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Article

## Examining the effect of learning environment on student behaviour through comparison of face-to-face and online design studio

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### ABSTRACT

Covid-19 pandemic has affected the field of education, and transition to the distance learning has led to changes in the learning environment and pedagogical transformations. In this process, design studios, which are the basis of architectural education, were also maintained on online platforms. The aim of this study is to investigate the effect of the rapid learning environment change in the architectural design studio due to the Covid-19 pandemic on student behaviour. Examining students' holistic perspectives and behaviours based on their experience in face-to-face design studios and online design studios, this research attempts to reveal the potential and challenges of face-to-face and online studios. In this study, students' behavioural changes regarding face-to-face studio and online studio were measured using the survey method, and these two learning environments were interpreted over six themes (peer learning, socially mediated learning, self-efficacy, self-regulation, motivation, and communication with the instructor) by using the survey results, the course structure and the theoretical framework. The findings reveal that change in the learning environment affects student behaviour and that face-to-face design studios and online design studios have different potentials and limitations. In addition, the course structure of the face-to-face studio and online studio, the tools and methods used in learning, the way of communication and collaboration vary depending on the structure of the learning environment. This study reveals that the face-to-face design studio is a learning environment where the social structure of the studio is developed, peer learning is supported, and methods such as physical model and hand-sketching are used as well as digital tools during communication with the instructor. It shows that the most important potentials of the online studio are that it offers a flexible learning environment, does not have time and place restrictions, allows for cross-cultural and inter-institutional collaboration, and supports self-study. As a result, the research shows that online studio experiences gained during the pandemic period can offer the opportunity to create blended learning environments by adding online features to the traditional face-to-face studio.

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## INTRODUCTION

Learning is the occurrence of permanent behavioural change as a result of experience and practice from the cognitive learning approach (Schunk, 2012). Based on cognitive and behavioural perspectives, Pritchard (2009) refers to definitions of learning such as acquiring knowledge and skills through study, the process leading to behaviour change, and the process of developing understanding through experience. On the other hand, Illeris (2009) offers a modern definition and defines learning as a process that causes permanent capacity change.

Bandura's (1986) triadic theory of human behaviour claims that person, behaviour and environment are related and interactive. In the learning environment, the communication between the teacher and the student, what they do, what they say, the questions they ask, and their thoughts affect each other and the environment. During learning, this triple effect continues in a loop and affects each other (Schunk, 2012).

There are some common issues discussed in learning theories. These include the role of memory and motivation in learning, the way transfer takes place, self-regulation processes, and the effects of teaching (Schunk, 2012). According to constructivist theory, learning is possible by making new additions to existing knowledge and skills, resulting from an active construction process (Pritchard, 2009). The constructivist theory emphasises the importance of students' self-learning while encouraging collaborative learning (Pritchard, 2009). In addition to this, the social aspect of learning, which is one of the important parts of learning, is related to peer learning (Vygotsky, 1978), social interaction, authentic tasks (Kocevar-Weidinger & Cooperstein, 2004), communication with the instructor (Schunk, 2012) and socially mediated processes.

Architectural education is based on the design studio. Environment, pedagogy and student behaviour are important parameters that are interrelated and affecting each other in the architectural design studio similar to the concept of learning (Higgins et al., 2005; Oblinger, 2005; Oblinger, 2006; Radcliffe et al., 2008). The design studio is a learning environment, where peer learning is intense due to the group work and juries, strong communication is established with the instructor during the crits, and socially mediated processes take place. At the same time, design studio involves a learning system that motivates students for self-learning, contributes to the development of their self-efficacy and includes self-regulation, which is defined as the coordination of mental functions. Therefore, it is possible to examine design studio education through these dimensions.

Now-a-days, architectural design studio develops day by day and traditional representation methods change in

architectural education. The development of technology, globalisation and the expectations of easy access to all parts of the world enables different learning environment experiences in the design studio. In addition, it has become inevitable to move the design studio to the online platform due to the requirements and mandatory conditions of the pandemic process. In short, the development of technology has created new learning environments, and the Covid-19 pandemic has accelerated this transformation (Dreamson, 2020; Yu et al., 2021). Design studios have started to be experienced in virtual environments, rather than physical environments where educators and students meet face-to-face. While the online learning environment creates a change in pedagogy, it also brings benefits and challenges (Alnusairat et al., 2021; Asadpour, 2021; Winters, 2021; Yu et al., 2021). Asadpour's (2021) research proposes new design pedagogy based on interaction and collaboration that see the teacher as a facilitator and focuses on students' self-learning. However, the change in the learning environment not only affects pedagogy but also changes student behaviours and the student's perception of the design studio.

In this context, the aim of this study is to investigate the effect of the learning environment change on student behaviour due to the acceleration of the transition from face-to-face design studios to online design studios resulting from the Covid-19 pandemic. Within the scope of the study, a survey was conducted to 3<sup>rd</sup> and 4<sup>th</sup>-year undergraduate architecture students, by accepting the dimensions in which learning was examined as the main topic. The survey was applied to students who have both experienced the face-to-face learning environment in the past and experienced the online learning environment during the pandemic and are enrolled in the 2020–2021 spring semester design studio course. This survey measures the behavioural and perception differences of students between face-to-face studios and online studios. The survey reveals these differences and evaluates them through the dimensions of peer learning, socially mediated learning, self-efficacy, self-regulation, motivation and communication with the instructor.

This study was designed due to the sudden transfer of architectural education from face-to-face environment to an online platform during the Covid-19 pandemic. In this process, it is important for the future of architectural education to evaluate the perspectives and behaviours of students about the change in the pedagogical structure of the design studio, the tools and methods used. The contribution of this article to the literature is to present a comparative assessment of the studio experience. Comparing two learning environments by the same group of students is important in revealing the advantages and difficulties of different studio environments. In this context, it is expected that this study will form a basis for future research on architectural education.

## DESIGN EDUCATION

The design studio, being at the centre of architectural education, begins with the implementation of the atelier system in the École des Beaux-Arts in the 19<sup>th</sup> century (Carlhian, 1979). The traditional architectural approach has laid the foundations of architectural education by adopting an approach where the design studio is at the centre of education. Nowadays, design education is still based on studio-based pedagogy (Wragg, 2019; Fleischmann, 2020a).

