

Journal of Turkish Science Education

<http://www.tused.org>

© ISSN: 1304-6020

Digital age and art of teaching online design courses, a development of effective strategies for pandemic

Afaq Hyder Chohan¹, Jihad Awad², Bouzid Boudiaf³, Adi Irfan Che Ani⁴

¹Ajman University, United Arab Emirates, Corresponding author, a.chohan@ajman.ac.ae, ORCID ID: 0000-0003-2483-2541

²Ajman University, United Arab Emirates, ORCID ID: 0000-0001-9270-9241

³Ajman University, United Arab Emirates, ORCID ID: 0000-0001-9339-8975

⁴University Kebangsaan Malaysia (UKM), Malaysia, ORCID ID: 0000-0002-8516-6522

ABSTRACT

The COVID-19 pandemic has significantly impacted traditional design education, forcing educators to adopt digital classrooms for architectural design instruction, which has led to various challenges and suboptimal student performance. This research explores effective online design teaching methods, particularly across different design modules (I-VI), using a synthesis and literature review methodology. It investigates three domains: pandemic teaching challenges, traditional design education, and suitable pandemic teaching methods. The study triangulates teaching during the pandemic, conventional techniques, and elements from content focus (CF) and support open learning (SL) methods to create a hybrid pedagogy. The proposed blended approach combines traditional design education with virtual instruction, offering guidelines for educators to structure academic activities and integrate effective online teaching strategies. The findings provide valuable insights for design instructors and educational institutions adapting to digital classrooms during the pandemic and beyond.

RESEARCH ARTICLE

ARTICLE INFORMATION

Received:
08.09.2023

Accepted:
02.01.2024

KEYWORDS:

Pandemic-era
educational challenges,
virtual instruction,
facilitation of learning
experiences,
distance learning,
pedagogical strategies in digital environments.

To cite this article: Chohan, A. H., Awad, J., Boudiaf, B., & Ani, A.I.C. (2024). Digital age and art of teaching online design courses, a development of effective strategies for pandemic. *Journal of Turkish Science Education*, 21(2), 345-368. DOI no: 10.36681/tused.2024.019

Introduction

This review about 'digital age and teaching online design', offers a fresh perspective on the powerful role of technology in reshaping the delivery of education. It presents a new frontier where educators must rethink strategies and adapt to a landscape transformed by a global pandemic. The global health crisis (Covid pandemic) has had a profound impact on over 1.5 billion students, the repercussions most severely felt by those in the most susceptible learning circumstances (UNESCO 2022).

This investigation delves into the rapid transformation in design pedagogy, propelled by an unexpected worldwide health crisis, which necessitated an immediate revision of our instructional approaches from traditional in-person classrooms to remote education via digital platforms. In design education worldwide, the design studio operates on the foundational belief that students working collaboratively and closely with each other gain immensely from exposure to from both their peers

and instructors. This belief rests on the premise that excellent ideas form the cornerstone of innovative design procedures (Goldschmidt & Tassa, 2005).

Whereas a designing process is defined by (Schön, 2015), in normal scenarios the de-signing process involves navigation through intricate and ambiguous circumstances to create products. Learners are actively involved in exploration while also shaping the domain consisting of items and relationships that become the basis for their investigations. Whether they function directly on the project location or within the digital realm of sketchpads, miniature models, or computer displays, they engage with different materials.

This study addresses the advent of a paradigm shift in design education, forced upon us by a sudden global pandemic, requiring us to swiftly restructure our teaching methods from formal classroom-based to online teaching through the means of digital technology. In this context the study has reviewed the literature review in various layers starting from understanding architectural design teaching and difference between design and other formal courses, issues of classic design teaching model in online teaching, teaching online design and flipped classroom, technological requirements Internet of Things (IoT) for teaching online design and the compatibility of existing models for teaching online design.

Moreover, this research underscores the need for architectural design institutions and communities to extract lessons from the COVID-19 pandemic and the associated lockdowns. It invites introspection on enhancing distance learning and preparing for potential future demands. In addition, discussed the ways crisis has exposed an untapped potential for providing online design diploma programmes and brief courses, presenting a valuable avenue for sustained progression within the design community. This paradigm shift catalysed by pandemic-induced challenges offers a unique opportunity to transform educational models and further empower the design community through adaptable and accessible learning platforms.

The field of architectural design, which combines various data and functions to create unified structures with powerful meaning, appearance, and shape, depends largely on learning and teaching. This learning usually happens in physical classrooms, with practical exercises and project presentations. This teaching style not only improves visual and presentation abilities but also encourages thoughtful creativity (Afify et al., 2021). Particularly, design education experienced a paradigm shift, moving to a hybrid model of teaching. In general, an architectural design teaching, a discipline converging design data and programmes, is traditionally taught in physical classrooms through studio presentations and hands-on practice to enhance graphical skills and stimulate critical thinking (IABFU 2020; Lueth 2008). However, teaching architectural design is challenging due to the absence of specific rules or guidelines to evaluate a design's comprehensiveness (Amer, 2019; Emam et al., 2018; McAllister, 2010). Architectural design pedagogy emphasises conceptual thinking and creativity, unlike other disciplines that focus on process description, evaluation, and enhancement (Lyon, 2016). Knowingly, architectural science, a profound manifestation of artistic expression, demands abstract thinking and logical reasoning. While concepts can be elusive, architects and designers must draw upon them to infuse their creations with architectural vision, ultimately leading to successful outcomes (Amer, 2019; Emam et al., 2018).

In fact, design education differs from traditional education due to its reliance on precedent works and case studies. In contrast, conventional pedagogy involves instruction and formal experiments in a controlled environment (Blundell et al., 2020; Engzell, et al., 2020). Additionally, design outcomes are unique to each student, unlike in traditional learning, where experimental results are pre-determined and validated against the expected outcome. However, teaching methodologies share similarities in design and engineering, as both require workshops and laboratories for practical learning (Thomas & Rogers, 2020; Mostafanezhad, 2020).

The COVID-19 pandemic spurred the adaption of a hybrid teaching model that combined online lectures and practical sessions, benefitting students, especially those undertaking internships (Lambert & Rennie, 2021.). This global health crisis triggered a swift transition from conventional instruction to online learning, emphasising the need for strong educator-student connections, blended

learning, efficient time management, course creation and evaluation techniques, timely feedback and responses, and high expectations for learners (Abe, 2020; Bhat et al., 2020; Debacq, et al., 2021; Janssen, 2020; Moorhouse, 2020). In this scenario the adaptation of the technology and internet for education peaked during 2020-2021, enabling theoretical and practical knowledge acquisition and time conservation (Alqurshi, 2020). However, the sudden shift to remote teaching posed challenges, particularly for junior learners, such as limited teacher-student interaction and technical difficulties during collaborative sessions. IoT and internet-enabled tools such as Blackboard Collaborate Ultra, Google Meet, and Zoom were used to mitigate these issues (Ripoll, 2021; González-Lloret, 2021).

Even though virtual platforms like Zoom, Google Meet, Kahoot, and Google Classroom offered some solutions, they could not replace in-person educators and traditional classroom environments completely (Abu Alatta, 2023). Consequently, a Technological Acceptance Model (TAM) was proposed to improve online design teaching, performance, motivation, and student interaction (Hassanpour, 2022). But for successful online design teaching, factors such as reflective discourse, student retention doesn't belong in this list, decision-making, and self-management were identified as crucial. These factors foster a sense of belonging among students, which is essential in design studio learning environments (Al Maani, 2021).

The discourse thus far, particularly within the literature review, underscores the significance of articulating design concepts via suitable linguistic and visual mediums in the realm of architectural design education. While virtual teaching has proven its efficacy in theoretical disciplines, the conveyance of architectural design principles online continues to pose notable difficulties for both instructors and learners. Nonetheless, the prospects offered by digital education platforms are considerable and cannot be overlooked, even though they may not completely supplant the traditional, in-person approach in the teaching of design.

Despite individual creative inclinations significantly impacting the instruction of architectural design principles, many professional design institutions utilize an educational tool to facilitate concept. Thus, a successful online design pedagogy requires careful consideration of both technological and pedagogical elements to ensure effective learning outcomes. In this regard, Table 1 has précised this section and outlined, what unprecedented challenges the pandemic has brought to the world of education, particularly affecting design students. Traditional teaching methodologies, previously effective in a classroom setting, have often proved inadequate in addressing the unique demands of remote learning. The inability to engage in collaborative, hands-on learning experiences, integral to design education, has been a significant hurting point for students. In addition, low access to necessary software and hardware, reliable internet connections, and the lack of personal interaction with instructors and peers, have contributed to widespread learning difficulties during this period. The situation necessitates the development and implementation of innovative, effective strategies for online design education.

