Mandatory Virtual Design Studio for All: Exploring the Transformations of Architectural Education amidst the Global Pandemic

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Abstract

Virtual design studio (VDS) has been a part of the discourse of architectural pedagogy for the past two decades. VDS has been showcased as a potential educational tool in schools of architecture often in controlled, pre-designed experiments. However, the global COVID-19 pandemic has forced most schools to move their design studios into virtual space. This article aims to explore the potential advantages and shortcomings of VDS during the COVID-19 quarantine from the perspective of students in a department of architecture. The study investigates three aspects of VDS namely, participating students’ evaluation of the virtual studio experience, the effectiveness of VDS in achieving the studio’s expected learning outcomes and the evaluation process for final design projects. Some 360 students from eight consecutive design studios participated in the study. The results indicate improvement in students’ ability to conduct independent research and in learning new computer-aided design (CAD) software. Furthermore, the study finds VDS to be much more applicable for third- and fourth-year students. The results also show a significant decline in background informal peer learning among students. Further studies are needed to address the implementation of a more immersive social experience in VDS.

Keywords
quarantine, virtual design studio, peer learning, architectural pedagogy, remote education, COVID-19

Introduction

Virtual Design Studio (VDS) has been a part of architectural pedagogy for more than two decades (Strojan & Mullins 2002; Kvan 2001; Wojtowicz 1995). The
relevance and utilisation of different tools and techniques available for virtual teaching have created an emerging discourse in the predominantly physical studio-based education system (Rodriguez et al. 2018). Kvan (2001) explored the merits of VDS and reported that the tools and communication technology of the time were not yet adequate for the purpose. However, in the past two decades the world has seen an immense leap forward in the way those technologies have become cheaper, more accessible, and an inseparable part of everyday life. Today, the feasibility of conducting virtual design studios is no longer in question and the focus has shifted instead to methods of implementation and utilisation of the emerging digital media. Although VDS has been trialled and refined in a limited number of cases, never before has it been adopted on a global scale. Indeed, the year 2020 can be considered the coming of age for VDS as a mainstream educational method. The COVID-19 pandemic and its related control measures have forced many higher educational institutes to migrate their teaching into virtual space. For most schools of architecture design studio is the central pedagogical approach; its migration to virtual space raises a number of issues as the design studio is not a mere classroom but is a way of life and poses an interconnected intrinsic socio-spatial character (Dutton 1987). Furthermore, the students of today are those who have been born and raised with digital communication media, they are the native speakers of the language of social media and digital space. Hence, their initial engagement with VDS might prove to be more fruitful as they have the capacity to use it to its full potential. This new generation of students may well have different interpretations of virtual place and thus be able to communicate more easily in a virtual setting (Pektaş 2015).

Overall, the pedagogical body of architecture is reluctant to implement any change in the design critique process (crit). Smith (2011) calls this ironic, arguing that the nature of architecture education is the empowerment of creativity and change. Perhaps, in the short window of time that virtuality was imposed on the design studio pedagogy by the COVID-19 lockdown, the hidden potential of VDS would emerge. The present study aims to explore the mandatory implementation of VDS during the global COVID-19 pandemic in a school of architecture. Whilst VDS was previously considered a research novelty, it became a new normal in a matter of weeks during the 2020 pandemic. The article will explore students’ experiences regarding VDS in comparison with the physical design studio (PDS). Moreover, students’ progress in the curriculum has not yet been addressed clearly in the literature. Hence, the study will compare VDS and PDS in relation to the students’ current semester. Accordingly, different aspects of VDS regarding its spatial dimension, peer learning, digital tools and common juries will be investigated. The findings will become a reference point for similar future events that might restrict spatial participation. Furthermore, VDS serves the multidimensional aspect of architecture as it has the capacity to extend the reach of cross-cultural and cross-disciplinary collaboration via virtual space. The recent mandatory VDS experience has created a new normal, a new status quo which was deemed impossible by many lecturers prior to this event. It should be noted that this article does not intend to present VDS as an ideal platform for educating architects, rather, it will show its potential advantages even in an unplanned emergency scenario. Accordingly, the strengths and weaknesses of this experience will be studied for future reference and will provide suggestions for improvement. The frameworks that emerged during this quarantine period could provide possibilities for future design studios that are a combination of both PDS and VDS. Furthermore, the lack of extensive

