Barriers to the Adoption of Online Design Education within Collegiate Landscape Architecture Programmes in North America

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The field of landscape architecture has yet to see the broad adoption of online education, and it is theorised that this is because of a failure to adequately address the concerns of faculty. This paper reports the results of a Delphi study that identified the critical barriers holding back landscape architecture faculty in North America from adopting online education. The findings indicate that faculty are most concerned about how the social component of traditional studio learning can be translated to an online environment. Faculty are also sceptical about the lack of precedents and believe they do not receive adequate compensation for online teaching. The study's findings suggest that previous research with online education in design fields has failed to address many of the primary barriers faculty identified, which may mean a reorientation of the research agenda is necessary.

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The past two decades have seen increased interest and investment in an online approach to higher education. Universities increasingly see online education as a means of adapting to the changing economic and competitive landscape in higher education as they seek to expand their presence, invest in technological innovation and respond to budgetary constraints (Christensen and Eyring, 2011; Yuan and Powell, 2013). Simultaneous with this expanding interest in online education has been a tremendous growth in the adoption of technological innovations in communication and programming. Such technologies have led to the development of more sophisticated online collaborative environments in which instructors and students are able to interact, work and communicate in modes that come increasingly close to those found in traditional face-to-face learning environments (García-Peñalvo et al, 2011; Hew and Cheung, 2013; Lokken and Mullins, 2014).

Despite the rapid advances, innovations and demonstrated efficacy of online education, it remains comparatively nascent in the fields of landscape architecture, architecture and interior design (Bender and Good, 2003; Li, 2007). The lack of adoption of online education, hereafter referred to as distributed design education (DDE), specifically in the field of landscape architecture is puzzling. One aspect of the field's recent past that would seem to support DDE is the nearly two decades of research on using virtual design studios (VDS) to facilitate learning and collaboration in design activities via online environments. The underdeveloped state of DDE is all the more perplexing considering the current student capacity of landscape architecture education, the growing landscape architecture market worldwide and the potential for DDE to contribute to pedagogy and curriculum.

EDUCATION

Furthermore, given the demand for landscape architects is projected to increase, it is likely the existing educational system cannot graduate enough students to meet the growing demands of the market (Commission for Architecture and the Built Environment, 2010; Grantham, 2011; Landscape Architecture CEO Roundtable, 2007; Smulian, 2010). It is expensive and difficult to expand existing landscape architecture programmes because they require considerable physical space and low student:teacher ratios for studio classes (Hunter, 2012; The UK Architectural Education Review Group, 2013). Moreover, because online education is gaining popularity in the curricular, structural and budgetary approaches of universities, it is likely the design fields will face greater pressure from colleagues and administrators to develop and offer an increasing number of online courses within the design disciplines (Christensen and Eyring, 2011; Lokken and Mullins, 2014).

Purpose

Previous research has identified many of the affordances and constraints of DDE. The research has demonstrated that DDE can be used to teach a design curriculum successfully, in both lecture and studio format classes, and to facilitate collaboration between students, instructors and practitioners (Bender and Vredevoogd, 2006; Ham and Schnable, 2011; Kvan, 2001). DDE provides many possibilities that are particularly well suited to design education. For example, with DDE, it is easy to preserve and catalogue design iterations, to share analyses and design concepts between many parties, and to collaborate with geographically dispersed students, faculty and practitioners (Dave and Danahy, 2000; Ham and Schnable, 2011; Park, 2008). Given the many successful precedents, it is hypothesised the slow adoption rate of DDE stems not from pedagogical or technological shortcomings of the method itself but, rather, from a lack of readiness among landscape architecture faculty to adopt DDE.

Most of the DDE research has focused on describing technical practices and identifying the affordances and constraints of DDE. However, the attitudes and needs of faculty in regard to DDE have rarely been analysed. Considering the state of the research, it is possible that the factors most important to faculty have not been identified and the failure of researchers to do so and address these factors is holding them back from adopting DDE. This research aims to redress this gap by asking: What are the critical barriers that prevent landscape architecture faculty from adopting online design education? Once these barriers are identified, researchers and educators will be better equipped to design successful DDE tools and pedagogy that are attractive to educators and therefore more likely to be adopted.

