

Anticipating the Impact of Virtual Reality for Learning the Design Fundamentals: Students' Perceptions and Perspectives

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ABSTRACT

An increasing adoption of Immersive Virtual Reality (iVR) based solutions can be observed in Higher Education and in design education particularly, namely in the teaching and learning the design fundamentals, usually referred to as Basic Design (BD). Research on this subject focuses mainly the overall potential of iVR digital technology for developing new pedagogical tools for teaching, being scarce regarding the understanding of the students' expectations about the adoption of such technology, which is essential in a Human-Centred Design (HCD) approach. The main objective of this study was to understand students' familiarity and expectations regarding the use of iVR for teaching-learning BD. An online questionnaire assessed the students' perception concerning: i) the difficulties related to the learning of the design fundamentals; ii) the suitability of the used digital technology; iii) and the receptivity/expectations to use iVR-based tools in the teaching-learning process. The results suggest that the students perceive the iVR-based tools as important and motivating for the learning process, being expected to assist the learning of all the BD-related content topics. Moreover, it is noteworthy that the most difficult content to learn appears to be 3D form, which iVR-based technologies are widely believed to aid in mastering. It is expected that the findings can support the development of learning activities assisted by iVR-based tools, more likely to meet the expectations of future students, thus contributing to engaging teaching-learning experiences and improved learning results.

Keywords: Immersive virtual reality, Basic design, Design fundamentals

INTRODUCTION

VR has been increasing its presence and importance in many educational scenarios, with doubtless positive contributions, despite being far from widely implemented in education (Kavanagh et al., 2017). The higher the immersivity of the VR system, more likely it is to provide a sense of presence, defined as a convincing sense of being, in the virtual world, indicating loss of consciousness that the body remains physically in the real world. Feeling presence is, in fact, an essential condition for effective learning. The sense of presence that is sought in VR applications, is what gives the sensation of engaging intensely and vividly in phenomena thus favouring learning. Also due this

fact, immersive technologies are expected to become more important and prominent (tom Dieck et al., 2021, p. vii).

In design education, digital technology has a key role in the transformation of educational models and processes, to which VR will be inevitably introduced as it allows access to artificial reality through the production of new objects and environments (Colucci, 2011). Therefore, VR is very likely to add to the teaching-learning of the design fundamentals (i.e., Basic Design). Research focusing the impact of VR-based tools on Basic Design (BD) pedagogy showed a growing tendency in the last decade, which will probably intensify to respond to the ongoing pandemic contingencies, as verified in the general education setting (Ball et al., 2021). Besides, the innovation factor of VR to education, particularly in the Higher Education context, makes the systematic adoption of VR technology closer to be a reality (Marks and Thomas, 2022).

The implementation of VR -based tool for supporting teaching and learning in the context of BD was approached theoretically by Neves & Duarte (2015) which lead subsequently to the development and test of a pedagogical tool in the context of a BD-derived course (Neves et al., 2016). The results of the pilot study revealed some of the factors that contributed to the non-conclusive results, such as the complexity of the task that involved coordinating pedagogical activities and experiment procedures, and others (Neves et al., 2017). The results also highlighted the quality of the experience of use through emotions detection, which revealed considerable levels of satisfaction among the students (Neves et al., 2017). The usability of VR in design education was tested by Özgen et al., (2019) during BD activities. The study reinforced the idea that VR can strongly enhance the problem-solving activities in BD context, therefore being considered a “*promising and complementary tool in basic design education*” (Özgen et al., 2019, p. 15). Another approach focused on innovative teaching in BD supported by the creation of synesthetic experiences using VR, and affording holistic learning tools (Liu, 2020; Liu et al., 2019). The artificial combinations of senses are enabled with the use of the mentioned digital technological medium, which can replace or add, the human body’s natural condition.

BD is considered the teaching-learning of the design fundamentals, which are the “*core concepts of the design approach that can be learned and improved on through practice and reflection*” (Nelson and Stolterman, 2012, p. 4). BD was created by Johannes Itten (1888-1967) who pioneered design education in the context of the first design course, at the Bauhaus School of Design (1919-1933). Design fundamentals, in the present study, coincide with the content topics, such as: Color; 2D form; 3D form; Texture; Visual principles; Personal values and skills; and Materials and techniques. Besides the content topics, the levels of understanding are the most significant building parts of the Learning Objectives (LOs). LOs are particular important in the Higher Education system, being indicative of what are the competences to be performed by the students (Dias, 2017), and therefore, to be addressed by the learning activities.

