



Design studio practice in the context of architectural education: a narrative literature review

Upeksha Hettithanthri^{1,2} · Preben Hansen¹

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Abstract

This review aims to synthesize the current knowledge on the conventional design studio context. This is a narrative literature review based on articles published within the last ten years, while 60 articles were selected for the literature review following a rigorous filtration process. The final articles were selected by applying inclusion and exclusion criteria to the initially selected articles. This review has synthesized the current knowledge on design studio contexts and will review the conventional design studio context, design studio practices that take place within design studios and use of digital tools. The main aim of this study is to broaden the understanding of design studio contexts and to comprehend the types of design studio contexts available in architectural studies. Furthermore, it discusses the digital tools used in design studio practices in the last 10 years. A thematic analysis was conducted in reviewing the articles. It is to be noted that no research has been carried out except one on generating design studio context outside the conventional design studio set-up. This study aims to identify the potential research possibilities of context generated design studios to engage in design studies.

Keywords Design studio context · Conventional design studio · Design process · Studio practices

Introduction

The meaning of the word context differs according to the situation (Koffeman & Snoek, 2019). As explicated by Edwards and Miller (2007, p. 265), the meaning of the context in an educational set-up is a bounded container that allows various activities to occur. Further, the context has a fluid nature that could accommodate the flexibility to entertain a

✉ Upeksha Hettithanthri
dilini@dsv.su.se

Preben Hansen
preben@dsv.su.se

¹ Department of Computer and Systems Sciences/DSV, Stockholm University, Postbox 7003, 164 07 Kista, Sweden

² National School of Business Management, Green University Town, Pitipana, Homagama, Sri Lanka

set of practices (Koffeman & Snoek, 2019). The design studio context is creating a learning environment that mainly focuses on increasing the creative learning abilities of the students (Ibrahim & Utaberta, 2012). The architectural design studio context is similar to other design studio contexts in graphics, fashion and communication disciplines, and it is almost similar in physical infrastructure and human involvement (Corazzoa, 2019). The sole difference lies in the specific tasks executed within the architectural design studio context. Students engage in solving architectural and spatial problems in architectural design studios. The physical infrastructure of the architectural design studio can even be used by other design disciplines because there is not much of a difference in the physical environment of the design studio. As illustrated by Emam et al. (2019, p. 164), design studios mainly cater to design education where students engage in project-based learning. The design studio context consists of situational and contextual factors, in addition to the engagement of students and lecturers. Orbey and Sarioglu (2020) claimed that the activities that occur within the design studio context had empowered the creative design abilities of students. The physical environment of the design studio will never create a studio context without the collaborative engagement of the students and lecturers (Rodriguez et al., 2018). As depicted by Bashier (2014, p. 426), the context of the design studio can be identified as a collaborative learning environment where students and lecturers are engaged in learning and teaching through real-life problem scenarios. According to Grover et al. (2020, p. 2), the design studio context motivates the intrinsic creativity of students through the learning environment.

Conventional design studio (CDS)

The conventional design studio context is a learning environment located within an institutional set-up with all the infrastructure created to collaborate, brainstorm, learn by doing, and engage in reflective practice (Orbey & Sarioglu Erdođdu, 2020). CDS context is a creative learning space where students gather with peers and tutors to solve design problems. Further, CDS is identified as a physical container created for the social interaction of students and design tutors (Corazzoa, 2019). The physical boundaries of the conventional design studio are limited to an academic or an institutional environment (Kay Brocato, 2009). However, pedagogical practices have heavily contributed to making the design studio conventional. Existing studies on CDS articulate it as an engagement or an approach for teaching occurring within a specific environment. Schon (1987, pp. 41–43) defines the design studio through four central learning concepts. He explained the design studio as (1) a culture where students and lecturers work together, (2) as a physical fixed space where teaching and learning can occur, (3) studio as a way of teaching and learning, and (4) as a program of activity. The learning culture of the design studio is students and lecturers working together, sharing ideas, testing best solutions, displaying the results, and this creates an interactive knowledge sharing, practice-based learning culture where students learn through reflection in action. This pedagogical practice is a unique learning culture. However, this reflective practice and collaborative learning culture is not limited only to CDS. This practice can even be seen in non-conventional, virtual, blended or online design studios. Echoing this fact, Schon (1987, p. 44) highlights “the studio as a physical fixed space where teaching and learning can be happening”. In strengthening the definition given by Schon, Corazzoa (2019, p. 1255) has defined the design studio context through six elements. They are (1) studio as making, (2) studio as bridging, (3) studio as meaning, (4) studio as enabling, (5) studio as backgrounding and (6) studio as disciplining. The Design

studio context enables students to work with materials and make artefacts. This fact further strengthens the point of learning by doing. Creating artefacts can happen in a CDS setting or even in a virtual/blended platform where students could collaborate online. In non-conventional virtual design studios, making happens through a digital medium by incorporating digital tools and technologies such as Auto Cad, 3D max, etc. These six elements are not only seen in non-conventional virtual/blended and online design studios; they are also visible in CDS. This Literature Review focuses on identifying the types of design studio contexts, including studio practices.