Theoretical perspective

The educational pedagogy of the modern design studio is rooted in the methods of the nineteenth-century French art school, the École des Beaux-Arts. Pedagogically the École des Beaux-Arts functioned in a similar manner to craft guilds. Apprentices laboured under the watchful eye of a master, and learnt their craft through observing and copying the master, working up from basic tasks to more advanced tasks (Anthony, 1991). Under the influence of luminaries such as Walter Gropius (Rogers, 2001), Christopher Alexander (1964), Ian McHarg

(1969) and Herbert Simon (1996), the design process came to be seen as a rational approach, crafted in terms such as design problems, solutions and alternatives (Alexander, 1964; Dorst, 2003). Despite this shift over the past century to a rational, process-focused approach in design education, the basic pedagogical tenets of design education, namely the design studio, have remained relatively constant (Bender, 2005; Broadfoot and Bennett, 2003). This pedagogy assumes that students learn best in an environment that provides access to instruction and modelling from a master, and where they are free to observe, collaborate with and learn from their peers.

The studio provides a rich learning environment in which students must confront the complexities of realistic design situations and, by so doing, advance their understanding and skills. The separation of the physical design studio from design education, as may occur in DDE, is a common concern mentioned in DDE research (Saghafi et al, 2012a; Silva and Lima, 2008). However, DDE might also be seen as a continuation of the movement toward teaching the design process, because it de-emphasises the creation of design artefacts and the physical studio environment, and allows for the careful exploration and critique of the design activity itself (Saghafi et al, 2012b).

Methods and data

This study had two phases. The first identified the constraints of DDE through a meta-synthesis of the existing research on DDE. This involved the open coding of the literature to identify the constraints. The list of codes was then analysed to consolidate similar codes, which were then used to create a list of constraints (see table 1). The constraints were further grouped into four thematic categories: pedagogical, social, structural and institutional.

The second research phase used a Delphi study to identify the critical barriers that work against landscape architecture faculty adopting DDE. A Delphi study comprises a series of moderated survey rounds distributed to an expert panel. The panellists provide a readily accessible source of expert opinion that the researcher can draw on to produce informed and defensible group conclusions (Baker et al, 2006).

Because the study's target population was educators at accredited landscape architecture schools in the United States of America and Canada, the expert panel was recruited, first, from educators who participated in the Design Teaching and Pedagogy track of the Council of Educators in Landscape Architecture (CELA) Annual Conference in 2011, 2012 or 2013. In addition, notifications were sent to the department heads of every accredited or candidate landscape architecture programme in the United States. Because many qualified individuals may not have presented at the CELA conferences, potential panellists were asked to refer other individuals, or design professionals, they believed were suited to participate in the panel. Recommended individuals needed to meet at least one of the following criteria to be included in the panel.

1. They currently teach a design studio class at a Landscape Architectural Accreditation Board (LAAB), American Institute of Architects (AIA) or Council for Interior Design Accreditation (CIDA) accredited or candidate programme.

2. They have taught a design studio class at an LAAB, AIA or CIDA accredited or candidate programme within the past five years.

As a result of this process, invitations were sent to 191 individuals. Of those, 43 agreed to participate on the panel (40 original invitees and 3 referrals). This participation rate is consistent with reported Delphi surveys in other fields (Fischer, 1978; Ono and Wedemeyer, 1994; So and Bonk, 2010).

The first round involved a prepared survey constructed from the findings of the meta-synthesis. The survey listed the barriers to adopting DDE and briefly described each barrier for context. To allow panellists to precisely express their position, they were asked to rate the importance of each barrier on a seven-point Likert scale. In addition, they had space to comment on each particular barrier. Suggestions for further barriers were also collected during the first round. From this process, two suggestions from the panel in the first round met the inclusion threshold of 5 per cent and were included along with the 22 original barriers in the second round.