### Design Studio as a Learning Environment (Studio-Based Learning)

The pedagogical structure of design learning is supported by different theories such as learning by doing (Schön, 1987), concept development and test (Ledewitz, 1985), learning through the transformation of experience (Kolb, 2015), reciprocal exchange of ideas (Demirbas & Demirkan, 2007), problem-solving activities (Simon, 1973), interrelation between social practices and design problems in the studio (Brandt et al., 2013), developing skills non-verbal communication and solving ill-defined problems (Cross, 1982). Design studios are a form of project-based education in which students are intellectually and socially active, and tools such as modelling and drawing are used as thinking and representation methods (Oxman, 2001), sketching is used as a reasoning modality (Goldschmidt, 1991). According to Ledewitz (1985), it is possible for students to learn three basic aspects of architectural education with the help of a design studio. It is through the studio that learning and practicing representation and visualisation, acquiring a new language and grasping “thinking architecturally”, are these three crucial aspects (Ledewitz, 1985).

It is thought that the design studio literature includes some basic concepts related to the pedagogical structure. It is possible to have a design studio discussion by categorising these concepts. Six concepts show different characterisations of the pedagogical structure of the studio, although this is not a complete list. These are communication with the instructor, peer learning, socially mediated learning, motivation, self-efficacy and self-regulation.

The first concept is communication with the instructor. Transfer and communication between instructor and student in the studio environment are critical. This structure, which Schön (1987) defines as a reflection in action, allows students to develop their critical thinking abilities and learn by doing in the studio (Schön, 1987). Instructors’ coaching guides students to understand the design problem better and to grasp the design-thinking path during the design education process. The learning experience is facilitated through healthy communication, open discussions, assignments, directions, and learning takes place tacitly (Cennamo et al., 2011). In addition, the existence of equal power relations (Webster, 2005) in the

studio and the rejection of hierarchy (Dutton, 1987) provide a more effective learning environment by improving social relations between tutor and student and supporting student-centred learning.

The second concept is peer learning and the third is socially mediated learning. The studies of Vygotsky, Bruner, and Bandura show that peer interaction is one of the foundations of learning (Pritchard, 2009). Peer-assisted learning includes methods like peer teaching, reciprocal learning, and collaborative learning (Schunk, 2012). Peer learning helps to support team working, develop self-assessment, manage learning because of collective perspectives, give opportunities to criticise others and transfer knowledge and ideas (Boud, 2001). Since interaction between peers is one of the crucial factors affecting the learning experience in design education (Güler, 2022; Yu et al., 2021), improving peer interaction and communication is one of the critical discussion topics. Many researchers (Vygotsky, 1978; Bandura, 1986; Pritchard, 2009; Schunk, 2012) emphasise the importance of social processes in learning. The social component of the learning environment has a critical role in increasing acculturation (Lave & Wenger, 1991) by influencing the learning process and collaboration (Sawyer & Greeno, 2008). The working environment of the design studio is also a social environment (Hart et al., 2011), which improves communication between students and supports peer learning. Disregarding social processes in design education causes a decrease in the exchange of ideas and the originality of the design ideas, as well as reduces communication and collaboration (George, 2017).

The fourth concept is motivation. Motivation refers to the process of initiating and maintaining a behaviour or attitude to achieve a goal (Schunk, 2012). The interaction-supportive structure of the social environment encourages participation and motivation (Kariippanon et al., 2017), increases the sense of belonging (Gee, 2006) and positively affects learning. The social component of the design studio is also effective in creating a sense of belonging and increasing the motivation of the students (Fleischmann, 2020a).

Two other concepts are self-efficacy and self-regulation. Self-efficacy describes one’s beliefs about performing actions and meeting expectations for learning (Bandura, 1993). In addition, it is a factor that affects the choice of activity, starting a task, the effort put into this task, and therefore learning (Schunk, 2012). Bandura defined self-efficacy as “*people’s judgements of their capabilities to organise and execute courses of action required to attain designated types of performances*” (Bandura, 1986, p. 391). On the other hand, self-regulation is defined as proactive processes to develop academic skills and it refers to “*the self-directive processes and self-beliefs that enable learners to transform their mental abilities, such as verbal aptitude, into an academic performance skill, such as writing*” (Zimmerman, 2008,

p. 166). Self-regulation refers to the processes by which students systematically use their thoughts, behaviours, and activities to achieve their goals. Adopting a more student-centred and flexible approach in universities affects the learning experience, changes communication methods, and increases students' responsibility for self-learning (Jamieson, 2003). Student-centred approaches improve students' self-confidence, allow them to express their ideas freely, and contribute to the development of their analytical and critical thinking skills. Inquiry-based learning aims to involve students in an authentic discovery process (Pedaste et al., 2015). According to Zimmerman's (2008) research, it is stated that there is a connection between students' self-regulation behaviours and their academic achievement, and that self-regulation processes and motivation are closely related concepts.

Contemporary design pedagogies still contain the traditional approach even though there are pedagogical transformations and innovations. The necessity of radical learning paradigm changes that will encourage students to be "critical thinkers", "active learners" and "knowledge producers" (Salama, 2016; Salama & Crosbie, 2020) in design studios is emphasised (Koch et al., 2006; Salama, 2016; Salama & Crosbie, 2020). AIAS's (American Institute of Architecture Students) report on design studio culture includes the critique of the current design studio, emphasising that the design process is as important as the design product, the necessity of interdisciplinary learning, the need to prioritise people, users and society while making design decisions. The report also claims that the studio culture should support collaboration over competition, healthy and constructive critiques, successful and clear methods of student assessment, innovative learning methodologies, leadership development, the value of time, and clear expectations and goals for learning (Koch et al., 2006).

