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# Evaluating the effectiveness of online teaching in architecture courses

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## Abstract

In recent decades there has been an increase in online learning in many disciplines including architecture. In 2020, this situation accelerated as architecture programs world-wide transitioned to online learning. This paper uses surveys and semi-structured interviews to evaluate the effectiveness of online teaching for architecture courses. A total of 15 courses from three Australian universities were included in this study, survey results from 88 students in these courses were collected, and three in-depth interviews with course convenors were conducted. The results indicate that students have relatively positive learning experiences in online courses, in particular due to the increased flexibility that they can enable. However, there is also a need for further development of the online teaching tools associated with architecture studio courses, and an opportunity to enhance teaching for online lecture-based courses which presently show sub-optimal student engagement.

## 1. Introduction

Traditionally architecture students learn to design in studio environments wherein a tutor, often a practicing architect, periodically reviews students' work (Schön, 1983). Advancements in IT technologies during the last few decades have enabled the development of online tools, such as Learning Management Systems (LMS), to better facilitate learning and teaching for architectural education. Past research indicates that online learning provides potential opportunities for enhancing student engagement (Francis & Shannon, 2013), sharing knowledge and promoting peer-to-peer collaboration (Chiu, 2008). Within the architecture discipline, it has been suggested that online "distant critics" can provide students with more diverse feedback from increased numbers of experts, tutors and peers (Zimring et al., 2001). Additionally, extensive online imagery is available, which potentially assists architectural students to further develop their design skills and projects. While online and "distance education" (the analogue predecessor of online) architecture courses have existed since the 1980s in many parts of the world, they have become more common in recent years, and in 2020 have become ubiquitous. With the increase in online learning, it is timely to consider the effectiveness of this mode of delivery for architecture courses.

Architectural programs are typically comprised of design studios and theory/skill-based courses. To date, there has been a lack of formal evaluation of both types of courses in their online modes of delivery, and how they relate to each other, and to more conventional face-to-face teaching. In particular, several major questions remain unanswered. What is the student learning experience in online architectural courses? What are the main issues pertaining to online teaching tools? What differences exist in terms of learning, between online studio courses and non-studio courses? What aspects of online courses do students typically like and dislike? Where does the greatest potential for further development of architectural online programs lie? To answer these questions, this paper explores the effectiveness of online

learning within architectural programs, in terms of both design studios and theory/skill-focused architecture courses.

This paper reports on the results of a survey of students ( $n = 88$ ), enrolled in courses ( $n = 15$ ) at three Australian universities. To assist with interpreting the results of the surveys, three in-depth interviews were conducted with course convenors. The paper commences with a background to online teaching in architecture and virtual design studios, before describing the method used to gather data for the present study. Thereafter, the survey results are described and analysed, and reference is made to interviews to assist in interpreting responses. The paper concludes with a series of observations about the data and its implications.

## **2. Background**

### **2.1. Architecture studio pedagogy**

The architectural design studio has been characterised as a place in which students learn the design process, developing proficiency through a regular process of consultation, feedback and reflection (Logan, 2008). A typical architecture studio comprises various teaching and learning activities including lectures, one-on-one consultations, group work, and critiques (Masdéu & Fuses, 2017). In architecture studios, architectural theory, technology, and communication related knowledge are applied to a design project. Content includes many societal, economic, and cultural factors which may need to be considered during a design process. Architecture studio pedagogy can be traced back to the studios at Ecole Des Beaux Arts (1819-1914), where art and architectural education focused on learning by doing, and students completed design projects with the supervision of professional architects (Anthony, 1991; Schön, 1984). Such project oriented, contextual problem solving approach and focus is seen throughout contemporary studio teaching approaches (Buchanan, 1992). Cuff (1992) suggests including more collaborative projects in architectural studios, to equip students with problem solving design skills within a collaborative context. Dutton (1987) emphasises that in design studios, it is more important for students to understand that design is ultimately heavily associated with social, economic, and political factors rather than purely concerned with beautiful forms. Architectural studios are commonly regarded as creating a type of “community of practice” or “simulated office environment”; such characteristics can serve to normalise the experience of designing, and focus creativity on the challenges of society and the needs of clients. These characteristics are typically accepted as goals for both traditional (face-to-face) and online studios.

With the development of Building Information Modelling (BIM) and increasingly distant professional collaborations in the Architecture, Engineering and Construction (AEC) industry, it is necessary to prepare students with the essential skill of online collaboration (Jones & Dewberry, 2013). Since 2020 in light of the societal impact of COVID-19, not only do online collaboration capabilities appear to be essential for future architects, but online studio education is also needed by most architectural schools.

### **2.2. Impact of delivery mode on students learning in architectural courses**

Within the architecture discipline opinions have typically been divided about the potential beneficial and detrimental impacts of online teaching. Whilst the global situation in 2020 has forced the majority of universities to embrace online offering, there is a lack of understanding about the current status of online architectural courses. One of the primary tensions that exists

is concerned with studio courses, which are regarded as delivering knowledge and also providing an opportunity for modelling appropriate attitudes and behaviours. The former is typically regarded as something that can be accommodated in online environments, whereas the latter is generally seen as something which requires face-to-face environments (Schön, 1987; Webster, 2008). These arguments are not new ones, and research into virtual design studios since the 1990s have reiterated these issues. For example, it may be difficult to translate the socialisation component of the studio into an online format. However, Kvan (2001) proposes that architectural education should focus more on the process, as students tend to fixate on specific criticisms of final projects, rather than the whole education process and the lessons learned. Conversely, to accommodate both the social and pedagogical properties of the studio, Bender and Vredevoogd (2006) advocate blended learning. Park (2008) also suggests the integration of both off- and on-campus modes of education, where platforms (like 'Blackboard') support online learning. Similarly, Saghafi et al. (2012) suggested a blended learning mode for architecture studios, that is optimal for student learning from the perspectives of self-determination, self-management, and personalisation of learning environments.

Ceylan et al. (2020) conducted a student survey of eight online architecture studios, to explore their satisfaction with, and degree of adaption of, 2020's online studio changes. The findings showed that there is a need for online advanced visualisation and representational methods. Students liked the fact that they could repeatedly re-watch recordings of discussions. First and second year students' online experiences in terms of digital drawing, hand sketching and model making were more positive than that of third and fourth year students. Another similar study about surveys of student satisfaction in relation to 2020's online design studios, suggests that many students were uncertain about their online learning experience; their most common areas of concern were technical issues such as unfamiliarity with new online teaching platforms, and resulting limitations in peer interaction (Alnusairat et al., 2020).

Vecchia et al. (2009) argue that virtual design studios actually increase the time students focus on reflection. Kvan (2001) also finds that the students who engaged more effectively in web-based learning explored twice the number of design ideas during their design development, compared to those who were not web based; however, he observed that it did not necessarily result in better learning outcomes. Another issue is that virtual studios tend to prioritise digital presentation techniques at the expense of hand drawn presentations.