IJADE 40.1 (2021)
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experience with regards to communication in virtual space emphasises the importance of developing further studies addressing VDS in a new light. Kvan (2001, 346) asks the same questions that we are facing today in the discourse of architecture education: ‘What changes when we move the design studio into the medium of computer-mediated collaboration? What becomes of the role of the instructor and what changes in the participation of the students?’

**Design studio and virtuality**

Studio and the critique session stand at the heart of architectural pedagogy; it is a socio-spatial construct that simultaneously enables both creativity and rationality (Wang 2010). Although it has been criticised and described as – perhaps – not the most optimum teaching method, it remains as the main ritual in becoming an architect. Some studies indicate that the common critique sessions are the main source of dissatisfaction among architecture students and that the process needs new adaptative approaches (Anthony 1991; Smith 2011). Nevertheless, Lewis (2013) argues that the process of having one’s hard work criticised in front of one’s peers is a rite of passage for all architects. The process of experiencing and taking part in the design studio is its main pedagogical function (Öztürk & Türkkan 2006). For Schon (1987) the concept of a design studio, or as he called it, ‘reflective practicum’ is built upon the premises of ‘learning-by-doing’ and ‘reflection-in-action’. The practicum, materialised in the form of the design studio, is intrinsically reflective and facilitates the process of reciprocal dialogue. This dialogue is not restricted to that between the tutor and the student, but is a social structure of collaborative learning which is often regarded as the ‘studio culture’ (Wagner & Gansemer-Topf 2005).

The discourse around transitioning to VDS revolves around keeping the positive qualities of PDS and adjusting the pedagogical framework to benefit from the unique opportunities that the virtual space has to offer. VDS has shown significant potential in creating a more connected, multicultural and interdisciplinary environment for learning (Webster 2008; Wojtowicz 1995; Sagun et al. 2001). Students’ reported improvement in conducting self-dependent research is a great asset in addressing the aforementioned shortcomings. In this light, the lack of proximal restriction in VDS is simultaneously its strength and weakness, for if VDS is utilised to enrich social and cultural collaboration and research it can bring new qualities into the pedagogy of architecture (Bradford et al. 1994). On the other hand, if the lack of spatiality limits the studio culture and informal internal learning among students, then it can become a liability.

VDS has been shown to have pedagogical merits in architecture. Bucinell et al. (1997) point to the benefits of VDS as a tool for building team management. VDS increases the outreach of the studio, enabling more possibilities for collaboration between different schools and disciplines (Wake & Levine 2002; Sagun et al. 2001). The communication media brought forth by Web2.0 have made interactive collaborative engagement in virtual space a powerful pedagogical tool which is still in its embryonic stages (Ham & Schnabel 2011). Furthermore, Kvan (2001) argues that VDS is more process-oriented, therefore, both the teaching approaches and the evaluation method need to be adapted in this regard.