In addition, new perspectives and new design education approaches that are different from the traditional method are emerging along with digital design thinking (Oxman, 2008). The educational paradigm transforms with the addition of digital learning to the curricula and adapts to today's conditions (Burdick & Willis, 2011). Perceiving Information and Communication Technologies (ICTs) as a multi-layered and comprehensive structure which is a way of thinking and a method of cognitive development rather than as a tool will contribute to the development of pedagogy and curricular structure. In this context, it is stated that digital learning encourages innovation, discovery and strategic learning, and improves collaboration, communication and group work (Burdick & Willis, 2011). Salama & Crosbie (2020) emphasise that the Covid-19 pandemic has brought up digitalisation discussions in architectural education more. This process is a temporary stage for building the post-pandemic design studio. Educators are investigating

the future potentials of design for "an education-delivery system that aims to graduate students able to meet the needs of the profession to a teaching/learning process that produces people who can create opportunities" (Salama & Crosbie, 2020, p. 2).

In this study, research was conducted through the concepts immanent in the pedagogical structure of the design studio. Six categorisations of the design studio were determined as peer learning and socially mediated learning dimensions that focus on the interaction between students; self-efficacy and self-regulation dimensions that include learning experience, tools and skills used by students; motivation as an uninterrupted process in the studio culture; and communication with the instructor.

### Online Design Studio

A virtual design studio is described as a learning space where the studio environment expands beyond the boundaries of physical space and time limits. This concept first emerged in the 90s with the development of technology (Pektaş, 2015). It was introduced by Wojtowicz (1995) as a result of a design exercise with various participants. Initial experiments with the virtual design studio are primarily aimed at improving the use of communication and network technology in the classroom and exploring the potential of online education (Maher & Simoff, 1999; Maher et al., 1999; Newman et al., 2018). The software used in these early virtual design studios combines the synchronous and asynchronous approaches (Kolarevic et al., 2000; Broadfoot & Bennett, 2003) and utilises multi-user dungeons (Maher et al., 1999).

Face-to-face and online studios are considered by some researchers (Broadfoot & Bennett, 2003; Saghafi et al., 2012) as different models that will support and improve each other since they have different potentials. It is seen that the online studio is more efficient in respect of self-study, research, and discussion (Saghafi et al., 2012), enriching cultural collaboration between different institutions (Bradford et al., 1994; Kolarevic et al., 2000), creating flexible environment (Kvan, 2001; Sagun et al., 2001; Yu et al., 2021) whereas the face-to-face studio has an advantage for supporting motivation, interaction, peer learning (Saghafi et al., 2012).

Online design studio, beyond being a concrete space surrounded by walls, expresses a dynamic environment where there is no time and space constraint, allowing interaction and communication between people from different time zones (Maher et al., 1999; Sagun et al., 2001; Newman et al., 2018). Moreover, online design studios can offer critiques and evaluations from professionals that students might not otherwise have access to (Gross & Do, 1999). Collaboration in a multicultural environment and the opportunity to work on the same design without being physically together have the potential to contribute to the

development of students. It has been observed that online education contributes to the development of students in sociocultural terms (Kvan, 2001), and provides ease of access due to the absence of time constraints (Kvan, 2001; Li & Murphy, 2004). In addition, it improves students' understanding and enables them to focus on the design process due to its data storage feature (Sagun et al., 2001). These positive contributions provide clues about the future potential of online studio learning.

Many researchers have concerns about the online studio as well as pointing out its advantages. The main limitations of the online design studio are the technological constraints (George, 2017), the lack of cost for the development of new technologies (Newman et al., 2018), the inability to transfer the social components of the studio to the online environment (George, 2017; Wragg, 2019; Fleischmann, 2020a; Iranmanesh & Onur, 2021), the lack of informal background learning (Iranmanesh & Onur, 2021). Insufficient opportunities for peer connections (George, 2017; Fleischmann, 2020a), lack of dialogue between instructor and student (Dreamson, 2020; Fleischmann, 2020a), difficulties in mentoring students and criticising their work (Saghafi et al., 2012; George, 2017; Newman et al., 2018) are related to the social structure of the studio. Wragg (2019) states that it is necessary to design the social environment of the online studio and "the social aspect of the studio cannot be left to evolve by chance" (Wragg, 2019, p. 5).

Many online design studio initiatives have been tried, although the conditions of studio-based learning pedagogy challenge online studios. Technology-enabled active learning environments (TEAL) have been created, and the importance of online participation has been emphasised with technology-supported programs such as "bring your own device" (Fisher, 2016). Virtual design studios such as The Kumamoto-Kyoto-MIT Collaborative Project (Yee et al., 1998) and CoOL Studio (Zimring et al., 2001) have explored the possibilities of the online studio by evaluating the advantages and disadvantages of online platforms as a result of the active virtual studio process. There have been many studies on the research of the potential of the online studio, the implementation and evaluation of innovative models, although the historical background of the virtual studio does not go back to the past.

### Emergency Online Design Studio

While the change in the education system as a result of the Covid-19 pandemic is addressed by some researchers as a shift to online education (Yorgancıoğlu, 2020), others define it as "emergency remote teaching" (Hodges et al., 2020), "crisis distance education" (Al Lily et al., 2020), "transitional emergency model" (Salama & Crosbie, 2020), "sink-or-swim situation" (Fleischmann, 2021). Online education debates have been going on for decades by proposing innovative methods and pedagogical infrastructures.

However, a sudden change occurred during the pandemic period and distance education discussions accelerated. Post-pandemic debates in architectural education have generally focused on the design studio. These studies reveal both the potentials and challenges of the online studio as a result of studio actors' feedback, analysis of the studio environment, and interpretations of the pedagogical framework.

Some studies (Alnusairat et al., 2021; Al Maani et al., 2021; Ibrahim et al., 2021) examining student perception of the online studio reveal that students' online learning experiences are challenging and need more guidance. Although students' overall satisfaction with the online studio experience is measured as low (Alnusairat et al., 2021; Al Maani et al., 2021), there are positive pedagogical contributions, such as students taking more responsibility, using the software more actively, discovering more educational resources, re-watching review recordings (Al Maani et al., 2021). In addition, the online studio has the advantage of providing a more flexible environment (Al Maani et al., 2021) and encouraging inter-institutional learning and international collaboration (Ibrahim et al., 2021). According to Iranmanesh & Onur (2021), the online studio supports self-learning and the success of instructor-student communication depends on how the studio is designed. However, peer learning is one of the shortcomings of the online studio.