### **2.3. Socialisation, communication, and interaction in online architecture studio**

The value or need for virtual design studios was initially identified in the 1990s (Mitchell, 1995), and more recently its benefits have been linked to its capacity to support complex social learning and interaction Jones et al. (2020). Past research on virtual design studio has been focused on virtual collaboration, involving students and teachers from various universities (Bennett, 2001 ; Chen et al., 1994; Maher et al., 2000; Schnabel & Kuan, 2001; Sclater, 2001).

In the virtual design studio, as in the traditional studio, students can view each other's work and draw motivation from this, and arguably this capacity may be even great online because of asynchronous communication and interaction. In order to be effective, however, online studios must be able to accommodate dynamic communication between tutor and student and between students. Conversely, communication in virtual studios may be compromised by individualisation of software, hardware and student's diverse capacity to use both.

Abbasi et al. (2018) state that communication and interaction in online design studios is particularly important. Teachers should provide opportunities for students to discuss ideas with each other, and to offer “live” critique sessions for students to receive feedback and reflect upon their designs.

The counterargument, as stated previously, is that socialisation must be learnt before it can be applied, and it is difficult to learn remotely. It is not taught as part of a formal lesson plan, rather it is developed through listening to and interacting with teachers and professionals (Webster, 2008). Online teaching requires the development of effective interfaces which support a collaborative culture (Stahl, 2011).

#### **2.4. Online tools development in architecture courses**

A key issue in the development of online learning for architecture is the availability of tools and environments to effectively support interaction and communication (Maher et al. (2000). The internet has undoubtedly revolutionised many aspects of the design process, providing the ability to research new products, download codes, transfer drawings and collaborate with colleagues globally. That realisation has led educators to argue that encouraging students to engage in online interaction is a key part of preparing them for their future careers. Michael Pelken et al. (2013), for example, developed a virtual design studio platform to facilitate the design process and its standard stages.

One attempt to overcome the innate problem of socialisation restrictions in online architectural education is proposed by Craig et al. (2000) who uses a technical, web-based format (*CoWeb*) to encourage peer-to-peer communication to resolve design issues and generate discussions. Niculae (2011) proposes three applications which have similar concerns. The first, “collective inductive learning” supports timely distribution of information. The second, “collective analysis” involves public presentation in the architectural studio, which is a core part of the learning process. The last, “collaborative work” supports students to have access to diverse functional and cultural learning support anywhere in the world. A further solution to the problem of socialisation is proposed by Schnabel and Ham (2014), who use a *Social Network Learning Cloud* to encourage social engagement among students. A similar platform is proposed by Vecchia et al. (2009), which allows chat, email, public forums, shared digital white board (collaborative 2D environments), shared VRML navigation (collaborative 3D environments), joint text editor, document transfer and collaborative use, all supported by group creation and scheduling.

Currently, the most frequently adopted online teaching tools are *Blackboard Collaborate Ultra*, *Microsoft Teams* and *Zoom*. In architectural studios, *Blackboard Collaborate Ultra* is particularly popular since it allows tutors to draw on top of students’ work, which to a large extent simulates the sketching process of traditional face-to-face studios.

Despite all of this past research, and many innovative ideas, there have been no recent studies to examine the effectiveness of online teaching across both studio based courses and theory based courses, which is the catalyst for the present paper.

### 3. Research Aim and Objectives

This study aims to explore the effectiveness of online learning within architectural programs, for both design studios and theory/skill-focused architecture courses. There are three research objectives of the paper:

*Objective 1: To evaluate students' experience of learning, communication and interaction, online learning tools and course content/structure.*

*Objective 2: To evaluate teachers' experience of course context, organisation of the online course, evaluation of students' learning outcomes, communication and engagement, and online teaching tools.*

*Objective 3: To provide suggestions to improve online teaching in architectural program.*

### 4. Research Design

This research adopts a combined method, a survey and a semi-structured in-depth interview. Use of surveys and interviews are a common and effective research method in relation to learning and teaching, to understand the perception of students and teachers. For example, Ceylan et al. (2020) adopted questionnaires to evaluate architectural students' learning experiences during COVID-19, and similar studies were conducted by Alnusairat et al. (2020) using online surveys. Interview methods play an important role in educational research; they can be applied to collect information that other methods cannot (Tierney & Dilley, 2001). Semi-structured interviews provide flexibility for the interviewer to ask additional questions based on an interviewee's responses. One example in architectural education of this method is Iyer and Roberts (2014)'s application of semi-structured interviews to understand architecture students' approaches to learning.

In our study, the online survey was targeted to architecture students in specific courses at three Australian universities. There are three types of online courses considered in this study: online studio, online non-studio and blended learning; those three types cover the online courses of most architecture programs. The study of all three of those types of online courses facilitates a more comprehensive understanding of online architectural teaching and learning. The courses were seven online studios, six online non-studio courses and two blended learning courses (total 15). Table 1 shows the criteria used to distinguish between the three types of courses. The survey questions were similar across the three types of courses. The survey questions were typically structured using a 5-point Likert scale for responses (Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree).

Table 1. Three types of courses defined in this research

Course type	Online component
Online studio ( $n=7$ )	All Lectures and studio sessions are online including online 'crit'
Online Non-studio ( $n=6$ )	Lecture and tutorial session are all online
Blended learning ( $n=2$ )	No less than 30% course content are online, including lecture and tutorial sessions

Semi-structured in-depth interviews were completed with one course convenor of each type of course offering. Five types of questions were framed (Table 2): course context, organisation of the online course, evaluation of students' learning outcomes, communication and engagement,

and online teaching tools. These questions were the starting point for each interview, although further follow-up questions could also be asked. Three interviews were conducted, one each from an online studio, online non-studio and blended non-studio course respectively.

Table 2. Semi-structured interview questions

Category	Questions
<b>Course context</b>	<ol style="list-style-type: none"> <li>1. Are the online courses synchronised with the on-campus courses?</li> <li>2. Are most of students international or domestic?</li> <li>3. For staff, has the teaching load reduced or increased for the online course.</li> </ol>
<b>Organisation of the online course</b>	<ol style="list-style-type: none"> <li>4. How are crits organised.</li> <li>5. What is the biggest challenge for online teaching?</li> <li>6. What is the benefit of online teaching?</li> <li>7. How are studio sessions taught? Do tutors have individual consultations with students? How are group discussions run?</li> </ol>
<b>Evaluation of students' learning outcomes</b>	<ol style="list-style-type: none"> <li>8. Do you think students achieve learning outcomes better for online courses?</li> </ol>
<b>Communication and engagement</b>	<ol style="list-style-type: none"> <li>9. Do you think students find it difficult to learn from each other for online courses?</li> <li>10. Do you think students engage better for online course or for face-to-face?</li> </ol>
<b>Online teaching tools</b>	<ol style="list-style-type: none"> <li>1. Is it difficult to use the current online teaching tools?</li> <li>2. What are the current challenges of using these tools?</li> <li>3. How do you organize the course and what online tools do you use for lectures?</li> <li>4. What tools are you using for the online studio?</li> </ol>