Table 1

COVID-19 and conventional classroom strategies to teach design

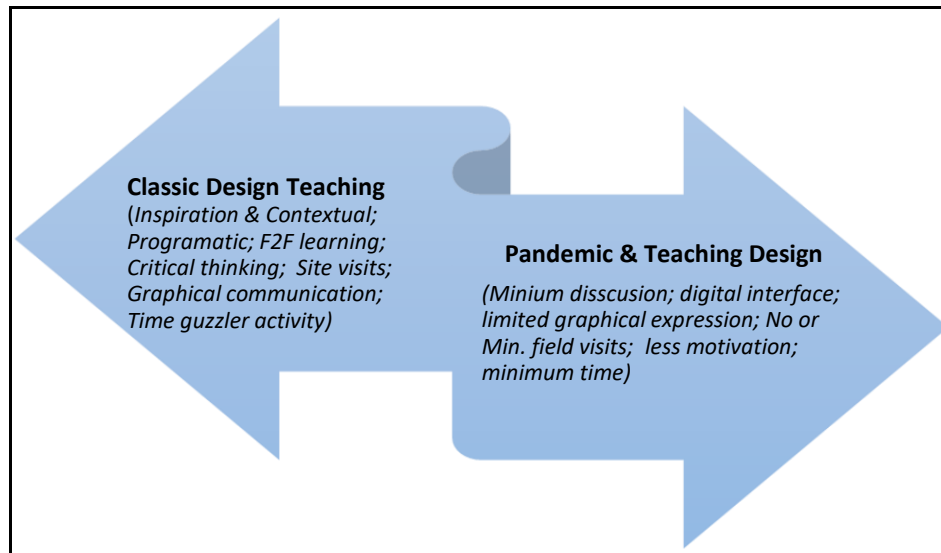
No	Conventional Strategy	Design Learning Requirements	Students Expectations	Covid-19 Constraints
1.	Design Brief	Given/apprised	Active discussion/ majority follow only design brief.	During Covid only online discussion/ poor communication.
2.	Inspiration & Contextual Study	Case studies/precedent works/ Keen observation	Visit restriction/ limited knowledge/ Self-learning and field study.	Limited/No visit/ Covid 19 made it more difficult.

3.	Concept (Personal expression)	Judgment and appraisal skill	Lack of understanding/ low decision making	No/limited interaction.
4.	Architectural Communication (Graphics Presentation)	Innate /erudite creativity/ Technology oriented.	Time-consuming and resources oriented.	No/Limited learning & resource availability.
5.	Critical Thinking	Innate skill/Coaching oriented	Low interpretation & expect more interaction.	Lean motivation/student tends to skip.
6.	Design	Self-learning of design standards/ blending (items 1- 3)	Expecting active assistance.	Limited or no assistance.

In examining pedagogical practices, this study raises the hypothesis that there is a disparity between conventional design teaching methodologies and online design teaching. This may not effectively address the distinctive challenges that arise in the dissemination of architectural design development within a digital educational milieu, as shown in Figure 1. It underscores the importance of deploying astute, technology-empowered teaching strategies. Such progressive methodologies can play a critical role in helping design students navigate and overcome the specific learning obstacles outlined in Figure 1. Moreover, these adaptive methods could provide a supportive platform for students to comprehend and convey comprehensive design principles and ideas seamlessly in a digitally mediated educational environment.

Figure 1

Disparity of teaching design in a pandemic



Study Aim and Objectives

The focus of this study is primarily to facilitate the process of teaching and learning in architectural design courses conducted remotely, by implementing learner-focused pedagogical strategies that are customised for the digital learning platform. It acknowledges the unique

circumstances posed by the global COVID-19 pandemic, which has necessitated a rapid shift from traditional in-person classrooms to online learning environments. Besides, this research is also driven by the imperative to provide support to both educators and students in overcoming the challenges inherent in this transition. It recognises the importance of subject-centred instructional methods, tailored to leverage the potential of the online learning environment, as key to the successful completion of architectural design courses in a remote setting.

In an effort to formalise and streamline this approach, a customized set of objectives specifically crafted for the education of architectural design.

- a) Develop a specialized strategy focused on the pedagogy of architectural design, tailored to address specific online educational needs.
- b) Formulate a comprehensive guide that acts as a detailed blueprint, outlining explicit, practical directives for both teaching and learning architectural design amidst the challenges posed by the global pandemic.
- c) Create a clear framework designed for the unique conditions necessitated by the shift to online education, with a focus on the specifics of architectural design.

Methodology and Matrix

This review study has followed a multi-faceted methodology based on review of relevant secondary data, its synthesis and categorization. In this regard dissecting distinct literature reviews to explore the landscape of online design education during a global health crisis. The study commences by evaluating the conventional mechanisms of design teaching and their adaptations due to the COVID-19 pandemic. Following this, it examines the strategies implemented for remote design instruction, focusing specifically on the flipped classroom model.

In the succeeding stage, the research investigates the technological underpinnings, specifically the role of Internet of Things (IoT) technologies, that serve as the backbone of effective online design education. The study then shifts to scrutinising the challenges encountered in the transition to online teaching, seeking to highlight potential obstacles and solutions.

Subsequently, the research conducts a comprehensive analysis of distance learning models that have risen to prominence during the pandemic, aiming to identify those most suited for design education. Specifically, the study scrutinizes the compatibility and effectiveness of Content-Focused (CF) and Supported Open Learning (SL) models in the context of remote design instruction. By employing this thorough and rigorous methodology, the study aims to uncover effective strategies for teaching design in an online environment during a pandemic. Based on research methodology this research proposed the following matrix in Table 1 depicting the key benchmarks of research.

Table 1

Research matrix

Categories	Traditional Classroom	Transition Phase	Online Classroom
Teaching Methodologies	[Overview of methods used in traditional design teaching]	[Methods adapted during the transition to online teaching due to the pandemic]	[Methods being used in fully online design teaching]
Technologies Used	[Technologies and tools used in traditional design teaching]	[Technologies and tools introduced during the transition phase]	[Technologies and tools commonly used in online design teaching, including IoT tools]
Challenges Faced	[Challenges faced in traditional design teaching]	[Challenges faced during the transition to online teaching]	[Challenges faced in online design teaching]
Pedagogical	[Pedagogical models used in	[Pedagogical models	[Exploring pedagogical models

Models	traditional design teaching]	adapted or introduced during the transition phase]	used in distance teaching /learning]
Effectiveness	[Effectiveness of traditional design teaching]	[Effectiveness of methods used during the transition phase]	[Effectiveness of distance /online teaching models towards design teaching strategies]

Review of Literature

Classic Methods of Teaching Design and COVID-19

Conventional design instruction heavily relies on in-person engagement, which may be challenging to replicate in digital classrooms. The process of acquiring design concepts demands dedication, inventiveness, and the integration of various aspects of a conceptualised structure/design until a novel form and style emerge. Topics covered in traditional design education include technical terminology, design ideologies, sources of inspiration, and a range of design intellects (Lueth, 2008).

Certainly, online virtual classes cannot fully supplant physical design workspaces, particularly in the realm of architectural design. It is highlighted that an architectural design studio necessitates exploratory, sensory, and cooperative work environments that are arduous to reproduce in a digital setting. Face-to-face interactions and tactile experiences are crucial for students to thoroughly develop their inventive and technical aptitudes in architectural design. Although digital classes offer advantages such as adaptability and access, they cannot substitute the distinct and invaluable experiences afforded by physical design studios. Furthermore, the inadequacy of conventional design instruction emerged as a prevalent issue confronted by numerous faculty members throughout the pandemic. The transition to digital education necessitated considerable alterations and adaptations in pedagogical approaches, posing greater difficulty for some educators than others (Shariatrad et al., 2022). Nonetheless, with appropriate training and assistance, a large number of faculty members successfully migrated to online instruction and maintained high-quality education for their students. Despite the obstacles encountered by both learners and educators during the pandemic, the shift towards virtual teaching and learning has also provided a chance for instructors to investigate novel educational techniques and technologies (Daumiller et al., 2021). Consequently, several studies have surfaced, concentrating on best practices for digital education and the adaptation of traditional teaching methodologies to the virtual landscape (Ortiz, 2020).

Teaching Online Design and Flipped Classroom

Problem based/interactive learning or the flipped classroom is a term based on Greek classical teaching philosophy characterised by two key factors: a case-based teaching and a problem-based learning. Flipped classroom or dynamic space learning encourages the students to work in collaboration and prepare a response to asked questions. During COVID-19, traditional physical lecture-based teaching has been questioned and a newly evolved interactive and collaborative online teaching model has been named a flipped classroom (Swart & MacLeod, 2021; Mushtaha et al., 2022).

Advancement of contemporary technology has proven vital during the COVID-19 pandemic, it has rapidly transformed and drastically changed conventional teaching and practices. In this concern, IT and the internet emerged as key tools to deliver all necessary information as per users' requirements. Students of engineering and usually learn structural design courses through F2FL (face to face learning) models. However, During COVID-19, the same course of steel design was offered through video-based e-learning and the instructor managed to accomplish most of the course learning outcomes. This format of learning provided an opportunity for students to repeat the lecture and

simulation gives insight and understanding of complex design elements and materials (El-Ariss et al., 2021).

However, teaching content of design and practical courses delivered through the adaptation of a unique approach that permits sending focused and determined tasks to engineering and design students to complete and produce the project at their place (Ting et al., 2020). Both instructors and students for effective transfer of knowledge and skills adapted self-learning approaches and discipline strategies. The rapid adaptation of collaborative learning in design and engineering schools has helped foster and promote teamwork, which is an important facet of teaching in any design and other professional programmes (Leung & Chu, 2020; Chadha, 2006).

Furthermore, it has been established that problem-based learning or the flipped class-room is better than the general teaching model (Prince, 2004). Whereas, to support this idea certain studies noted that flipped classrooms are the better option of teaching because it is a teaching method comprised of two parts, an interactive learning initiated by the teacher either in the virtual or physical classroom, and collaborative learning (outside class) by a group of students through computer and individual efforts (Bishop & Verleger, 2013; Talbot, 2020). To support this, claim another study presented analogous statistics between flipped and face-to-face physical classrooms, referring the results of two variables (communication and flexibility) from study concluded that 75% of students preferred to have direct communication with instructors and consider the physical classroom as an effective model of teaching. Whereas regarding flexibility, a 68% of students preferred to choose flipped classrooms because of economic savings, flexibility, convenience to refer the recorded lectures, and collaborative work (Dios & Piñero Charlo, 2021).