Contemporary design education focuses more and more on the technological, technical and compositional features of the design often at the expense of its social
and cultural aspects (Salama & Wilkinson 2007). In this light, VDS, with the computer screen being its main medium of interaction, can isolate those values more, hence one of the main limitations of VDS could be its lack of engagement with the development of students’ social interaction and background learning. The PDS seems to be more efficient in peer learning through a hierarchical social process, whereas VDS has more potential regarding research, discussion and self-dependency (Saghaﬁ et al. 2012). Undoubtedly, architectural education is not only about problem-solving and design products; it is also about developing a social character, a communicable identity with the capacity to observe and make peer connections (McLaughlan & Chatterjee 2020). This is what Dutton (1987) calls the ‘hidden curriculum’, one that is centred around socio-spatial engagement. The nature of the informal background learning process from one’s peers is an intangible – but critical – aspect of architectural pedagogy. As McClean & Hourigan (2013, 35) argue, ‘the informal, socially-based peer interaction that characterises the studio is complementary to, and quite distinct from, the learning derived through tutor interaction’. Background learning that occurs in the design studio is contingent upon the availability of physical space. The studio system is designed to impose a tacit learning process that encourages architectural students to learn to communicate and collaborate with each other, thereby building essential skills for entering the job market. Nevertheless, there is disagreement regarding the potential for peer learning in VDS. The nature of emerging social media has been shown to be influential in fostering a social structure for VDS (Ham & Schnabel 2011). Indeed, the setting of a VDS is getting closer to PDS as the emerging technologies have made the one-to-many and many-to-many real-time interactions possible, overcoming what was considered the main limitation of VDS in its earliest trials (Kvan 1997). For many students, the motivation behind coming to a campus far away from their home is that it is a character-building experience that allows them to develop independence and to form new personal communities (Saghaﬁ et al. 2012). The lack of sense of place could be addressed in two ways, first, by creating a hybrid of VDS and PDS, and second, by future developments in virtual reality (Hsu et al. 2020). Clark & Maher (2005) argue that some modiﬁcations like the visual presence of avatars instead of just names would improve students’ sense of place in VDS. Accordingly, the following case study analysis explores these concepts as VDS became mandatory for all courses and for students of all levels in a department of architecture.

Case study

The present study was conducted in one of the major universities in Cyprus at the end of the spring semester of 2019–20. The architecture programme consists of eight semesters including eight consecutive design studios. The spring semester of 2019–20 began as a regular semester with classes commencing on 17 February 2020. The majority of students in the School of Architecture (90.5 per cent) came from abroad and were from a variety of different nationalities. As concerns regarding the spread of the pandemic increased throughout the country, all gatherings, including educational activities, were halted on at 12 pm on 10 March. In the early days of the transition, various media such as WhatsApp groups, Facebook groups, YouTube videos and Skype were used by different studios. However, classes resumed in virtual space via Google Meet the following week with all studio
 submissions being gathered by the central university’s remote learning platform. In the beginning it seemed counter-intuitive to hold a virtual design studio, but after a few sessions students and lecturers started to adapt their approaches to manage the ongoing situation. The quickly adapted method consisted of a cycle of online submission, virtual meetings, screen-sharing, feedback sessions and class discussions (Figure 1). Common juries were conducted on a regular basis with guest jury members from different design studios, disciplines and other schools. All studio sessions and common juries were recorded and were made available to students for review.

New adaptations in dire situations often lead to the emergence of a new normal. In this case, the ongoing pandemic was considered a window in which to introduce remote architectural education and to study its benefits and possible limitations. Accordingly, a survey was designed to address the unique circumstances in which architectural education was conducted during this timeframe. The survey consisted of 32 questions addressing five main topics:

- student satisfaction and self-evaluation of the online design studio during the quarantine;
- communication and peer learning;
- virtual space and utilisation of digital media in conducting VDS;
- juries and evaluation; and
- effectiveness of meeting the Programme Learning Outcomes (PLOs).

The survey collected data on a linear Likert scale measuring the students’ evaluations regarding VDS (1. Much worse than PDS, to 5. Much better than PDS).

Figure 1
The quickly adapted method of transition to VDS after the quarantine.
The survey was initially reviewed and approved by the ethics committee of the related institution. Some 360 active students of the Faculty of Architecture who took design studio participated in the survey; this number accounted for 74 per cent of all active students (Table 1). These students included those from two parallel programmes in Turkish (n=220) and English (n=140). Among the participants, 48.6 per cent travelled back to their home country, a group which consisted mainly of Turkish students for whom travel was easier, and of these, 13 per cent reported experiencing a period of quarantine. Another 36 per cent remained on the Island. Furthermore, the data was controlled and compared between the two programmes (Turkish and English), and between the two groups (inside vs outside). If a significant difference was observed it was reported, otherwise, the entire dataset was used for the analysis. The local students (9.5 per cent) were categorised with those who travelled back to their families.