## 5. Results

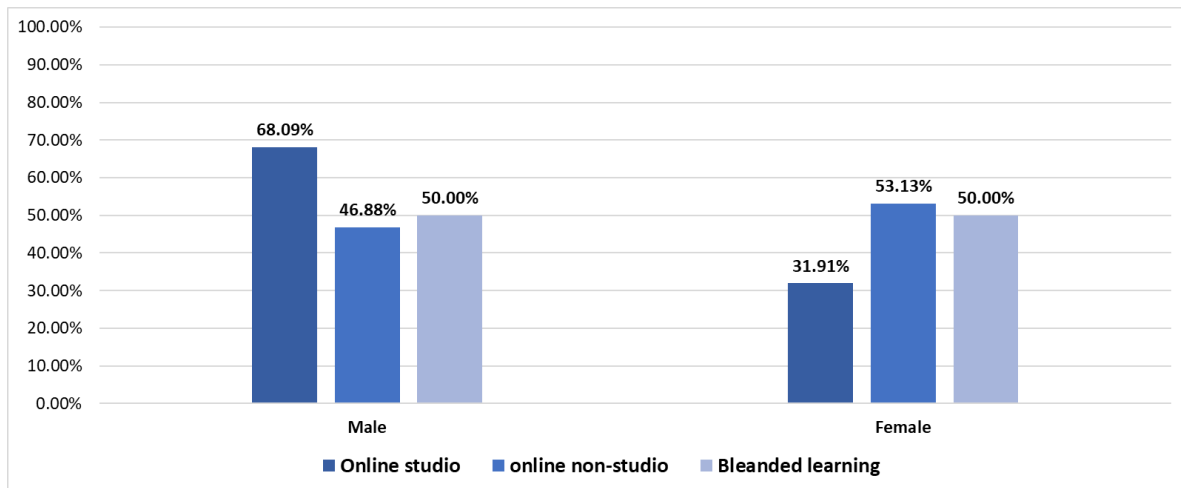
### 5.1. General information

The architectural programs of three Australian universities were selected – Curtin University, Griffith University and University of South Australia. The selection criteria were the availability of online architecture courses: Curtin University is the only university in Australia which provides a full online architecture program including online studio. In the context of the selected universities, “course” refers to a single unit within a degree “program”. Any students enrolled in the selected courses were eligible to participate in the survey. From 15 courses (note: surveys were sent to 19 courses, but 15 received participant responses) at three Australian universities, a total of 778 students viewed the survey and 93 students participated in the survey, leading to 88 completed survey responses (15 from Year 1, 21 from Year 2, 41 from Year 3, 3 from Year 4, and 10 from Year 5). Surveys were sent to seven online studios. 50 students participated in the survey and 47 completed survey results were received. As shown in Figure 1 and Figure 2 (data in the figures represent the completed responses), there are 68.09% male and 31.91% female students, 95.83% are domestic students and 4.17% are international. Among domestic students, only 18.75% students are local city based. The studios we surveyed are across five years (22.92% year 1 and 2, 39.58% year 3, 2.08% year 4 and 12.50% year 5). 58.33% of the students have experienced an online studio before, and 64.58% have experienced another non-studio online course before. Among them, 56.25% have previously experienced a face-to-face studio.

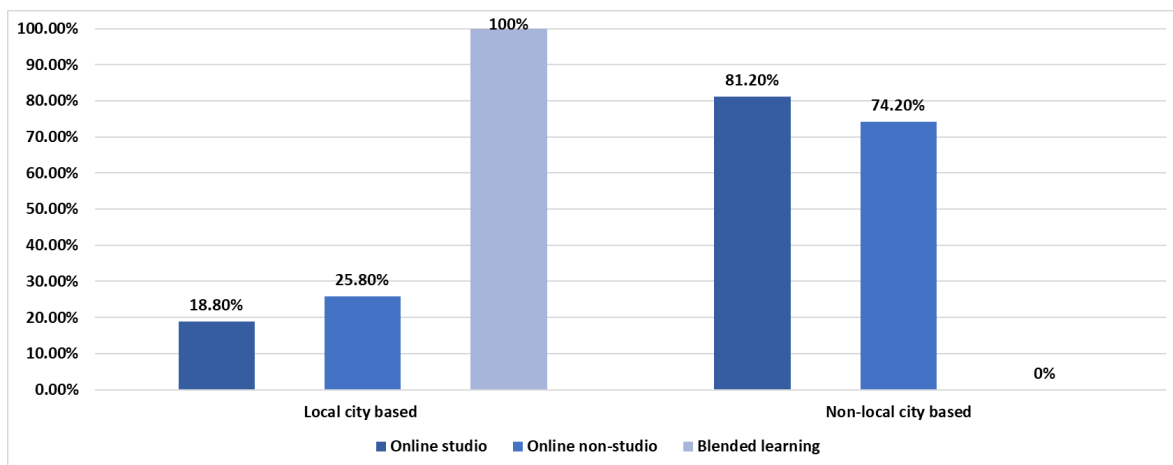
Six online non-studio courses have been included in the survey. 33 students participated in the survey and 31 completed students' responses have been received. Among them, as shown in Figure 1, 46.88% are male students and 53.12% are female students. Of the participating

students, 12.50% of them are from year 1, 28.13% are from year 2, 40.63% from year 3, 6.25% from year 4, and 12.50% from year 5. Figure 2 shows that 90.63% are domestic students (25.81% based in local cities), with 90.32% of them having already experienced at least one traditional face-to-face course prior to their current online course.

For blended learning, the survey was sent to students enrolled in two blended learning courses. 10 students' complete responses were received, with 50% male and 50% Female (Figure 1). Students are all local city based students (Figure 2) who have experienced of both online and face to face course before.