After the first round, the second-round survey was constructed using the same barriers (plus the two new ones) and data collection methods as the first round. However, in the second round, panellists were also shown their previous response on the Likert scale for each barrier, as well as the panel's mean, standard deviation and any submitted declarative statements for each barrier. The statements were

Coded constraints
1. Lack of face-to-face interaction; lack of communicating non-verbal cues
2. Time and resources needed to develop and teach online courses
3. Technical constraints or difficulties
4. Issues with faculty adopting technology
5. Students need to be proficient with technology
6. Building rapport and a sense of community takes longer or is not possible
7. Advanced technologies may be too expensive
8. Perceived incompatibility with studio method
9. Difficulty with collaboration
10. Unreliability of some internet resources
11. Faculty spent too much time online
12. Faculty opposition
13. Limited adoption by faculty
14. Requires motivated and organised students
15. Feelings of isolation for students
16. Potential negative impact on creativity
17. Fears that technology will replace faculty and/or staff
18. Lack of precedents
19. Students may need to purchase new technology
20. More scaffolding needed to give students direction
21. Cultural conflicts with collaborators
22. Lack of interaction with a physical site
23. Unsuited for difficult design subjects
24. Difficulties conducting juries
25. Perception that technologically produced designs are inferior
26. Students focus on learning technology instead of the design process

Table 1: List of constraints to distributed design education as identified from a meta-synthesis of the literature

included unedited, except in cases where the comments may have revealed an individual panellist's identity. The third round followed an identical format.

Scheibe et al's (1975) stability measurement formula was used at the conclusion of the third round to determine if the distribution for each particular barrier was stable, and if further consensus was likely to be achieved (Schmidt, 1997). This analysis showed that 23 of the 24 barriers had reached stability, suggesting further consensus was unlikely to be achieved on these barriers. It was therefore decided to end the Delphi after the third round.

Results

The barriers were ranked using the mean score of the panel's responses (see table 2). Graphing the mean score of each barrier revealed natural breaks in the data, allowing the barriers to be divided into four categories: *critical*, *important*, *less important* and *not important* (see figure 1). While initially falling outside the critical tier, the seventh-ranked barrier was included as critical because it shares a close thematic relationship with the critical barriers ranked 4 to 6.

The survey results suggest that the critical barriers holding back faculty from adopting DDE are a lack of confidence in the medium (barriers 1 and 3), issues with financial compensation (barrier 2) and issues related to social interaction (barriers 4 to 7). Examining the written comments from the panel on each barrier

Barrier	Mean	SD	Category
Instructors believe the studio method cannot be replicated using DDE	5.61	1.033	Critical
Faculty do not receive adequate compensation during the development phase	5.30	1.105	Critical
A lack of precedents for DDE	5.05	0.999	Critical
Building rapport with others is difficult	4.96	1.364	Critical
Students feel socially isolated from their peers	4.91	1.443	Critical
Lack of face-to-face interaction	4.91	1.379	Critical
Critiquing student work is difficult	4.78	1.506	Critical
Designs produced solely on a computer are inferior	4.70	1.941	Important
Upfront costs may deter development	4.70	1.329	Important
DDE constrains a student's creative process	4.65	1.722	Important
Only motivated and organised students can succeed	4.61	1.196	Important
Faculty have theoretical or pedagogical opposition	4.57	1.376	Important
Faculty struggle to adopt necessary technology	4.52	1.41	Important
Students spend less time and energy on DDE projects	4.52	1.123	Important
It is difficult for students to collaborate	4.48	1.675	Important
Teaching consumes unacceptable amounts of faculty time	4.32	1.323	Less Imp
Faculty concern that DDE will decrease tenured positions	4.30	1.579	Less Imp
Internet resources may be unreliable	4.14	1.699	Less Imp
Private concern DDE will threaten personal job security	4.09	1.505	Less Imp
Faculty are unwilling to adopt necessary technology	4.04	1.397	Less Imp
Ongoing costs deter continued offering	4.04	1.147	Less Imp
Necessary technology is too expensive for students	3.70	1.329	Not Imp
Necessary technology is too expensive for programmes	3.61	1.27	Not Imp
Required technology proficiency is unreasonable for students	3.22	1.347	Not Imp