**Student experiences regarding VDS**

The first item on the survey asked about the overall satisfaction with VDS and the results indicated that it was a relatively positive experience for all participants (Table 2: mean=3.74 and median=4). The positive experience seemed to be consistent throughout irrespective of the programme and the design studio. However, the students who travelled back to their homes seemed to be relatively more satisfied with the experience (Table 2: mean 3.84>3.60). The differentiation between students who stayed vs the ones who went back might result from the higher level of comfort at home. Of the students who went back 68 per cent reported benefiting from being close to their families. The least positive experience was reported by the first-semester students who stayed on the Island.

Furthermore, student satisfaction regarding their final design product was evaluated. Here, the only significant difference was among the first-semester students. These students experienced the worst of the transition into the education system. Those who went back showed the highest degree of satisfaction with their design product. Albeit, the rest of the students in the design studios reported it as similar to what they would have done having attended the physical studio (Table 2).

When compared with the physical design studio, 59 per cent of the students mentioned that face-to-face interaction with the teacher was the most important missing feature of the virtual space and that the video chat did not substitute for this quality. The majority of students reported that not being able to have face-to-face table critics made their design studio experience much worse than in the previous semesters (Table 2: mean= 2.24, median= 2).

**Communication and peer learning**

One of the concerns with the VDS was the process of conveying information regarding critical thinking, design strategies and common mistakes. This learning process often happens through critique sessions in PDS where other students are encouraged to participate. Accordingly, the survey first tried to explore the role of communication between the tutor and the student. Communication is addressed in two questions regarding the legibility of critiques given by design tutors, and from the students' point of view indicating how well they could express their ideas. Here the majority of students expressed their understanding of the critiques to be similar to the PDS, although there were cases at both ends of the spectrum. Within the confines of VDS, students reported the degree in which they could
| Total number of active students, Department of Architecture, Fall 2019–20 semester: 511, including 138 female, 373 male, 49 locals, 462 international | Number of students registered in a design studio | Number of students who participated in the survey |
|---|---|---|
| | Programme: Turkish | Programme: English | Total Registered | Programme: Turkish | Programme: English | Total survey | Participation rate |
| ARC 101: Basic Of Arch. Design I | 9 | 10 | 19 | 6 | 6 | 12 | 63.1% |
| ARC 102: Basic of Arch. Design II | 40 | 38 | 78 | 29 | 16 | 45 | 57.6% |
| ARC 201: Arch. Design 1 | 11 | 20 | 31 | 15 | 4 | 19 | 61.2% |
| ARC 202: Arch. Design 2 | 55 | 29 | 84 | 42 | 20 | 62 | 73.8% |
| ARC 301: Arch. Design 3 | 4 | 16 | 20 | 9 | 11 | 20 | 100% |
| ARC 302: Arch. Design 4 | 77 | 29 | 106 | 33 | 28 | 61 | 57.5% |
| ARC 401: Arch. Design 5 | 36 | 29 | 65 | 48 | 11 | 59 | 90.7% |
| ARC 402: Graduation Project | 32 | 51 | 83 | 38 | 44 | 82 | 98.7% |
| Total | 264 | 222 | 486 | 220 | 140 | 360 | 74.0% |
TABLE 2 Comparing the mean value of survey items across design studios and the location of students