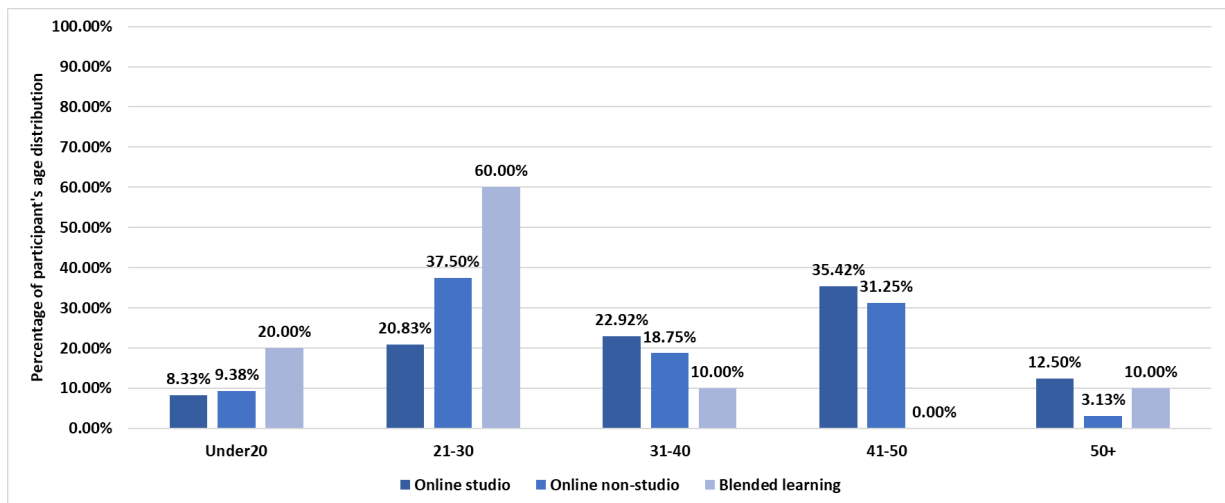
**Figure 1.** Participant's gender



**Figure 2.** Participant's location

Figure 3 shows participant's age groups in the three types of courses. 35.42% of students in the online studio courses and 31.25% of students in the online non-studio courses are in the 41-50 age group. This profile is very different to that of on-campus students, indicating that flexibility provided by online modes of delivery enable mature students, who are often working full-time, to complete their courses. In contrast, the students in blended learning courses have a more typical on-campus age profile, with 60% in the 21-30 age group.





**Figure 3.** Participant's age group

## 5.2 Students survey results

Survey questions were designed around the four main themes of students' learning experiences, online tools, communication and interaction, and course content and structure (Table 4). Those four main themes were developed based on common issues in online architectural courses identified from literature review. Table 3 shows the survey results for the three course types and Table 4 is the categorisation of survey questions in terms of positive/negative experience. The neutral threshold for this was 2.5-3.5, which determines that a mean ( $\mu$ ) value less than 2.5 is positive, and mean value higher than 3.5 is negative.

The results indicate that overall students are mostly positive about their learning experience, including learning outcome ( $\mu = 2.19$ ), satisfaction ( $\mu = 2.17$ ), and flexibility ( $\mu = 1.66$ ). However, self-motivation is neutral ( $\mu = 2.84$ ), which aligns with our expectation that for online courses students tend to be less self-motivated than in face-to-face courses. Overall, students were positive about course content ( $\mu = 1.96$ ), especially for the online critique ( $\mu = 2.00$ ) in the online studio. The difficulty level of online tools ( $\mu = 3.40$ ), and communications with peers ( $\mu = 2.68$ ) and teachers ( $\mu = 2.74$ ) were all neutral.

For online studios, most students had an overall positive learning outcome ( $\mu = 2.01$ ) and satisfaction rate ( $\mu = 1.98$ ). Students' preference for specific delivery mode is neutral ( $\mu = 3.02$ ) and most of them were neutral about the difficulty level of using online tools ( $\mu = 3.44$ ). Student's experience of interacting with peers and teacher was neutral, and most agree that the interaction is effective and they do not consider it is currently an obstacle for the online studio. Students did not consider lack of motivation and engagement an obstacle for their studio learning ( $\mu = 2.89$ ) and they were relatively happy about course content ( $\mu = 1.92$ ) and feedback ( $\mu = 2.00$ ). The most positive aspect identified by students was flexibility, with a mean score is 1.39. For online non-studio course, results suggest that most students had overall positive learning outcome ( $\mu = 2.15$ ) and satisfaction ( $\mu = 2.23$ ). Students were also relative happy about

the course content ( $\mu = 1.84$ ). The most positive aspect for students was also flexibility ( $\mu = 1.68$ ). Delivery mode, online tools, interaction with peers, self-engaging and motivation were all neutral. Students in the blended learning course, provided mean neutral results in terms of learning outcome ( $\mu = 2.75$ ), course content ( $\mu = 2.80$ ) and flexibility ( $\mu = 2.80$ ). Delivery mode ( $\mu = 3.40$ ), interaction with teacher and online tools ( $\mu = 3.70$ ) were all negative.

The results for questions 2, 4, 5, 8, 9, 10 and 15 all have *SD* value that are less than 1 (Table 3). This indicates that students' responses are dispersed within a level of agreement from the mean value for those questions. For example, most students agree that flexibility is the biggest advantage for the online studio ( $\mu = 1.30$ ,  $SD = 0.62$ ). For online non-studio courses, students are positive about effectiveness ( $\mu = 1.84$ ,  $SD = 0.59$ ), flexibility ( $\mu = 1.74$ ,  $SD = 0.82$ ) and location ( $\mu = 1.61$ ,  $SD = 0.80$ ). For blended learning course, students are in agreement with each other that there is minor difficulty with online tools ( $\mu = 3.70$ ,  $SD = 0.68$ ), and the interaction with other students is helpful ( $\mu = 1.70$ ,  $SD = 0.68$ ).

The data overwhelmingly confirms that students appreciate the flexibility of online learning, in both studio and non-studio courses. Students are able to remotely learn from any geographical location, and with a relatively flexible schedule. Students have minor difficulties using online tools in online studios and blended learning courses. This suggests that this generation of students has a strong capability for mastering the use of online tools. While engagement with teacher and peers was positive in online studio courses, it was neutral or negative in other courses. This may also be due to the nature of studio, where tutors must interact with students in a more intensive and sustained way.

**Table 3.** Likert scale survey results (Strongly agree -1, Agree -2, Neutral -3, Disagree- 4, Strongly disagree -5) Note, slight variations in questions to accommodate different delivery modes.

	Questions	Online studio		Online non-studio		Blended learning		All students	
		Mean Score	SD	Mean Score	SD	Mean Score	SD	Mean Score	SD
1	I prefer online delivery to face to face mode	3.02	1.06	2.84	1.29	3.40	1.43	3.00	1.18
2	My learning experience with this online studio/online course/blended learning course is positive	1.98	0.99*	2.23	1.12	2.90	1.60	2.17	1.13
3	I have experienced difficulties using the online learning tools	3.44	1.07	3.26	1.24	3.70	0.68*	3.40	1.09
4	This online studio effectively helps me to develop my design project/ The online tutorial /tutorial is effective in terms of helping me with my assessment.	2.06	0.84*	2.32	1.17	2.60	1.43	2.21	1.03
5	The online lecture information is helpful	1.92	0.77*	1.84	0.69*	2.50	1.51	1.96	0.86*
6	The interaction with my tutor is effective	2.13	1.06	2.42	1.23	2.80	1.32	2.30	1.16
7	The interaction with other students is helpful	2.35	1.02	2.52	1.09	1.70	0.68*	2.34	1.03
8	The online critique is helpful	2.00	0.95*	-	-	-	-		
9	Flexible time is the biggest advantage for this online studio/course	1.49	0.83*	1.74	0.82*	2.70	1.42	1.72	0.96*

