

TEACHING INTERIOR DESIGN IN AUGMENTED REALITY

Lana Frančeska Dreimane, Zinta Zālīte-Supe
University of Latvia, Faculty of Education, Psychology and Art

ABSTRACT

Augmented Reality (AR) has been effectively utilised across a diverse range of industries, including entertainment, medicine, the military, engineering and design. In parallel, AR has irreversibly changed the potential for interaction with the learning object across all education levels and a broad variety of disciplines ranging from the introduction of new concepts in Primary Education to more complex learning in STEM (science, technology, engineering, and mathematics), social sciences and humanities in Secondary and Tertiary Education. Current 21st Century research presents evidence that effective application of AR in education can facilitate effective competence acquisition while strengthening learner motivation and ensuring successful knowledge transfer to new contexts. Because of the swiftly shifting demands of the labour market and the immense potential of technology, the learning environment and context has become fundamental for learning in the 21st Century. Interior design as a field is a balance between creative innovation and the unbreakable bond with the physical reality demanding respect for precision and functionality. Major international companies, such as Amazon, Ikea, Wayfair and Target have been successfully utilising AR since the 2010s. Thus, nowadays, interior design education is unimaginable without incorporating AR technology, as this enables educators to deliver new forms of engaging and addressing interior design. AR permits experimentation without losing the attributes of the physical environment, thus allowing learners to gain more practical and diverse experience. This study addresses the lack of a systematised knowledge base, which is necessary to inform pedagogic and instructional decisions for interior design education at the secondary school level by examining scientific literature and analysing case study experience in order to formulate findings and recommendations for interior design educators and course developers.

Keywords: *augmented reality, education, interior design, secondary education*

Introduction

Since 2020, new teaching content and approach have been gradually introduced in Latvian schools in line with the new standards for basic and secondary education; in particular, the subject of “Design and Technology I”,

which requires students to learn different topics of design, including interior design. It is an entirely new subject where teachers need to acquire the knowledge and understanding of the programme’s framework as well as being able to traverse the variety and effectively utilise the new these methods and tools to deliver high quality learning process.

In Autumn 2021, the IT Education Foundation conducted a survey of 459 pupils from every Latvian secondary school in which “Design and technology” as a subject is taught. The survey showed that 77% of all students would like to learn subjects of design and technology on a digital platform with a variety of video materials, game elements, augmented reality tools and other interactive capabilities. The greatest interest for pupils would be, initially, in interior design (36%) and this shows that students have an interest and desire to use digital tools in design and technology lessons.

Technological developments in the 21st Century have created an opportunity to transform learning and education (Laurillard, 2007; Zhu, et al., 2016; Daniela, 2021; Dreimane, 2020). The use of technology includes a set of processes which teachers must consider. First, before technology can be used in the training process, these processes must be assessed in the light of the defined learning outcomes to be achieved (Daniela, 2019). Secondly, digital and virtual solutions must be carefully evaluated before they are used as a learning resource or tool, for example, so that their purpose is not confined to the principle of entertainment (Daniela, 2020). Thirdly, the teacher needs the knowledge and expertise to choose the most relevant technology or digital tool for the topic being studied.

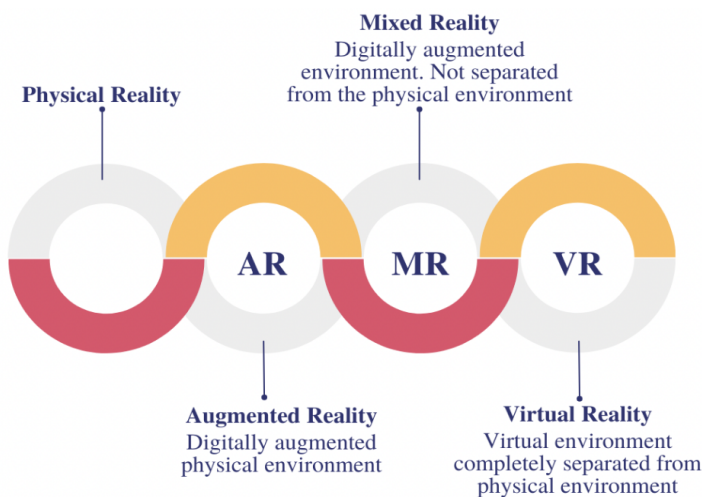


Figure 1. Levels of Virtuality – Immersive Technologies.
Concept developed based on Dreimane (2020)