Besides the above many studies concluded that two groups of students emerged during Covid-19. One group preferred to go with flipped classrooms, whereas as another group of students preferred face to face classroom teaching. Following Table 2 shows results of other supplementary studies about flipped and traditional face to face classrooms.

Table 2

Students' perceptions on online and traditional teaching

No	Studies	Student's Perceptions on Flipped Classroom & Traditional Teaching
1.	(Homan & Macpherson, 2005; Mohammadi et.al. 2008).	Problem-based, or active learning, classrooms designed to facilitate collaborative work are becoming more common. A large number of students prefer to learn through a diverse and interactive learning environment of a flipped and collaborative classroom.
2.	(Gamage et al., 2020; Son et al., 2020.)	Students do not like collaborative learning in flipped classrooms, while others prefer to go to the flipped classroom and teamwork.
3.	Shim & Lee, 2020)	The study revealed that comparing formal teaching there is no significant difference or improvement was noticed in student performance in collaborative settings.
4.	(Edward, 2020)	The University of Berkeley developed an adaptive learning system to analyse the strengths and weaknesses of students during the learning process. The system work as an online tutor driven by a framework of AI (artificial intelligence), the developed system is capable to attain the individual needs of the student and effectively communicate personalised instructions
5.	(Ahmed & Zanelidin, 2013)	The study narrates that, there is a need for a mass inquiry into the relationship between active learning classrooms and student attitudes toward collaborative learning.

6.	(Browning, 2021)	Indeed, students have been facilitated through online teaching to continue university education during Covid-19, nevertheless, some of the known penalties of online learning and Covid-19 eventually appeared as interrupted education, remoteness, and desolation.
7.	(Iqbal, 2014; Al-Marzouqi & Ahmed, 2016)	Despite various uncertainties, the core advantages of e-learning under the Covid-19 lockdown can be characterized as, efficient learning from remote locations; effective interface between students and instructors; cohesive and rationalized content; virtual learning atmosphere; flexibility, cost, and time saving method.
8.	(Gamage et al., 2022)	The study established that the success of hybrid and online teaching depends upon certain modifications of teaching methods in the classic F2FL model.
9.	(Capperucci, 2022)	The study has investigated the relationship between remote teaching practices and its assessment methods, in the context of effectiveness and performance of students. The study declared that students tested through alternative assessment (group/collaborative work) evaluated higher did better than the students tested under the conventional assessment method.
10.	(Katsavounidou, 2022)	This study portrays that faculty teaching design courses faced more problems and challenges as compared to other courses. The study added that physical teamwork and peer learning are the key components of teaching these courses and these practices were non-existent during a pandemic.
11.	(Maulam, 2022)	This study has highlighted the issues that evolved in the planning process because of COVID-19. The study added that there are some advantages of using ICT in the planning process but many users concluded that ICT systems have several limitations in the context of planning decisions, engagement, and use of technology. However, results added that online technology has provided a practical way to attain cumulative decisions among various individuals working at distant locations.
12.	(Murray, 2023)	The research implies considerable potential advantages in offering hybrid architectural design studios, albeit with significant areas of potential loss and opposition. A substantial segment of students is receptive to this blended learning approach, indicating a preference for online lectures paired with face-to-face studio sessions.
13.	(Fleischmann, 2022)	The research bolsters discussions on the integration of technology-enhanced teaching within practical design studios. The study's outcomes offer valuable perspectives on changing attitudes among design educators, who increasingly appear to be embracing online solutions as viable alternatives to the traditional studio pedagogy distinctive to design education.

It may be summarized that the pandemic has underscored the necessity for a pedagogical transformation in delivering design education online. Although technology is a critical component, it is not the exclusive remedy. Digital instruction demands a distinct approach that considers the singular difficulties and prospects of virtual settings. Instructors and institutions must adjust and cultivate novel educational tactics that effectively involve and assist students in online design classes.

Technological (IoT) Requirement of Teaching Online Design

This study considers that the integration of IoT devices and systems in online design education can offer numerous benefits. For instance, these technologies can enable real-time monitoring of student progress, facilitating data-driven insights for personalised learning experiences. Furthermore, IoT can streamline communication between students and educators, fostering

collaboration and engagement in the virtual classroom. However, social and communicative interaction between the student and the teacher are important components of physical classroom learning. Questioning, opinion, reasoning, and disagreement between teachers and students are elements of learning. During the COVID-19 pandemic, this phenomenon was established through the use of communication applications such as Zoom; Google Meet, and Microsoft Teams and operated through Internet (Medina, 2015; Muzammil et al., 2020). User's friendly internet modules helped students to discuss, oppose, converse, and debate. This practice skill is one of the key demands of students learning through virtual classrooms ((Noviana et al., 2020; Johnson et al., 2000).

Besides the above, some other studies (e.g. Klawitter, 2022; Kolata, 2020) assert that, problematic technical issues are inevitable Frail Internet speed, flecked WIFI, and timeworn computer peripherals are major issues most likely to appear in online teaching, these issues add up the percentages of challenges to keep up with the learning environment of the virtual class. However, certain technology has proven to be very effective in delivering online lectures in teaching design and general courses. In such cases, the part of practical and field experience (case studies) could take place online by showing relevant videos, conducting simulations of projects, and presenting examples of data modelling and analysis. In addition to these, sharing databases, links to online resources, and setting up virtual labs could also be helping in teaching online design. In addition to the above-mentioned customised methods, it is having been noticed that both teachers and students have also benefited from Microsoft Teams (virtual classroom), Skype (virtual classroom) Zoom (virtual classroom), and Google Drive (storage and access work). Furthermore, other communication platforms such as WhatsApp, Moodle, and Botim have been established as proven cost-efficient IT platforms to facilitate online teaching (Mostafanezhad, 2020).

Challenges of Online Teaching

At this stage of research, it has been established that the complexities of online education present a unique set of hurdles that educators must navigate in order to deliver effective instruction. One of the primary challenges stems from the absence of face-to-face interaction, which can hinder the establishment of rapport between teachers and students, making it difficult to gauge comprehension levels or address individual learning needs promptly. It has been recorded that, during Covid -19 in UAE, students of first-year architecture programmes suffered from higher levels of anxiety, and they were not satisfied with the output of their design work. Whereas students in 4th year also have anxiety about online learning but they were satisfied with the output of their design work (Amro, 2022).

There is a widespread opinion that formal classroom-based teaching is better than online teaching. But the problem of student attention in the online class, students have also decried about lack of infrastructure, internet speed, limitations of site visits and data collection, and inequality in digital competency among students (Wong et al., 2023). It has been noted that the student satisfaction metrics declined sharply during online learning because students considered that peer interaction, design crits, and tutorials were badly suffered during online classes (Yazit & Ho, 2023).

While some studies have mentioned that online teaching is somehow a duplication of classroom teaching, but it does not possess the feature of informal learning that is vital in teaching architectural design. Initially, students were totally confused about the online learning experience and always wanted more assistance and support both from instructors and system managers. Moreover, regarding the issues of internet quality and lack of expertise with computer applications and usage, students have also reported restricted interaction with concerned teachers and instructors which is highly necessitated in learning architectural design (Grover & Wright, 2022; Alnusairat et al., 2021).

Overall, many studies shows that design students favour traditional, in-person learning environments, particularly for project-based or drawing classes. Interestingly, this preference tends to be more pronounced among second and third-year students compared to their first-year counterparts. These insights carry substantial implications for design education. Simply replicating the conventional

design educational model in a remote setting might be ill-advised, suggesting that design education may necessitate distinct formats, including distance learning, to provide a rewarding educational experience for students (Rosa & Ferreira, J. 2023).

Whereas design students in Egypt during COVID-19 faced hurdles as, institutions were unprepared for implementing online teaching. They eventually adopted various technologies and teaching tools, including Zoom and Google Classroom, to facilitate synchronous and asynchronous learning explain these esoteric terms. While a decline in academic interest among students due to the pandemic's impact was noticed. However, there was substantial support from educators and learners for the use of online platforms in delivering practical courses (Fewella, 2023).

This section 3.4 can be précised as student attention and attendance during online classes are the foremost challenges to instructors engaged in online remote learning. Particularly it seems difficult to define attendance in an online classroom. The studies above proposed a few tips to monitor students' attendance and interest in studies through monitoring the performance of students. Some of these tips include timely submission of assignments and exams; level of class participation; referring students posting in online collaborative study groups; concentration of inquiries and questions asked by students through email and what's app. In addition to this, digital logbooks and selfie cameras were also engaged in monitoring attendance and the presence of students in an online classroom.

However, it has been noted that various forms of interruptions and problems were faced by both instructors and students in online teaching. Both parties are holding class in an informal environment and are always subject to disturbance from situational incidents. For example, if a pet or young sibling suddenly appears in the teaching and learning space, this could be distracting for both the instructor and the student. Studies revealed that the attention of both learner and teacher is frequently diverted because of social media applications. To avoid such incidents of distraction, it is suggested that a proper priority schedule/thing to do list and plan of weekly chores should be displayed outside the virtual learning space to inform and update house inmates about nature work and its requirements. Work out the quiet time/zone to complete the tasks required for interactive and online teaching /learning. Regarding disruption from social media posts, study suggests that during class sessions timeout settings or tools to block/ avoid untimely social media posts (Ghasem & Ghannam, 2021).

Models of Distance Teaching & Pandemic

The concept of distance learning is a long-established element within the educational sphere, not a new innovation. It stands as a well-regarded and time-tested instructional method that hinges on several effective and proven pedagogical frameworks These include the Teacher-Centred (TC) approach, which positions educators as knowledge leaders guiding a structured learning process, and the Learner-Centred (LC) model, which encourages student autonomy and active involvement. A Content-Focused (CF) method, emphasizing a comprehensive understanding of the course material, also plays a significant role in distance learning. Moreover, the Interactive Participative (IP) model, fostering an environment of active collaboration, further reinforces this learning approach. Lastly, Supported Open Learning (SL) offers a flexible, personalised approach, underpinning learner self-direction while ensuring suitable support. Collectively, these unique yet complimentary frameworks bolster the efficacy and reliability of distance learning as a reputable educational format (Yaeger, 2002; Raturi, 2010).