10.	Flexible location is the biggest advantage for this online studio/course	1.30	0.62*	1.61	0.80*	2.90	1.37	1.59	0.92*
11.	Better engaging is the biggest advantage for this online studio/course	2.77	1.26	2.87	1.12	3.10	1.29	2.84	1.20
12.	Lack of self-learning motivation is the biggest obstacle for this online studio/course	3.02	1.45	2.68	1.35	2.50	1.51	2.84	1.41
13.	Difficult to interact with teacher is the biggest obstacle for this online studio/course.	3.00	1.23	2.90	1.17	1.80	1.03	2.83	1.23
	Reverse negatives	3.00	1.22	3.10	1.15	4.20	0.98	3.17	1.23
14.	Difficult to communicate with peers is the biggest obstacle for this online studio/course	2.96	1.22	2.84	1.13	3.67	1.32	2.99	1.20
	Reverse negatives	3.04	1.20	3.16	1.11	2.33	1.25	3.01	1.20
15.	Overall the course learning outcomes are achieved	1.96	0.78*	1.97	1.02	2.90	1.29	2.07	0.96*
16	The online component of this course is helpful	-	-	-	-	3.10	1.37	-	-

\*SD<1

**Table 4.** Categorisation of survey questions.

		Mean			Over- all	Positive/Negative			Over- all
		Online studio	Online non- studio	Blended learning		Online studio	Online non- studio	Blended learning	
Learning experience	Learning outcome	2.01 (Q4, 15)	2.15 (Q4, 15)	2.75 (Q4, 15)	2.14 (Q4, 15)	Positive	Positive	Neutral	Positive
	Students satisfaction	1.98 (Q2)	2.23 (Q2)	2.90 (Q2)	2.17 (Q2)	Positive	Positive	Neutral	Positive
	Self- engaging, motivation	2.89 (Q11, 12)	2.79 (Q11, 12)	2.80 (Q11, 12)	2.84 (Q11, 12)	Neutral	Neutral	Neutral	Neutral
	Flexibility	1.39 (Q9, 10)	1.68 (Q9, 10)	2.80 (Q9, 10)	1.66 (Q9, 10)	Positive	Positive	Neutral	Positive
Online tools	Difficulty level of using Online tools	3.44 (Q3)	3.26 (Q3)	3.70 (Q3)	3.40 (Q3)	Neutral	Neutral	Positive	Neutral
Communic ation and interaction	Interaction with peers	2.70 (Q7, 14)	2.84 (Q7, 14)	2.02 (Q7, 14)	2.68 (Q7, 14)	Neutral	Neutral	Positive	Neutral
	Interaction with teachers	2.57 (Q6, 13)	1.79 (Q6, 13)	3.5 (Q6, 13)	2.74 (Q6, 13)	Neutral	Positive	Negative	Neutral
Course content and structure	Course content	1.93 (Q5)	1.84 (Q5)	2.80 (Q5)	1.96 (Q5)	Positive	Positive	Neutral	Positive
	Online critique	2.00 (Q8)	-	-	-	Positive	-	-	

	Online component	-	-	3.10 (Q16)	-	-	-	Neutral	-
	Delivery mode	3.02 (Q1)	2.84 (Q1)	3.40 (Q1)	3.00 (Q1)	Neutra l	Neutral	Neutral	Neutra l

In order to test the relationship between students' learning experiences and the other three factors (difficulty level of using online tools, communication/interaction, and course content/structure), ordinal regression testing was conducted using SPSS. In this model, learning experience is the dependent variable, and the other three factors are independent variables. We used all of the student responses from the three types of courses (questions 8 and 16 were excluded to ensure the data contain all students responses). Table 5 shows the sig. of various test results. Normalised testing suggested that the data is not normally distributed ( $p < 0.001$ ), which make sense in Likert scale analysis. The model fits the data very well (model fitting information  $p < 0.001$ , goodness-of-fit  $p = 1.000$ ). The test of parallel lines suggests that there is no validated proportional odds, therefore further ordinal regression testing was conducted (Table 6). R-Square of linear regression results suggest that 54.2% of change of the dependent variable is the results of independent variables (Nagelkerke = 0.542).

**Table 5.** Sig. of various test results

	Normalised test	Model fitting information	Goodness-of-fit		Test of parallel Lines
Sig.	<0.001*	<0.001*	Pearson	1.000	1.000
			Deviance	1.000	

\* $p < 0.05$

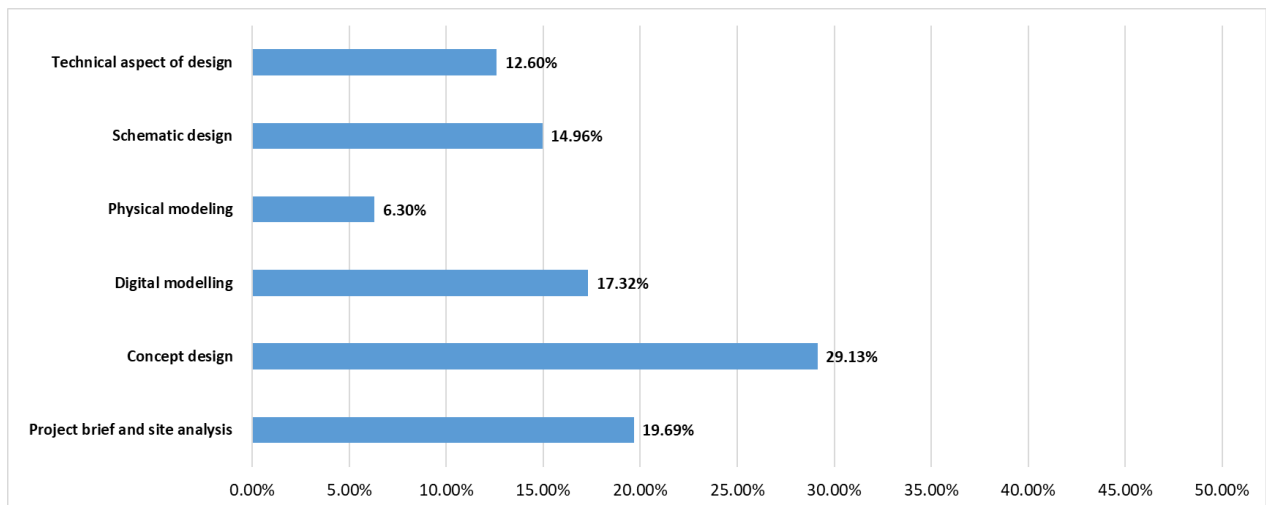
Ordinal regression test results in Table 6 suggest, that communication and interaction with teachers and peers ( $p < 0.001$ ) and course content/structure ( $p = 0.012$ ), were both significant positive predictors of students' learning experience. Among them, communication and interaction were stronger factors. However, the difficulty level of using online tools does not appear to be significantly related to students' learning experience.

**Table 6.** Ordinal regression test (learning experience as dependent variable)

	Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Difficulty level of using online tools	.349	.192	3.326	1	.068	-.026	.725
Course content/structure	.761	.301	6.370	1	.012*	.170	1.351
Communication/interaction	1.813	.346	27.479	1	<0.001*	1.135	2.491

\* $p < 0.05$

Figure 4 shows multiple stages of the design project which students consider most beneficial from the online studios. From the figure we can see that 29.13% of the students consider concept design is beneficial from online learning. This is followed with project brief and site analysis (19.69%), digital modelling (17.32%), Schematic design (14.69%), technical aspects of design (12.60%) and physical modelling (6.30%). Generally students believe that online learning is mostly beneficial at the early design stages.

