usually most studies are designed in a regulated manner, i.e. within an educational environment and a formal student training. However, in recent decades, there have been studies and research that emphasize the importance of other forms of education away from schools (regardless of the level) [4]. Learning processes are not only confined in regulated areas but also non-formal or informal are present throughout a person's lifetime [5]. To do so initially we must clearly differentiate between all types of education currently defined [6–8]:

- Formal Education: Learning typically provided by an education or training institution, structured and leading to certification. Formal learning is intentional from the learner's perspective: the hierarchically structured, chronologically graded 'education system', running from primary school through university and including, in addition to general academic studies, a variety of specialized programs and institution for full-time technical and professional training.
- Non Formal: Any organized educational activity outside the established formal system – either operating separately or as an important feature of some broader activity – that is intended to serve identifiable learning users and learning objectives.
- Informal: Learning resulting from daily life activities related to work, family or leisure. It is not structured (in terms of learning objectives, learning time or learning support) and typically does not lead to certification. In this case, each individual acquires attitudes, values, skills and knowledge from daily experience and the educational influence and resources in his or hers environment.

In base of these definitions, the architectural edication allows incorporationg (in a complementary way) non-formal educational elements, such as specialized courses, as well as informal education. In the education of a future architect or of a similar profession (such as a building engineer, civil engineer, interior design), the acquisition of knowledge informally is vital, because the development of a professional project always has a huge based on experience. Along this line, one of the great forgotten issues in urban design has been the project perception of the end-users. This review not only determines the success or failure of a project, but also informally influences the education of both future architects and active professionals.

It would be difficult to compile the number of functional projects in the design phases that have become architectural failures or that have generated controversy once finished because of the number of possible examples [9–11]. As we see below, not even the great architects and their works have been free of bad user experiences, from structural problems or other minimum problems that affect the end user. The perception and assimilation of the criticism continues to be an example of informal education, better or worse incorporated into new professional projects:

- 7 buildings with structural problems that cause problems in the environment or in its habitability [12].
- Examples of dangerous construction for users and /or with building problems [13]:
- Constitution Bridge, Venice. Santiago Calatrava.
- Zubizuri Bridge, Bilbao. Santiago Calatrava.
- City of Culture, Santiago de Compostela, Peter Eisenman.
- Nous Encants, Barcelona, Fermín Vázquez.
- Farnsworth House, Mies van der Rohe. This weekend retreat was never inhabited apart from the budget problems between client and architect; it is remarkable due to environmental confort issues [14].
- Ville Savoye, Le Corbusier [15]. From the outset of this construction, the building had severe problems with the weather, both from water and wind, being widely documented in the correspondence between the residents and the architect [16, 17]:
- Paving tiles in Paseo de Gracia, Esteve Terradas. The design of the new pavement meets aesthetic, a comprehensive study of materials and their adaptation to the Mediterranean climate, but has also been criticized for its roughness and possible problems that can cause treading with heels [18].
- The disease of modern buildings: the semicircular lipoatrophy. Referenced and related buildings for the first time in 1974 [19–21].

This does not only happen in the professional field, the same thing happens in educational fields for example: Designing an educational experiment does not always work successfully. Involving new technologies and the use of various devices is not always synonym of an effective user experience [22, 23]. A good design to motivate and improve students' learning can be transformed into just the opposite. Any "Good Educational Practice" must have different parameters for monitoring and evaluating each exercise, environment and student [24, 25].

And on the opposite side is the student's work. As a practical exercise it can perfectly meet all evaluable and pre-established criteria in technology and performance. But it

would be necessary to check whether the proposal is also functional and usable [26]. This step is an essential step which is usually forgotten in the teaching faculties, mainly due to lack of time [27], and where we focus our case study.

2.2 Improving the Student's Motivation: Assessment of IT in Education

In recent years, various technologies are proving useful in all kinds of educational areas, noted for its flexibility, spatial ability and adaptability to all educational levels. AR has emerged from research in VR. VR environments make possible total immersion in an artificial three-dimensional (3D) world. The involvement of VR techniques and models in the development of educational applications brings new perspectives to engineering and architectural (civil, building and urban) degrees. For example, through interaction with 3D models of the environment, the whole construction sequence in time and space of a bridge deck can be simulated for students' better understanding [28]. We can also explore hidden structure through ghosted views overlaid on the real-world scenes [29] or find several examples of AR and VR applied to monitoring the maintenance of new buildings and to preserve cultural heritage [30–32].