Table 2: Ranked results of the barriers to adopting DDE, as identified by the Delphi study
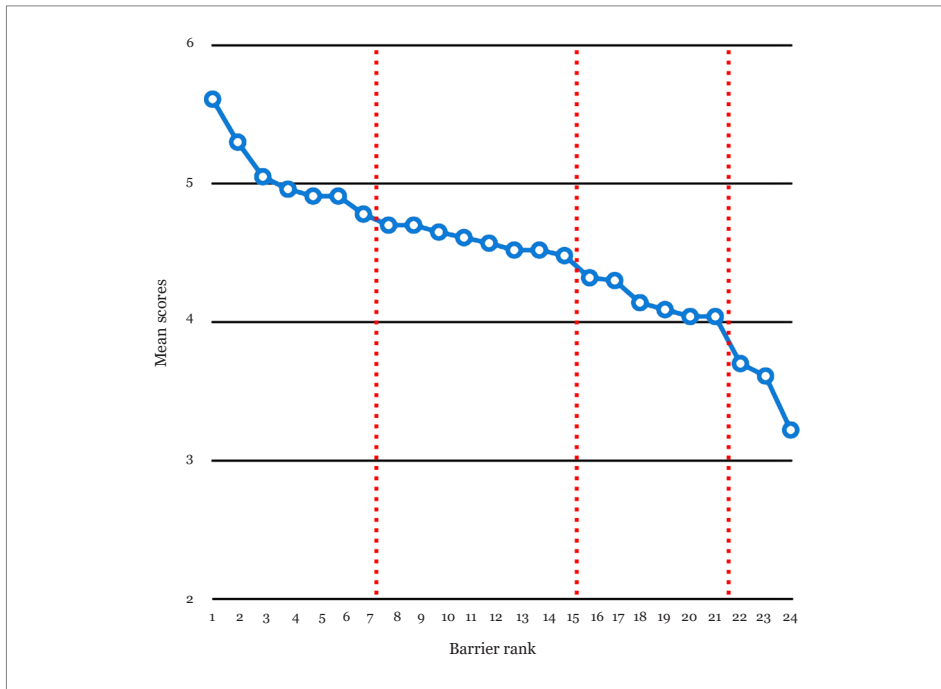
provides insight into the key factors the panel considered in their evaluation. Next we examine the panel's responses for each critical barrier and discuss the implications of these results.

Critical barrier 1: Instructors believe the studio method cannot be replicated using DDE

The most common theme in the comments was doubt about whether the physical and social interactions of the studio space can be translated into an online format. Panel members expressed concern about the loss of physical interaction as a means of conveying and converging on information and design ideas. Several comments referred to an intangible quality of the studio, a *something* that is not replicable outside the physical confines of the studio.

> There is something lost when students can't look across to others [sic] desks and see their works and/or iterations, overhear conversations, or participate in impromptu pop-up discussions and topics.

Several panellists discussed how technology can facilitate many of the types of in situ communication that occurs in the studio, but considered that elements of the learning process are either lost or degraded in a digital form. For instance, one panellist wrote: 'I think that it could be done technically and logistically, but I think that the process and the experience would lose something important'. Closely related to this idea are concerns about technical constraints or difficulties, and how these impact on communication and learning in a graphic-intensive design process.

The comments also reveal that some panel members are unfamiliar with successful examples, or do not know if the available technology could support DDE. This unfamiliarity with DDE tools and with the existing precedents suggests faculty have broader concerns related to the dissemination of research related to DDE. (See barrier 3 for a more thorough discussion.)

This barrier presents a unique challenge when compared with the other six critical barriers, because it is concerned more with an overarching concept (the entire studio method) than with a specific facet of DDE or studio teaching, such as critiques, social rapport or technology access. That this barrier was ranked as the most critical implies either that current forms of DDE are insufficient to replicate the traditional design studio or that many landscape architecture educators may have an underlying bias against or misunderstanding of DDE. If the first explanation is true, the solution is to conduct more rigorous research to identify the exact deficiencies of DDE and ways of overcoming them. If the latter applies, two approaches may be proposed to address this barrier.

The first is to assume that this barrier can only be addressed by resolving the specific concerns of the other six critical barriers. The second is to assume that this barrier represents an underlying bias against or misunderstanding of DDE, in which case the appropriate solution is to improve education about the affordances, constraints and potential uses of DDE. Bender and Good (2003) have come to similar conclusions about the need for substantial faculty education on DDE. Logically, because it is already necessary to develop methods of reducing the other critical barriers, the second strategy should be applied as a further way of addressing this barrier. Educators need to be better informed about all aspects of DDE and they need opportunities to both observe and experiment with DDE.