It has been established that, COVID-19 converted conventional classroom learning into online/distance learning, making IoT-based systems (zoom, google meets, blackboard etc) mandatory as a new mode of teaching in schools and universities. The health crisis has compelled numerous academic establishments to adjust and embrace digital instructional techniques, enabled by progress in internet and communication technologies. However, Chunxia, D. (2021) mentioned that web-based teaching systems may present certain difficulties, they also offer prospects for enhanced educational accessibility, adaptable learning, and the creation of innovative teaching and learning approaches.

Consequently, it is probable that these methods will persist in being employed and refined even after the pandemic subsides.

During the COVID-19 pandemic, many students reported that learning about digital tools and computer applications is the most significant learning experience they had during learning online architecture studios. The study further revealed that the students have realised that they can learn independently at a remote distance with the help of online instructors (Ceylan, 2021). The transition to digital instruction and learning amid the COVID-19 crisis posed obstacles for design education, especially in courses that depend extensively on tactile, experience-based learning. Although certain elements of design education, including theory and history, can be proficiently imparted through online platforms, other facets, like design studios, necessitate face-to-face cooperation, exploration, and evaluation. Both students and faculty members have voiced apprehension regarding the constraints of web-based design education and the challenge of adjusting to novel educational and learning techniques (Ibrahim et al., 2021).

However, online and distance learning have advantages and disadvantages. They are well-suited for emergencies when physical learning is not possible, along with being flexible, open, and accessible (Guohong et al., 2012; Fojtík, 2018; Sajid, 2020). Successful online instruction necessitates distinct methodologies and tactics in comparison to traditional in-person teaching. It is vital for architectural schools to recognize and implement suitable digital teaching methods that cater to the needs of both learners and faculty members (Fojtík, 2018). Modifying established instructional approaches to fit the virtual setting can be beneficial in this context. Furthermore, ongoing assessment and enhancement of online teaching techniques should be emphasised to guarantee their efficacy.

Educators have displayed a keenness to acquire new instructional methods in response to the difficulties presented by remote learning during the COVID-19 crisis. The various teaching approaches, encompassing teacher-centred, student-centred, content-focused, and interactive/participatory, possess unique attributes that can be adapted to virtual teaching modes, as illustrated in Table 2. Instructors and institutions can choose an appropriate format, or a combination of formats based on their abilities and course necessities. Research has been undertaken to comprehend and pinpoint the most effective teaching strategies for digital learning (Zhang, 2008; Naqvi, 2012).

Table 3*Classification of teaching methods*

Five Types of Teaching Methods				
Teacher-centred (TC)	Learner centred (LC)	Content focused. (CF)	Interactive Participative (IP)	Supported open learning (SL)
<ul style="list-style-type: none"> ▸ The teacher acts as master of the subject. ▸ Learners consider a teacher as an expert or an authority. ▸ Learners act as passive recipients of knowledge. ▸ Formal lecture methods. ▸ Little or no involvement of learners in the teaching process. ▸ A “closed-ended” method. 	<ul style="list-style-type: none"> • Both a teacher and a student act as learners. • Teachers tend to extend the intellectual knowledge base of students. • The teacher also learns new things every day which are not known before. <p>Teacher acts as a resource rather than an authority.</p> <ul style="list-style-type: none"> • Discussion/discovery /inquiry method. 	<ul style="list-style-type: none"> ▸ Both the teacher and the learners fit into the course content. ▸ Information and skills to be taught are regarded very important or vital. A lot of emphasis on clarity and careful analyses of content. ▸ Both the teacher and the learners cannot alter or become critical of anything to do with the content. ▸ Timesaving, brief and direct. <p>Applications</p> <ul style="list-style-type: none"> ▸ Suitable for open universities/online teaching institutes. ▸ Good for pre-planned courses and controlled teaching. 	<ul style="list-style-type: none"> • This fourth category borrows a bit from the three other methods. • Driven by the situational analysis (focus only at immediate need to learn) <p>Learner requires a participatory understanding of varied domains and factors.</p>	<ul style="list-style-type: none"> • Students work from remote locations. ▸ Students get all the high-quality materials they need to study. • Tutors provide academic expertise, guidance and feedback and run group tutorials. • Teaching aids (tutorials) are focused. • Assessments are close ended less critical. • Assessment is more formative.
Suitable for primary and junior learning. Good for instructional courses	<ul style="list-style-type: none"> ▪ Suitable for undergraduate level of studies. <p>Good for experimental or lab-based courses.</p>		<ul style="list-style-type: none"> ▪ Suitable for skill teaching institutes. ▸ Good for teaching pre-planned and specific trade. 	<ul style="list-style-type: none"> ▪ Open Universities ▪ Good for teaching pre-planned and specific courses & trades.

Note. Adapted from the studies [79, 80]

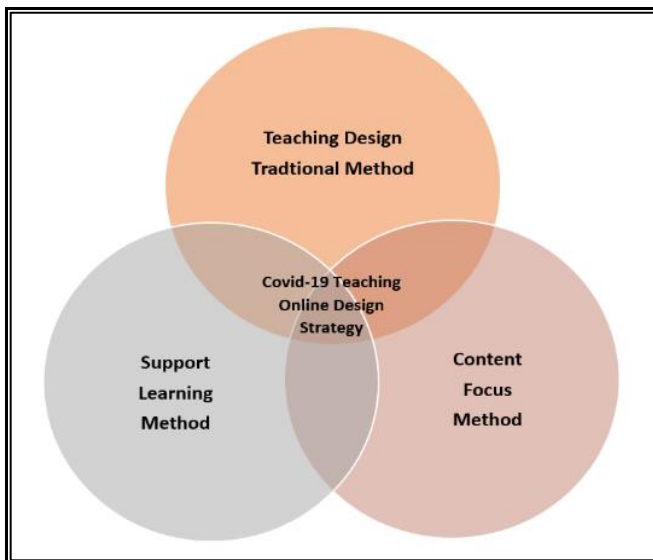
Table 3 depicts a synthesis of these established teaching models that could be employed to devise a novel pedagogy for online design teaching. Besides it explains the key factors of teaching methods that eases a transition to digital instruction, adjusting the traditional design teaching methodology to accommodate online delivery has become crucial. A revised system incorporating hands-on teaching methods, well-directed tasks, and individualized assessments can facilitate more effective design concept learning for students. Furthermore, integrating aspects of the CF and SL models, such as cooperative learning, project-based learning, and experiential learning, can assist in adapting the conventional design teaching philosophy for online settings, thereby enhancing the design course's effectiveness. The CF (content-focused) and SL (Support open Learning) models possess specific features that can aid in tailoring traditional design teaching methods for efficient online design course delivery. The CF model emphasizes structured and organised content delivery, while the SL model encourages students to assume greater responsibility for their education and actively engage in the learning process. A fusion of these models could be employed to devise a novel pedagogy for online design teaching, as depicted in Table 2.

Discussion on the Compatibility of (CF & SL) Models for Teaching Online Design

This investigation contends that the prevailing circumstances necessitate an innovative and proficient pedagogical approach for design courses in the virtual environment instigated by the COVID-19 pandemic. To tackle this issue, it is proposed that a potent technique can be devised by amalgamating three fundamental instructional methodologies: CF, SL, and conventional teaching tactics while acknowledging the restrictions and challenges imposed by the pandemic and the digital learning platform (depicted in Figure 2). Earlier segments of this study have scrutinised the repercussions of COVID-19 on education and the customary design teaching paradigm. Within this section, we explore pedagogical models and assess their functional attributes to pinpoint and modify the most fitting alternatives.

Figure 2

Interaction of (CFT- SLT- Traditional Models) & COVID-19 strategy



Certain research actively supported the CF teaching model and stressed that the (CF) constitutes an apt and inventive instructional approach for design, particularly regarding the design process, implementation, and procedural expertise. This potent method effectively addresses inquiries and encapsulates significant aspects of pedagogy, encompassing functionality within context, conceptualization, justification, goal attainment, procedural approaches, mentality, and indicators of method efficacy. Content focus (CF) represents an innovative pedagogical approach, optimally tailored for imparting design processes, practical skills, and procedural know-how. This robust and efficacious methodology adeptly addresses inquiries while excelling in encapsulating specific educational realms, including contextual functionality, conceptual framing, underlying principles, goal attainment, procedural implementation, cognitive approach, and determinants of technique efficacy (Blessing & Chakrabarti, 2009; Cantamessa, 2003; Daalhuizen et al., 2014).

Moreover, some other studies assert that CF effectively elucidates design theory by delineating anticipated objectives through well-structured processes and insights. It possesses the ability to arrange knowledge to establish associations between variables and foresee the consequences of various factors (Hevner, 2007; Daalhuizen et al., 2019). CF is engineered to convey accurate and applicable data in a clear fashion (De-Araujo & Claudiano, 2001). Furthermore, CF is fitting for design artifacts, given that the information it imparts is pragmatic, rational, and essential (Gottfredson, 2015). To support the CF model of teaching Daalhuizen & Cash (2021) formulated a content theory framework for design education and implementation, demonstrating that CF surpassed other

pedagogical models in communication and learning attributes due to its precise assessment of user outcomes (design) and adaptability to the scholastic milieu.