In defining the Conventional Design Studio, it is stated that as a comprehensive model of design learning established many decades before, its system, built structure, and epistemology intermingle together to create a unique learning environment following problem-based learning (Brandt et al., 2013). Design studio context provides room for both implicit and explicit learning (Park, 2020). We identified the conventional design studio as a structured, systematic learning and designing process by being in a dedicated fixed built structure. However, students in the conventional design studio face many problems, making the process adopted in the CDS more problematic (Chen, 2016). In the context of CDS, the design process that is followed is more linear; the instructors set the design process into small tasks and request students to work according to those instructions (Chen, 2016). Students in the CDS are guided by expert designers in the industry (Rodriguez et al., 2018). The conventional design studio has reported that students have less motivation and engagement, and there are many reasons behind it (Rodriguez et al., 2018). The structured, systematic process of the CDS provides a less diversified learning experience to the students, impacting their creativity and design thinking in various ways (Rodriguez et al., 2018). Moreover, the CDS context has reported the disconnection from real-world problem scenarios, highlighting that finding solutions for problems set in the outside world while sitting in a dedicated working environment might be the key reason for this disconnection (Rodriguez et al., 2018).

It is essential to understand what distinguishes the conventional design studio context from other contexts. CDS is a creative learning environment where students are assigned to solve real-life problems through creative design solutions while being in a dedicated room for designing in an institutional set-up. Furthermore, CDS is a controlled creative learning environment that has been specifically designed to engage in creative activities. However, the unique feature of the CDS is that it is accompanied by all the tools that are especially required for design. This fact distinguishes the CDS unique form from other contexts. When creating a design studio context outside of an institutional set-up, facilitating those design tools is challenging because those were designed to work within a CDS context.

Design studio practices

The studio practices are the activities students and facilitators are engaged in. The design studio context facilitates numerous activities. Students are learning by creative pursuits. They work together with their peer to find design solutions to real-life problems. Face-to-face learning, peer support, assessments, and reflective practice are commonly discussed studio practices in literature. As explained by Emam et al., (2019, pp. 164–165), within the conventional design studio context, students engage in a single open-ended, project-based problem, allowing students to solve the problem in their own way. The design solutions are generated through an iterative process, and the design solutions are continuously reviewed, judged and open for comments by the jury and the peer (Ardington & Drury,

2017). Another practice that is generated through students' engagements with projects is Interaction and engagement. The design studio context fosters motivation and helps to develop strong learning communities. This enhances deep learning and sustainable retention of the learning outcomes of design studies. Thus, this literature review highlights the existing evidence on commonly used studio practices.

Use of tools

Usage of tools plays a vital role in the design studio context. Students use tools for various tasks. They need the aid of tools from the beginning of the design process to the end. Some tools are supportive in creative designing, and some tools are supportive in creative design communication, whilst another set of tools are supportive in teaching and learning in design studios. Tools used in design studios are found in both digital and manual formats. Therefore, identifying the types of tools used in design studios is one of the aims of this literature review.

This review aims to understand the design studio contexts found in literature and identify the key characteristics of the studio context. Furthermore, this review explores the type of studio practices found within the design studio context. This review will give a broad understanding of the design studio context and existing studio practices. This study has adopted the narrative literature review methodology, and articles published over the last decade (2010–2020) were selected. The reason for the selection is that the writer needed to explore how teaching and learning have taken place in the recent past and how it has changed from its original form. The literature has revealed a cross-section of how the CDS and its practices have been explored and investigated by other researchers throughout the last decade.

To summarize, the CDS has shown problems in the areas of (1) student engagement, (2) motivation, (3) disconnection from real-world problem scenarios. These issues demand a move from the CDS context. Moreover, there is a substantial gap in literature on context generated design studios that could create the design studio outside the conventional framework.

Problem formulation

The context of education has changed rapidly from face-to-face learning to online distance learning. In addition, the use of digital tools for teaching and learning has escalated drastically. How these changes have reflected on architectural studio context is a subject that lacks discussion and, therefore, an important aspect that warrants further research.

The conventional design studio context has not undergone many changes from its original form. The contextual influences on students' design process are important; however, it has lacked in-depth research over the last few decades. The aim of this literature review is to understand how those researchers have been identified within the design studio context in the respective empirical studies and to assess the contextual contribution towards design studio practices. For this purpose, empirical studies on the design studio context and design studio practices were selected after a rigorous filtration process.

Research has indicated that the learning needs of contemporary architectural learners have evolved to a complex level. Therefore, it becomes imperative to explore the potential practices that could be adopted by using digital technologies to benefit future architectural

learners. The studio has been recognized as the unique learning context for architectural studies. However, stepping out from the typical pedagogic framework while keeping unique elementary needs of the conventional design studio context is an important fact that many researchers have not explored. The problem has been formulated to understand the contextual contribution of the design studio to the design studio practices and to understand how the digital technologies could be used in teaching and learning in design studios.

Research questions

This literature review was conducted to find answers for the following research questions:

RQ 1—What are the architectural design studio contexts available?

RQ 2—What are the architectural design studio practices available?

RQ 3—What are the digital tools and technologies used in architectural design studios?

Methodology

For this literature review, the narrative review methodology was adopted (SAGE Internet Research Methods, 2019). Narrative literature reviews consist of a credible, comprehensive, in-depth analysis of a particular subject domain, allowing the writer to critically analyze and summarize theories and concepts (Baker, 2016) (Green et al., 2006). Adopting a narrative literature review methodology will be supportive in identifying patterns and trends in the literature and identify existing gaps in the body of the knowledge domain (Green et al., 2006). The study needed to generate more focus on the research questions and discover and produce comprehensive, methodological, and logical answers based on the publications selected. A narrative literature review provides a theoretical focus on the existing knowledge domains and logical explanations of available knowledge sources. Even though we have adopted the narrative literature review methodology, a rigorous systematic method of searching and selection of articles adopted is further explained in “[Search strategy](#)” section.