In this sense, to acknowledge students’ expectations can be indicative of possible limitations and success factors related to the learning process and

to performing the LOs (Baek et al., 2008). Questionnaires are one process of revealing users' expectations, as in the case of Bernardo & Duarte (2020). An online questionnaire enabled to evidence the familiarity of the design teachers with VR or Mixed Reality (MR), as well as their interest in learning and using VR for teaching. However, relating the students' expectations about the adoption of VR, research is scarce. Therefore, the present study aimed to assess, through an online questionnaire, the students' receptivity and expectations of using iVR for performing the LOs, in a near future, for learning the design fundamentals. Accordingly, was collected the students' perception concerning: i) the level of difficulties related to the learning of each of the main design fundamentals; ii) the suitability of digital technology used in the learning process; iii) and the receptivity/expectations to use iVR-based tools during the teaching-learning process, as well as for performing the main LOs.

METHOD

To develop VR-based tools for learning BD, according to a Human-Centred Design (HCD) approach, requires involving the users throughout design and development, as mentioned in the normative ISO 9241-210 (International Organization of Standardization - ISO, 2019). An online questionnaire was developed to access the expectations of the students towards the possible use of such tools in the teaching-learning process, including, for performing the LO's.

Participants, Procedures and Materials

58 students, 18 males (31%) and 40 females (69%), with age ranging from 19 to 28 ($M=20,45$; $SD=1,547$), volunteered in the study. They were enrolled in design bachelor's degrees in Portugal (87.9% from IADE, Universidade Europeia) and in Turkey (1.7% from Middle East Technical University, and 10.4% from Atilim University Fine Arts, Design and Architecture Faculty). All the participants had already completed, at least, one course that specifically addressed the design fundamentals. The online questionnaire was created using a free online form builder. After presenting the objectives of the study, the participants agreed to sign an informed consent. In the first part of the questionnaire, the perceptions of their previous learning experiences during BD lectures were collected, including the perceived adequacy of digital technology use. In the second part, they assisted a four-minute video presenting the iVR technology for art & design. The video was created in Adobe Premiere software using parts of promotional videos available on the internet. The collected data concerned the proficiency with iVR and the expectations towards using iVR-based tools in the teaching-learning of the design fundamentals, including performing the most characteristic LOs of the BD pedagogy.

To develop the questionnaire, we used the matrixes of levels of understanding and content-topics pointed by Neves et al. (2019) which included the most important and frequent Design Fundamentals, (i.e., the subcategories Color; 2D form; 3D form, and Visual principles); Personal values and skills, Means and techniques, and Texture. For the sections related with the type

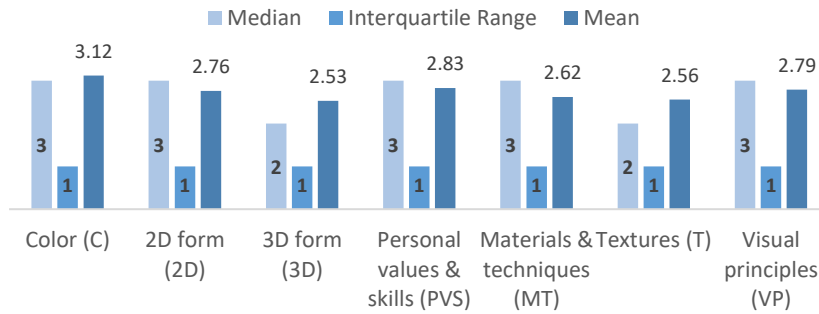


Figure 1: Perceived ease to learn the content topics.

of technology used in BD lectures, we considered the Taxonomy of Digital Technology in education (Zednik, 2020).

RESULTS & DISCUSSION

The data was analysed using IBM SPSS statistics for Windows, v. 27 (IBM Corp., 2020). A descriptive statistics was applied according to Marôco (2021). Regarding the perception of easiness to learn the content topics, participants replied using a Likert scale, from 1 to 4, indicative of “Not easy at all” and “Very easy”, respectively. Results show that Color is the easiest to learn, followed by Personal values & skills. Down the list, the content topic considered the most difficult to learn is 3D form (see Figure 1).

The results also pointed out the relative frequency of learning the 7 content topics, as some students only learned a few of them. Likewise, the less learned content is Texture, with 82.8% responses, followed by Materials & Techniques, with 94.8%. Visual principles were learned by 96.6% of the students and 3D form was learned by 98.3%. The other 3 content topics i.e., Color; 2D form; and Personal values and skills, were learned by all the participants. This data confirms the advanced by Neves et al. (2019) on the analysis to the Portuguese BD study plans, that the content topics Personal values & skills, and Design Fundamentals (i.e., the 4 content topics included in that category: Color, 2D form, 3D form, and Visual principles) are the most frequently learned. The lack of learning of Materials & techniques can be due to the pandemic contingency measures that were implemented in the latest years, privileging the digital instead of the analogic, thus limiting the access and manipulation of materials and techniques. Texture is absent from the Portuguese BD study plans (Neves, Dias, Duarte, et al., 2019), what can justify the fact that the content Textures is pointed out as the less learned of all (i.e., it was not learned by 17.2% of the students, all Portuguese). Considering the mentioned study, the fact that textures is being learned at all, comes as unexpected. One possible explanation is that the content Textures is lectured despite not being included in the analyzed study plans. Another possibility is a recent inclusion of the content topic in the design curricula.