Conversely, other studies focusing on student behaviour (Ceylan et al., 2021; Jones et al., 2021) claim that the online studio supports social learning, positively affecting student achievement (Jones et al., 2021), and distance studio is efficient if appropriate tools and necessary environment are provided (Ceylan et al., 2021). Güler (2022) proposes a guide for effective design education in the online environment. In addition, Iranmanesh & Onur (2021) states that online studio pedagogy is more suitable for 3rd and 4th grades because of "encouraging them to become more independent" (p. 263). On the other hand, the transition to the online studio during the pandemic period is an emerging concept that offers a preliminary experience of the future of architectural education (Dreamson, 2020; Marshalsey & Sclater, 2020; Ceylan et al., 2021). Dreamson (2020) states that "online design education is not the next best alternative but an emergent design studio" (p. 495). It is possible to perceive this process as an opportunity to evaluate online learning in detail instead of interpreting it as a radical change in the design studio pedagogy (Yorgancıoğlu, 2020).

Many researchers (Fleischmann, 2020a, b; Ceylan et al., 2021; Fleischmann, 2021; Megahed & Hassan, 2021; Varma & Jafri, 2021) address that blended learning, designed by combining the advantages of face-to-face and online education, has the potential to be a suitable system for the design studio. Fleischmann (2020b) claims that the blended

design studio pedagogy supported by technology while maintaining the essence of the design studio, provides an effective studio experience by allowing for more flexible study opportunities. However, the blended approach is not a replacement for the face-to-face studio experience (Megahed & Hassan, 2021), it can be considered as a transitional environment for a fully online design studio (Fleischmann, 2020a, b). The learning styles of students have changed during the pandemic with the use of new technological tools and methods. Accordingly, the need for new pedagogical frameworks has increased. Megahed & Hassan (2021) proposes a blended studio model in which the sustainability of learning in architectural education can be achieved. Some studies (Fleischmann, 2021; Varma & Jafri, 2021) obtaining data from instructors during the pandemic also agree that blended learning has significant potential for the future of the design studio. Even educators, who had a negative view of the online studio prior to the pandemic, think that blending online and face-to-face approaches can improve design studios (Fleischmann, 2021).

It is necessary to evaluate the design studio structure and curriculum under changing conditions and to develop appropriate pedagogical frameworks for the future of architectural education. The integration of online platforms, which will strengthen the face-to-face design studio, with design education is one of the critical breaking points that accelerated with the pandemic, and it will also affect the future of architectural education (Fleischmann, 2021; Varma & Jafri, 2021).

This study is essential in terms of evaluating student behaviours and learning the student expectations in face-to-face and online design studios by comparing face-to-face and online studios through students who have experienced both studios. In addition, this study includes question sets that measure students' behaviours related to both individual learning and collective learning. Since the architectural design studio is an environment where individual and collective learning coexists, examining student behaviour in a multidimensional way provides a broad perspective for the future trajectory of architectural education.

## RESEARCH METHODOLOGY

This study explores the effect of the change in architectural design studios on student behaviour due to the rapid transition from face-to-face learning environment to online learning environment as a result of the Covid-19 pandemic. Student behaviour changes and perception differences in face-to-face and online studios are compared through six defined categories (peer learning, socially mediated learning, self-efficacy, self-regulation, motivation and communication with the instructor) in order to understand the impact of the learning environment.

A mixed research approach is used when conducting this inquiry. While the self-reported survey is evaluated qualitatively through statistical methods, open-ended questions and comments based on observation constitute the quantitative part of the study.

### Research Sample

Within the scope of this study, a questionnaire was applied to the students enrolled in the 2020–2021 spring semester design studio course. A structured online survey was used because of its ease of data collection and access to large audiences. The questionnaire was applied to 3rd and 4th-year undergraduate architecture students because both had experienced the face-to-face learning environment in the past and they experienced the online learning environment during the lockdown. In total, of the 93 students who participated in the survey, 39 were in the 3<sup>rd</sup> grade and 54 were in the 4<sup>th</sup> grade. The sample consists of 58 female and 35 male students.

The survey was applied to students who attend online studio education due to the Covid-19 lockdown. The students had three semesters of experience in an online design studio. In addition, these students had at least 2 years of experience in face-to-face design studio. Therefore, this study measured students' holistic perspectives and behaviours based on their total experiences in face-to-face and online design studios.

### Course Structure

This study examines students' experiences from four different design studio sections, all 3<sup>rd</sup> and 4<sup>th</sup> grades. Although the content and subject of the studios change, the course structure does not differ fundamentally. The studio courses in the university where this study was conducted consist of eight studio courses in total, 12-hour courses per week, with different expectations and outcomes. In all design studio courses, students are expected to produce solutions for architectural problems of different scales. This course structure was applied in online design studios as well. Although online design studios are fundamentally similar to face-to-face design studios in the host university, there are differences in the tools and methods used.

After the Covid-19 pandemic, in the university this study was conducted, online design studios were organised through the Microsoft Teams platform. Microsoft Teams is an online platform allowing students and teachers to meet and discuss through synchronous lessons. This platform enabled students and instructors to transmit audio and video, share files and screens, establish dialogue, and exchange ideas. On the other hand, it is possible to share files between students and teachers, upload jury and final projects, share examples, and communicate asynchronously by commenting on each other's projects. It also allowed students to follow the course recordings after the lesson.

Students at the host university preferred digital programs such as AutoCAD, Archicad, Google SketchUp, Rhino, Revit, Lumion, Adobe Photoshop for modelling and drawing, apart from the Microsoft Teams platform. In addition, while google drive was used for sharing the large-size file, WhatsApp group was preferred for instant communication and example sharing between instructors and students, and extracurricular feedback was provided via e-mail. It has been determined that the use of techniques such as hand sketching and physical modelling, which are widely used in face-to-face design studio, is infrequent in the online design studio. The reasons for this situation are that it is difficult for students to communicate through these tools on the online platform and the limited access to materials for physical modelling and hand sketching during the pandemic.