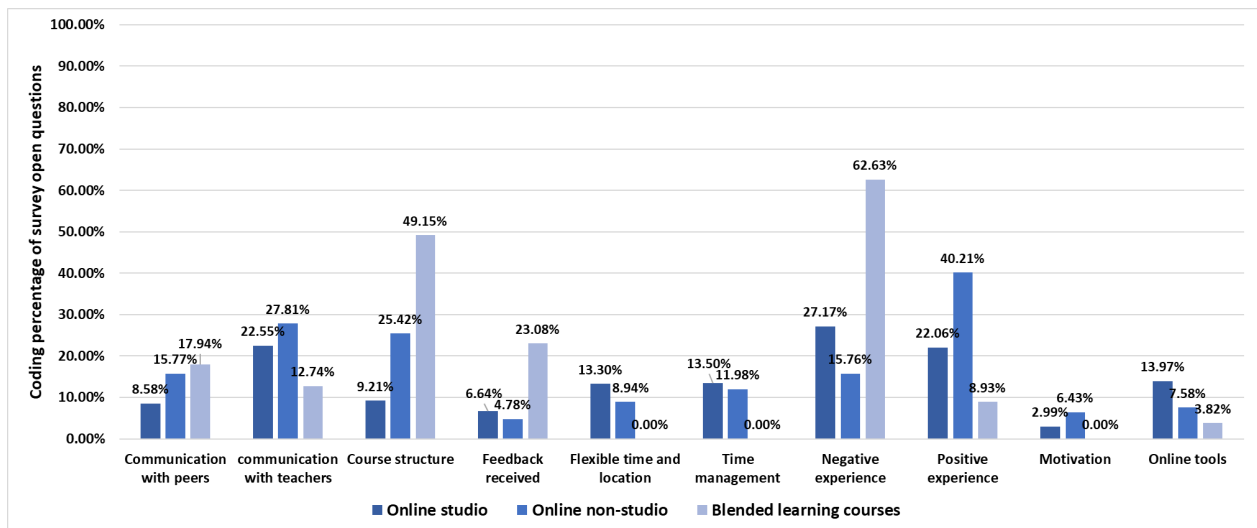


**Figure 4.** The stages of design project which is beneficial from the online studio

### 5.3. Student survey open question analysis

The last question in the survey allowed an open text response to the question, “do you have further comments for this online studio/courses?” Figure 5 codes the themes raised in the open question for online studio, online non-studio and blended learning courses. Qualitative data analysis tool *Nvivo* was used to code the open text data. The code was developed based on the four main themes of students’ learning experiences (negative/positive experience, flexibility, time management, motivation and self-motivation), online tools, communication and interaction (with peers and teachers), and course content/ structure.

For online studio courses, negative experiences (27.17%) were raised slightly more often than positive ones (22.06%). This contradicts the Likert scale results and may be due to the fact that students commented open text responses mostly related to specific difficult situations. The most common responses were concerned with interaction with teacher (22.55%), online tools (13.97%) and flexibility (13.30%). For online non-studio courses, students had a more positive experience (40.21%) than negative (15.76%), which aligns with the Likert scale results. Students’ discussion focused on communication with teachers (27.81%) and course structure (25.42%). The themes with the least comments were feedback (4.78%) and motivation (6.43%). This is very different from online studio courses, where students pay more attention to online tools and less to course structure. For the blended learning courses, students had more negative (62.63%) than positive (8.93%) open text responses. Course structure was the area of most concern for students (49.15%), followed by feedback (23.08%), communication with peers (17.94%) and teachers (12.74%).



**Figure 5.** Percentage of open text question coding for online studio, online non-studio and blended learning course.

Figures 6, 7 and 8 are the matrix coding which shows the correlation between positive/negative experiences reported in open questions and various aspects of their learning experience. The first of these, Figure 6, shows the matrix coding of online studio open questions. The results show that flexibility strongly associated with positive experience and communication and interaction are related to negative experiences. Online tools are responsible for more negative experiences than positive. In the Likert scale questions, the results suggest that students do not have significant difficulty in using the online teaching tools. However their experiences with using online tools have been negative. One student specifically commented on Collaborate Ultra which is the main online teaching tools for online studio: “Collaborate Ultra ... lacks a fair amount of flexibility to draw over and share ideas through sketching. It’s too artificial, and ideas are then limited to what the program can do, rather than your thought process.”

Figure 7 shows the matrix of online non-studio open questions. From the figure we can see that flexibility and course structure are strongly related to positive experiences, whereas there are both positive and negative experiences for communication and interaction, with slightly higher percentage of the positive. There are both positive and negative experiences associated with online tools. Figure 8 reports the results for the blended learning open questions. For this set, course structure is closely related to negative experiences, followed by feedback received. The sample size for the courses is, however, the lowest of the three.

