Chapter 68

Augmented reality applied in distance education in the undergraduate course in architecture and urbanism: experience and innovation report

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ABSTRACT
Currently, the race to implement technology in higher education institutions (HEIs) is, without precedent, a need that has been greatly exacerbated and evidenced by the covid-19 pandemic. Mandatory social isolation has made the main forms of approximations and exchanges occur through the internet. From the beginning, education became one of the most impacted sectors, with strictly face-to-face courses migrating in days or at most weeks, becoming completely distance learning. The objective of this study is to understand and analyze what are the aspects of innovation, creativity, sustainability, and user experience in augmented reality technology that can be developed and leveraged in education in architecture and urbanism. The unit of analysis is a case study, carried out with teachers, tutors, and the distance learning coordination team on the BAONLINE Moodle platform of an HEI in São Paulo. As a method of user experience analysis, the case study used the Attrakdiff protocol, which evidences the points to be improved in the interface of the Augmentecture augmented reality platform, so that students can have a better experience with the technology when deployed. The results obtained with the data at the end of the research are based on the experiences of teachers, tutors, and the coordination team of the HEI's distance education platform. It is concluded that through the analysis of teachers and tutors, augmented reality collaborates a lot with student learning and research participants are interested in seeing the tool applied in other disciplines and in learning how to develop interactions in augmented reality for classes. The main limitations are the lack of knowledge in handling the technology and the difficulty found to visualize the interactions on the Augmentecture platform, as there is a need to simplify the interface about technical visualization issues.

Keywords: Distance Education – EaD, augmented reality, architecture and urbanism, higher education.

1 INTRODUCTION

Augmented Reality (AR) applied to Architecture and Urbanism is an innovative way of visualization, which enables the understanding of the project or object in 4D (four dimensions), a necessary form of representation that allows a more complete experience of the project, enabling the observation of its three dimensions from any point of view (ZEVI, 1994), being suitable for observing: urban spaces,

architectural constructions and even details, furniture, small objects on an enlarged scale and contexts and large systems on a reduced scale, and it is often possible to visualize it in full scale using Smartphones.

Usually, in HEIs, Architecture and Urbanism projects and activities are represented by two-dimensional drawings, 3D photorealistic perspectives, videos, or physical models that, sometimes, present limitations to the complete understanding of the project, since there is a gap between reality and the plans, facades, and elevations (technical drawings), which were conceived to establish metrics and consequently in this way illustrating a project with the proportions closest to the real one for the understanding of the client or spectator (ZEVI, 1994). The representation design of the intention of a project is always symbolic and is following the technology used, however, the less abstract the representations are, the easier it is for the receiver to understand when all the digital and analog technologies used in the project converge to understand broader, be it two-dimensional or three-dimensional.

When considering that AR is a digital work tool that facilitates the understanding of content when the most accessible alternative to education since the beginning of the COVID-19 pandemic is Distance Learning (EaD), the technology of AR can offer greater interaction and a different way of viewing educational content online and also in person. In this scenario, the study presents an alternative of graphic representation with innovative disruptive technology in Architecture and Urbanism, because according to Prensky (2012), the use of technologies has enabled more relevant and differentiated learning when compared to the previous one without digital resources, since 21st-century students are raised very differently from those who were not born with the technology present since childhood, and the teaching model created and replicated in the last century has not yet evolved significantly to accompany this transformation. Digital inclusion in the classroom, or another educational environment, enables access to information, in an interactive way and with applications in the most varied segments, its positive contributions and needs for improvement are evidenced according to what one wants to obtain in the visualization of the object or process.

The interaction project with AR in EaD developed on the BAONLINE platform is illustrated in figure 1, below. All works that were selected are emblematic of the study of Architecture and Urbanism. The development of the project for the case study can also be used to exemplify an activity that could be proposed by the teachers, where it is necessary to visualize and/or study works, either by the technique in which the work was developed or by the unusual structural form. The teacher can include the transformation of digital models into 2D and 3D through AR, proposing activities to students in the following ways: freehand observation drawings, visualization of painting techniques, furniture and buildings settings, interactive tours on 3D modeling on a larger scale, visualization of 3D construction systems, 3D models as a basis for aiding in the preparation of cuts in instrumental technical drawing, among other possibilities.

Figure 1 – Statue of Venus de Milo on top of the table in AR.

Source: Prepared by the authors (2020).