The contemporary conceptualization of a design method encompasses a knowledge-driven procedure that facilitates designers in crafting suitable designs for distinct scenarios utilizing accessible resources (Hevner, 2007; Daalhuizen et al., 2019). Consequently, it can be inferred that the design process hinges on the collection of data, delineation of specifications, and their implementation via interpretation, evaluation, and adjustment in accordance with users' requirements. CF acts as a manifest representation of comprehending present or newly conceived design practices (Cross, 2018; Ulrich & Eppinger, 2015). Within design execution, CF is vital for disseminating knowledge, fostering collaboration, and stimulating effective communication among design practitioners (Daalhuizen et al., 2009).

Conversely, numerous investigations propose that SL represents a more pragmatic approach to distance learning. These studies emphasize that SL provides exceptional instructional materials, and consistent tutorial sessions, and gathers feedback to customize assessments in alignment with the course's requirements. SL lessons concentrate more on practical applications as opposed to theoretical notions, simplifying the process for learners to comprehend and apply their acquired knowledge (Zhang, 2008; Larenas et al., 2011). Furthermore, Guohong et al., (2012) also posits that SL is appropriate for a diverse range of courses and programs, rendering it a viable option for remote instruction.

Besides the appropriateness of SL for design instruction, scholars have underscored the significance of assessment within the SL framework. It has been disclosed that well-defined assessments align effectively with distance education, and assignments and evaluations crafted for SL employ formative techniques, fostering independent and self-assured learners. Education via SL is more self-governed compared to conventional methodologies, allowing students to choose their learning environment, schedule, and pace, and exhibit self-discipline and regulation (Littlejohn et al., 2016; Wang et.al 2013). Nevertheless, some novice learners may perceive SL as sparse and encounter challenges in effectively managing their educational journey (Bol & Garner, 2011).

The implementation of SL instruction bolsters student advancement by encouraging individual effort, generating superior-quality work, and fostering leadership abilities in learners (Brusilovsky et al., 2016). Furthermore, the transparent nature of SL instructional models empowers professionals and educators to scrutinize and understand them. This open methodology in SL instruction also cultivates diverse learning outcomes, including critical thinking, analysis, strategizing, and time management (Bull et al., 2018; Bull, 2016). The open learner instruction model recognizes students' proficiency in various ways, inspiring learners to reflect and engage in the orchestration of their education (Hooshyar et al., 2020; Bull, 2010). Hence, it can be deduced that both SL and CF have the capacity to augment students' capabilities in attaining goals about time management, analytical thinking, and forecasting results. These facets bear considerable relevance within the realm of design education and when addressing the intricacies of online studios. Fundamentally, CF and SL prove successful in satisfying the critical design instructional tactics outlined in Table 4.

Table 4

Teaching design through CF and SL methods

S. No	Design Strategy	Challenges in Online Teaching	CF & SL teaching Models	The Rationale of the CF & SL Method
1.	Personal expression	The majority need extended time.	Both student and teacher fit into the course	Participation/discussion would grasp & answer the individual needs
2.	Inspiration	Intellectual & time intense activity	Provision of quality learning material	Identify viable spots & describe the procedure

3.	Skills (digital graphics)	Learning resources are not always available	Focused teaching aids (tutorials).	Construal through pictorials/hands-on practice
4.	Presentation	Time-consuming & visual limitations	Only vital information and skills to be taught	Guidance and feedback
5.	Contextual study	Covid 19 made it more difficult.	The tutor shares academic expertise & guidance	Examples of subject inquiry
6.	Design Brief/ Programme	Wide and time-consuming	Clarity and careful analysis of content.	Teaching aids & clear direction on expectations
7.	Critical Thinking	Low understanding/time guzzler activity.	A brief and direct approach	Participation and time management

Table 4 encapsulates an overview of the design teaching strategies that have been employed during the current pandemic, underscoring the evolution and adaptation of content and methodologies from classical pedagogical methods. The primary elements of the Content-Focused (CF) approach resonate with those of traditional design teaching, with analytical skills being fostered as a key problem-solving tool for both students and design educators. However, it must be recognized that the transition to virtual instruction amidst the COVID-19 crisis poses numerous challenges and may contribute to heightened stress levels. Although the effectiveness of CF is heavily dependent on the instructor's experience, enthusiasm, and teaching competencies, there have been concerns raised by both parents and experts about the quality of education delivered during this global health crisis.

In light of the significant challenges that beset online design education, it becomes imperative to fuse traditional design pedagogical principles with digital methodologies and incorporate additional blended teaching approaches. As a result, this study proposes a comprehensive set of guidelines for design teachers, advising the use of both the CF and Supported Open Learning (SL) models in delivering online design education, as detailed in Table 5. These guidelines aim to bridge the gap between traditional and digital teaching strategies, offering a resilient approach to design education in these challenging times.

Table 5

CF and SL teaching and the instructor's role

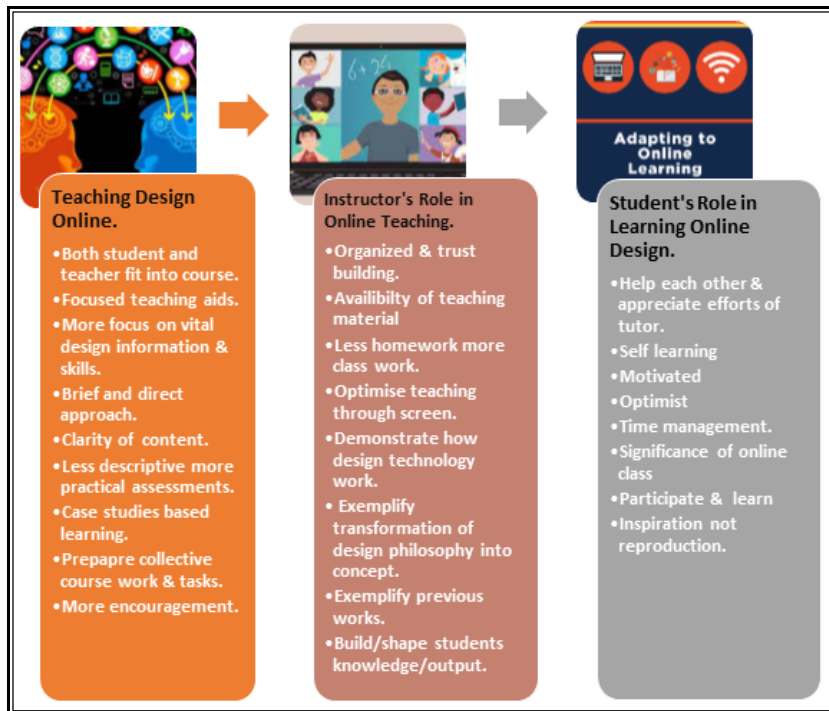
No	Factors of CF & SL Teaching Method	Role of Design Instructor (Online Teaching) Implementation of (CT and SL models)	Student Role in Online Class
1.	Both student and teacher fit into a course	More organized instructor Re-design coursework. Develop trust between the instructor & students. Understand the learning level of students. Help students to develop groups for collaborative learning.	Help each other Appreciate the efforts of the tutor
2.	Provision of quality learning material	Learning materials should be available & accessible. Understandable lecture notes for The majority of students. Focus on more input and minimal assessment.	Self-studies Be alert in class.
3.	Focused teaching aids (tutorials).	Focus on student learning needs. Many corrections & more encouragement. Show endurance & tolerance. Show examples, of how design philosophy transforms into the concept. Minimal descriptive assessment.	Motivation. Time management. Class participation. Teamwork Discipline and punctuality

Collaborative assessment.			
4.	Focus more on vital information and skills.	Prepared well in advance. Less homework more classwork Create a supportive classroom. Prepare frequent quizzes/assessments Proper planning	Optimist Confident
5.	The tutor shares academic expertise & guidance	Advance teaching strategy. Choose accessible technology for all. Encourage and reward more participation. "Chalk and talk." through a screen. Show (videos/refer www links)	Significance to an online class.
6.	Clarity and careful analyses of content.	how design technology works (<i>construction, design innovations, automation, materials application, etc.</i>). Develop case studies-based assessment tasks.	Affection to learning Keen observation Entity correlation
7.	The brief and direct approach.	Create effective online design learning. Share knowledge to improve design work. Refer to relevant precedent design.	Inspiration not reproduction

Table 5 delineates the roles and responsibilities in an educational context, integrating Content Focus Learning (CF) and Supported Open Learning (SL) methodologies. It under-scores the design instructor's role, emphasizing the need for organization, trust-building, comprehension of student learning levels, and promotion of collaborative learning, along-side providing high-quality materials and focusing on student-centric approaches. The table also highlights the student's role, stressing the importance of active engagement, discipline, teamwork, and time management in online classes. Furthermore, it discusses educational strategies, detailing the employment of specific teaching aids, motivational techniques, and the significance of planning and strategic teaching, including leveraging technology for more accessible learning and direct content delivery.

In addition to the above the studies of (Avsar et al., 2021; Prahani et al., 2021; Carmen Lucena et al., 2021; Yesiloglu et al., 2021; Putri et al., 2022;) have added precious findings about issues of teaching and adapted methodologies to teach online science courses during Covid pandemic. These studies asserted that the COVID-19 pandemic significantly impacted online science education, leading to several important observations. The sudden move to digital learning required preservice teachers to quickly adjust their teaching methods, emphasizing the necessity for comprehensive training in digital teaching techniques. This period also saw a surge in Scientific Creativity Learning (OSCL), driving educators to develop and implement innovative and engaging online teaching strategies. Such changes promoted a more learner-centric model, utilizing technology for more interactive and exploratory educational experiences. In summary, the pandemic acted as a driving force for substantial shifts in science education, underscoring the value of adaptability, creativity, and resilience in educational approaches. Despite its challenges, it created avenues for progress and evolution in online science education, influencing its future direction.