Relating the use of digital technology in the BD teaching-learning context, participants were asked to reply using a Likert scale, from 1 to 5, meaning “Never used” to “Regularly used”, respectively. As reported, Virtual

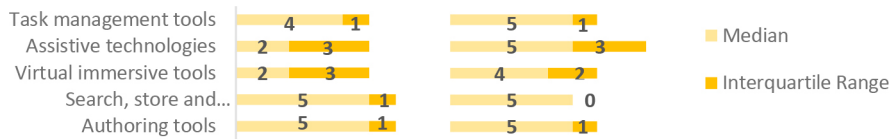


Figure 2 (left) & 3 (right): Use of digital technology (2) & Adequacy of digital technology use (3).

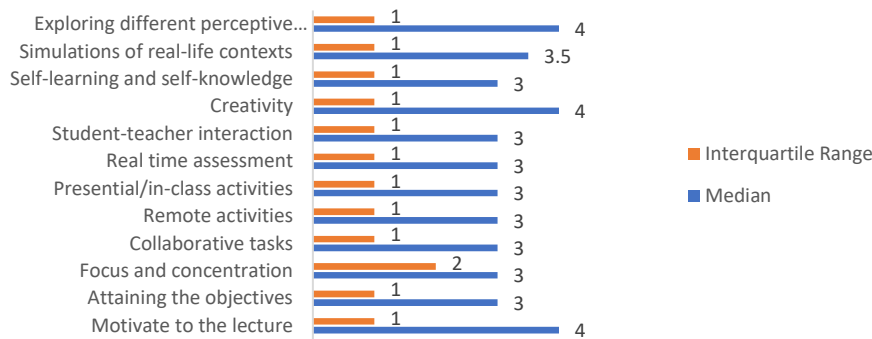


Figure 4: Perception of using iVR for the teaching-learning of the design fundamentals.

immersive tools are the least used, much as Assistive technologies. Task management tools were indicated as often used, surpassed by the Search, store and socialize, and by Authoring tools, both acknowledged as being regularly used (see Figure 2). As for the perception of the adequacy of the use of digital technology, a scale to from 1 to 9 was used, representing 1, an extreme lack of use; and 9, an extreme excess of use. In general, the use of digital technology is considered adequate in all the categories (see Figure 3).

Students' proficiency in VR technology was assessed, thus revealing that 79,3% do not have any experience with VR. The remaining 20,7% had at least one experience with the digital technology, more accentuated in the Teaching-learning contexts (6,9%) followed by Random experiences or curiosity trials (5,2%). From the observed, the low proficiency with VR is not impeditive to it's use in the BD context.

As observed in figures 5-8, the content topic most expected to be learned using iVR-based tools is 3D form (97,4%), followed by Visual principles (96,5%), Color (93,8%), 2D form (92,2%), Textures (88,7%), Personal values & skills (88,3%), and finally, the least expected, Materials & Techniques (87,9%).

It is highly expected to use iVR-based tools to perform the LOs, in all 4 levels of understanding, being least expected in the 4th (91,6%), followed by the 1st and 3rd levels (91,8%). The most expected level is the 2nd (93,3%). The most frequent verb, in each level of understanding indicates Apply, in the 3rd level (27,1%); Identify, in the 1st level (29,3%); Explore/experiment in the 2nd level (32%); and Create/compose, in the 4th level (37%). Accordingly, these are the verbs that are offered to be considered in future iVR-based tools for BD.

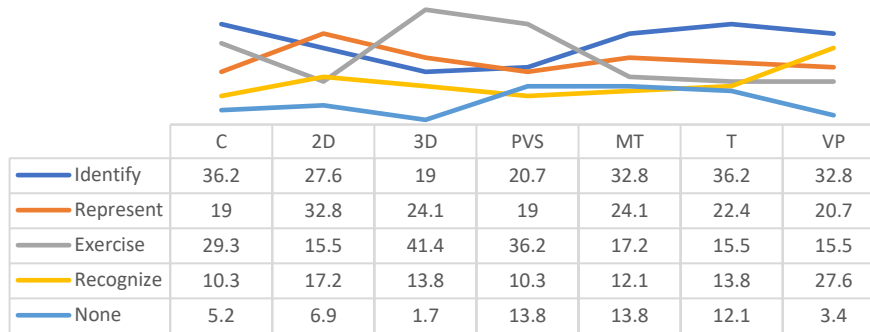


Figure 5: Expectations to perform the LOs, in the 1st level of understanding (%).