2 OBJECTIVE

This research aims to understand and analyze how AR can help in the teaching of Architecture and Urbanism in Brazil, as well as to verify which are the main aspects of the technology used in learning and teaching Architecture and Urbanism, including lines of research linked to innovation. , creativity, and sustainability of AR technology. It also deals with how this work tool can be applied in the development of teaching and student projects, in the urban and architectural context, as it seeks to analyze its impact on the presentations and execution of these projects, contextualizing the theme from understandings that are necessary to evolve analyzes of what AR is and how it can benefit HEIs, students, and faculty. In this sense, it aims to justify and substantiate the scientific and social relevance of research with the inclusion of digital technology in teaching, which, according to the World Economic Forum (2020), is a global need that is highlighted and enhanced in times of mandatory social isolation such as those that we have lived since 2020, due to the COVID-19 pandemic.

3 THEORETICAL REFERENCE

Graduation in Architecture and Urbanism in Brazil is a professional training process, where the student has at his disposal contents that present diverse knowledge for application in the profession in several areas of work. However, among the main contents are those that illustrate the construction and management of physical space projects with buildings, and urban and regional areas. In the teaching-learning methodologies of higher education in Architecture and Urbanism, there is a division between the theoretical part and the practical part of the same content, with the practice being carried out in laboratories and ateliers, a process adopted at the German Bauhaus school. According to Fontoura (2009), at the Bauhaus, the teaching model was not focused on transmitting information from the teacher to the student, but through theoretical teaching applied to practice in workshops and spaces intended for carrying out activities. This institution specializes in teaching Arts, Design, and Architecture and was founded in 1919, with the teaching-learning process replicated by HEIs worldwide. The training of students must comply

with the National Curriculum Guidelines since the profession is unified throughout the territory. The regulation of the profession is guaranteed by law, where there are activities and attributions exclusive to the professional. To demonstrate the importance of teaching methodologies linked to the practice and experience of the student, Reyes (2001), states that Architects in tradition, acquire knowledge during training and learn to design mainly in the practice of creativity, which can be defined, (Zetune,2003, p.24, apud Oliveira; Arab; et al. 2019 p.30), as the ability to constantly produce distinct and valid results. Creativity is what differentiates each product and/or service. The term Creative Economy, coined by Howkins (2013), introduces that creativity is not necessarily an economic activity, but it can become one if it produces an idea with economic implications or a marketable product.

The challenge of innovating and other priorities that education currently faces are many, and several of them are complex to resolve, whether due to a lack of specialized labor or economic issues. It is a need that demands efforts mainly from the HEI and the professors regarding the mentioned barriers. Innovation is, therefore, one of the priority demands of the present. "Efficient schools are schools open to innovation, in continuous search for better answers to recurrent problems" (THURLER, 2001, p.10 apud FONSECA, 2007, p 13). The inclusion of the distance learning teacher and tutor in the sustainable innovation process is important for the better development of the project or innovation proposal, due to aspects related to the broad understanding of what is intended to be obtained related to the perceived need, making the teacher feel co-responsible for the success of the initiative.

Hernández et al. (2000), evaluate the causes of failure in the process of implementing educational innovations and presented the following hypotheses: a) A simplistic model of innovation that did not take into account the complexity of the relationships that permeate educational organizations; b) Due to the lack of knowledge of details and the absence of an interdisciplinary vision, there was always a mismatch between planning and execution; c) Innovations enacted from the top down provoked a cultural change, considering that innovation processes have always been controlled by teachers; d) Disdain for the fundamental role that the teacher occupies in carrying out innovations in school. These hypotheses must be taken into account, as this type of innovation proposed in the case study is applicable mainly in the hybrid teaching model since the idea is that educators and students can teach and learn at different times and places at the HEI.

The first record of the denomination Augmented Reality was by Tom Caudell and Mizell in 1992, researchers who visualized that AR could help the aircraft manufacturer Boeing, due to immersion and interactivity being almost the only way to educate pilots in aviation. Soon, AR will be more part of daily human activities in many areas, as well as computer software on mobile phones. Be it through social networking applications or project presentations. This is due to the advancement of the Fourth Industrial Revolution.

Technological systems are still in their infancy, being developed at universities and high-tech companies, both implementing techniques and/or interaction observations that still need to be evolved. The applications of AR are very extensive. It can be used for marketing actions, online product sales, to

applications in medicine, which is one of the most important fields for the use of AR, as this system can serve to guide some types of surgeries and also in preoperative studies. , including surgery planning.