While the studio duration remains the same in face-to-face and online design studios, the hours that students will receive feedback are predetermined in order to facilitate the operation in the online design studio. Besides, while instructors generally use the hand sketching method when giving feedback in face-to-face design studios, this situation has also changed with the transition to online platforms. Instructors started to make instant interventions through 3D programs and continued to give feedback with hand sketching using digital tablets. Online design studios have also affected the way instructors give feedback to students. As well as the online critiques, the juries were held online without any change in their schedule. The online jury provides an advantage as it allows the participation of instructors from different countries or universities. In addition, the possibility of recording the jury sessions and watching them later also contributes to the students.

Considering the design studio as a social environment, it was not sufficient to transfer the social component of the studio to the online environment. Students used tools such as e-mail, Discord, Zoom, Google Docs, and social media channels for reciprocal interaction and online collaboration outside of class hours to support the social structure of the studio.

### Research Instruments

A questionnaire based on literature analysis was designed to measure the effect of learning environment changes on student behaviour in the architectural design studio. The questionnaire was designed to consist of a self-reported survey and open-ended questions. Behaviour change resulting from a change in the learning environment is a parameter that can be measured by individuals' self-evaluation. For this reason, the issues that cause behavioural changes were determined, presented to the students in sets of questions, and they were expected to be evaluated by scoring in the questionnaire. In this way, it is possible to evaluate the subjects for which behaviour change is

expected in a comparative and qualitative manner. In addition, open-ended questions provide more general data on learning practice and behaviour change. It provides the opportunity to obtain the change in the general structure of the studio with the observations of the students.

The self-reported survey which includes 25 statements, consists of six sets of questions (Table 1). These are peer learning, socially mediated learning, self-efficacy, self-regulation, motivation and communication with the instructor. Each statement was asked to be evaluated for face-to-face and online learning environments. Student behaviour was measured using a 5-point Likert scale ranging from "strongly disagree" to "strongly agree" in order to compare face-to-face studios and online studios.

The concepts of peer learning and socially mediated learning as the main dimensions were determined by quoting from Vygotsky (1978), and the notions of self-efficacy, self-regulation, motivation and communication with the instructor by quoting from Schunk (2012) while constructing the questionnaire. The 25 items from this survey were adapted from various studies (Cho & Cho, 2014; Fleischmann, 2020a; Grover & Wright, 2020; Alnusairat et al., 2021; Ceylan et al., 2021). Appropriate expressions were selected from these studies, these items were classified according to the determined categories, and a self-report questionnaire was created by adding the necessary items.

Each of the question sets in the self-reported survey measures a different kind of behaviour. While self-efficacy, self-regulation and motivation question students' individual learning practices and behaviours, peer learning, socially mediated learning and communication with the instructor give information about behaviour change in collaboration and interactive learning. Since the architectural design studio is a learning environment where the student learns both individually and collaboratively, it is important to continue the questionnaire in two different directions.

Cronbach alpha, which gives a reliability scale, was calculated to evaluate whether the questions and statements had internal consistency. For the general satisfaction scale of 25 items, Cronbach alpha was measured as 0.891 in the face-to-face learning environment and 0.924 in the online learning environment (Table 2). This shows that the items form a scale with good internal consistency and reliability.

For the second phase, three open-ended questions were asked in order to get the general ideas of the students about the architectural design studio and to investigate the communication and collaboration methods in online education. Open-ended questions allow one to obtain data from a wider perspective without limiting the person. In this study, open-ended questions were asked to acquire observations from the students about the design studio beyond the determined sets of questions.

**Table 1.** Structure of questionnaire

Dimensions	Questions
Peer Learning	PL1. I know the projects/designs of my classmates
	PL2. I know the projects/designs of students in other sections/years
	PL3. I can get ideas from other students
	PL4. I think group work is easy
	PL5. I have face-to-face communication with my classmates for group works
Socially Mediated Learning	SML1. I have social contact with my classmates
	SML2. I have social contact with students in other sections/years
	SML3. I work together with my classmates for assignments and juries
Self-Efficacy	SE1. I think learning experience is well designed
	SE2. I can design successful and creative projects
	SE3. I think design course and assignments are difficult
	SE4. My workload is too much
	SE5. I use time efficiently during my design studies
Self-Regulation	SR1. I can clearly express my design ideas
	SR2. I have the opportunity to improve my software (CAD, Photoshop, etc.) skills
	SR3. I have the opportunity to improve my hand sketching skills
	SR4. I have the opportunity to improve my physical model making skills
Motivation	M1. I can easily focus while the instructor gives feedback
	M2. I have no problem with understanding learning contents, materials, requirements, instructions, etc.
	M3. I can achieve learning outcomes/objectives of design course
	M4. I attend all course hours of design studio
Communication with the instructor	C1. I can easily reach instructors and communicate with them during studio hours
	C2. I can easily reach instructors and communicate with them out of studio hours
	C3. I can easily interact with professionals and instructors out-of-university
	C4. I feel comfortable with sharing my design projects during studio and juries

**Table 2.** Cronbach's alpha analysis

	Cronbach's Alpha	Number of Items
Face-to-Face	0.891	25
Online	0.924	25

### Data Analysis

This study measures students' perspectives and behavioural changes based on students' holistic experiences in face-to-face and online design studios and presents a comparison of these two different studio environments. While conducting the study, students were asked to rate each statement for the face-to-face and online studio using a 5-point Likert scale. Student behaviours and perceptions in face-to-face and online environments are evaluated by examining the data of the survey participants. A paired sample t-test method was used by transferring the data to SPSS to evaluate the students' responses to the six dimensions (peer learning,

socially mediated learning, self-efficacy, self-regulation, motivation, and communication with the instructor) and to compare the face-to-face and online learning according to these dimensions. Since the same questions were used for both behavioural conditions, a paired sample t-test was used to investigate whether there are statistically significant differences among the predefined categories in the face-to-face and online studio.

### RESEARCH FINDINGS AND DISCUSSION

The design studio education, which was intensively conducted face-to-face until the Covid-19 pandemic, was changed due to mandatory conditions. During this process, students and instructors learned to use new interfaces, developed new methods and gained new communication skills. The rapid transformation, which was mandatory due to the pandemic, required adaptation to the new process. The comparison of the face-to-face and online studio experience in this study



shows that students and instructors adapt more easily to some themes, while they adapt more difficult to others.