Critical barrier 2: Faculty do not receive adequate compensation during the development phase of online courses

Discussion on this barrier mainly revolved around insufficient monetary compensation for faculty members when they develop online courses. One panellist stated, 'My university encourage [sic] faculty to develop online courses but fail to provide adequate compensation.' Another expressed similar frustration over administrators lobbying for course development, but providing no monetary backing.

The lack of additional compensation is critical to faculty because of the time they must commit to develop an online course. Even a panellist unaware of the time commitment required recognised the potential problems such a project presents to faculty: 'Don't know for sure, but if time off from studio/lectures are [sic] not given for developing then, YES [this is critical].'

Several methods could mitigate this barrier. First, administrators could increase their investment in development costs to make DDE course development more attractive to faculty. Several comments from the panellists indicated that universities seem more willing to invest in programmes and infrastructure than in the human resources needed to develop online courses. Given all of the other demands placed on faculty, the lack of financial compensation is a significant disincentive to develop DDE courses.

A second approach would be to reduce the amount of time and energy a faculty member needs to commit to developing DDE (Lawhon, 2003). For example, some of the work could be offloaded to others, such as instructional designers. This approach, combined with modest increases in compensation, can make DDE course development much more attractive to faculty.

The problem of a lack of investment is compounded by concerns over intellectual property rights. Many faculty are protective of their course material, as it often represents a substantial investment of their time and research efforts. Many may fear that their work will be taken from them and freely distributed without credit or compensation. Guarantees of intellectual property rights need to be defined at all levels of a university in a clear and transparent manner in order to give faculty the proper assurances (Godschalk and Lacey, 2001). Faculty members may be less concerned about compensation during the development phase if their university makes a clear provision on how each of them will receive ongoing compensation from the use of their course content. In this model, faculty would essentially be paid a royalty fee for use of their content. However, because many academic institutions may need to adjust their current intellectual property policies to accommodate such a model, it is uncertain whether this approach would be adopted widely.

Critical barrier 3: A lack of precedents for DDE deters programmes from committing to developing such courses

The most common theme of discussion for this barrier was that few precedents for DDE exist. Several expressed a desire to 'see successful examples of studio design being taught online'. Panellists also wanted to see longitudinal studies documenting the impacts of DDE on 'intellectual growth and creativity' over several years. These comments suggest that panellists were concerned about not only documentation of DDE in practice, but also the rigour of the assessment of those cases.

A couple of comments indicate that panellists did not know which journals would publish papers on DDE precedents and studies. This finding suggests that part of this critical barrier is a critique of the way information on practical experiences with DDE is disseminated. This component is unsurprising, as the meta-synthesis found the majority of DDE literature is published in journals and conference proceedings related to technology and education, rather than the design fields.

For other panellists, the lack of precedents was not a concern because they were satisfied with precedents set in similar education fields. Furthermore, one panellist mused, 'lack of precedents have not deterred other explorations in design pedagogy'. Another stated that precedent is not the problem, but rather a 'lack of an understandable and motivating push to [adopt DDE]'.

Taken together, these responses suggest that dissemination of information about DDE precedents through traditional methods (journals and conferences) has been relatively ineffective in reaching landscape architecture faculty. To address this shortfall, steps should be taken to disseminate DDE work in non-traditional methods. For example, DDE experts might offer guest lectures or trainings, and departments could encourage faculty to explore DDE practices by conducting distance collaborations (Bender and Good, 2003). As discussed under barrier 1, involving faculty more closely with DDE may be beneficial. Moreover, instead of having only one or two faculty members pursuing DDE, department administrators may want to make it a concerted effort, involving many faculty members, so that the whole faculty is exposed to and understands DDE.

Comments from the panel also make it clear that faculty wish to see more rigorous research on DDE, such as through long-term longitudinal studies to better assess DDE's impact on the educational development of students and the achievement of teaching objectives. This study's evaluation of the literature also reveals that much of the current research on DDE uses deficient research methods. Therefore, more rigorous and targeted research should be conducted in order to instil greater confidence in the existing precedents for DDE.

Critical barrier 4: Building rapport with others is difficult in a DDE environment

This barrier is the first of four critical barriers that deal with social factors, indicating a significant concern about whether the various social dynamics of design education can be translated into a DDE environment. As this barrier identifies, the most common concern was whether technological tools can support the rich forms of communication necessary to build rapport. Panellists expressed the view that 'there is a disconnect between [people]' when using technology to communicate, and that individuals are unable to develop the 'deeper and more meaningful connections' that can be made face to face. Another concern was how students will learn to communicate with their future clients and the public if they come from a DDE environment.