4 METHODOLOGICAL PROCEDURES

This study uses the qualitative research method. Documental research was developed through a survey and reading of scientific articles and publications on renowned websites, related to the object of study, analyzing mainly the bibliographical references that historically contextualized the forms of representations linked to Architecture, Urbanism, and Teaching. Thus, we wanted to understand greater depth the particular phenomenon by using a single case. For the delimitation of the case, it was decided to study an HEI based on the activities carried out by the professors and the distance learning coordination team.

It is also exploratory research that seeks first information about the phenomenon, with multiple sources of evidence and their convergence based on the triangulation of data from the Attrakdiff protocol, with theoretical definitions helping in the analysis process. The Attrakdiff survey method by Hassenzahl et al. 2003, aims to analyze the convergence of data in a linear structure report, analyzing the pragmatic quality, stimulus hedonics, identity hedonics, and attractiveness of the mobile application used, through a structured questionnaire. In this case, the protocol was applied in such a way that the application of the American StartUp AUGmentecture Inc., which made the use of the platform available for free during the first half of 2020, was analyzed so that it was feasible to delimit the main characteristics perceived by users during use, along with data collection and analysis of the results for better future application performance. All data were obtained based on the user's experience during learning, to reach some conclusions about the use of the application and the final user experience.

The case study presented was carried out in a course taught at a distance, entitled History of Art: from antiquity to the nineteenth century, which allowed exploring the issue dealt with closely, since 15 interactions in Augmented Reality were developed and applied. For the visualization of these interactions, a tutorial was made available containing the step-by-step way of visualization and manipulation of the AR application AUGmentecture for teachers and tutors. The information was made available during the modules in parts of the discipline for the first half of 2020. Based on the premise that we are seeking to understand how HEIs can improve teaching through AR, the units of analysis should be two: the HEI and the AR application, understanding how decisions are made by individuals, analyzing how knowledge transfer occurs and how this tool can become more attractive to users. It is a kind of built-in case, due to the two units of analysis, with the preparation for data collection in the pilot format, where lessons learned in the first place are emphasized for future research. Figure 2 below illustrates in diagrammatic form the general methodology developed, and applied in the case study:

Figure 2 – Diagram of the pilot project structuring method.

Source: Prepared by the authors (2020).
Subtitle: First line
Ideation and presentation of the project
Project approval by IES
License to use the AUGmentecture platform granted by the CEO
Analysis of content to be transformed into AR
Selection of works

Second line
Availability of files in open modeling databases
Compatibility and file adjustments
Transformation of 3D models into AR
Assistance from app technical support for adjustments
Elaboration and application of the marker

Third line
Approval of final models by IES
Insertion in the BAONLINE EAD platform
Testing on IOS and Android systems
Release to use the tool
Application of the Attrackdiff protocol

Fourth line
Analysis of results
Information shared with the AUGmentecture platform
Improvement of identified points and mapping of the next ones to be improved
Note: It is recommended to review the technology every 6 months or according to updates released with technological advancement

5 RESULTS

The data obtained at the end of the research are based on the experiences of teachers, tutors, and the coordination team of the EaD platform at the IES. AR visualization was performed using the AUGmentecture platform. The Attrakdiff questionnaire was made available to a total of 183 professionals, online via email and WhatsApp (instant messaging software), due to mandatory social isolation. The questionnaire was sent three times on different days and times, available for a response for 1 (one) week.

Sample 1: Professors of Architecture and Urbanism: 13 out of 54 responded, which corresponds to 24.07% of the sample; in the response of the participants related to the group of professors of Architecture and Urbanism, 53.84% of the people were women, and 46.16% men. Of these, only 15.38% were aged between 20 and 40 years and the remaining 83.34% were aged over 40 years. Half of the sample stated that they have mastered the technology, but 61.53% used the AUGmentecture application for the first time or less than a month ago. Of this group, 92.30% would like to see AR in some or all disciplines and are

interested in learning how to do this type of interaction. Regarding help in viewing the interaction through the application, 38.46% of the participants needed a lot of help in viewing. Of these, 100% are over 40 years old.

Sample 2: Teachers from areas linked to the creative economy: 12 out of 117 responded, which corresponds to 10.25% of the sample, where 75% of the participants were men, and 16.66% are between 20 and 40 years old. Of these, 100% are interested in seeing AR applied in some or all disciplines and believe that technology greatly contributes to student learning. Only 8.33% are not interested in learning about technology.