| Survey item                                      | Location: Outside the island | Location: Inside the island | Overall |
|--------------------------------------------------|------------------------------|-----------------------------|---------|
| Overall experience regarding VDS, 1. Much worse than the PDS, 5. Much better than the PDS. | Mean 4.00 3.38 3.80 3.25 3.70 4.33 3.84 3.84 | Mean 2.00 3.64 3.71 3.50 3.25 3.88 3.91 3.60 | Overall 2.75 3.48 3.81 3.77 3.38 3.49 4.25 3.88 3.74 |
| SD 1.00 1.10 1.13 1.58 1.14 0.66 1.03 1.07 | SD 1.41 0.93 0.89 1.10 0.76 1.22 0.64 1.00 1.09 | SD 1.58 1.04 1.05 1.11 1.20 1.19 0.67 1.00 1.08 | SD 1.58 1.04 1.05 1.11 1.20 1.19 0.67 1.00 1.08 |
| Self-evaluation of final design product, 1. Much worse than the PDS, 5. Much better than the PDS. | Mean 4.00 3.19 3.27 3.15 3.00 3.32 3.75 3.32 3.36 | Mean 2.40 3.21 3.40 3.67 3.50 2.88 3.63 3.50 3.34 | Overall 3.00 3.20 3.31 3.35 3.25 3.10 3.73 3.43 3.35 |
| SD 1.00 0.98 1.10 1.31 1.20 1.18 0.78 0.95 1.06 | SD 1.34 0.89 0.89 0.97 1.20 1.23 0.52 0.97 1.05 | SD 1.41 0.94 1.01 1.21 1.18 1.21 0.74 0.96 1.06 | SD 1.41 0.94 1.01 1.21 1.18 1.21 0.74 0.96 1.06 |
| The reported level of discomfort in not having a physical face-to-face interaction in VDS compared with PDS, 1. Much worse than the PDS, 5. Much better than the PDS. | Mean 3.33 1.65 2.00 2.26 2.50 2.63 2.53 2.16 2.29 | Mean 2.00 1.85 1.40 2.45 1.38 1.96 2.63 2.46 2.18 | Overall 2.50 1.72 1.81 2.33 1.94 2.31 2.54 2.35 2.24 |
| SD 1.53 0.89 0.89 1.42 1.41 1.52 1.45 1.18 1.34 | SD 0.71 1.14 0.55 1.39 1.06 1.30 1.19 1.07 1.20 | SD 1.20 0.97 0.83 1.40 1.34 1.45 1.40 1.12 1.28 | SD 1.20 0.97 0.83 1.40 1.34 1.45 1.40 1.12 1.28 |
communicate their design ideas with the teacher to be very similar to PDS (overall mean: 3.16, median: 3: similar to physical design studio). However, some variations can be observed most likely due to the different methods implemented in each studio (Figure 2). This seemed to apply equally for all students when expressing their ideas and for when tutors were making remarks on the design. However, whilst the first-year students found communicating with the tutor in VDS inferior to PDS, the fourth-year students found it more successful (Figure 2: a).

Class discussions showed a similar trend to the tutor–student communication, but the item targeting peer learning showed the lowest score across the board. The score seemed to be similar across the two programmes, but the value for background peer learning was much lower for the third- and fourth-year students. This was expected as they would have had more time to form stronger bonds and a social structure amongst themselves in comparison with first- and second-year students (Figure 2: b).

Another communication medium for the VDS was the accessible recording of critique sessions, providing the students with the opportunity to revisit their discussions after the class. This was especially beneficial for some students who were too stressed to note everything down during the session. Although the availability of critique session recording is beneficial for some students, it could create an uncomfortable or unfriendly environment for some as everything remains on permanent record.

**Integration of digital media**

Adaptation of the digital medium into the design studio seemed to be one of the most significant parts of the transition into VDS. In line with the aforementioned results, the communication in VDS happened via a range of different media. In this case, the class was conducted using Google Meet which the majority of students found successful and easy to use (78.1 per cent). Nevertheless, the virtual meeting room did not play the most important role in the learning process. In PDS students routinely use a variety of flexible interactive methods in their critique sessions. They might pin-up their project, or use tables that everybody gathers around, use a variety of drawing tools and media such as transparent paper, or use physical

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**Figure 2**

a: Communication between tutor and students, b: Peer communication among students
models to address the ongoing process of the project. The transition of these methods into VDS seemed to play a critical role in the pedagogical process. Media such as AutoCAD and SketchUp were among the most popular across all studios because usually both the tutor and the student were able to use them. The interactive critique of the 3D model seemed to be superior to verbal communication. As a result, the majority of students in all studios reported significant improvement in their CAD skills during this period since it was the most practical way to express their ideas (Figure 3: b). The practical implementation of 3D modelling instead of a physical model became more significant in higher design studios; the students in the fourth year found the 3D model to be superior to the physical model (Figure 3: a). For the first-year students the tangible physical model seemed to be better suited for their pedagogical needs. Third- and fourth-year students seemed to be more capable of implementing the interactive CAD modelling into their critique session workflow.