One of the technology groups used in education to achieve the learning goals is immersive technology. Dreimane has defined immersive technology as a “Technology group whose unique characteristics are digitally generated three-dimensional visualization, or 3D environment, and the capabilities of different levels of interaction with the 3D environment (human interaction). The immersive technology group includes Augmented Reality (AR), Mixed Reality (MR) and Virtual Reality (VR) technologies (2020) (Fig. 1). In the context of this study, the AR has been used and studied. AR can be explained as: “interaction with the real world through “additional” digital information coverage (additional information on the physical environment around)” (Dreimane, 2020, p. 37).

Interior design as a field encompasses a balance between creative innovation and the unbreakable bond with the physical reality demanding respect for precision and functionality (Nee et al., 2012). Major international companies, such as Amazon, Ikea, Wayfair and Target have been successfully utilising AR from 2017 (Gürçınar & Esen, 2018). The AR technology is applied to classroom-based learning and is better for teaching interior design (Nee et al., 2012; Billinghamurst & Duenser, 2012; Chang et al., 2019). This technology, compared to other immersive technologies, is more accessible because it can be used on tablets, mobile phones and stationary or portable computers (Nee et al., 2012). The first AR learning experience for use in the interior design sector were developed in 2005 for the purposes of marketing. This AR learning experience – “KPS Click & Design” allowed virtual furniture (Haller et al., 2006) to be placed in a room. Twenty-seven years have passed since the first AR learning experience was developed directly for use in the educational environment when, in 1995, a team of researchers (Kancherla et al., 1995) presented a learning experience in anatomy (Garzón, 2021). However, the turning point in the development of AR technology was in 2016, when the public met Pokemon GO (Qiao et al., 2019). It gained unprecedented popularity and during the first eight weeks following publication, Pokemon GO was downloaded more than 500 million times (Pokémon report GO, 2016).

A series of studies have been conducted during these years (Hampshire et al., 2006; Dunleavy et al., 2009; Billinghamurst & Duenser, 2012; Radu, 2012; Wu et al., 2013; Bower et al., 2014; Bacca et al., 2014; Akçayır & Akçayır, 2017; Ibáñez & Delgado-Cloos, 2018; Masmuzidin & Aziz, 2018; Chang et al., 2019; Kumari, 2020; Kairu, 2021) explaining and studying the importance of AR in the education sector and teaching subjects related to science, technology, engineering and mathematics (STEM), music, interior design and art amongst others. However, there is a lack of systematic studies focusing on the pedagogical principles of using AR in the teaching and learning process. This is a very important aspect, since it is

not technology that needs to be viewed primarily, but how it can support teachers and pupils in the teaching and learning process.

Researchers (Masmuzidin & Aziz, 2018; Kairu, 2021), list four main educational benefits from using AR at education:

- 1) learning content in the 3D environment,
- 2) collaborative, situative and engaging learning,
- 3) feeling of presence and immersion in the environment, and
- 4) the opportunity to visualize “unseen”.

In addition, interior design practitioners (Charmaine, 2018; Sobacchi, 2019) and researchers (Hui, 2015; Gürçınar & Esen, 2018; Samant & Vartak, 2019; Chang et al., 2019) explain that modern interior design education is not conceivable without using immersive technology because it enables educators to offer new ways to attract interior design issues. This experience can help students to prepare for the changing working environment, as well as acquiring knowledge which will serve as a strong basis for future levels of education (Chang et al., 2019).