In a way, the new digital systems, devices and users (*based on the role of the students as "digital native"* users), enable new workflows that allow testing of more interactive, collaborative and generally misplaced progress and student skills. The 3D modeling and computer simulations (using both CAD and BIM models, Computer Assisted Design / Building Information Modelling), provide new ways for architecture students to study the relationship between the design, the space and the construction of buildings. Digital media helps integrating and expanding the content of courses in drafting, construction and design using for example d*igital sketching (DS), and hybrid models* [33].

However, there is a fundamental problem: the evaluation. And when we do, we evaluate at different levels:

- The Teacher evaluation. In this field, we are migrating from traditional systems based on tests to testing new models that assess the degree of acquisition of competencies and skills described in each case. The evaluation through rubrics and their adaptation to the student tracking systems are currently a challenge for its implementation.
- The evaluation of the technological proposals and their adaptation to students. For any given assessment of both technological or not, discussions arise whether the best approach is quantitative work, qualitative or mixed (that fuses both), the generation of statistical analysis of responses, indicators, correlation studies, etc.
- The evaluation of the informal feedback from users. The study by SCC and PBL generates a huge amount of subjective and difficult to parameterize information, but nevertheless provides a quality assessment on the work done by the student.

For the experiment described in this paper we propose the use of AR and DS as working platforms and presentation of planning proposals. To this objective we will design various assessment tasks in order to parameterize the experience at the highest level possible. This process is necessary for future iterations to more clearly define in a teaching methodology that integrates formal and informal aspects. Initially students will do a quantitative test to assess their technological profile. After the practical part, we

have generated rubrics for teacher evaluation, a quantitative test for the evaluation of the usability of the technology used and a qualitative assessment interview the proposed method. Finally (and in order to incorporate the informal evaluation of the project), we have interviewed a number of random users about whether their valuations affect the educational experience of students, but this first proposal without being quantified formally.

3 Case of Study

The city of Tonalá is located a few kilometers from Guadalajara and is part of its urban area. It is an urban area whose traditional activity has been the industry and handicraft of pottery and its street markets, called "Tianguis", having ones taking place on Sundays and Wednesday an industrial fame because of its size and the variety of products sold. This market chaotically occupies much of the streets of the city and the Municipality of Tonalá is trying to regulate them while at the same time improving the infrastructure of the city, especially the streets, sidewalks and signage. These objectives not only aim to improve the urban landscape but also remove architectural barriers (Fig. 1). Citizen participation in those processes is not common practice in Mexico. In this occasion, in addition to evaluating the use of ICT in the design phase and the visualization of new proposals in an education environment, we aimed to harness the structure of the University of Guadalajara to engage the students in the Tonalá High School, with whom several collaboration links had been established.

The objective to be developed throughout 2014 was the usage of QR (Quick Response) codes to perform an experiment on citizen participation that allowed the evaluation of proposals in its location. The final presentation of the course was the creation of a panel, triptych or report that explained the urban design project and point of sale proposal that at the same time described the creative process. For this purpose, the students had to illustrate their work and the design process through DS, AR and VR-Objects, including an explanation of the process [34]. All the information had to be stored in a link identified with a QR code. This code would be the one which, attached to all places in Tonalá where the project would be built (in the second phase of the work to be developed over 2014−2015), would allow the students of the High School of Tonalá of the UDG that wished to access the studies of CUAAD to participate in the evaluation of the projects (see sample panel in Fig. 2).