The study adopted literature within the last ten years because finding the most current studio practices and design processes within the design studio context is important in framing the research. The primary selection criteria for the articles focused on identifying papers containing data and empirical studies on the architectural design studio context, which explains the design process of the students. Furthermore, the necessary keywords for advanced study were established based on the above focus.

Search strategy

For this study, articles were browsed from the following databases: Scopus, Web of Science, and Science Direct. The reason behind selecting these three databases is that they are widely used for literature reviews on architectural studies by many scholars, and they contain a heavy number of articles related to architectural studies. At the initial search, 1594 peer-reviewed articles were found. For this search, articles published from 2010–2020 were selected as the time duration. This specific choice of publication years was to meet the study’s requirement of exploring recent knowledge domains and contemporary practices related to design studios.

Articles were browsed using several keywords, and those keywords were generated by using similar meanings and applications of the design studio. The appearance of those keywords in all sections, including the title, abstract, and full text, were taken into account. “Architectural Design Studio” OR “Design Studio Education” OR “Design studio context” OR “Context of Design studio” OR “Design Studio environment” OR “Design studios” OR “Learning in Architectural Design Studios” OR “Interior Design Studios” AND “Online Design Studios” OR “Mobile Design Studios” OR “Remote Design Studios” OR “Distance Learning in Architectural Studio” were used as keywords in browsing. Articles were selected irrespective of region or country. Journal and conference articles have both been taken into account for the review.

Inclusion and exclusion

The initial screening included reading the abstracts of the selected article and thereafter selected 663 relevant articles for further examination. Duplicates were removed, after which 416 articles remained. Design studio experiments conducted in order for IT students to discover HCI matters were removed at the second filtration due to the lack of explanations on design studio context. Broadcasting design studios and studio-based learning in computer science and linguistic studies were also excluded. Since the design studio context is almost equivalent to the architectural design studio, literature on graphic design studios and product design studios were included in this study. Landscape design studios that have conducted empirical research on fieldwork with no involvement of digital technology or digital tools were excluded at the second filtration. Empirical studies on design studio practices, empirical studies on conventional design studios, studio space and context, empirical studies on the use of digital and manual tools in design studio education, virtual design studios, blended learning design studios and teaching experiments in design studios were included for the full article review. In addition, literature reviews conducted on architectural design studios were included for the review because those contained summaries of the knowledge gained through referring to many research studies found on architectural design studio contexts. This literature review aims to understand how the CDS context and its practices have been explained in the existing literature. Concept papers found did not encompass sufficient information in explaining the design studio context, the role of the studio and studio practices. Therefore, those papers were excluded. Empirical studies on creative design studio practices were included; however, studies on creativity and creative cognition were excluded because creativity is a different domain and exploring creativity is not a central aim of this study. Articles that lacked explanation on design studio practices, workshop summaries, and articles with limited access to the full text were excluded at the third filtration. Moreover, for the review, quantitative, qualitative, mixed-method, and ethnographic studies were selected (Fig. 1).

Eligibility criteria for inclusion

After the rigorous filtration process, 60 peer-reviewed articles written in the English Language were selected for the literature review. The following eligibility criteria were established to find the current status of literature in the architectural design studio context. Criteria were established in answering the research questions generated. In answering RQ1, Criteria 1 and 2 were created. This will support filtering the best-fit articles to describe the design studio context and broaden the understanding of the design studio context as a