Design studio differs from other courses with its unique pedagogical approaches and differences in the learning process. The change in the design studio environments, which are based on communication and cooperation and where learning continues in a social environment, directly affects the structure of learning and the student's behaviour. The results of this study revealed that there are significant differences in student behaviour between face-to-face and online design studios.

The survey outcomes addressed the mean differences in students' perceptions of face-to-face and online studio and their behaviours in these environments. Student behaviours in two different environments were compared over the categories of peer learning, socially mediated learning, self-efficacy, self-regulation, motivation, and communication with the instructor. Comparison results are presented in Table 3. While each theme was analysed under a separate heading according to the differences in the learning environment, it was evaluated by making use of the course structure and theoretical framework, as well as the survey results.

**Table 3.** A paired sample t-test between face-to-face and online studio

	Face-to-Face		Online		t	Sig (2-tailed)
	M	SD	M	SD		
<b>Peer Learning</b>	<b>3.78</b>	<b>0.72</b>	<b>2.56</b>	<b>0.84</b>	<b>8.67</b>	<b>0.000</b>
PL1	3.94	0.96	3.04	1.20	4.48	0.000
PL2	3.55	1.09	1.90	1.06	9.34	0.000
PL3	3.86	1.07	2.66	1.22	6.07	0.000
PL4	3.45	1.07	2.66	1.42	4.17	0.000
PL5	4.11	0.94	2.53	1.16	9.20	0.000
<b>Socially Mediated Learning</b>	<b>4.14</b>	<b>0.60</b>	<b>2.27</b>	<b>0.91</b>	<b>14.08</b>	<b>0.000</b>
SML1	4.40	0.66	2.45	1.07	13.70	0.000
SML2	3.88	0.97	1.91	0.92	13.61	0.000
SML3	4.13	0.92	2.45	1.22	9.58	0.000
<b>Self-Efficacy</b>	<b>3.80</b>	<b>0.43</b>	<b>3.27</b>	<b>0.67</b>	<b>6.32</b>	<b>0.000</b>
SE1	3.75	0.90	2.44	1.04	8.99	0.000
SE2	4.02	0.72	2.78	1.25	7.59	0.000
SE3	3.69	0.91	4.03	1.09	-2.59	0.011
SE4	3.83	0.77	4.49	0.83	-6.09	0.000
SE5	3.71	1.01	2.61	1.34	6.13	0.000
<b>Self-Regulation</b>	<b>3.92</b>	<b>0.56</b>	<b>2.63</b>	<b>0.83</b>	<b>11.59</b>	<b>0.000</b>
SR1	3.95	0.68	2.67	1.20	8.62	0.000
SR2	3.67	0.78	3.74	1.04	-0.55	0.584
SR3	3.91	0.80	2.28	1.09	10.98	0.000
SR4	4.16	0.77	1.85	1.16	13.86	0.000
<b>Motivation</b>	<b>4.03</b>	<b>0.55</b>	<b>2.96</b>	<b>0.98</b>	<b>8.99</b>	<b>0.000</b>
M1	4.12	0.75	2.75	1.25	7.90	0.000
M2	3.88	0.81	2.68	1.22	8.06	0.000
M3	3.92	0.63	3.05	1.08	6.95	0.000
M4	4.19	0.68	3.34	1.29	5.96	0.000
<b>Communication with the instructor</b>	<b>3.63</b>	<b>0.66</b>	<b>3.18</b>	<b>0.96</b>	<b>3.30</b>	<b>0.001</b>
C1	4.22	0.67	3.46	1.21	5.09	0.000
C2	3.62	0.93	3.46	1.13	0.93	0.356
C3	3.06	0.93	3.06	1.17	0.00	1.000
C4	3.60	1.10	2.75	1.38	4.60	0.000

### Peer Learning

A paired sample t-test on peer learning reveals significant differences between face-to-face (M: 3.78, SD: 0.72) and online learning environments (M: 2.56, SD: 0.84). According to the survey results, it is observed that one of the most significant differences between face-to-face and online studios emerged in the dimension of peer learning. The most important reason for that may be the difficulty of adapting the social structure of the studio to the online environment. Many studies (George, 2017; Wragg, 2019; Fleischmann, 2020a; Iranmanesh & Onur, 2021) also claim that the difficulty of transferring the social component of the studio to the online environment negatively affects online learning.

Peer learning is measured by knowing the projects/designs of classmates (face-to-face M:3.94 SD:0.96, online M:3.04 SD:1.20), knowing the projects/designs of students in other sections/years (face-to-face M:3.55 SD:1.09, online M:1.90 SD:1.06), getting ideas from other students (face-to-face M:3.86 SD:1.07, online M:2.66 SD:1.22), thoughts about group work (face-to-face M:3.45 SD:1.07, online M:2.66 SD:1.42), and communication with classmates for group works (face-to-face M:4.11 SD:0.94, online M:2.53 SD:1.16). Based on the survey results, it can be deduced that the low level of communication between students in the online studio, the decrease in the time they spend together, and the lack of common working environments negatively affect the social learning process and peer learning. Due to the fact that informal interaction and spontaneous encounters between students are less in online studios than in face-to-face studios, peer-to-peer dialogue, learning experience and environments for communication might be insufficient.

Likewise, it can be concluded that another reason for the less positive perception of peer learning is the nature of the online environment. While students can meet and discuss easily and sometimes spontaneously in a face-to-face environment, certain conditions must be completed beforehand, such as organising meetings in order to create a discussion environment in an online platform. This process can be challenging for students with less online experience. In fact, online platforms have the potential to allow students to communicate without time constraints and openly share their ideas and comment on each other's projects, thanks to asynchronous interaction. However, it is observed from the survey results that students are not familiar with the online platforms and tools required by the post-pandemic mandatory conditions, which makes peer-to-peer interaction and sharing of ideas difficult. Because of this, the online studio is perceived as less efficient than the face-to-face studio. Besides, spending a long time to understand the structure of the platforms, and the inability to use the platforms beneficially negatively affects peer learning.