Nevertheless, the answers regarding the 3D model might be biased as the cost of the physical model was a burden on the students’ pockets. Digital modelling was reported by 79 per cent of all students to be an economic disadvantage; it must be noted that they had access to free educational licenses for CAD programs.

### Juries and evaluation

Juries are a critical aspect of architectural education. In design studios the role of common juries is to decrease the subjectivity of evaluation and to teach students to correspond with a variety of opinions regarding design. In the present study, students reported the online design jury to be slightly better than the physical studio juries (Table 3: mean=3.19, median=3). Online juries have some characteristics that might be considered advantageous over the physical jury. First, the student has more control over exactly what is being presented at any particular moment.

| Jury experience | ARC 101 | ARC 102 | ARC 201 | ARC 202 | ARC 301 | ARC 302 | ARC 401 | ARC 402 | Total |
|-----------------|---------|---------|---------|---------|---------|---------|---------|---------|-------|
| **Mean**        | 3.25    | 2.69    | 3.11    | 3.13    | 3.30    | 2.89    | 3.52    | 3.48    | 3.19  |
| **SD**          | 1.54    | 1.12    | 1.28    | 1.42    | 1.38    | 1.48    | 1.00    | 1.16    | 1.29  |

Figure 3

a: Successful implementation of 3D programs in virtual space, b: learning new digital graphic communication skills
as opposed to having all their documents on display. This would allow the student to focus on the strengths of the project. Second, recordings of the juries were made available to the students later on, providing the opportunity for re-checking the jury’s comments since they might have been unable to note everything down during the jury session. Moreover, juries provide a forum for students to explore their identity and legitimacy in front of their future colleagues. In this regard, not being able to find every small technical error creates a less dramatic experience, one which is more centred on the processes, concepts, and design ideas. This might create a more significant sense of empowerment for the student. The unexpected COVID-19 juries brought the shortcomings of traditional juries to the fore. It often happens that jury members might try to impose their own identity into a design project – albeit not always deliberately –, thus students are often forced to focus on the outcome of the jury as opposed to the fundamentals of design ideas (Webster 2007).

The online jury in this case came with some disadvantages as well. First, the students’ presentation was limited to one screen at a time. This could potentially have undermined the coherency of their project and how it was observed by the jury. It became increasingly difficult to cross-reference the presented document with its accompanying plans with sections, elevations and 3Ds. Second, the digital media used in this case do not make it possible to point at something specific on the screen so it was necessary to use verbal communication to convey any relevant information. In our observation the online juries were more focused on the abstract conception of the project and less likely to address the technical issues because of these limitations. Third, peer pre-jury and post-jury communications were mainly eliminated in the virtual setting. These informal peer comments are known to be a critical aspect of the design jury as they are the counter-hegemonic forces against the negativity imposed by the power of the jury critique (McClean & Hourigan 2013). In this case, students’ survey responses indicated that they had found the virtual jury to be similar to – or slightly better than – the physical jury (mean=3.19). The similar trend of fourth-year students finding it more successful was also seen here. The first-semester students did not have a point of reference for comparison hence their higher evaluation of the digital jury. This is interesting in terms of defining a new normal; for the first-semester students the virtual jury is now the normal jury.