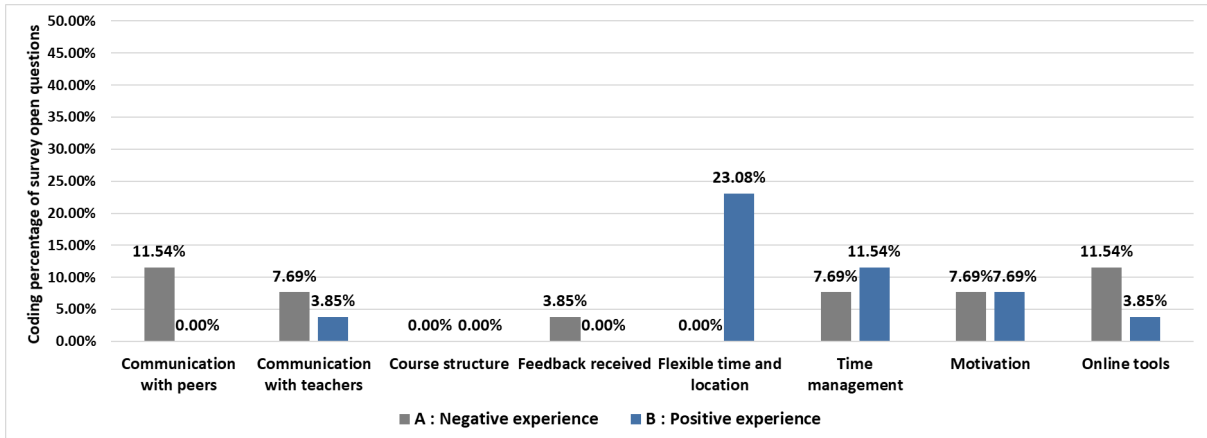


Figure 6. Matrix coding of online studio open questions

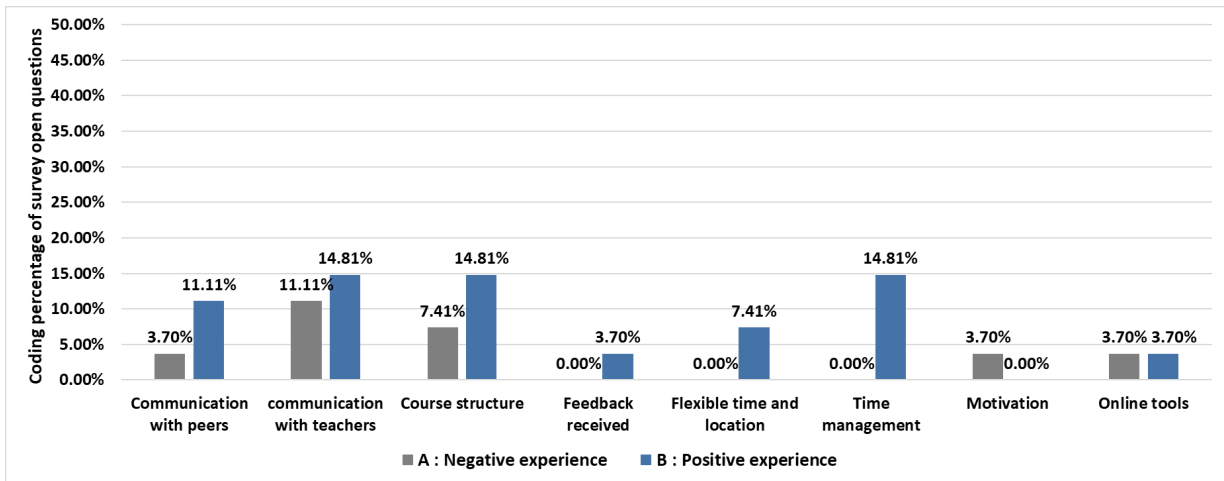


Figure 7. Matrix coding of online non-studio open questions

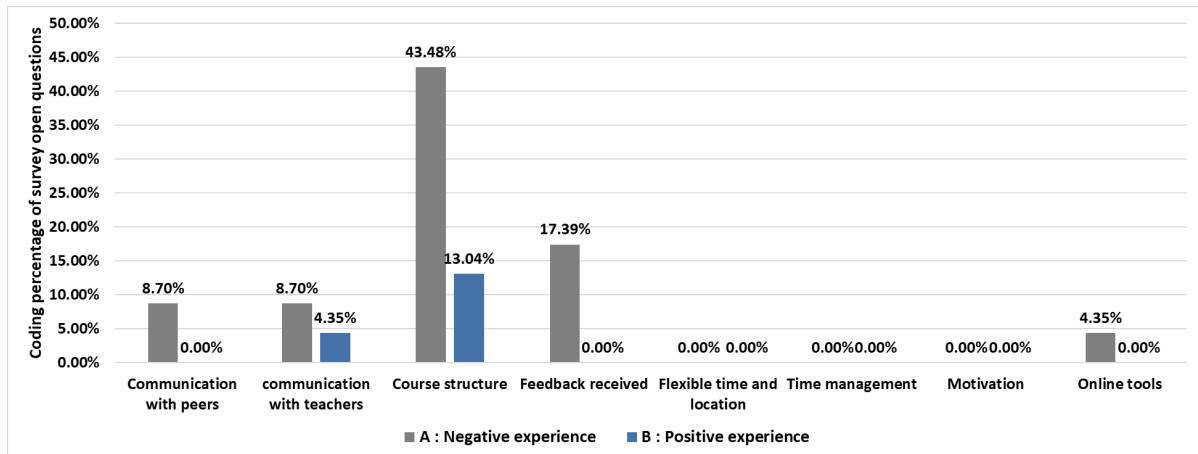


Figure 8. Matrix coding of blended learning open questions

## 5.4. Interview results

Semi-structured in-depth interviews were conducted with three course convenors, each convening online studio, online non-studio and blended learning courses. The interview revealed the following findings.

### *Online course structure*

Generally, course content and structure do not have fundamental differences between online courses and on-campus courses. Some course convenors prefer to adopt a “flipped classroom” (Abeysekera & Dawson, 2015; Låg & Sæle, 2019; Sams & Bergmann, 2012) model where the lecture recording is uploaded prior to the lecture session and the session is mainly focused on discussions. Online studio courses are comprised of lectures, studio sessions and crits similarly to on-campus studio courses. The course structure for online non-studios is usually comprised of online lectures, readings and associated learning sources. Interviewee 2 stated (Jun 10<sup>th</sup> 2020 interview) that “whether it's face-to-face or online, the thing that engages students is whether the material is interesting and entertaining, whether it captures their imagination”. There are also designated times each week when students can personally engage with the teaching staff.

### ***Online teaching tools***

There are two main approaches to online studio teaching: synchronous sessions mostly delivered via *Blackboard Collaborate Ultra*, or asynchronous sessions via *ePinup* based on the “*Hiveflare*” proprietary online platform. The benefit of using *Blackboard Collaborate Ultra* is that it allows tutors to draw overlaid on top of students' work (however its drawing tool is fairly rudimentary and has only one line weight); it also allows tutors to have one-on-one sessions with students while other students are watching along as well, and other students who are in the session may ask questions or comment along in the chat without everyone needing their microphone on simultaneously. Meanwhile, *ePinup* is a closed social networking site where students post images of their work, and then tutors and other students review the work and make comments, which potentially allows immediate feedback outside of fixed studio times. An issue emerging from online studio sessions is that if a participant has an inadequate internet connection, it can result in unpredictable delays to the whole group session which impacts everyone's learning experience.

The online teaching tool used for non-studio courses, is primarily *Blackboard*. *Microsoft Teams* was used for weekly tutorials at designated times however it was found not to work well for that use. And *Zoom* software was utilised discussions and face-to-face sessions. A main issue of concern, is that none of those aforementioned tools integrate all necessary teaching functions into any single software tool. So there either needs to be better integration between these disparate tools, or there is a need for the development of a single comprehensive online teaching tools that fulfils all necessary teaching functions well. As things stand, generally *Blackboard* provides a much better framework and way of organising teaching material compared to other software tools, however *Blackboard* is not ideal for communicating with students, since *Zoom* is a much more functional and better performing way to have one-on-one discussions. As interviewee 2 stated (Jun 10<sup>th</sup> 2020 interview): “...there's just different platforms that do different parts well, but at the moment they don't speak to each other terribly well”. So there's quite a lot of manual administration work needed to make all of the needed platforms work together effectively. There is a need for the online teaching platform to have the capability to efficiently and easily manage spontaneous communications with students, rather than relying on asynchronous communication models that may result in inefficient use of both teachers' and students' time if work and learning is slowed down by waiting for multiple asynchronous responses.

Mixing up approaches to suit the type of course is important, for example, if an immersive physical group experience is expected to be likely to assist with a course's learning objectives,



then technology such as VR or AR (including simulated auditory and possibly simulated tactile/haptic technologies) may assist with fulfilling such requirements as much as practically possible in lieu of a real physical experience.