Countering the theme of a technology gap was discussion on how modern students collaborate. Some panellists felt that students are digital natives who find it as easy to build rapport in an online setting as face to face. One panellist stated that building rapport online is the 'preferred method' of modern students and, given their heavy involvement with social media, it is possible that 'rapport of this kind has come into its own in education'.

In between these two sides of the debate are comments that building rapport is no more or less difficult online than it is face to face, and that building good rapport in a face-to-face environment is not guaranteed. Such comments suggest that building rapport and communicating effectively are more about the characteristics of the individual students and the scaffolding that the course offers.

This barrier might be addressed using both systematic and pedagogical methods. Systematically, the technology and software used to facilitate interactions between students should foster *rapport building*, rather than just information transmission. Pedagogically, the instructor should introduce course activities that provide scaffolding for rapport building in a DDE course, which may not have been necessary in a face-to-face course.

Despite the critical ranking of this barrier, some of the comments suggest that it may be more important for faculty than for students, who have grown up using social media and share and collaborate freely in an online environment. Panellists concede that some factors may not translate as well to a DDE course, and that communicating may be more difficult, although it is generally possible and effective. While these are concerns, it is likely that as technology continues to advance, facilitating rapport building will become less of a technological issue and more of a pedagogical one.

Critical barrier 5: Students feel socially isolated from their peers and may suffer from a lack of social interaction with them in a DDE environment

This is another barrier that suggests panellists are concerned about the social ramifications of DDE. Concerns related to this barrier are best understood in the context of the physical environment of the studio, where students are free to observe and interact with their peers. Social isolation, in design pedagogy, has more substantive consequences than simply reducing the amount of social exchanges between students: it represents a reduction in the quantity of ideas that are shared, and, by extension, in the quality of designs that are subsequently produced (Dutton, 1987; Schön, 1983).

For this barrier, the most commonly discussed topic revolved around modern students and how they socialise. Despite its high overall ranking, many panellists were dismissive of this barrier, stating that 'students don't care' about being isolated, and that the large majority of modern students regularly communicate and socialise via social media. In contrast, however, many panellists stated that some of the most important learning in the studio occurs organically between peers, and that students isolated in a DDE environment cannot enjoy a similar social experience. Even though a student might appear to be more connected than ever via digital devices, some panellists believed that DDE 'may really isolate them further'.

As Hutchins (1995) theorises in the horizon of observation model, it is critical that learners are able to observe each other, especially their more advanced peers, in order to learn and master more advanced skills. Lave and Wenger (1991) also demonstrate that observation of others is critical to learning and enculturation. In the studio, this observation often takes the form of socialising between students, as they move between each other's desks to talk about their designs and other topics. The need to address social and creative isolation is therefore clearly supported theoretically and by the results of the survey.

The ways of mitigating this barrier seem to be closely tied to those for building rapport. Solutions need to be both systematic, through improved communication tools, and pedagogical, by introducing course activities that encourage students to regularly socialise. For inspiration on addressing both the systematic and pedagogical facets, researchers might look to Luther et al's (2012) work on the open source project management system Pipeline, as well as to existing commercial social and sharing networks.

Critical barrier 6: Lack of face-to-face interaction prevents verbal and non-verbal communication in a DDE environment

As for the previous two barriers, a common concern with this barrier was the constraints that technology places on the communication process. While some panellists acknowledged that verbal and non-verbal communication can be facilitated online, they were concerned about the 'limitations of technology to replicate all of the factors involved in communication'. These limitations impact on how students communicate and, therefore, on what type of culture they form among themselves. Panel members expressed a belief that students benefit immensely from the culture of the studio environment, which 'replicates real world situations of design practice'.

Several panellists shared personal success stories of having students communicate effectively without face-to-face interaction, and also pointed out that new technologies permit many forms of face-to-face communication. They recognised that 'DDE could facilitate effective communication but may be [sic] not the same type of communication that happens [in the studio]'. Out of such concerns arises a discussion of the pros and cons of any potential changes, such as impacts on the time it takes to communicate, the ability to include more stakeholders in the communication process, and the ability to record and revisit conversations later.