4 Informal Feedback. Main Results

As stated previously, to evaluate theend-users' feedback based on their subjective criteria visualizing the student's proposals, a qualitative approach was used. The users were invited to voluntarily participate in the study and share their opinion. The first set of users who tested the display was composed of a total of 24 people. We have identified four main subgroups, users related to architecture (students and professionals N1: 6), commercials (N2: 4), workers with no architecture skills (N3: 7), students and teachers from high school (N4: 7). Asked about two proposals made by the students, the most

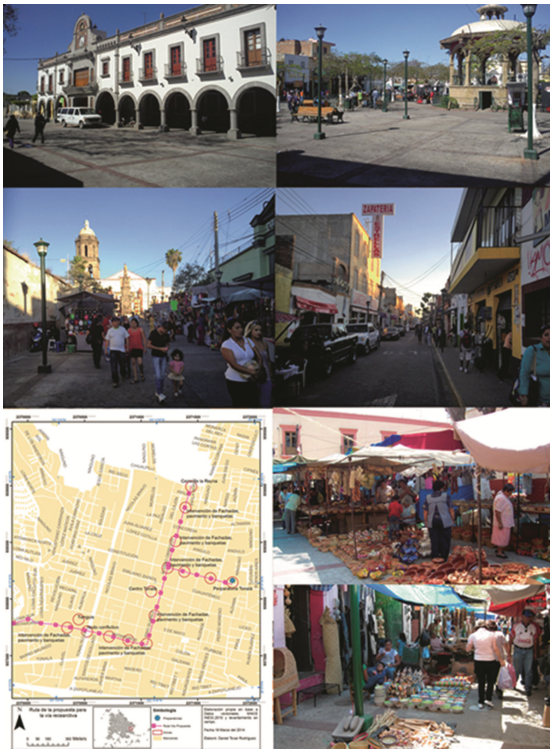

Fig. 1. Urban-rehabilitation project: "Tianguis", the new street markets

talked about aspects (positive and negative) mentioned were:

- Mention Index 45.83 % (+, positive aspect): Users who first saw operation of RA and were highly impressed. Highlights included citations of 71.4 % of students and 57.1 % of employed persons, and that none of the merchants in the market discussed the technology used.
- 29.16 % (-, negative aspect): The users understood that these proposal would be best suited to a wider environment (like a square) and for stationary use (static, without displacement). The mobile tianguis proposed do not adapt to the urbanization of Tonalá and produce serious problems of its installation and displacement. This has been cited by 75 % of traders, reflecting the understanding of the problem as something close to their daily work. The other subgroups have cited this aspect below average, highlighting the 28.5 % of students.
- 29.16 % (-): Selection of materials used in the proposals was criticized, considering that the more traditional wood be better adapted to the market rate, instead of other cutting edge materials. The group with a higher rate in this commentary was the people related to architecture (50 %).
- 24.33 % (+): Users understood the AR as a very useful and applicable technology in other areas especially on issues related to architecture, leisure, tourism and generally

Fig. 2. Final presentation

displaying heritage. In this section, the group that has commented on this aspect was those related to the field of architecture with a total of 33.3 %.

- 16.6 % (-): Little display space for products and /or too much unexploited volume. 75 % of traders have criticized the proposals due to a reduction in the useful area of commercial stands compare to the current system, something that directly affects their operation.

5 Conclusions

The first results of the education designed experiment show as we had previously hypothesized the importance of informal education. Of the students who conducted the

workshop for the proposed exercise, 95 % got the job done in time and fulfilling their objectives, with success rates of exercises presented all of them with passing grades and 85 % of them with distinction. However, as a result of informal surveys conducted for users who viewed and interacted with their proposals, we can conclude that they would not adapt successfully to the main objectives of the experiment: a new reformulation and urban restructuring of street trading in Tonalá. We discover 1 in 3 people (about 30 %) questioned the proposals, just the kind of information that allows to informally educate students in areas not covered by the proposed practices.

Note also that the AR is a technology that adapts very well to the actual visualization needs both architectural and urban 3D models. This adaptability and ease of use allows us to state that to the extent that they can optimally control aspects such as display materials, casting shadows and the ability to make changes and queries directly on the models, it is a system that perfectly complements one of the key aspects in architectural education: project presentation.

Nowadays, the project continues with the next phase of collectiong the opinions of users viewing ths site proposals. It is anticipated that this phase of informal assessment and wide sample of comments performed in this article will be closed throughout the month of January 2015. With the final results a new workshop is proposed disaggregating comments by user gropus as the main desing principle so that students effectively incorporate the information received informally in their proposals.

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