Overall, this study supports a collaborative, interactive approach in online design education, aiming to refine teaching strategies to boost student engagement and learning. Figure 3 is a pictorial representation that serves as a tool to better understand and implement the roles and responsibilities outlined in Table 5, facilitating a more effective online design education experience. This framework visually represents the interconnected roles of instructors and students in an online design education setting.

Figure 3*Online design teaching strategy*

Conclusion

This research has examined the obstacles emerging in the domain of design education, specifically within the architectural design sphere, due to the COVID-19 pandemic. The investigation underscores that COVID-19 has forced educational establishments and instructors to cease in-person classes and transition to the non-traditional approach of virtual instruction. While some educators and learners were able to promptly adapt to this modality due to the availability of IoT-based student management systems, others have expressed concerns about its constraints, particularly when imparting practical courses. Indeed, the transition to digital instruction has significantly impacted engineering and design curricula. To achieve pedagogical objectives amid COVID-19, this research has determined that implementing conventional teaching methods for online education presents difficulties. As a result, an exhaustive literature review was carried out, encompassing three vital domains: virtual instruction and its challenges, traditional design teaching strategies, and alternative pedagogical models for online design education.

Study reveals that varying access to technology and reliable internet connectivity among students can lead to disparities in learning experiences. Moreover, maintaining student engagement in virtual classrooms can be demanding, as distractions are often more prevalent in-home environments. Ultimately this study proposes the model overcoming these challenges requires a combination of creativity, flexibility, and dedication from both educators and students to ensure that online teaching remains an effective and impactful method of learning. The research has expanded the potential of CF and SL models (see Tables 2 and 4) and suggested a blended teaching approach resulting from the triangulation of traditional design teaching strategies and CF and SL techniques (as depicted in Figure 3).

This research has determined that providing design courses online requires significant effort from instructors and learners. Nevertheless, considering the challenges posed by COVID-19, blended teaching models may be an appropriate alternative. The suggested blended instructional method could be a feasible solution for enriching design studio courses through IoT-based delivery systems.

The advocated pedagogical framework embodies a harmonious blend of time-tested design teaching methodologies and the inclusion of Content focus (CF) and Support learning (SL) techniques (refer to Table 4 for details). Utilizing CF and SL paradigms not only holds the potential to stimulate student interest and engagement by providing an immersive educational journey but also creates a dynamic dialogue between conventional and online teaching practices. This innovative confluence of teaching styles aids in reconciling the dichotomy between the two modalities, thus warranting that learners are privy to a superior standard of design education, irrespective of the learning environment.

To conclude, the investigation puts forth a compelling argument for the adoption of a hybrid pedagogical framework, blending tried-and-tested design teaching methodologies with CF and SL paradigms, thereby revolutionizing the instruction of online design courses. This amalgamated approach may serve as a crucial asset in the domain of design education, especially amidst the ongoing global health crisis. Based on the investigation's findings, the following recommendations can be made for online design education:

1. **Adopt a Hybrid Pedagogical Framework:** Implement a teaching approach that combines traditional design teaching methods with innovative strategies like Content Focus (CF) and Support Open Learning (SL). This will cater to the evolving needs of design education, particularly in times of crisis like pandemics.

2. **Utilize Technology-Driven Strategies:** Embrace tech-driven instructional strategies, ensuring that design curricula are delivered comprehensively and engagingly within a digital environment.

3. **Address Challenges and Opportunities:** To enhance the effectiveness of online design education recognize and address the inherent challenges and opportunities in virtual design instruction, especially under unprecedented circumstances like natural disasters or pandemics.

However, there is still much room for further research in this field. Future studies could explore the effectiveness of the proposed blended teaching model in more detail by conducting comparative studies against other available teaching models. Additionally, further research could investigate the challenges students and faculty face when implementing the proposed blended teaching model and identify effective strategies to overcome those challenges. Another area for future research could be to analyse the impact of the proposed blended teaching model on student engagement and academic performance in design courses. Further research could also explore the potential of emerging technologies such as virtual and augmented reality in online design education, as well as the role of design thinking in online design education.

References

- Abe, M. (2020). Interactional practices for online collaborative writing. *Journal of Second Language Writing*, 49, 100752. doi:10.1016/j.jslw.2020.100752
- Abu Alatta, R. T., Momani, H. M., & Bataineh, A. M. (2023). The effect of online teaching on basic design studio in the time of COVID-19: an application of the technology acceptance model. *Architectural Science Review*, 66(6), 417-432.
- Afify, H. M. N., Alhefnawi, M. A. M., Mohammed J. Istanbuli, Aymen H. Alsayed, & Zeineb A. Abd ElGaffar Elmoghazy. (2021). An evaluation of physical model-making as a teaching method in the architectural design studio – a case study at Imam Abdulrahman Bin Faisal University. *Ain Shams Engineering Journal*, 12(1), 1123–1132. doi:10.1016/j.asej.2020.07.002.
- Ahmed, W. K., & Zaneldin, E. (2013). E-Learning as a stimulation methodology to undergraduate engineering students. *International Journal of Emerging Technologies in Learning*, 8, 18-24. doi:10.3991/ijet.v8i1.2395
- Al Maani, D., Alnusairat, S., & Al-Jokhadar, A. (2021). Transforming learning for architecture: online design studio as new norm for crises adaptation under COVID-19. *Open House International*, 46(1), 9-16. doi:10.1080/01684522.2020.1863599
- Al-Marzouqi, A. H., & Ahmed, W. K. (2016). Experimenting e-learning for postgraduate courses. *International Journal of Emerging Technologies in Learning*, 11(4), 29-37. doi:10.3991/ijet.v11i04.5214
- Alnusairat, S., Al Maani, D., & Al-Jokhadar, A. (2021). Architecture students' satisfaction with and perceptions of online design studios during COVID-19 lockdown: the case of Jordan universities. *Archnet-IJAR*, 15(1), 219-236. doi:10.1108/ARCH-09-2020-0195
- Alqurshi, A. (2020). Investigating the impact of COVID-19 lockdown on pharmaceutical education in Saudi Arabia – a call for a remote teaching contingency strategy. *Saudi Pharmaceutical Journal*, 28(9), 1075–1083. doi:10.1016/j.jsps.2020.07.008
- Amer, N. (2019). Biomimetic approach in architectural education: case study of 'biomimicry in architecture' course. *Ain Shams Engineering Journal*, 10(3), 499–506. doi:10.1016/j.asej.2018.11.005.
- Amro, D. K. (2022). The impact of COVID-19 lockdown on design students' performance case study in the UAE. *International Journal of Art & Design Education*, 41(1), 108-124.
- Avsar Erumit, B., Tanis Ozcelik, A., Yuksel, T., & Tekbiyik, A. (2021). Examining the Views of Preservice Teachers about Online Science Education during the COVID-19 Lockdown: Expectations, Opportunities, Threats, Motivations, and Beliefs. *Journal of Turkish Science Education*, 18, 2-26.
- Bhat, R., Singh, V. K., Naik, N., Kamath, C. R., Mulimani, P., & Kulkarni, N. (2020). COVID-19 outbreak: The disappointment in Indian teachers. *Asian Journal of Psychiatry*, 50, 102047. doi:10.1016/j.ajp.2020.102047
- Bishop, J., & Verleger, M. (2013, June 23–26). *The flipped classroom: A survey of the research*. [Paper presentation]. In Proceedings of the 120th ASEE Annual Conference and Exposition, Atlanta, GA, USA.
- Blessing, L. T. M., & Chakrabarti, A. (2009). *DRM: a design research methodology*. Springer.
- Blundell, R., Costa, D. M., Joyce, R., & Xu, X. (2020). COVID-19 and inequalities. *Fiscal Studies*, 41, 291–319. doi:10.1111/1475-5890.12240
- Bol, L., & Garner, J. K. (2011). Challenges in supporting self-regulation in distance education environments. *Journal of Computing in Higher Education*, 23(2–3), 104–123. doi:10.1007/s12528-011-9046-7.
- Browning, M. H., Larson, L. R., Sharaievska, I., Rigolon, A., McAnirlin, O., Mullenbach, L., Reigner, N. (2021). Psychological impacts from COVID-19 among university students: Risk factors across seven states in the United States. *PLoS ONE*, 16, e0245327. doi:10.1371/journal.pone.0245327