Many of the panellists suggested that it is possible to use various communication technologies (VoiceThread, video chat, etc) to overcome this barrier, but that these tools will not produce a communication medium as rich as face to face. This issue of depth and quality was a prominent point of discussion among the panellists, and the overall feeling was that this barrier could be overcome to a degree – but not to the full extent to achieve the same benefits as in a face-to-face studio. However, the panel's comments suggest that even though physical face-to-face communication is preferable, a lack of it is not insurmountable. It is likely this barrier will become less of a concern as technology improves and students gain the ability to communicate in a manner ever closer to face-to-face interactions.

Critical barrier 7: Critiquing student work is difficult in a DDE environment

Panellists were concerned that what is already 'a difficult process in a face-to-face environment' would become more difficult in a DDE one, and that often 'technology complicates simple communication'. The concern appears to be not that technology cannot be used to conduct a critique, but rather that using it makes the process more difficult. In response to these initial concerns, several panellists shared personal experiences of successfully critiquing students in a DDE environment.

Several commented on specific factors related to implementation (issues of scale, system variables, assessment and workload). They worried that one-to-one critiquing might be possible, but that group critiques would be difficult. Another concern was that many different variables would impact on how effective DDE critiques might be and on how well student progress can be assessed during the critique process.

The literature largely ignores this barrier: only one article identifies difficulty with critiquing student work as a constraint of DDE. However, this omission is unsurprising, as most of the DDE projects reported in the literature described student–student collaboration, and few reported details of the teacher–student relationship.

In a moderately strong correlation, panellists who had experience with online teaching were less likely to consider this a critical barrier (r_{pb} = 0.450). It is interesting that this, of all the social barriers in the study, is the only instance where online teaching experience is significantly correlated. It is also the only social barrier that is specifically concerned with the teacher–student relationship.

While some panellists had clear concerns about the impact of DDE on the critiquing process, others strongly supported DDE critiques. Several believed

that one-to-one critiquing is not a problem, as long as the communication system supports multiple representations and enables a view of the development process. A couple of panellists provided examples of how they facilitated online critiques using VoiceThread or other technologies. One even stated they prefer to critique a digital file over a hard copy. Other panellists pointed out that these tools, and the practice of distance critique and collaboration, are already being used extensively in private practice, so it is appropriate that design education should also train students to design and critique in a DDE environment.

Discussion

When the seven critical barriers are considered together, several common features are apparent. Four of the seven are social barriers, suggesting that panellists were very concerned about how the social nature of the physical design studio can be replicated in DDE. Particular concerns for many panellists were how to replicate peer learning, rapport, and the mechanics and authenticity of communication.

Across all the critical barriers, four topics stand out. The most common topic of discussion is the technical constraints and the gap between what is possible in a physical design studio and what is possible with DDE. Panellists were especially concerned about the impact of technology on the communication process. Lack of precedents for DDE is the next most common topic in the comments. Although several panellists provided examples of how they successfully used DDE techniques, none of the panellists appears to have published or presented on such experiences, and so these successful examples have remained unknown to the larger academic community. The third most common topic is that faculty receive insufficient compensation for developing DDE courses. The fourth topic concerns the changing characteristics of the student population. Many panellists felt today's students are digital natives who regularly socialise and collaborate online. These panellists share Prensky's (2001) opinion that modern design students differ from previous generations as they have grown up under technology's constant influence, so concerns about their abilities to collaborate online are unfounded.

An important finding of this research is the existence of a disconnect between the critical barriers identified by the Delphi panel and the focus of existing DDE research. No statistically significant correlation was found between the rankings of the most common constraints from the meta-synthesis and the barriers from the Delphi. As figure 2 shows, the critical barriers are especially misaligned with the most common constraints according to the literature: the top seven barriers are ranked respectively in the literature as 9th, unranked, 20th (tie), 4th, 14th, 1st and 20th (tie). Only two of the critical barriers are in the top quartile of the most commonly identified constraints from the meta-synthesis. Conversely, three of the critical barriers were in the lowest quartile of the meta-synthesis.