Addressing programme learning outcome (PLOs) in VDS

The Department of Architecture has established a set of key learning outcomes that students are expected to comprehend before graduation (read the full list: Near East University 2020). These learning outcomes cover a wide range of topics such as critical thinking, communication skills, environmental control, ethics and structure. The majority of these learning outcomes are dedicated to the design studio or other courses that are serving the studios. Accordingly, in this section, the study aimed to explore the degree to which these programme learning outcomes (PLOs) were met in VDS compared with those in PDS. Overall, students reported a similar level of achievement compared with the physical design studio, although it varied across the items and semesters. Students of all design studios reported a higher level of achievement regarding digital communication and the ability to conduct independent research. Students of upper design studios showed a significantly higher degree of achievement as they were more self-dependent. The basic design studios showed the lowest score across the spectrum (Table 4, 3. indicates ‘similar to PDS’).
| Programmes' learning outcomes (PLOs)                                      | ARC 101 Mean | ARC 102 Mean | ARC 201 Mean | ARC 202 Mean | ARC 301 Mean | ARC 302 Mean | ARC 401 Mean | ARC 402 Mean | Total Mean |
|------------------------------------------------------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|------------|
| Analyse and evaluate information.                                      | 2.50         | 2.71         | 3.06         | 2.93         | 2.94         | 2.72         | 3.02         | 3.39         | 2.99       |
| Critical thinking, learning how to solve design problems creatively.   | 2.60         | 2.62         | 3.00         | 2.90         | 2.88         | 2.81         | 3.05         | 3.32         | 2.97       |
| Computer applications and their implementation in the design process.  | 2.70         | 3.31         | 3.25         | 3.66         | 3.35         | 3.53         | 3.48         | 3.85         | 3.54       |
| Developing architectural programme                                     | 2.40         | 2.93         | 3.31         | 3.00         | 3.41         | 3.05         | 3.16         | 3.57         | 3.18       |
| Structural systems                                                    | 2.50         | 2.78         | 3.06         | 2.56         | 3.25         | 2.86         | 3.10         | 3.15         | 2.93       |
| Building materials and applications                                   | 2.25         | 3.00         | 3.00         | 2.64         | 3.19         | 2.93         | 3.00         | 3.22         | 2.97       |
| Context and surroundings                                              | 1.88         | 2.95         | 2.94         | 2.90         | 3.19         | 2.93         | 2.96         | 3.30         | 3.01       |
| Formal aesthetics in architecture and design                          | 2.30         | 2.98         | 2.81         | 2.80         | 3.38         | 3.07         | 3.11         | 3.39         | 3.07       |
| Research and reach information                                        | 3.40         | 3.35         | 3.44         | 3.46         | 3.59         | 3.46         | 3.41         | 3.68         | 3.49       |
| Digital graphic communication skills                                  | 3.20         | 3.29         | 3.56         | 3.53         | 3.69         | 3.35         | 3.35         | 3.79         | 3.50       |
| Hand-drawn graphic communication skills                               | 3.10         | 2.76         | 2.69         | 2.71         | 3.00         | 2.91         | 2.66         | 2.86         | 2.80       |
| Architecture history and culture                                      | 3.60         | 3.12         | 3.38         | 2.81         | 3.29         | 3.21         | 3.12         | 3.30         | 3.16       |
| Climatic issues and environmental control                              | 3.30         | 3.12         | 3.50         | 3.03         | 3.47         | 3.09         | 3.16         | 3.41         | 3.21       |
The other notable improvement in achieving PLOs was related to digital communication skills, where students were forced by the ongoing situation to improve their skills. Nevertheless, not all PLOs were met successfully; understanding and integration with context and surrounding, structural systems and hand-drawn graphic communication skills were reported as less successful than in PDS.

Discussion and conclusion

Schön’s ideas regarding reflective learning have been central in formulating architectural pedagogy (Schon 1987). The 2020 global pandemic provided a moment to reconsider the emerging phenomenon of virtual design studio. VDS, as shown here, provides an opportunity to increase the self-dependence and research-oriented design approach which, in return, can enhance the interdisciplinary nature of architecture pedagogy (Webster 2008; Wojtowicz 1995). Reflection-in-action and learning by doing can take place in VDS as it emphasised a student-oriented process. The findings of this article indicate the usefulness of VDS for upper-year architecture students. Across all items, their experience with the VDS was more successful. The students in the third and fourth years were well-versed in digital communication methods and had learned the necessary skills to become more self-dependent. In this case, VDS might have been a better pedagogical tool for fourth-year students, encouraging them to become more independent. On the contrary, the first-year students required closer one-to-one and hands-on tutorials aiming at building their skills for abstraction, conceptions and critical spatial thinking (Akoury 2020). Although the first-year students have also shown improvement in their digital communication and CAD skills, their lack of spatial experience might have made VDS more difficult for them and less fruitful.