- Brusilovsky, P., Somyurek, S., Guerra, J., Hosseini, R., Zadorozhny, V., & Durlach, P. J. (2016). Open social student modeling for personalized learning. *IEEE Transactions on Emerging Topics in Computing*, 4(3), 450–461. doi:10.1109/TETC.2015.2501243.
- Bull, S. (2010). Features of an independent open learner model influencing uptake by university students. In P. De Bra, A. Kobsa, & D. Chin (Eds.), *User Modeling, Adaptation, and Personalization* (pp. 393–398). Springer.
- Bull, S. (2016). Negotiated learner modelling to maintain today's learner models. *Research and Practice in Technology Enhanced Learning*, 11(1), 10. doi:10.1186/s41039-016-0035
- Bull, S., Brusilovsky, P., & Guerra, J. (2018, September 3-5). *Which learning visualisations to offer students?*. In *Lifelong Technology-Enhanced Learning: 13th European Conference on Technology Enhanced Learning, EC-TEL 2018, Leeds, UK, Proceedings 13* (pp. 524-530). Springer International Publishing.
- Cantamessa, M. (2003). An Empirical Perspective Upon Design Research. *Journal of Engineering Design*, 14(1), 1–15.
- Capperucci, D., Scierri, I. D. M., Salvadori, I., Batini, F., Toti, G., Barbisoni, G., & Pera, E. (2022). Remote teaching during COVID-19 Emergency: Teaching and assessment strategies and the role of previous training. *Education Sciences*, 12(10), 646.
- Ceylan, S., Pınar, S., Seçmen, S., & Somer, M. E. (2021). An evaluation of online architectural design studios during COVID-19 outbreak. *Archnet-IJAR: International Journal of Architectural Research*, 15(1), 203-218. doi:10.1108/ARCH-10-2020-0230
- Chadha, D. (2006). A curriculum model for transferable skills development. *Engineering Education*, 1, 19–24.
- Chunxia, D. (2021). Design of online volleyball remote teaching system based on AR technology. *Alexandria Engineering Journal*, 60, 4299–4306. doi:10.1016/j.aej.2021.06.023
- Costado Dios, M. T., & Piñero Charlo, J. C. (2021). Face-to-Face vs. e-learning models in the COVID-19 Era: Survey Research in a Spanish University. *Educ. Sci.*, 11, 293. doi:10.3390/educsci11060293
- Cross, N. (2018). Expertise in professional design. In K. A. Ericsson, R. R. Hoffman, A. Kozbelt, & A. M. Williams (Eds.). *The Cambridge handbook of expertise and expert performance* (pp. 372–388). Cambridge University Press.
- Daalhuizen, J., & Cash, P. (2021). Design method content theory: towards a new understanding of methods in design. *Design Studies*, 75, 101019. doi:10.1016/j.destud.2021.101018
- Daalhuizen, J., Badke-Schaub, P., & Batill, S. M. (2009). Dealing with uncertainty in design practice: issues for design-centered methodology. In *The Proceedings of the International Conference on Design Engineering, ICED'09* (pp. 147-158).
- Daalhuizen, J., Person, O., & Gattol, V. (2014). A personal matter? An investigation of students' design process experiences when using a heuristic or a systematic method. *Design Studies*, 35(2), 133-159.
- Daalhuizen, J., Timmer, R., Welie, M. VD., & Gardien, P. (2019). An architecture of design doing: a framework for capturing the ever-evolving practice of design to drive organizational learning. *International Journal of Design*, 13(1), 37–52.
- Daumiller, M., Rinas, R., Hein, J., Janke, S., Dickhauser, O., & Dresel, M. (2021). Shifting from face-to-face to online teaching during COVID-19: the role of university faculty achievement goals for attitudes towards this sudden change, and their relevance for burnout/engagement and student evaluations of teaching quality. *Computers in Human Behavior*, 118, 106677. doi:10.1016/j.chb.2020.106677
- De-Araujo, J., & Claudiano, S. (2001). *Acquisition of product development tools in industry: a theoretical contribution* [Unpublished doctoral dissertation]. Technical University of Denmark.
- Debacq, M., Almeida, G., Lachin, K., Lameloise, M.-L., Lee, J., Pagliaro, S., Romdhana, H., & Roux, S. (2021). Delivering remote food engineering labs in COVID-19 time. *Education for Chemical Engineers*, 34, 9-20. doi:10.1016/j.ece.2020.10.002

- Edward, L. (2020). The Pandemic Could Open a Door to New Technology and Dramatic Innovation in Education. Berkeley News. Retrieved from <https://news.berkeley.edu/2020/05/27/the-pandemic-could-open-a-door-to-new-technology-and-dramatic-innovation-in-education/>
- El-Ariss, B., Zanelidin, E., & Ahmed, W. (2021). Using videos in blended e-learning for a structural steel design course. *Educ. Sci.*, 11, 290. doi:10.3390/educsci11060290
- Emam, M., Taha, D., & ElSayad, Z. (2018). Collaborative pedagogy in architectural design studio: a case study in applying collaborative design. *Alexandria Engineering Journal*, 58(1), 163–170. doi:10.1016/j.aej.2018.03.005
- Engzell, P., Frey, A., & Verhagen, M. D. (2020). Learning Inequality during the COVID-19 Pandemic. SocArXiv. Retrieved from <https://osf.io/preprints/socarxiv/ve4z7/>
- Fewella, L. N. (2023). Impact of COVID-19 on distance learning practical design courses. *International Journal of Technology and Design Education*, 1-24. doi:10.1007/s10798-023-09674-6
- Fleischmann, K. (2022). A paradigm shift in studio pedagogy during pandemic times: An international perspective on challenges and opportunities teaching design online. *Journal of Design, Business & Society*, 8(2), 247-272. doi:10.1386/dbs_00054_1
- Fojtki, R. (2018). Problems of distance education. *ICTE Journal*, 7(1), 14–23.
- Gamage, K. A. A., Gamage, A., & Dehideniya, S. C. P. (2022). Online and hybrid teaching and learning: enhance effective student engagement and experience. *Educ. Sci.*, 12(10), 651. doi:10.3390/educsci12100651
- Gamage, K. A., Wijesuriya, D. I., Ekanayake, S. Y., Rennie, A. E., Lambert, C. G., & Gunawardhana, N. (2020). Online delivery of teaching and laboratory practices: Continuity of University Programmes during COVID-19 pandemic. *Educ. Sci.*, 10, 291. doi:10.3390/educsci10100291
- Ghasem, N., & Ghannam, M. (2021). Challenges, benefits & drawbacks of chemical engineering online teaching during COVID-19 pandemic. *Education for Chemical Engineers*, 36, 107–114. doi:10.1016/j.ece.2020.10.002
- Goldschmidt, G., & Tatsa, D. (2005). How good are good ideas? Correlates of design creativity. *Design Studies*, 26(6), 593-611.
- González-Lloret, M. (2021). Online collaboration through tasks for L2 pragmatic development. In *Working Collaboratively in Second/Foreign Language Learning* (pp. 199-216). John Benjamins Publishing Company.
- Gottfredson, D. C., Cook, T. D., Frances, E. M., Gardner, D. G., Gorman-Smith, D., Howe, G. W., Sandler, I. N., & Zafft, K. M. (2015). Standards of evidence for efficacy, effectiveness, and scale-up research in prevention science: next generation. *Prevention Science*, 16(7). doi:10.1007/s11121-015-0555-x.
- Grover, R., & Wright, A. (2023). Shutting the studio: the impact of the Covid-19 pandemic on architectural education in the United Kingdom. *International Journal of Technology and Design Education*, 33(3), 1173-1197.
- Guohong, G., Ning, L., Wenxian, X., & Wenlong, W. (2012). The study on the development of internet-based distance education and problems. *Energy Procedia*, 17, 1362–1368. doi:10.1016/j.egypro.2012.02.294
- Hassanpour, B. (2023). Transformational contribution of technology to studio culture: experience of an online first-year architecture design studio during the COVID-19 pandemic. *Archnet-IJAR: International Journal of Architectural Research*, 17(2), 393-408.
- Hevner, A. R. (2007). A Three Cycle View of Design Science Research. *Scandinavian Journal of Information Systems*, 19(2), 1-7.
- Homan, G., & Macpherson, A. (2005). E-learning in the corporate university. *Journal of European Industrial Training*, 29(1), 75-90.
- Hooshyar, D., Pedaste, M., Saks, K., Leijen, A., Bardone, E., & Wang, M. (2020). Open learner models in supporting self-regulated learning in higher education: a systematic literature review. *Computers & Education*, 154, 103878.

- IABFU (Imam Abdurehman bin Faisal University). (2022). Architecture Design III Course Description. Retrieved from <https://www.iau.edu.sa/en/courses/design-iii> on Sep 27, 2022.
- Ibrahim, A. F., Ahmed, S. A., Bataineh, A. M., & Hikmat, H. A. (2021). Evaluation of the online teaching of architectural design and basic design courses: case study – college of architecture at JUST, Jordan. *Ain Shams Engineering Journal*, 12, 2345–2353. doi:10.1016/j.asej.2021.02.028
- Iqbal, H., Sheikh, A. K., & Samad, M. A. (2014, April 3–5). *Introducing CAD/CAM and CNC machining by using a feature based methodology in a manufacturing lab course, a conceptual framework*. In Proceedings of the 2014 IEEE Global Engineering Education Conference (EDUCON), Istanbul, Türkiye. doi:10.1109/EDUCON.2014.6826226
- Janssen, L. (2020). How COVID-19 Exposed Challenges for Technology in Education. GSTIC Expert Story. Retrieved from <https://www.gstic.org/expert-story/how-covid-19-has-exposed-the-challenges-for-technology-in-education/>
- Johnson, S. D., Aragon, S. R., Shaik, N., & Palma-Rivas, N. (2000). Comparative analysis of learner satisfaction and learning outcomes in online and face-to-face learning environments. *Journal of Interactive Learning Research*, 11, 29–49.
- Katsavounidou, G. (2022). Distance teaching urban design and planning studio courses during the pandemic: challenges and lessons learnt. *Journal of Planning Education and Research*, 1-13. doi:10.1177/0739456X221084992
- Klawitter, A. (2022). Challenges students face with online learning in 2022. Retrieved from <https://meratas.com/blog/5-challenges-students-face-with-remote-learning/>
- Kolata, S. (2020). Online pedagogy: how to teach hands-on architecture and design courses virtually. March 15, 2020. Retrieved from <https://sarakolata.medium.com/online-pedagogy-how-to-teach-hands-on-architecture-and-design-courses-virtually-3e178e0d0ff5>
- Lambert, C. G., & Rennie, A. E. W. (2021). Experiences from COVID-19 and emergency remote teaching for entrepreneurship education in engineering programmes. *Educ. Sci.*, 11, 282. doi:10.3390/educsci11060282
- Larenas, D., Claudio H., Andrea Victoria Rodríguez Moran, & Karen Jocelyn Poblete Rivera. (2011). Comparing teaching styles and personality types of EFL instructors in the public and private Sectors. *Profile Issues in Teachers Professional Development*, 13(1), 111–127.
- Leung, J. K., & Chu, S. K. (2020). Inspiring Makers in First-Year Engineering under Emergency Remote Teaching. *Adv. Eng. Educ.*, 8(4). doi:10.11120/ae.2020.08040043
- Littlejohn, A., Hood, N., Milligan, C., & Mustain, P. (2016). Learning in MOOCs: motivations and self-regulated learning in MOOCs. *Internet and Higher Education*, 29, 40–48. doi:10.1016/j.iheduc.2015.12.003.
- Lueth, P. L. O. (2008). *The architectural design studio as a learning environment: A qualitative exploration of architecture design student learning experiences in design studios from first-through fourth-year*. Iowa State University.
- Lyon, P. (2016). *Design education: Learning, teaching and researching through design*. CRC Press.
- Maulam, N., Israel, E., & Max, D. (2022). Moving to online planning during the COVID-19 pandemic: an assessment of zoom and the impact of ict on planning boards' discussions. *Journal of Planning Education and Research*, 1-20. doi:10.1177/0739456X221105811
- McAllister, K. (2010). The design process – making it relevant for students. *International Journal of Architectural Research*, 4(2/3), 76–89.
- Medina, M. B. E. (2015). Influencia de la interacción alumno-docente en el proceso enseñanza-aprendizaje. Paakat: Revista de Tecnología y Sociedad, 8. Retrieved from <http://www.udgvirtual.udg.mx/paakat/index.php/paakat/article/view/230/347>
- Mohammadi, H., Monadjemi, S. A., Moallem, P., & Olounabadi, A. A. (2008). E-learning system development using an open-source customization approach. *Journal of Computer Science*, 4(5), 360. doi:10.3844/jcssp.2008.144.152