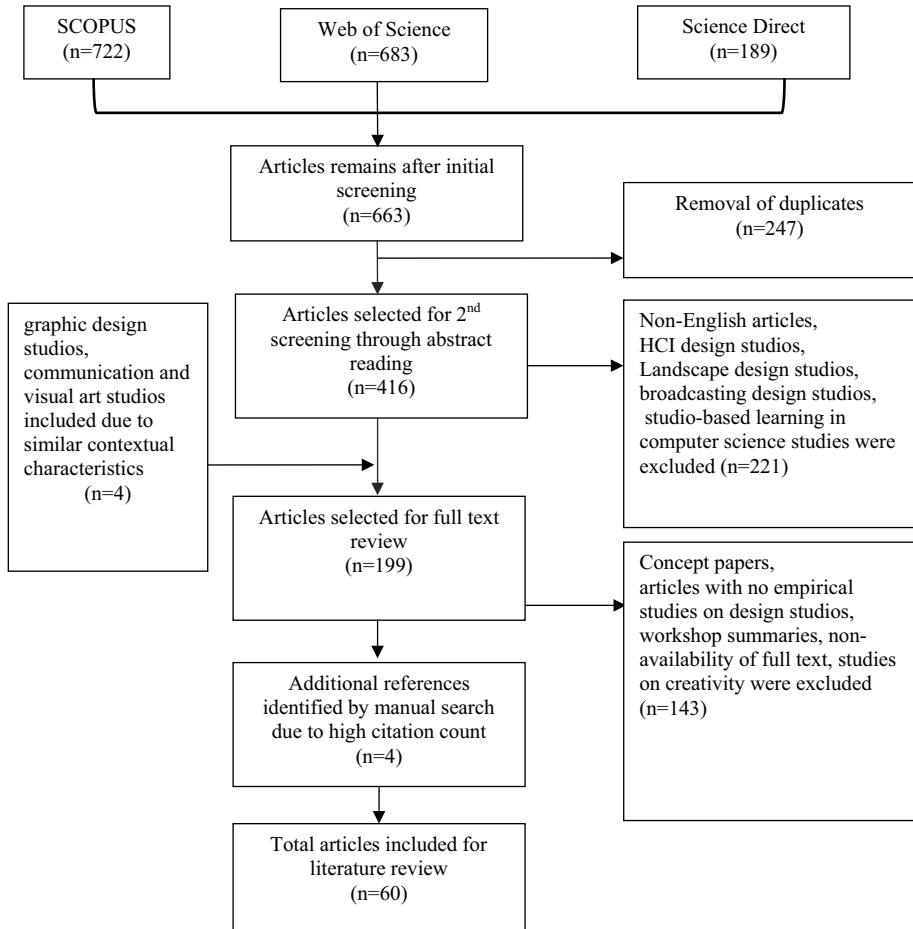


Fig. 1 Process map of article selection

learning environment. Criteria 3,4 and 5 was created in answering RQ2. RQ 2 focuses on determining the current studio practices found in literature. In investigating this matter, the studio practice has been divided into two major streams: pedagogical practices and creative design practices and studies conducted under those areas were mapped accordingly under the categories created. RQ 3 focuses on understanding the types of digital tools and technologies used in design studios, and criteria 6 and 7 address this matter.

List of criteria

- Criteria 1 Empirical studies describing conventional design studio context
- Criteria 2 Empirical studies on distance, virtual and blended design studio contexts.
- Criteria 3 Empirical studies on creating design studio context outside the conventional institutional set-up
- Criteria 4 Empirical studies on pedagogical practices in design studios

- Criteria 5 Empirical studies on creative design practices in design studios
- Criteria 6 Empirical studies on digital pedagogical tools used in design studio practice
- Criteria 7 Empirical studies on creative digital design tools used in design studios

Results

The table of criteria generated the following outcomes. Among 27 articles, 60 described the conventional design studio context through their empirical studies. Amid those 27 articles, 7 articles described the conventional design studio context in addition to virtual/ blended /online design studios. There was only one article amidst them, which had stepped beyond the conventional studio set-up and facilitated the students' design process in a non-institutional environment, and it was a fieldwork project. 34 articles were discussed pedagogical practices within the design studio context. Perusing the articles, it was evident that the research interest in pedagogical practices within design studios has escalated within the last ten years. 21 studies generated discussions on creative design practices. Furthermore, 21 articles with discussions on digital pedagogical tools used in design studios were found, and 13 articles discussed creative digital design tools. As shown in Table 1, we found a substantial gap in studies focusing on context generated design studios.

Methodology

The study adopted the Thematic analysis based on the Grounded Theory under the qualitative methodology in analyzing data. Grounded theory is a mechanism that is applied in order to build a theory from available data (Corbin & Strauss, 2020). In the application of Grounded Theory, it is unnecessary to start with a pre articulated hypothesis or a theory, but it allows the researcher to build a theory based on the data generated through empirical study (Byrne, 2016). Thematic analysis is a methodology that could show existing patterns in data. Thematic Analysis comes under the umbrella of qualitative research methodology, which could develop themes through the data gathered. The thematic analysis reveals a pattern within the recognized data that has emerged through analysis categories (Jennifer Fereday & Eimear Muir-Cochrane, 2006). This was guided by 6 phases of thematic analysis, and an inductive approach has been undertaken (Hoskyns, 2016). Utilizing an inductive approach in qualitative data analysis is a method that involves reading raw data and generating categories and themes based on the researcher's criteria instead of adhering to existing theories. The inductive approach is a bottom-up method where the researcher uses observations to see the patterns. Moreover, the inductive approach allows the researcher to develop a theory that emerges from the data (Yukhymenko et al., 2014).

Familiarizing with the data, creating initial codes, searching for themes, reviewing themes, defining the themes, and reporting were the significant six steps to generate themes. As the initial step of the thematic analysis, important data identified through rigorous filtration were extracted from the articles. The data was fed into a codebook in an Excel sheet. The study followed a three-phased coding methodology commencing with open coding. The coding was conducted to seek the answers to the research questions generated. Firstly, the narrations were coded into multiple open codes. Open codes consist of narrations on the design studio context, virtual studios, studio practices, experiments, examples, explanations on tools, technology and multiple related facts. In order to filter the data generated from open coding, it was further clustered into meaningful axial codes by

Table 1 Table of criteria

Paper	C1	C2	C3	C4	C5	C6	C7
1. Kuyrukçu and Kuyrukçu (2015)	×			×			
2. Soliman (2017)	×			×			
3. Rodriguez et al. (2018)	×	×			×		
4. Emam et al. (2019)	×				×		
5. Grover et al. (2020)	×			×			
6. Marshalsey and Sclater (2018)	×	×		×	×		
7. Orbey and Sarıoğlu Erdoğdu (2020)				×			
8. Ardington and Drury (2017)	×			×			
9. Mewburn (2012)				×			
10. Utaberta et al. (2015)	×			×	×		
11. Djabarouti and O'Flaherty (2019)			×	×			
12. Kaiser and Ogoli (2016)				×			
13. Gencosmanoglu et al. (2011)	×			×			
14. Pontus Wärnestål (2016)	×			×		×	
15. Fleischmann (2019)	×	×					
16. Crowther (2013)	×			×			
17. Vosinakis and Koutsabasis (2013)		×			×	×	
18. Ibrahim and Utaberta (2012)	×			×	×		
19. Hassanpour et al. (2015)				×	×		
20. Mewburn (2012)	×			×			
21. Corazza (2019)	×						
22. Yurtkuran and Taneli (2013)	×			×	×		
23. Ciravoğlu (2014)				×			
24. Ioannou (2018)		×				×	×
25. Marta Masdéu and Josep Fuses (2017)		×				×	×
26. Utaberta and Hassanpour (2012)				×			
27. Feier and Milincu (2015)				×	×		
28. Bashier (2014)				×			
29. Megahed (2018)	×			×			
30. Kara (2015)						×	×
31. Ismail et al. (2012)	×						×
32. Fleischmann (2018)		×				×	
33. Yavuz and Yildirim (2012b)						×	×
34. Hundhausen et al. (2011)		×		×		×	
35. Wang (2010)				×	×		
36. Cho (2017)				×	×		
37. Lloyd (2013)		×				×	×
38. Park et al. (2019)	×				×		
39. Wragg (2019)		×			×		×
40. Kalantar and Borhani (2016)				×	×		
41. Yavuz and Yildirim (2012a)						×	×
42. Katherine Cennamo and Carol Brandt (2012)	×			×			
43. Pektas (2012)	×	×				×	
44. Pektaş (2015)		×				×	×