The results of the open-ended questions show that students use additional tools besides Microsoft Teams to support peer interaction and increase collaboration in the online studio. Students stated that they frequently use social media channels (54%) and e-mail (45%) for extracurricular collaboration and group work. Many studies (Pektaş, 2015; Fleischmann, 2020a) claim that social media platforms have a supporting role in online learning and online collaboration. In this study, it is one of the results that social media tools are widely preferred by students for online collaboration. Due to the nature of the online studio, it is observed in the research outcomes that a single platform is insufficient for cooperation and that different tools should be used for different purposes.

### Socially Mediated Learning

A paired sample t-test on socially mediated learning shows significant differences between face-to-face and online learning. This study shows that the socially mediated learning dimension has the highest mean value (M: 4.14, SD: 0.60) in the face-to-face environment and the lowest mean value (M: 2.27, SD: 0.90) in the online environment compared to other dimensions. The results reveal that students evaluate the online environment as less effective for collaborative study than the face-to-face environment and have fewer social contacts in the online learning environment.

Socially mediated learning is examined in terms of social contact with classmates (face-to-face M:4.40 SD:0.66, online M:2.45 SD:1.07), social contact with students in other sections/years (face-to-face M:3.88 SD:0.97, online M:1.91 SD:0.92), and working with classmates (face-to-face M:4.13 SD:0.92, online M:2.45 SD:1.22). Based on these results, it can be concluded that the online design studio is insufficient in promoting social interaction between students and group work. The reason for the negative perceptions of the students in this study regarding the socially mediated learning dimension can be seen as the low level of socialisation in the online studio. While the face-to-face design studio is a social environment, it allows "unstructured and momentary activities" (Ceylan et al., 2021), the immediacy of communication and the possibility to receive direct feedback from instructors and peers (Fleischmann, 2020a). Therefore, face-to-face design studios support an interactive and social learning environment, unlike online design studios.

According to the results of open-ended questions, 86% of the students stated that they use additional tools such as social media platforms for social contact and online collaboration in order to maintain the social structure of the studio. However, the social structure of the design studio needs to be restructured in order to adapt to online environments, and online design studios have the potential to develop in this regard.

### Self-Efficacy

The results of a paired sample t-test show that the mean value differences between face-to-face learning (M: 3.80, SD: 0.43) and online learning (M: 3.27, SD: 0.67) in the self-efficacy dimension are less than the other dimensions. In other words, when evaluated in terms of self-efficacy, it is seen that face-to-face learning and online learning have similar attributes. It can be concluded that learning environment changes do not substantially affect students' self-efficacy behaviours, since self-efficacy is related to one's own cognitive capacity.

With regard to self-efficacy, a paired t-test demonstrates significant differences in the learning experience (face-to-face M:3.75 SD:0.90, online M:2.44 SD:1.04), designing successful and creative projects (face-to-face M:4.02 SD:0.72, online M:2.78 SD:1.25), workload (face-to-face M:3.83 SD:0.77, online M:4.49 SD:0.83) and time management (face-to-face M:3.71 SD:1.01, online M:2.61 SD:1.34). However, no significant differences are found in terms of the difficulty of design courses and assignments. The results show that students view the workload in online learning as higher than face-to-face learning, but they view face-to-face learning as more effective in terms of a well-designed learning experience, designing successful and creative projects, and time management. In addition, it is concluded that the change in the learning environment does not affect the perception of the students that the design courses and assignments are difficult.

According to this study, student behaviours are similar in terms of self-efficacy in online and face-to-face design studios due to the structure of the online learning environment that supports self-study. Many studies in the literature (Saghafi et al., 2012; Newman et al., 2018; Iranmanesh & Onur, 2021) also state that online learning supports self-study and self-dependent research. In the online studio, students can independently conduct their work, without the time and place restrictions. They can also improve their learning experience with the opportunity to rewatch jury and critique recordings. The flexible learning experience offered by the online design studio is effective in creating a positive perception in students about self-efficacy.

### Self-Regulation

A paired sample t-test on self-regulation reveals significant differences between face-to-face (M: 3.92, SD: 0.56) and online learning environments (M: 2.63, SD: 0.83). The self-regulation dimension results align with the general results because student behaviour has a lower mean value in the online environment than in the face-to-face environment.

Regarding the self-regulation dimension, a paired sample t-test show significant differences in terms of expressing design ideas (face-to-face M:3.95 SD:0.68, online M:2.67 SD:1.20), improving hand-sketching skills (face-to-face

M:3.91 SD:0.80, online M:2.28 SD:1.09), and improving physical model-making skills (face-to-face M:4.16 SD:0.77, online M:1.85 SD:1.16). However, no significant differences are found between face-to-face and online studios in improving software skills. Based on these outcomes, it can be concluded that while students actively use communication tools such as physical model-making and hand-sketching in the face-to-face studio, these methods cannot be transferred into the online environment during the rapid transition. On the other hand, it can be stated that digital tools are widely used since the communication in the online studio is based on technology-based tools, and therefore the students' software skills increase.

In the online design studio, using 3D models instead of physical models and CAD programs instead of hand drawing allows students to develop their software skills. However, physical model-making and hand-sketching methods are also essential tools in the development of students' perception of space. Since not using these tools in design education will cause negative results in design learning, adapting sketching and physical model-making to the online environment will be necessary for the success of online design studios. In the literature, there are thoughts that the future design of online studios where hand sketching and physical model making will be used more actively will benefit architectural education (Ceylan et al., 2021).

### Motivation

In the motivation dimension, it is noteworthy that there is a big gap between face-to-face and online learning environments. The mean value in the face-to-face studio is M: 4.03, SD: 0.55, and the mean value in the online studio is only M: 2.96, SD: 0.98. The survey results show that the students have difficulties adapting to the online design studio in terms of motivation dimension. The most important reason for that may be attributed to the student's experience of the online studio as a "transitional emergency model" (Salama & Crosbie, 2020) due to the Covid-19 pandemic. The rapid change in learning environments and accordingly change in tools and methods have made it difficult for students to adapt to the new system and has caused a loss of motivation. In short, it is possible to perceive the online studio negatively due to the lack of experience with the applications in the online learning environment and the traditional education habits that have been going on for years. Similarly, it is claimed that students who have previously experienced online studios have a more positive perception of online collaboration in Cho & Cho's (2014) study.