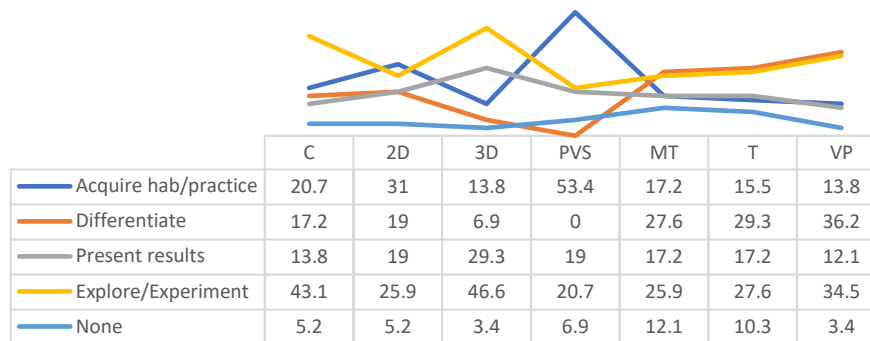


Figure 6: Expectations to perform the LOs, in the 2nd level of understanding (%).

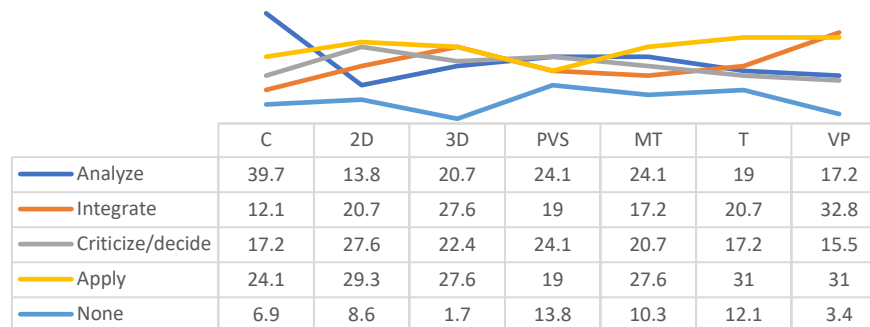


Figure 7: Expectations to perform the LOs, in the 3rd level of understanding (%).

Create/compose is the most frequent verb of the 4th level (see Figure 8), being also the most frequent of all the levels of understanding, with 37% of the participants preferences. Should be highlighted that the analysis to the BD study plans (Neves, Dias, Ramalho, et al., 2019) also points to the create/compose verb, as the most representative of all at the 4th level of understanding. The high expectation that iVR-based tools can improve creativity in the teaching learning context is also high (see Figure 4). This reinforces the probability of competences related to creativity be positively affected by using iVR-based tools, and due that fact, it can be highly recommended for developing creativity.

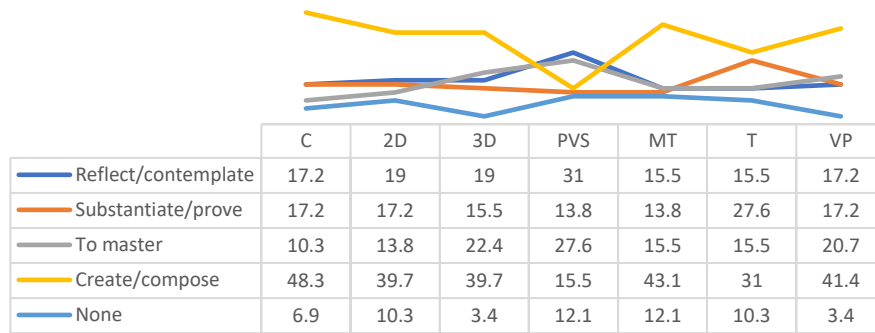


Figure 8: Expectations to perform the LOs, in the 4th level of understanding (%).

CONCLUSION

An online questionnaire enabled the identification of students' perceptions relating previous BD learning experiences, and their intentions of using iVR-based tools for teaching-learning BD. Results gathered suggest that despite the inexistent and limited proficiency of most students relating the iVR digital technology, iVR-based tools are perceived as important and motivating for the learning process, as well as highly expected to support creativity. iVR-based tools are expected to assist the learning of all the design fundamentals. However, more seems to be expected for learning 3D form, the most challenging content topic, thus suggesting that iVR-based tools are likely to add considerably to surpassing difficulties relating the content topic. The expectations to perform the LOs using iVR-based tools is high in all the levels of understanding, but more accentuated in the 2nd level where activities involving Explore/experiment are to be more welcomed, particularly if related with 3D form. Next steps can consider developing a prototype of an iVR-based tool, and testing its efficacy for learning 3D form, both with students and teachers. Hopefully, these findings will guide teachers and learning designers in developing iVR-based tools for the BD context, independently of the pedagogical approaches, which may contribute to more engaging teaching-learning experiences and improved learning results.

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