Table 1 (continued)

Paper	C1	C2	C3	C4	C5	C6	C7
45. Bâldea et al. (2015)		×				×	
46. Ham and Schnabel (2011, p. 0)		×				×	
47. Nicolai and Khalid (2017)		×		×		×	
48. Fraser and Don (2011)				×		×	×
49. KhakZand and Babaei (2018)				×	×		
50. Varinlioğlu et al. (2018)						×	×
51. Safin et al. (2012)						×	×
52. Cho et al. (2016)	×	×			×	×	×
53. Cho and Cho (2014)	×	×			×		
54. Adiloglu (2011)					×	×	
55. Güler (2015)					×	×	
56. Saghafi et al. (2012)	×	×					
57. Vyas (2013)				×	×		
58. Mahmoud et al. (2020)	×			×			
59. Durmus Ozturk (2020)				×	×		
60. Schön (2016)	×			×			

collecting similar subject areas into axial coding. A set of axial codes generated selective codes, which supports generating categories. Those categories generated themes that could answer the research questions created. The coding process was done through MAXQDA 11, and the affinity diagram was used at the beginning of the process before it was fed into the software.

Thematic analysis—design studio contexts

RQ 1 is created to identify the types of design studio contexts found in literature. In this process, we identified codes in literature describing the design studio context and its characteristics. The identified codes were clustered into 22 major categories. Six themes emerged through the categories identified, and three of them described the conventional design studio context, and the rest described the non-conventional design studio context (Table 2).

The design studio contexts depicted in the literature has generated two major dimensions as conventional design studio context and non-conventional design studio context. Identified codes generated 11 major categories, and it led to identifying three major themes as material space, pedagogical practices and creative design practices, which created the dimension: conventional design studio context. On the other hand, virtual space, pedagogical practices, and creative design practices generated the dimension non-conventional design studio context. The codes and categories have shown that the CDS context has many common features that are even visible in non-conventional design studio contexts. The studio context comprises physical infrastructure such as pinup boards, tables and chairs, which support design and drawing purposes, display panels for demonstrations, and model making areas for prototyping and testing.

Table 2 Table of categories, themes and dimensions

Dimension	Theme	Category
Conventional design studio context (CDS)	Material space	1. Fixed infrastructure
		2. Immobile physical set-up
		3. Located in a university environment
	Pedagogical practices	4. Face to face collaboration
		5. Less remote collaboration
		6. Project-based learning
		7. Peer support and assessment
		8. Critics, juries and desk assessments, field visits
		9. Heavy paper works
Creative design practices	10. Pen, pencil, sketch, verbal communication	
	11. Heavy paper mock-ups	
	12. Location is not fixed	
Non-conventional design studio contexts (NCDS)	Virtual space	13. Mediated through digital platforms
		14. Blended—online and face to face
		15. Digital tools for collaboration
	Pedagogical practices	16. Peer support and assessments
		17. Critics, juries and desk assessments
		18. Process-based learning
		19. Field visits, live projects
		20. Digital tools for visual communication
		digital tools in designing, testing and prototyping
	Creative design practices	21. Less paperwork

The material space of the design studio is the built environment and the working culture of a studio. In defining the material space of the CDS, Corazzola (2019, p. 1255) has explained it through five elements. The material space of a studio empowers Making, Bridging, Meaning, Enabling, Backgrounding and Disciplining. Further, explaining this fact, the CDS context comprises a space for making and creating artifacts or models for testing design ideations. The built environment and physical infrastructure contribute heavily to this fact. The activities taking place in the CDS confer meanings and values such as periodic critics, demonstrations and conversations and dialogues on projects contributing to meaningful outcomes.

Further, the material space of a CDS enables students and tutors to collaborate more through interactive activities that support sharing knowledge and experience. The material space of CDS provides the background for all learning and teaching activities and acts as a backdrop for all the activities. Finally, the material space of CDS contributes to carving the design discipline, in addition to creating a culture of designing.

The existence of martial space will not convert the space into a design studio context. To make it a studio context, the contribution of pedagogical and creative design practices has played a vital role. The codes have shown that the conventional context of the design studio is not only made by the fixed, immobile physical infrastructure of the design studio. Even within the modern, non-traditional set-up, the CDS context has found teaching and learning practices followed by the conventional master apprenticeship model. The fixed

physical nature of the design studio is not the only demarcation that makes it conventional. In order to deem it a conventional design studio, the pedagogical practices followed would contribute.