Sample 3: Online BA platform tutors: 4 out of 6 responded, which corresponds to 66.66% of the sample. In the group of tutors, 75% of the participants were women and 100% of the participants are up to 40 years old. All believe that AR collaborates for teaching and would like to see its application in other disciplines, also interested in learning how to interact with technology, but 75% of these did not master the technology and needed some kind of help for visualization.

Sample 4: Online BA platform coordination team: 5 out of 6 responded, which corresponds to 83.33% of the sample. In the coordination team, 80% of the participants were women, and 60% were aged between 20 and 40. Of these, 100% believe that AR contributes to teaching and would like to learn and see the technology applied to other disciplines. These people use the technology for up to 1 year and have learned to manipulate the software in the deployment process, not having much difficulty and requiring little help, when that was the case.

The samples are considered sufficiently taking into account the total number of professors at the HEI, and also, these participants are professors or tutors, people who are responsible for teaching or helping with the content of the HEI. Once one of these professionals is interested and applies, in just one class, an average of 30 people will have access to the interactive content, with a teacher who is willing to participate in an excellent technology communication channel. What can also be considered limiting to the responses is that due to COVID-19, teachers had to update quickly and are still adjusting to the technological boom that was imposed so that face-to-face activities continued digitally. Therefore, there may be an overload of activities and other issues related to time constraints and interest in the line of research studied.

The information below refers to the percentages of the samples, taking into account the total number of participants who answered the questionnaire. In total, 34 people participated, totaling 100% of the numbers that will be presented in the sequence. The data show that 50% of the survey participants were men and 50% women, all aged over 20 years, with the largest population between 40 and 60 years old at 50%, the intermediate between 20 and 40 years old at 35.3%, and the smallest over 60 years old, totaling 14.7%. Based on these data, it can be concluded that most of the people who participated in the survey are over 40 years old, totaling 64.7%. All participants who are not teachers have a higher education degree and those who are teachers have a Master's or Doctor degree, showing a high degree of technical knowledge in areas related to the study.

In questions related to the domain of technology, 66.7% of the participants do not master any type of AR technology, and only 33.3% mastered some AR technology. However, 90.6% of the participants are interested in learning how to make this type of interaction presented in the case study in class; 3.1% already work with some AR technology in classes and only 6.3% are not interested in learning how to do it.

The research also made it possible to realize that the application is not so easy to be manipulated by users because even though almost half of the participants did not need much help, 61.7% of the participants need some kind of help, which is a number relevant to the sample. It is considered necessary to improve the beginning of the visualization process, as this necessary external help requested by users can become an implementation limitation.

The limitations of technology from the perspective of the participants were also questioned in the survey using the Attrakdiff form, receiving several comments, including the availability of educational content, cost of platforms, difficulty in accessing the internet, the need to acquire mobile devices with better performance, the expectation of high realism on the part of the students and a specialized team for the development and preparation of activities for the classes.

The free comments linked to the experience as a whole are mostly encouraging, expressing the desire of the participants to know more, and that they felt that these are activities that cause engagement and interest in an innovative way with many different possibilities, also citing the possibility of expansion from the project.

According to the experiences and the analyzed information obtained through the users, it is possible to analyze the AR application AUGmentecuture, with graphs generated automatically by the Attrakdiff protocol on the website http://attrakdiff.de/ (last seen on Aug 03 . of 2020), from pairs of words and their location for the AUGmentecuture app. In the analysis, the application has a clear acceptance by users, even with access difficulties and help needs. All aspects of the application can be improved for the best user experience. However, the point that should be improved with priority is related to the ease of viewing the model, due to the language used in the interface, which is more technical than human. Following are the results obtained, showing the score obtained by the platform, on a scale of -3 to 3. The AUGmentecture platform scored more than 1.3 in 3 out of 4 questions related to the practical issues of the platform, and only the pragmatic quality below a score of 1. Finally, by protocol, AUGmentecture's AR technology is considered between self-oriented and desired. The protocol contributions were sent to the CEO of the AUGmentecture platform, aiming at the development of technology for the best performance of users in HEIs.