### ***Advantages of online courses***

The interviewees about online studios emphasised that students who enrol as online students are often part-time students, so they would usually spend more than three years to complete their bachelor's degree. The greatest benefit of online programs is their accessibility – giving people access to a university education, such as for mature students who also have significant family and job commitments. That also reaffirms the survey results, which indicated that flexibility is the most positive aspect of the online studio course experience, and that students' average age is relatively higher compared to on-campus students. The flexibility of online course schedules allows students to engage with lectures and course materials in diverse ways that are best suited to their personal needs, e.g. students can cram the material if they wish, or periodically watch a few lectures in a row. Compared to the inconsistency of live presented lectures, pre-recorded lectures can be more consistent and predictable and focused.

Another advantage of online teaching is that it promises to help make education more equal for a diversity of potential students. Students may gain access to the lectures of the top-ranking universities, that previously they may not have had realistic access to at all; that could lead to students receiving improved standards of education.

### ***Course tasks which are disadvantaged by online delivery***

There are some aspects of learning and teaching that are limited by online delivery methods. For instance, since in online delivery most communications between students and lecturers are handled via time-consuming email correspondence instead of brief face-to-face conversations, consequently the academic staff's teaching load becomes somewhat higher compared with traditional face-to-face teaching. Additionally, the need to give basic advice to students about their basic IT-related misunderstandings (that some students inevitable have arising from the online delivery methods), also adds to academic staff's teaching load.

Fascinatingly, some of the tasks that we expected to be particularly difficult to accomplish via online delivery methods, were surprisingly solvable to certain extents. Traditional forms of site visits, can be practically replaced in one of two ways; either by each student choosing a criteria-matching site that is also in close geographical proximity to them (to allow the student to trivially travel there to survey the site in person), or by teachers pre-selecting a site which has easy online availability of information associated with it (to allow the student to virtually survey the site via online maps, etc). Also, the construction of physical models during online studios is in practice not as difficult as may be initially imagined. Although online studio students were not able to use a 3D printing or laser cutter machine, they managed to make use of other material and methods to complete their physical model and some of them had good results. However, nevertheless it remains a challenge to fabricate highly physical aspects of traditional studio work, that requires use of 3D printers, CNC machines, laser cutters, or robot arms, etc. As interviewee 1 stated (Mar 31<sup>st</sup> 2020 interview): “the biggest challenge for online studio is the manufacturing and fabrication, something that is very physical”. Usage of such tools is difficult to teach purely virtually online.

### ***Interactions and engagement***

Interactions between students in online studio sessions is not as simple as in traditional face-to-face studio sessions. One possible approach is for students to all join with webcams and mutually discuss their work with their peers at the beginning of a study session. The *ePinup* tool aims to develop such a community where students can practically share their ideas, however social connectedness is harder to establish and maintain in an online setting than face-to-face in a physical studio. A flipped classroom approach can enhance the interaction between teachers and some of their students; for studio sessions that approach allows for better discussing the material to assist with higher student engagement during the session (however some segment of students can complain about a lack of motivation if asked to watch pre-recorded lectures).

For online non-studio courses, the desired engagement model between teachers and students would ideally be the same as with traditional face-to-face teaching; an underlying trigger of engaging a student is to craft the course material to be simultaneously interesting, informative and entertaining, and to attempt to capture students' imaginations. Whether it's online or face-to-face, teachers still have to engage in an appropriate way with their audience, and also encourage students to engage with their peers. Quite often for students who may be introverts for example, the course will need to include certain mandatory provisions to actually get such students to engage in a certain way that enhances their learning. Accordingly, online courses in particular may benefit from implementing some kind of requirement for students to engage with each other, via processes that facilitate such collaborative learning and engagement.

### ***Learning outcomes of online courses***

In relation to learning outcomes, it currently remains unclear whether online students will attain better results than on-campus students. One of the reasons for continued uncertainty, is that students enrolled in online courses include substantially different age groups, some of whom may already be working in related practices for many years (as such variables impact a student's learning outcome). One of the theoretical advantages for online students however, could be that since all online 'desk crits' include a short formal presentation of student work, online students typically would get more practice and familiarity with formally introducing and presenting their work (since online teaching delivery methods routinely expect students to more frequently communicate in a manner similar to a formal recorded presentation).

## **6. Conclusion**

This paper evaluates the outcomes from online architectural courses, including online studios, online non-studios, and blended learning courses. Interviews and surveys were conducted with both students and course convenors, and based on subsequent analysis the following conclusions have been made:

Firstly, the typically most favoured aspects of online courses by participating students, is the flexibility that such online courses allow. Online teaching allows students to be able to learn anywhere, and with relatively flexible scheduling as well. It also provides greater opportunities for students to complete their degrees on a part-time basis, and especially accommodating for mature students. Such also applies to online critiques, in particular it enables the possibility of inviting international external reviewers from around the world to provide specialist feedback to students. And of course, these methods also greatly beneficial in the presently challenging

COVID-19 situation, during which time the majority of teaching has switched to online delivery models.

Secondly, we have seen a strong need for further development of online studio tools, with the consideration of current generation of students can actually adapt to the online technology very well. In order to assist with students' design projects, tutors need to be able to provide feedback about students work, including via sketching (be able to draw on top of students work, etc.); however current online studio tools are too limited in this respect. Current tools are working acceptably for lecture-based non-studio architecture courses, however they are suboptimal, since course convenors often currently need to manually combine together multiple online teaching tools, in order to meet all of their requirements. Therefore there is a definite need for better integration of current online teaching tools, to enable them to interoperate more smoothly with each other.

Thirdly, data indicates that students have generally positive learning experiences during online courses. However students also experience a lack of learning self-motivation compared to traditional non-online teaching models. This is indicative that online architectural programs hold great potential, provided that further exploration is done for methods to enhance students' self-motivation in online teaching environments.

Fourthly, communication and interaction with teachers and peers and course content/structure were both significant positive predictors of students' learning experience. For architectural programs, the question of how to enhance the communication and interactions between teachers and students and among students is a critical one.

Fifthly, some of the tasks that were expected to be challenging such as site visits and physical model making, can still be conducted acceptably via online teaching methods. However the biggest challenge with online architecture studios, is the manufacturing and fabrication, such as the use of 3D printers, laser cutters, or CNC machine.

Lastly, we have seen that there appears to be a need for teachers to find better ways to engage with students, especially when conducting lecture-based online courses. Possible examples beneficial to such engagement include, providing a greater number of opportunities for students to engage with both teachers and peers, and/or increasing proportions of live sessions (such as live lectures).

This study indicates that it is feasible to further move towards online based architectural program in the future. And once architecture courses are migrated to online forms, then it also can lead to greater educational equality for students; providing improved scheduling flexibility for mature age students (who may have family or work commitments) to complete their degree, and allowing students regardless of their geographical location to receive their education from a myriad of universities all over the world. Further development of online architectural program will have a focus on online teaching and learning tools, especially for online studio.

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