- Moorhouse, B. L. (2020). Adaptations to a face-to-face initial teacher education course 'forced' online due to the COVID-19 pandemic. *Journal of Education for Teaching*, 46(4), 609-611. doi:10.1080/02607476.2020.1755205
- Mostafanezhad, M. (2020). Covid-19 is an unnatural disaster: Hope in revelatory moments of crisis. *Tour. Geogr.*, 22, 639–645. doi:10.1080/14616688.2020.1779218
- Mostafanezhad, M. (2020). Covid-19 is an unnatural disaster: Hope in revelatory moments of crisis. *Tourism Geographies*, 22, 639–645. doi:10.1080/14616688.2020.1744495
- Murray, A., Fox, J., Sleight, J., & Oldfield, P. (2023). The online studio: cultures, perceptions and questions for the future. *International Journal of Art & Design Education*, 42(1), 108-124. doi:10.1111/jade.12410
- Mushtaha, E., Abu Dabous, S., Alsyuf, I., Oda, A., & Raafat Abdraboh, N. (2022). The challenges and opportunities of online learning and teaching at engineering and theoretical colleges during the pandemic. *Ain Shams Engineering Journal*, 13, 101770. doi:10.1016/j.asej.2022.101770
- Muzammil, M., Sutawijaya, A., & Harsasi, M. (2020). Investigating student satisfaction in online learning: the role of student interaction and engagement in distance learning university. *Turkish Online Journal of Distance Education*, 21, 88–96.
- Naqvi, S. (2012). Methods of Teaching. Higher Education Commission of Pakistan (HEC). United States Agency for International Development (USAID). Retrieved from https://hec.gov.pk/english/services/universities/RevisedCurricula/Documents/2011-2012/Education/MethodsTeaching_Sept13.pdf
- Noviana, M., Sukardi, S., & Suryanti, N. M. N. (2020). Learning process during Covid-19 pandemic from various variables in senior high school. *SAR Journal*, 3, 160–165.
- Ortiz, P. A. (2020). Teaching in the time of COVID-19. *Biochemistry and Molecular Biology Education*, 48(3), 201. doi:10.1002/bmb.21348
- Prahani, Binar Kurnia; Suprpto, Nadi; Rachmadiarti, Fida; Sholahuddin, Arif; Mahtari, Saiyidah; Suyidno; Siswanto, Joko. (2021). Online scientific creativity learning (OSCL) in science education to improve students' scientific creativity in COVID-19 pandemic. *Journal of Turkish Science Education*, 18(spec iss), 77-90..
- Prince, N. (2004). Does active learning work? A review of the research. *Journal of Engineering Education*, 93, 223–231. doi:10.1002/j.2168-9830.2004.tb00809.x
- Putri, A. H., Samsudin, A., & Suhandi, A. (2022). Exhaustive studies before covid-19 pandemic attack of students' conceptual change in science education: a literature review. *Journal of Turkish Science Education*, 19(3), 808-829.
- Raturi, S. (2010). Learners' satisfaction of, and preference for, different instructional delivery modes: A case study from the University of the South Pacific (USP). Suva, Central, Fiji.
- Ripoll, V., Godino-Ojer, M., Calzada, J., Alqurshi, A., Debaq, M., Almeida, G., Lachin, K., Lameloise, M.-L., Lee, J., Pagliaro, S., Romdhana, H., & Roux, S. (2021). Investigating the impact of COVID-19 lockdown on pharmaceutical education in Saudi Arabia– a call for a remote teaching contin-gency strategy. *Educ. Chem. Eng.*, 34, 21–32. doi:10.1016/j.ece.2020.11.001
- Rodríguez, C. L., Mula, J., Segovia, J. D., & Cruz-González, C. (2021). The effects of covid-19 on science education: A thematic review of international research. *Journal of Turkish Science Education*, 18(Covid-19 Special Issue), 26-45.
- Rosa, C., & Ferreira, J. (2023). The distant studio: a survey of design students' experience with distance educational formats. *International Journal of Technology and Design Education*, 1-25. doi:10.1007/s10798-023-09673-7
- Sajid, M. J. (2020). Online Teaching in the Age of COVID-19: A Case of Personal Experience. In *Materials of the International Online Distance Conference On Modern Informatics and Its Teaching Methods*.
- Schön, D. A. (2015). Learning to design and designing to learn. *NA*, 6(1). Retrieved from <http://arkitekturforskning.net/na/article/viewFile/767/711> on May 21, 2023.

- Shariatrad, F., Doostabadi, M. A., Dehbandi, R., & Senemari, F. (2022). Factors affecting online education of architectural design studio. *Soffeh*, 32, 9-14. doi:10.52547/SOFEH.2021.220904.1014
- Shim, T. E., & Lee, S. Y. (2020). College students' experience of emergency remote teaching due to COVID-19. *Children and Youth Services Review*, 119, 105578. doi:10.1016/j.chilyouth.2020.105578
- Son, C., Hegde, S., Smith, A., Wang, X., & Sasangohar, F. (2020). Effects of COVID-19 on college students' mental health in the United States: interview survey study. *Journal of Medical Internet Research*, 22, e21279. doi:10.2196/21279
- Swart, W., & MacLeod, K. (2021). Evaluating learning space designs for flipped and collaborative learning: a transactional distance approach. *Educ. Sci.*, 11, 292. doi:10.3390/educsci11060292
- Talbot, R. (2020). How Much Research Has Been Done on Flipped Learning? 2020 Update for 2020. Retrieved from <http://rtalbert.org/how-much-research-has-been-done-on-flipped-learning-update-for-2020/>
- Thomas, M. S., & Rogers, C. (2020). Education, the science of learning, and the COVID-19 crisis. *Prospects*, 49, 87-90. doi:10.1007/s11125-020-09495-w
- Ting, D. S., Carin, L., Dzau, V., & Wong, T. Y. (2020). Digital technology and COVID-19. *Nature Medicine*, 26, 459-461. doi:10.1038/s41591-020-0824-5
- Ulrich, K., & Eppinger, S. (2015). *Product design and development*. McGraw Hill Education.
- UNESCO. (2022). COVID-19 Recovery: Education: from school closure to Recovery (Feb 2020- June 2022) [Website]. Retrieved May 23, 2023, from <https://www.unesco.org/en/covid-19/education-response>
- Wang, C.-H., Shannon, D. M., & Ross, M. E. (2013). Students' characteristics, self-regulated learning, technology self-efficacy, and course outcomes in online learning. *Distance Education*, 34, 302-323. doi:10.1080/01587919.2013.835779.
- Wong, M. H. J., Mohamed, R. N. S. B., Raja Mohd Yazit, R. N. S. B., & Ho, J. C. Y. (2023). Challenges Faced by Students in Online Architectural Design Studio During COVID-19 Pandemic: Universities in Sarawak. In *Advances in Civil Engineering Materials* (pp. 81-91). doi:10.1007/978-981-19-8024-4_7
- Yaeger, P. M. (2002). *Innovations and outcomes in engineering education: Active learning in dynamics classes*. The Pennsylvania State University.
- Yazit, M., & Ho, J. C. Y. (2023). Challenges Faced by Students in Online Architectural Design Studio During COVID-19 Pandemic: Universities in Sarawak. In *Advances in Civil Engineering Materials* (pp. 81-91). doi:10.1007/978-981-19-8024-4_7
- Yesiloglu, Sevinç Nihal; Gençer, Sinem; Ekici, Funda; Isik, Burcu. Examining Pre-Service Teachers' Views about Online Chemistry Laboratory learning experiences amid the COVID-19 pandemic. *Journal of Turkish Science Education*, 18(special issue) , 108-124.
- Zhang, L. (2008). Teachers' Styles of Thinking: An Exploratory Study. *The Journal of Psychology*, 142(1), 37-55.