The theme generated as "creative design practices" comprises heavy paperwork, pen and pencil work, and verbal communication. Students in CDSs produce heavy paper prototypes and rough mock-ups (Vosinakis & Koutsabasis, 2013). In CDS, students are encouraged to build solid skills through manual drafting, rendering and making. The dependency and encouragement to utilize manual techniques and tools are higher in CDS contexts. The mixed-use of digital and manual tools is commonly evident as a pedagogical practice in CDS. The mode of engagement is face to face in the CDS context. The face-to-face interaction enables students to see and reflect on the other peer learners' design approaches and witness pitfalls in their design solutions. Problem-based learning is heavily practiced in CDS. Students learning in CDS contexts bring the problem to the design studio to solve. This has created a disconnection from real-world problem scenarios. Stepping out from the conventional context to where the problem is generated and solving it by being in the real problem context was not evident in CDS. In this scenario, live projects can be identified as a pedagogical practice found in non-conventional design studio contexts where students work and design in real problem courses by being in those contexts.

In answering RQ1, the thematic analysis brought up two major design studio contexts found in empirical studies, namely conventional design studio and non-conventional design studio contexts. The study noted that pedagogical and creative design practices contribute heavily to making the set-up conventional or non-conventional. This literature review identified CDS as a fixed, immobile, physical environment located within an institutional set-up for design students and lecturers to engage in their design practices. Moreover, the study highlights that the CDS context has been created by adopting conventional pedagogical practices into the studio without moderating them to fit into the studio user's current knowledge and skill levels. The facts found in literature strengthened the notion that the studio practices could step beyond the conventional studio environment to the context generated design studios where students could create their design studio through engagement.

Studio practices

RQ 2 was focused on identifying studio practices followed in studio contexts. The pedagogical approaches followed in the conventional design studio is mainly followed by traditional teaching and learning methods. Students are learning through the reflection of the design tutors, and this has been explained by Schon (1987), 30 years prior to his theory on the reflective practitioner. "Reflection on action" is the established pedagogical practice in the conventional design studio. The non-conventional design studio context displays more freedom when guiding novice designers. The categories have shown that the NCDSs are rich in digital technologies. It uses digital tools, software and platforms in various levels of teaching and learning. Design communication and collaboration is done chiefly through digital platforms. Blogs, Web 2.0, and social media platforms became popular among non-CDS users (Bâldea et al., 2015). The use of digital technologies for communication is not commonly available in the CDS context. Students and design tutors gather face to face at design studios and discuss, demonstrate, present and criticize design attempts. Therefore, technology does not play a significant role in communication in the conventional design studio context.

The CDS context is featured as a safe and ideal place for problem-based learning in literature. Furthermore, it generates the feeling of a laboratory where many experiments and testing with the involvement of many parties in an open, less formal and less hierarchical workplace environment (Ardington & Drury, 2017). Furthermore, the conventional design studio context comprises high material character with sketches, notes, artifacts, paper mock-ups, physical models and pinup presentation facilities (Vyas, 2013). The flexible infrastructure of the studio environment supports adaptability to various scenarios (Corazzo, 2019). Compared to the virtual/ online design studio context, the material character has been replaced through digital tools such as digital drawing platforms, virtual realities etc. The change of the material space or physical infrastructure has not sufficiently influenced the creative design practice of students because it stands as a facilitator in the conventional design studio context.

It was challenging to identify clear margins on differentiating design studio practices of CDS and NCDS. The boundaries got blurred due to the most common features visible in both contexts. It was evident in literature; NCDSs practice the same pedagogical practices; however, they use different platforms. The collaboration is mostly happening through the digitally mediated platforms in NCDS contexts. In this scenario, virtual, blended, and online design studios were counted as NCDSs, where students collaborate mainly through digitally mediated virtual environments. Literature depicts that students in NCDS contexts generate more virtual and digital prototypes than students in CDS contexts. Making digital prototypes is again visible in the CDS context. Nevertheless, in virtual and online studio contexts, students mainly get the help of software and virtual realities in developing, prototyping and testing design solutions. The availability of the material space is not a mandatory factor in NCDS contexts.

Codes and categories have emphasized that CDS is more focused on bringing design problems into the design studio and engaging in solving those within the physical boundaries of the CDS. The pedagogical practices are more centered on generating solutions for real-life problems while engaging in studio activities. This practice has created a unique working culture within the CDS. Students empathize, synthesize and generate ultimate solutions to problems generated in the world outside the design studio set-up while being in the CDS environment. This scenario has even been reflected in virtual and online design studios. In the virtual, blended or online design studio, students are more distant to the actual problem domain, and the level of collaboration and levels of empathizing and synthesizing have varied from the CDS. Being in the context where a problem has occurred or working in the context where more inspiration could be found rather than bringing them back to the studio can be identified as non-conventional studio practices, and the generated codes and categories supported this fact. Process-based learning than project-based learning is visible in non-conventional studio practices.

We believe those pedagogical practices and creative design practices heavily contribute to converting the material space of the CDS into a studio context. The material space of the design studio has no meaning without creative and pedagogical practices embedded within it. From our point of view, any context could be converted into a design studio by adopting pedagogical and creative design practices and the involvement of active collaboration of students and lecturers. The flexibility of the design studio environment is a motivational factor in moving out from the conventional design studio to context generated design studios. We strongly believe that any context could be transferred into a context generated design studio by facilitating the creative and pedagogical practices within any environment.

Digital tools

RQ 3 aims at identifying digital tools used in design studio contexts identified in RQ1. In answering this question, the study generated seven major categories via 21 major codes identified. Those categories led to three themes that fall under three dimensions. Literature shows evidence on the escalation in digital tools in design studio practice from 2012–2020 (Table 3).