Methodology

This research was implemented using a design-based study approach in combination with two qualitative research methods: analysis of scientific literature and testing, pooling and analysing AR learning experiences for interior design skills. The collection of AR learning experiences was carried out using the social networking analysis method – Nodes (Robin, 2015). The Nodes method is based on a premise that network is interrelated. Finding one AR learning experience or a case study leads to the next one.

AR learning experiences were analysed using VR learning experience evaluation tool developed by Dreimane (2020) There were three criteria groups:

- 1) Purpose of learning experience;
- 2) Instructional strategy; and
- 3) The design of experience, and a total of 20 criteria, 88 sub-criteria.

The tool was designed primarily for evaluating virtual reality experiences, but it has broader aims:

The proposed VR experience evaluation tool was essentially developed to serve as a purposeful quality control or a design development instrument that would inform instructional designers, educators, learners and VR content and technology professionals by providing a clear and multi-purpose framework that outlined the alignment between the instructional, pedagogical and VR learning environment in order to ensure and strengthen the efficiency of the VR learning design and instructional strategies (Dreimane, 2020, p. 64)

Learning experiences were tested to primarily assess whether the learning experience was related to the interior design area, followed by learning experience gathering and analysis. As a result, ten learning experiences were analysed.

Discussion

Scientific literature does not single out just one theoretic framework which explains the general principles of learning in a technology enhanced environment. This study is based on the learning of a number of pedagogical theories – Constructivism (Piaget, 1956; Vygotsky, 1978; von Glasersfeld, 1974), Constructionism (Papert, 1993) and Connectivism (Siemens, 2005). Within each of these learning theories, there are important aspects that explain the importance of technology in education and can serve as a justification for selecting a specific digital tool and developing a certain learning design. The framework of Constructivist learning explains that learning is an active process and knowledge is constructed on the basis of past experience (Piaget & Cook, 1956). Constructivism is one of the most important of all the applied theories (Anderson, 2016), which constitutes an understanding of learning through technology (Garzón & Acevedo, 2020). Another fundamental theory explaining the potential benefits of using immersive technologies is Constructionism, developed by Papert (1993). This theory highlights the potential for practical tasks during learning or learning by doing (Papert & Harel, 1991). It was considered that by integrating technology with traditional constructive activities, pupils themselves create new experiences and new ways of thinking (Papert, 1993). Online interactive learning plays an increasingly important role in modern education. Connectivity is a learning theory for the digital century (Duke et al., 2013) and explains the key aspects of learning in the digital environment (Siemens, 2005). Siemens explained that learning is becoming a process of creating knowledge where the human network is used as a developer of knowledge capacity.

However, in order to ensure a targeted implementation of AR in the teaching process, it is necessary to define technology opportunities, limitations and to set how the defined learning outcomes will be achieved. AR has been used in education to visualise abstract objects and to enable pupils to address the challenges that are as close as possible to real life (Liono et al., 2021). In the modern era of information shifting, an in-depth understanding of learning content and a longer period of remembering (Radu, 2012) are essential aspects of the teaching and learning process.

There is some evidence presented in scientific studies, where the researchers justified how the teaching of design-related subjects can be

improved by AR technology. Billinghamurst and Duenser (2012) explain how, for secondary and primary-school pupils, scenes of AR can be an educational experience for themselves, because pupils need to think about how to use technology to reflect complex concepts more easily.

Other scientists (Nee et al., 2012; Carmigniani et al., 2011) explained that AR technology is becoming an important tool for prototyping. Teaching and learning architecture and interior design within AR technology can create three-dimensional models, where the physical, surrounding, environment is linked to the virtual environment, interacting with each other. From the perspective of both pupils and teachers, the use of AR technology in the teaching and learning process has more benefits than shortcomings, but the authors of current study agree with the findings of researchers (Dalgarno & Lee, 2010) that the technology does not ensure learning on its own, but rather presents potential for learning benefits. When developing learning design, the teacher should consider both benefits and risks.