6 FINAL CONSIDERATIONS

The world is in constant evolution and it is extremely important to accompany this process so that we can contribute with ideas and achieve new technologies by creating innovative types and spaces of solutions for the common good. The main contribution of this project was to initiate a process to assist HEIs in the implementation of AR technology, as well as the development of the AR platform AUGmentecture, which is present in teaching activities in more than 60 HEIs around the world (data obtained from exchanges of information on the application of AR in HEIs, with the CEO of the platform at the end of 2019), so that both companies become more assertive in managing innovation with AR technology, with accurate information directed towards the desired purpose of the experiences offered to users, in this case, students and teachers, Architects and Urban Planners. The results obtained help to improve the interface of the AUGmentecture platform, highlighting the technical issues that must be corrected, mainly the pragmatic issues related to the visualization, since it was verified by the analysis of the users a great difficulty in the realization of the visualization, in several of the cases being help necessary, but there was also great interest on the part of educators in the technology learning process. One hypothesis is that this is due to the perception of collaboration in understanding the project with AR technology. Due to the inherent limitations of the research, the spatial scope must be taken into account, where, when, and how the research was carried out, in this case in a particular HEI, in the state of São Paulo, Brazil, with the support of the American Startup AUGmentecture using it. using the Attrakdiff user experience analysis method, during the first half of 2020, simultaneously with the worsening of the COVID-19 pandemic, in Brazil, a country widely affected with more than 130,000 deaths caused by the disease in the same period of the study. The approach used in this research makes room for future projects with possible analyzes of other platforms since the experiences collaborate a lot with the student's learning and the professors are interested in applying it in the academic routine. As a theme for future work, we suggest the study of AR applied in an EaD discipline for a whole semester, seeking acceptance and analysis by students, starting from this assumption the use of the Attrakdiff method for data comparison even in situations with different characteristics, since the main factor is the user's experience with the technology. Studies should highlight the limitations of technology so that students can have better and better experiences as technology advances. Different realities can be analyzed with the same study protocol. With this, the case study carried out with the support of the IES of São Paulo for teachers and tutors of the History of Art discipline: from antiquity to the nineteenth century, in the first half of 2020, contributed to the evolution of technology with its developers, so that it is improved for the use of students, aiming at a future that is benefited by AR technology more widely in HEIs. This is a social impact on teaching, aiming at the possibility of AR technology being used in favor of a sustainable social, economic, and financial result, substantially relevant for educational institutions.

REFERENCES

CAUDELL, T. and MIZELL, D. ***"Augmented Reality: An Application of Heads-Up Display Technology to Manual Manufacturing Processes."*** *Proc. Hawaii International Conf. On Systems Science,* Vol. 2, 659-669, 1992.

FONSECA, E. M. **Barreiras à Inovação Educacional: As dificuldades em utilizar a autoavaliação de inovação**. Dissertação de Mestrado. 144p, 2007. Disponível em: https://repositorio.unb.br/bitstream/10482/3208/1/2007_EdilbertoMouradaFonseca.pdf. Acesso em: 12 Jul. 2020.

FONTOURA, A. M. **Bauhaus A pedagogia da ação**. Revista ABCDesign, 2009. Disponível em: http://abcdesign.com.br/teoria/bauhaus-apedagogia-da-acao/. Acesso em: 12 Jul. 2020.

HASSENZAHL, M., BURMESTER, M. e KOLLER, F**. *"AttrakDiff: Ein Fragebogen zur Messung wahrgenommener hedonischer und pragmatischer Qualität"****, In Mensch & Computer*, p. 187-196, 2003.

HERNANDES, Fernando et. al. **Aprendendo com as inovações nas escolas**. Trad. Ernani Rosa. Porto Alegre: Artmed, 2000.

HOWKINS, John. Economia Criativa: Como ganhar dinheiro com ideias criativas. São Paulo: M. Books, 2013. Disponível em: https://www.paulofreire.org/o-instituto-paulo-freire Acesso em: 16 jun. 2021

OLIVEIRA, L. R., ARAB, M. A., CARDIM. P. G., et al. **A arte de empreender na economia criativa: pensar, compreende e agir**. São Paulo: Editora Reflexão: Centro Universitário Belas Artes de São Paulo, 2019.

PRENSKY, Marc. **Aprendizagem baseada em jogos digitais**. São Paulo: SENAC São Paulo, 2012. 575 p. ISBN 9788539602711.

REYES, J. A. A. **Expressão Gráfica e Novos Meios Educativos: metodologias coletivas para o ensino de projeto em engenharia e Arquitetura**. Revista Escola de Minas, v. 54, n.1, 2001. Disponível em: http://dx.doi.org/10.1590/S0370-44672001000100010. Acesso em: 12 Jul. 2020

ZEVI, Bruno. **Saber ver a Arquitetura**. Martins Fontes, 1994.