The coding was done based on the understanding of what those tools support. Twenty-six codes were generated, and they were clustered into seven major categories. It was tested and depicted in literature; some digital tools have contributed to improving the students' creative design thinking ability. Most digital tools such as the internet, virtual reality, video cameras and some 3D abstractions and construction of digital 3Ds have been supported in improving creative design abilities (Lloyd, 2013). Virtual realities have created a platform for students to see beyond what they can predict and assume to see. Further, these digital tools have more flexibility to conduct many revisions, which indirectly supports the improvement of creative thinking. Using the internet for searching, identifying the precedents, analyzing and extracting relevant knowledge to solve the problem at hand also makes the designer creative in identifying potential applications. This identification generates the first dimension, "Digital tools supported for creative design thinking".

In addition to designing, effective communication of the design is also essential in design studio education. The second dimension has been generated through identifying the digital tools which are supportive in creative design communication. Students use various methods and mechanisms to explain their design ideation or solutions. In order to do this, the support of digital tools is needed. These digital tools support accurate drafting, sizing, visualizing, prototyping and making explanations and justifications for the developed design (Yavuz & Yildirim, 2012a). In literature, we identified ten digital tool types that heavily contribute to creative design communication in conventional and non-conventional design studio contexts. Students are using digital tools as an expressive medium to communicate their design to others, especially tutors and other peer learners. In the conventional set-up, design communication is mostly done through pinup panels and paper mock-ups or hybrid mechanisms. However, in non-conventional studio contexts where teaching, learning and collaboration occur through digitally mediated platforms, the appearance of the digital tools for design communication was placed at a higher level. So, we can say the level of dependency on digital design communication tools in NCDS was higher than the CDS found in literature. Since students are engaged within the CDS, in most instances, a hybrid mechanism for design communication with a blend of manual and digital tools is used.

The third dimension, "Digital tools supported for collaboration and mutual learning", explains the types of digital tools used for mutual learning and collaboration in selected literature. According to Pontus, digital tools for collaboration motivate well-defined, device-centric routine engagement (Pontus Wärnestål, 2016). Online collaboration through social media platforms, blogs, virtual workspaces and Web CT are the most commonly used collaborative digital tools. Combining asynchronous tools such as discussion boards; or Moodle was found in literature as digital tools used for collaboration, mutual learning and teaching. (Cho & Cho, 2014). Güler (2015), in his article, has highlighted what is lacking in the use of digital tools for collaboration; they are face to face dialogues, facial expressions, body language, tone of voice. This is one of the

Table 3 Codes and categories for digital tools

Dimension	Theme	Category	Code
Digital Tools supported for creative design thinking	Creative thinking	Observing, visualizing, sketching, and enhancing	Video cameras
			Google, Internet
			Construction of 3D prototypes
Digital Tools supported for creative design communication	In explaining the design	Expressive medium	Virtual realities
			Video clips
			Walkthroughs
			3D models
			CAD, CAM, Auto Cad
			BIM
Digital Tools supported for collaboration and mutual learning	Interpersonal Interaction and collaboration	Peer support	Sketchup
			3D studio
			3D Max
			Viz and Lumion
			Videos
			Web 2.0
Digital Tools supported for collaboration and mutual learning	Networking the design team	Peer support	Moodle
			Blackboard
			Google+
			Online teaching / online meetings
			Blogs
			Facebook
			Google+
			Web CT
			Virtual workplaces
			Online teaching/online meetings
Facebook			

disadvantages identified in digital collaborative tools. However, these digital tools were supportive in collaborating with students beyond the boundaries of the CDS.

We strongly believe that digital tools have escalated design communication skills, design thinking skills, and collaboration and mutual learning among students. However, those tools have some limitations as well. From our point of view, 3D modeling will allow the designer to see and test the design solution in a digitally mediated platform. However, manual prototyping and model making will improve patience and develop students' soft skills. Furthermore, manual tools can replace many digital tools, but the problem is that using manual tools instead of digital tools for design communication, collaboration, and design thinking will consume more time and effort. However, we firmly believe effective amalgamation of both types of tools will be more supportive in carving a good designer, and heavy dependency on one type (digital or manual) will limit the creative potential of the student. Gaining soft skills are indeed essential to be a good designer, and manual tools such as drawing boards, handcrafted paper mock-ups, and panels assist in gaining lifelong skills which are required for designing.

Discussion

This narrative review aims to understand design studio contexts found in empirical studies, assess the design studio practices that occur in design studios, and identify types of digital tools used in design studios. After reviewing the selected 60 articles, the study identified that the design studio context has not drastically changed from its original form of conventional design studios. In 45% of the selected articles, it was evident that they were describing the conventional design studio, and 25% of them were discussing the conventional design studio context in addition to the virtual, blended, online design studios. 56% of the articles described pedagogical practices and creative design practices in the conventional design studio context. Furthermore, 56% of the articles were encompassed discussions on pedagogical and creative digital tools used in conventional and virtual design studios.

To answer research question 1: *What are the architectural design studio contexts available?* The study identified two types of design studio contexts depicted in literature. Conventional design studio contexts and non-conventional design studio contexts are the two main contexts identified. It was evident in literature that CDS and NCDS possess similarities as well as differences. The CDS context could be described as a fixed learning environment with all the physical infrastructure created to support design doings. In contrast, the NCDS utilizes the virtual space, with a heavy dependency on digital tools. CDS is encouraging and depends on heavy paper works and mock-ups. Design students and tutors in the CDS context collaborate face to face. Digital prototyping tools, drawing tools and software, have replaced paper prototyping and heavy paperwork in the NCDS context. However, we noticed that the CDS context had created many limitations. Conventional studio practices could frame the design thinking ability of the students. Moreover, the CDS context has a pedagogical structure that is framed by the context. Limited boundaries of the CDS creates less space for students to explore. Everything occurs within the design studio's four walls, which might limit the students' empathy and sensitivity. The study identified the CDS context as a framed, fixed and stereotypical space that has many limitations.