The learning process of a design studio happens in three major ways; self-dependent research and exploration, the communication between tutors and students via critique sessions, and the background informal peer learning among the students. The findings of this study indicate that VDS facilitates the self-dependent learning process in both research and acquiring new skills. The tutor–student communication, however, is dependent on the level of students, the skill set of both the student and the tutor in digital media, and the structure of VDS. The virtual space must offer an interactive and collaborative forum for the architectural learning process. Conducting a successful VDS requires both teachers and students to be familiar with a variety of new digital tools, whereas a traditional table critique could be done using only a pencil. Limiting the interactions in VDS to verbal instructions only could create a negative experience, especially for first-year students. Students’ initial experiences with design studio are more successful when conducted in the physical space (Saghaﬁ et al. 2012).

Peer learning, on the other hand, seems to be the major missing part of VDS as the method used in this case did not allow for immersive collaboration among students. In this case, screen-sharing was used as the method for conducting the design studio but other more immersive alternatives that facilitate communication and development of the sense of place must be sought (Maher & Simmoff 1999).

The results of this study show the strong preference of students for having a hybrid studio, between the physical and virtual studios, one which is more pertinent to the nature of the contemporary world with the digital space being interconnected with all aspects of everyday life (Wake & Levine 2002). VDS can be most successful
when its full potentials are utilised, namely, open multicultural, multidisciplinary inter-
actions that supersede the restrictions of traditional PDS. According to Rodriguez et al. (2018), the combination of PDS and VDS can bring the best of both worlds to
architectural pedagogy. Pektaş (2015) shows a successful attempt at VDS indicating
the strengths of blended methods that can highlight the potential of both VDS and
PDS. Nevertheless, it seems that the VDS might require some spatial experience at
the early stages of the design regarding site visits. In this case, since the first two
weeks of the semester were conducted in the physical studio, this aspect was not
taken into account and was left for future studies.

The architecture studio juries and the critique sessions, are essentially stu-
dent-centred events, although this quality is often lost in the hierarchical presuppo-
sitions between the tutor and the student (Stuart-Murray 2010). VDS, as shown
here, gives more control over their projects to the students as they can be more
selective about which aspects of their design must be emphasised. The hierarchical
structure of VDS is different from PDS, making it closer to what it is supposed to
be, a student-oriented learning process that celebrates students’ evolving creative
skills in becoming an architect.

Going back to Kvan’s (2001) questions regarding VDS, it could be argued that the
role of the instructor needs to change in VDS. In VDS the instructor becomes more the
mediator of an ongoing process rather than the lead influencer of the process. On the
other hand, the future instructor of VDS needs to be well versed in a variety of digital
media to facilitate the design process. The virtual space itself needs to become more
interactive to address the importance of background peer learning.

In the past, despite showing strong potential, VDS was limited by technical
issues such as the internet bandwidth, cost and accessibility, limitations of CAD
programs, and limitations of digital media for housing and recording design studio
sessions (Wojtowicz 1995; Kvan 2001; Reffat 2007; Schnabel & Kvan 2001; Rus-
sell 2001) but today, many of those concerns have been ameliorated by the accel-
erated development of digital technology. Thus, it is time to define new empirical
frameworks for VDS, ones which are no longer bound by technical limitations, but
by a traditional system that resists change. This article does not indicate that VDS
is the new answer to architectural pedagogy, rather it calls for re-evaluation of the
usefulness of VDS as it clearly has a lot to offer.

This study explored the overall reported experiences of the students of a
school of architecture but it must be noted that this approach has some limitations
regarding methodology and theoretical frameworks that should be addressed in
further studies regarding the pedagogy of architectural VDS. In particular, it should
be noted that the article does not delve deeply into the pedagogical methods that
might be applied by tutors at different studios. Furthermore, it does not take the
demographic background of students into account. Age, gender, nationality, average
grade, economic status and culture might all influence how students experience
VDS. These variables require the development of a detailed pedagogical framework
that takes a large body of existing literature into account. Further studies are
required to address these issues.

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