In order for an teachers to have practical tools that could be used to teach interior design, this study implemented testing, pooling and analysis of ten AR learning experiences for developing interior design skills, using VR learning experience evaluation tool developed by Dreimane (2020). One of the key lessons that emerged is that there are relatively few platforms designed to be used in the learning process of developing interior design skills. Out of a total of ten AR learning experiences, only two directly focused on education (Live Home 3D and Planner 5D). Eight AR learning experiences can be adapted and integrated into the teaching and learning process (see Table 1).

Table 1. Learning experiences for teaching interior design in augmented reality environments

No.	Title of learning experience	Brief general description (functionality, accessibility)
1.	Roomy	In this learning experience, you can choose from a variety of online shops and use them to fit the room using AR. Offer both for a specific room to design, such as your own room, and choose one of the existing solutions. You can choose different colours, fabrics, patterns, and styles for interior design projects. Operating system – IOS, free Online link: https://roomy.com/interior-design
2.	Houzz	A learning experience which offers the possibility of purchasing different interior objects, drawing inspiration from projects already developed and creating your own interior design projects. Operating system – IOS, free Online link: https://apps.apple.com/ca/app/houzz-interior-design-ideas/id399563465

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3.	IKEA Place	One of the first AR learning experiences that offered the user the chance to “try” it in a particular room before buying a commodity, with the augmented reality. Operating system – IOS and ANDROID, free Online link: https://apps.apple.com/ca/app/houzz-interior-design-ideas/id399563465 or https://www.ikea.com/au/en/customer-service/mobile-apps/say-hej-to-ikea-place/pub1f8af050
4.	Measure	With this, AR can “convert” your learning experience, phone, or lanetwork into a measuring instrument. Operating system – IOS, free Online link: https://support.apple.com/en-ca/HT208924
5.	Myty	AR learning experience in which you can create interior design solutions. Offers you the opportunity to meet the different stories of designers and the products they create. Operating system – IOS and ANDROID, charging platform, basic features free Online Link: https://myty.app/en
6.	Magic plan	AR learning experience in which space plans and plots can be created and it is possible to perform calculations. You can also add different photos. Operating system – IOS and ANDROID, charges (depending on the purpose of use, ranging from € 9.99 to € 89.99) Online Link: https://www.magicplan.app
7.	Decormatters	AR learning experience that offers the possibility of creating interior design projects for different residential areas. Interior professionals are evaluating the projects they have created. Operating system – IOS, separate functions free of charge (each interior item should be purchased separately) Online Link: https://www.decormatters.com/office
8.	Dulux	AR learning experience that offers room-changing colours for walls and ceilings. Operating system – IOS and ANDROID, free Online link: https://www.dulux.co.uk/en/articles/dulux-visualizer-app
9.	Live home 3D	AR learning experience in designing and looking at interior design solutions in a 3D environment. A wide selection of rooms and houses and various interior design objects, colours, textures and styles are also available. Operating system – IOS and ANDROID, Individual features free. For the education sector, a basic offer of around EUR 20 for professionals, around EUR 35. Online Link: https://www.livehome3d.com/support/
10.	Planner 5D	AR learning experience where to find design solutions for interior design and to look at them in the AR environment. In addition, there is an interior design school where you can learn different topics in video lectures in this industry and how to use the Planner 5D platform. Operating system – IOS, Windows, ANDROID, charging platform, around € 20 Online Link: https://planner5d.com/ar

“*Decormatters*” offers an opportunity to create an interior design project and to publish it on a platform and get a score from other users, which includes professional designers. Thus, pupils would have the opportunity to have a practical and engaging experience that could complement theoretical knowledge. It would be necessary to assess the risk that feedback from other users would be difficult to integrate into the traditional learning process, as evaluation criteria are not clearly defined and the subjectivity factor cannot be excluded. A learning experience free version should be used for publishing and evaluating the design (ranging from EUR 10.99 to EUR 69.99). Learning experiences that offer more functionality should be integrated into the learning process. In “*Decormatters*” users can only design a single room. Accordingly, the authors of the study would recommend that the teacher be able to present such experience to pupils and, if there was a desire, to acquire additional interior design knowledge and to obtain feedback from professionals and other users, this can be done individually.