To answer research question 2: *What are the architectural design studio practices available?* The study identified pedagogical practices and creative design practices as the key design studio practices depicted in literature. It is difficult to draw a clear margin

between design studio practices followed in a conventional and non-conventional design studio context. However, we noticed CDS is more focused on bringing the problem into the design studio and solving it collaboratively within the design studio. Problem-based learning is significantly evident in CDSs. The solution-driven mechanism was found in the CDS, and all the studio practices were created to support this mechanism. However, the study identified this problem-based learning as a linear process.

In architectural studies, the end solution and the process followed to generate solutions are equally important. Bringing the problem into the design studio is creating less room to empathize with the real problem. If students are working in real contexts where the problem has been created, they might empathize with the problem more, leading them to generate timeless solutions. This is one of the key problems that were identified in the CDS context. The CDS practice brings experts from the field for students to obtain real-life reflections of the industry. The key role of those expert designers is to influence students and increase their creative thinking by sharing real-life design experiences (Schön, 2016). One drawback of this method is that most students would emulate them, imitate their architectural styles, and design language regardless of the real problem. In the context of the CDS, it was found that due to the lack of exposure experienced by the students, real reflective learning was a challenge, and therefore, needs to be addressed. This is another critical issue identified in CDS practices. In addition to the expert designers, all the other art forms, music, art, theatre, and even life events could influence the design learner via numerous inspirations and stimuli (Charles & Hokanson, 2009).

Nevertheless, constantly working in a CDS context minimizes the potential of getting exposed, narrowing down their creative thinking parameters. Therefore, it is the view of this study that the design studio practices followed in the CDS context does not lead to an increase in the design thinking ability of students. The studio practices followed has framed the natural design behavior of the students. In NCDS contexts, it was evident that the level of collaboration shows signs of escalation due to the networking ability generated through digital communication tools. However, such digitally mediated platforms played the role of a facilitator, and therefore, did not prove to support the design thinking ability of the students. Further, the research indicated that the virtual design studios and blended studios had also followed the same type of studio practices by working in a virtual context.

To answer research question 3: *What are the digital tools and technologies used in architectural design studios?* The study identified twenty-six types of digital tools used in design studios. Those digital tools were found to be a supportive medium in all the studio contexts. In the CDS context, the study found that students use digital tools as a supportive medium to improve creative design thinking and as a supportive medium for design communication. It was identified, in NCDS contexts, that the students and teachers engaged via digital tools as a supportive medium for collaboration and mutual learning than utilize the above two functions found in the CDS context. The study identified digital tools as a supportive medium in any design studio context. Those tools cannot replace human creativity and thinking ability which is vital for architectural studies.

Therefore, the study shows how the studio practices followed in CDS have created many limitations, and it has framed the mindset of students, which could limit their creativity. However, more research is required to identify the contextual influences of the design studio to design studio practices. Furthermore, the study shows that a movement from the CDS context is required; however, researchers have not explored this subject over the last ten years.

Conclusion

Throughout the last ten years, the research focus has been oriented towards critically examining the design process and practices in design studios, but not in examining the potentials of the context-generated design studios that could be created outside the institutional set-up. It is evident that the research focus of numerous scholars has been pedagogical and creative practices in conventional and virtual/ blended/online design studios. However, the current study is of the view that CDS practices are stereotypical. Furthermore, the current study also revealed that the CDS context has limitations in carving creative designers. It showed that CDS follows conventional design studio practices that were established many decades before, and not much has changed to address the current learning context of the students. These conventional studio practices followed in the CDS context might limit the students' design thinking ability, which needs to be addressed in future research. The fixed space and routine engagement of studio practices have been given less space to explore and feel. Empathizing is a critical phase of the design process, and CDSs have limited room for the students to empathize. Even though the design studio practices consist of field visits, the students strive to resolve those facts within the design studio. This process has limited the thinking and exploring ability of the students. The current study shows that the CDS context provides fewer stimulants to human senses, which are required for design thinking. Students in the CDS context are more solutions-driven; however, the process has received less prominence.

Even in virtual and blended design studios, the exact reflection of the CDS practice was seen. The NCDS contexts gain more support from technology for collaboration, prototyping, and making artifacts. The design process received more prominence in the NCDS context. Therefore, the study proposes that the CDS context requires a transition from its conventional way of practicing and needs to be addressed in future research.

Unorthodox approaches to creating design studios, disregarding the CDS' physical infrastructure and material space, are lacking. Moreover, this review uncovered a gap in the literature pertaining to the potential of transforming the design studio into any other contexts beyond its existing boundaries. The concept of context generated design studios was not addressed in the majority of the selected scholarly articles. The design studio can be where the problem has been generated or where most of the design generators or inspirations are found. On the contrary, it can be any place where students could engage in creative design practices to solve problems through novel designs. The design studio context should not be limited to the institutional set-up. It can be any context, and students and lecturers can create most of the qualitative features of the design studio by engaging in studio practices in their own way. The current study has found a substantial gap in research focusing on context generated design studios, and therefore there is a potential for pursuing future research on context generated design studios.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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