It is important to remember that the third-ranked barrier is a lack of precedents in DDE research, suggesting that panellists were largely unaware of the existing body of work on DDE, and therefore it can be assumed they reached their conclusions independently of a knowledge of existing DDE research. Consequently, as noted above, the findings clearly point to the existence of a disconnect between the research and the barriers faculty identified, indicating that DDE researchers need to re-evaluate their research agendas so as to more
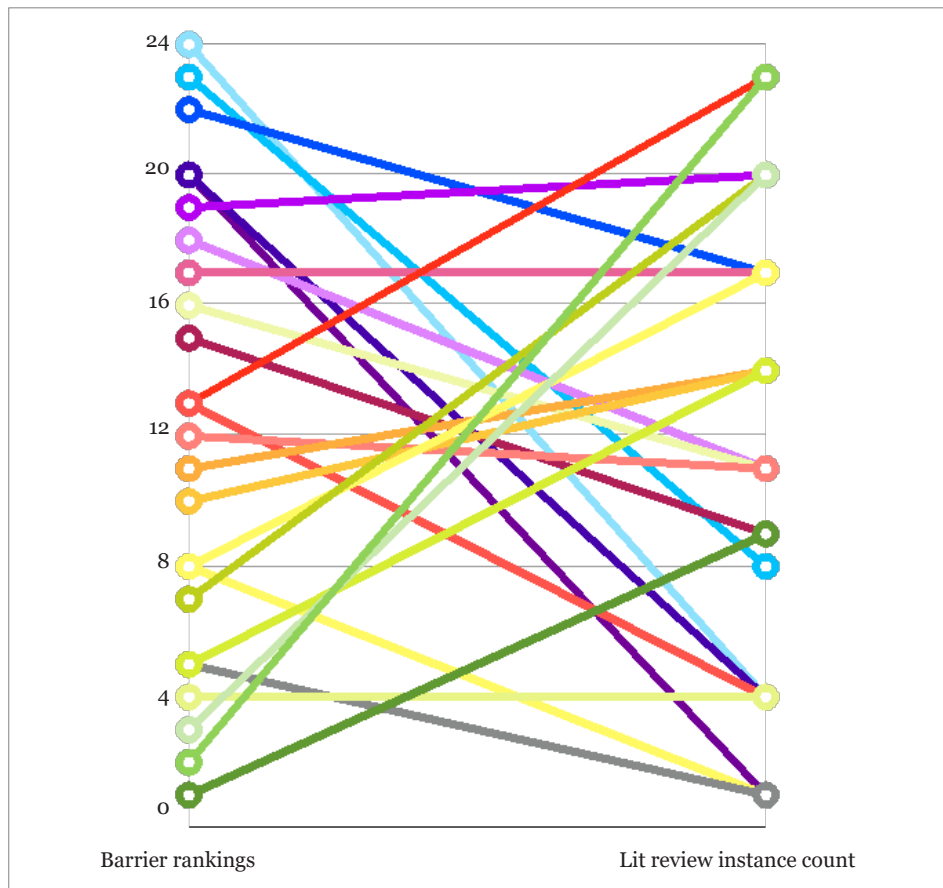
Figure 2: A comparison of panellists' final barrier rankings and the most common constraints as identified in the literature

The barrier rankings are presented on the left while the instance count on the right shows how many times the meta-synthesis found each constraint was mentioned in the literature. The highest-ranked barriers begin at the bottom of the chart.

closely align with the concerns of faculty. Much of the current research focuses on technological, structural and institutional topics, with only limited attention to social factors.

Conclusion

As online education becomes more important to university administrators, it is likely that design programmes will face increasing pressure to adopt some form of DDE. This study has suggested a direction for the focus of research and development efforts in creating DDE courses that not only are effective, but also increase the likelihood that faculty will adopt them. In addition, research on DDE needs to be more rigorous, especially with comparative studies of the efficacy of DDE versus traditional studio pedagogy. An interesting companion to this study would be to examine the motivations of faculty who have adopted DDE, and to explore how best to demonstrate and support successful experiences of DDE. That social issues are among the critical barriers also suggests that future research needs to focus on not only facilitating the social processes of the studio, but also mimicking its complete social character and the multiple ways in which students learn in the studio environment. Future research should seek to reduce these barriers in developing DDE, to avoid the risk of developing teaching methods that are unpalatable to the design faculty who might otherwise use them.

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