“*Measure*” and “*Magic plan*” are learning experiences where programming, sketching and measuring existing spaces can be learned from the instructions and examples with different solutions are also available. Pupils would have the opportunity to gain practical and engaging experience in measuring, “immersion” in the environment, and visualising the unseen and exposed would lead to an in-depth understanding of the dimensions of the room.

However, in the assessment of the study authors, the most relevant AR for the integration of the platform into the classroom would be “*Live Home 3D*” and “*Planner 5D*”, because students can have more versatility for developing interior design skills by experiencing a sense of presence from looking at designs created in an updated reality environment. These learning experiences can be “immersed” in an established interior that would be a natural type of interaction and a natural extension of learning, as close as possible to a real-life situation. On the functionality side, the learning experience offers video-based instructions on different topics related to both interior design and the use of the learning experience itself. Popular opinion articles from industry professionals on interior design are available. “*Planner 5D*” also offers “theme battles” where you can submit your own design solution and compete with other designers – both beginners and professionals. The study authors assessment, “*Live Home 3D*” and “*Planner 5D*”, also contributes to the higher cognitive dimensions (create, evaluate, create). Another important aspect is that these learning experiences can create design solutions at the same time for the entire apartment or home complex, easily experimenting and making a variety of changes to create, for example, a particular mood and emotion.

Results

AR plays an important role in acquiring interior design skills, since it allows experimenting, interacting with objects and practical experience that is as close as possible to real-life situations.

As a result of the AR learning experience analysis, it was concluded that only two experiences for developing interior design skills – “Live Home 3D” and “Planner 5D”, where 3-dimensional models can be developed and displayed in an advanced reality environment, were developed for primary use for educational purposes. These learning experiences also received the highest ratings.

Based on the results of the study, recommendations were developed to integrate advanced reality technologies for the teaching of interior design:

When choosing the technology for Augmented Reality, there should be a clear plan of what it is meant to achieve and how the learning process will be complemented as well as what the expected benefits are, while assessing and managing the associated risks. AR should be applied in accordance with the training objectives pursued. Before use, it should be evaluated and the educator should be educated in AR technology functionality.

Constructivism, Constructionism and Connectivism pedagogical framework explain the general learning principles from applying AR. Within each of the frameworks of these learning theories, there are important aspects that create awareness of learning through technology and thus justify AR relevance to education. In fact, these theories also describe the transformation of pedagogy into digital culture and the learning aspects of AR, so that knowledge of the design, remembering and exploitation of thinking and knowledge can serve as a support for the more effective development of the objectives and skills identified.

By integrating AR technologies in the teaching process of interior design, pupils have the opportunity to experiment in an AR environment with practical and diverse experience. This experience can help prepare for the changing work environment, as well as the acquired knowledge which will serve as a strong basis for future levels of education. At the same time, educators have the opportunity to offer new ways to attract and address interior design issues.

Conclusion

This study has shown that AR learning experiences offer a variety of materials, colours, light, room (kitchen, bathroom, living room and other options) and change the design of the room. This brings two main benefits: first, pupils can experiment without fear of being wrong and learning

during the process and, secondly, AR technology is more convenient for the use of all materials, lights, colours and various forms of space in the environment. With traditional materials (such as paper and pencil) this process would be much slower and more time consuming. Pupils can more easily understand the context. AR technology is becoming an important tool for prototyping, since three-dimensional models can be created, where the physical (surrounding) environment is linked to the virtual environment through interaction.

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