Motivation is measured in terms of focusing while the instructor gives feedback (face-to-face M:4.12 SD:0.75, online M:2.75 SD:1.25), understanding learning contents, materials, requirements, instructions (face-to-face M:3.88 SD:0.81, online M:2.68 SD:1.22), achieving learning outcomes/objectives (face-to-face M:3.92 SD:0.63, online

M:3.05 SD:1.08) and student attendance (face-to-face M:4.19 SD:0.68, online M:3.34 SD:1.29). According to the results, it is seen that the students evaluate the online learning environment as inadequate compared to the face-to-face environment in terms of understanding the learning content and obtaining the learning outcomes, and they do not prefer the online environment when receiving feedback from the instructor. In the face-to-face studio at the university where this study was conducted, students are encouraged to stay in the studio all day, listen to peers' feedback and participate in the discussion. However, based on the survey results, it is stated that participation and motivation are lower in the online studio. The fact that each student has the assigned time for critiques and the difficulty of collaboration and discussion on online platforms can be explained as the reasons for lower motivation.

In fact, the online design studio has the potential to increase student motivation. The possibility of recording and re-watching synchronous sessions, uploading all course materials, presentations to the Microsoft Teams system, communicating with the instructor during out-of-studio hours allow students to adapt to the studio and contribute positively to student motivation. Rather than setting time for each student, adapting architectural education pedagogies to the online environment and creating a learning environment, where students discuss together can improve students' motivation in the online design studio.

### Communication with the Instructor

The results of a paired sample t-test on communication with the instructor indicate the least mean value differences between face-to-face (M: 3.63 SD: 0.66) and online learning environment (M: 3.19 SD: 0.96). The survey results reveal that there is not much difference between the two different learning environments in terms of communication with the instructor. Since the online studio and the face-to-face studio have different potentials to communicate with the teacher, it can be deduced that the dimension of communication with the instructor is one of the easily adapted themes in the transition to the online studio.

With regard to communication with the instructor, a paired sample t-test show significant differences in reaching instructors during studio hours (face-to-face M: 4.22 SD: 0.67, online M: 3.46 SD: 1.21) and feeling comfortable with sharing design projects during studio and jury (face-to-face M: 3.60 SD: 1.10, online M: 2.75 SD: 1.38). However, no significant differences are found between face-to-face and online studios in reaching instructors during the non-studio hours (face-to-face M: 3.62 SD: 0.93, online M: 3.46 SD: 1.13) and interacting with professionals and instructors out-of-university (face-to-face M: 3.06 SD: 0.93, online M: 3.06 SD: 1.17). The results reveal that students prefer the face-to-face studio rather than the online studio to share their design ideas comfortably and receive feedback during

studio hours. One of the reasons for this may be that students cannot express themselves adequately and cannot directly observe the instructor's reactions due to the limitations of the online environment. In addition, although 67% of the students prefer the manual sketching feedback according to the results of the open-ended questions, the limitation of the feedback method in the online studio increases the students' negative perceptions. Similarly to this research, many studies (Howland & Moore, 2002; Vonderwell, 2003) in the literature emphasise that students' satisfaction with the online learning environment is directly related to constructive communication with the instructor.

Nevertheless, based on the survey results, it is concluded that the opportunity to reach the instructor during non-studio hours and the opportunity to communicate with professionals from out of the university in the online design studio positively affect the perception of the students. It is observed that online studio positively affects student performance by providing students with time flexibility to communicate and work with the instructor, the opportunity for extracurricular feedback via e-mail and sharing of examples via WhatsApp. In addition, inviting architects and educators from different institutions to the sessions and juries of the online studio at the university where this study was conducted offers students the opportunity to get ideas from professionals they would not usually reach.

Moreover, it has been observed that students who are not familiar with the tools and dialogue style of the online design studio initially had a negative perception of the online learning environment. Therefore, instructors have a great responsibility to overcome the limiting factors of the online environment through actions such as involving students in online education and increasing reciprocal interaction with students. Changing the way of feedback to students and starting to use new tools and methods specific to the online platform, such as digital tablets and extra cameras enable improved communication with the instructor in the online design studio.

### CONCLUSION

The structure, learning methods, pedagogies and learning environments of the design studio are constantly changing and evolving. The rapid and unplanned transition from traditional teaching methods to online platforms due to the Covid-19 pandemic has brought along inquiries about architectural education. This article focuses on the comparison of students' perceptions and behavioural changes in face-to-face and online studios. These comparisons and evaluations of previous studies can form a basis for future studies on design education by revealing the potential and challenges of face-to-face and online studios.

This study shows that the most important potentials of the

online studio are that offers a flexible learning environment, has no time and place restrictions, allows for cross-cultural and inter-institutional collaboration, and supports self-study. On the other hand, it is revealed that students have difficulties adapting to the online studio in terms of social interaction, peer learning, group collaboration, and instant feedback from the instructor. Although the traditional design studio is thought to have a face-to-face pedagogical framework, it has completely shifted to digital platforms during the pandemic. The online studio experiences gained during the pandemic period can present an opportunity to create flexible and blended learning environments by adding online features to the traditional face-to-face studio.

Blended learning environments can be created with a holistic perspective of the design studio, by evaluating learning methods, tools and platforms, communication techniques and adapting them to face-to-face and online learning environments. The blended learning environment has also been discussed in the context of architectural design studios in recent years, and many studies (Fleischmann, 2020a, b; Ceylan et al., 2021; Fleischmann, 2021; Megahed & Hassan, 2021; Varma & Jafri, 2021) are conducted on this subject. The blended studio pedagogy, which will be designed considering the potential of the face-to-face and online studios, will include the advantages of both studio experiences.

This study has some limitations regarding the sample group, as it only reflects students' perspectives in a single university. For future studies, it is essential to use a larger sample group from different universities to obtain more detailed results. In addition, the educators' experiences and perspectives about the learning environment of the design studio are among the factors that will contribute to further studies.

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