

Research Paper

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Success Factors in Online Architectural Education: Comprehensive Analysis of Digital Learning Platforms

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Abstract: In recent years, the online education system (OES) has been actively used at all educational levels for various reasons, becoming a lasting element of education. Identifying critical success factors for effective online architectural education (OAE) is essential for educational sustainability. This study aimed to pinpoint these success factors and identify an appropriate digital platform to uphold education quality. A mixed-methods approach, incorporating both qualitative and quantitative techniques, was utilised. A systematic literature review (SLR) identified 69 success criteria (SCs). A survey was conducted with 232 architecture students in Turkey, and the data were analysed quantitatively. This research comprehensively quantified transition process-related SCs impacting OAE, categorising them by scope and impact and uncovering their sub-dimensions. The study also calculated effect sizes and determined the significance levels of these factors. It explored the relationship between these factors influencing the success of OAE and digital platforms, while examining the correlation between course types and these platforms.

Keywords: architectural education, online education, online learning, digital platforms

1 Introduction

Architectural education (AE) has traditionally focused on hands-on, experiential learning, setting it apart from

other disciplines. Recently, however, there has been a shift to online education system (OES), which challenges the fundamental nature of AE. OES has resulted in more passive learning, thereby hindering student progress in AE. Consequently, the effectiveness and sustainability of online architectural education (OAE) have been questioned due to these challenges.

Despite the persistence of traditional education, OES has become a permanent fixture in higher education. Therefore, it is essential to understand OAE and choose suitable methods and platforms tailored to its unique characteristics. Identifying success factors for OAE is critical for its sustainability.

Previous research in this domain has mainly concentrated on architecture students' satisfaction with OAE, tackling transition challenges, proposing guidelines, investigating the role of virtual reality (VR) in education and identifying obstacles to OAE adoption (Alkhalil et al. 2021; Al Maani et al. 2021; Alnusairat et al. 2021; Asadpour 2021; Ceylan et al. 2021a; Dennis 2021; Elrawy and Abouelmagd 2021; Koh and Wong 2021; Komarzyńska-Świeściak et al. 2021; Leon et al. 2021; Peimani and Kamalipour 2021a; Wu et al. 2021; Bakir and Alsaadani 2022; Tandon et al. 2022; Xi and Cong 2022; Güler 2023). However, these studies have overlooked critical success factors which impede the development of sustainable strategies for OAE. Assessing the appropriateness of digital platforms for OAE in architecture schools is crucial. This study aims to identify success criteria (SCs), compare digital platforms across various variables and provide recommendations to enhance OAE's and AE's sustainability.

The current study is unique as it evaluates the success of OAE and digital platforms in both theoretical and practical courses, prioritises SCs, compares digital platforms and examines the impact of various factors on these platforms, thereby addressing a significant research gap.

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2 The significance of the study and the literature gap

Architecture schools are rapidly transitioning to OES utilising university resources, resulting in diverse approaches among institutions. While the swift shift to OES has provided some benefits, it has also introduced challenges that must be addressed to ensure equality in education, especially in developing countries like Turkey.

The worldwide adoption of OES at various educational levels has prompted extensive research into its effects on educational methodologies. This global shift has captured the interest of researchers, resulting in numerous studies examining aspects of OAE.

Many studies in the current literature have primarily focused on the impact of the transition on OAE (Al Maani et al. 2021; Alnusairat et al. 2021; Asadpour 2021; Ceylan et al. 2021a; Mayer 2021; Scatena et al. 2021; Metinal and Gumusburun Ayalp 2022; Nubani and Lee 2022). These studies show that technological, psychological, pedagogical, economic and interactional factors significantly influence the success of OAE (Al Maani et al. 2021; Alnusairat et al. 2021; Asadpour 2021; Scatena et al. 2021; Bakir and Alsaadani 2022; Khan and Thilagam 2022; Nubani and Lee 2022; Travis 2022). The choice of the digital platform is crucial for OAE, as teaching effectiveness depends on the platform's features (Ferng 2020; Varma and Jafri 2021; Yu et al. 2022). Therefore, selecting the appropriate digital platform is essential for optimising OAE effectiveness.

Researchers have explored numerous facets of OAE. These include course quality (Tang et al. 2021), student satisfaction (Alkhalil et al. 2021; Alnusairat et al. 2021), changes in AE due to the transition (Elrawy and Abouelmagd 2021), architectural design communication in AE (Akçay Kavakoğlu et al. 2022) and student perceptions and experiences in the context of OAE (Al Maani et al. 2021; Komarzyńska-świeściak et al. 2021; Peimani and Kamalipour 2021a).

Moreover, several scholars have examined architecture students' assessments of online design studios (Andiyan et al. 2021; Ceylan et al. 2021a) and recommended pedagogical frameworks for online architectural studios (Khan and Thilagam 2021). Additionally, studies have highlighted key drivers, challenges and facilitators for OAE (Khan and Thilagam 2022; Tandon et al. 2022).

Endeavours to tackle challenges in OAE include developing video-based VR approaches for online design courses (Wu et al. 2021), introducing new teaching methods and curriculum enhancements (Milovanović et al. 2020), digitally adapting building information modelling and

communication technologies (Leon et al. 2021), and mapping students' strategies for digital well-being in OAE (Dennis 2021).

Although previous studies on OAE provide valuable insights, they typically focus on quantitative or qualitative analyses using specific methodologies. Quantitative analyses encompass descriptive statistics and correlation analysis (Alnusairat et al. 2021; Koh and Wong 2021; Varma and Jafri 2021; Peimani and Kamalipour 2022; Güler 2023), exploratory factor analysis (Asadpour 2021), structural equation modelling (Akçay Kavakoğlu et al. 2022; Tandon et al. 2022; Metinal and Gumusburun Ayalp 2024) and analytic hierarchy process (Tang et al. 2021). Qualitative analyses include experimental studies (Wu et al. 2021), semi-structured interviews (Megahed and Hassan 2022; Yu et al. 2022) and focus group interviews (Ibrahim et al. 2021).

While these studies provide a range of insights into OAE, they often need to pay more attention to critical questions regarding OAE's success factors and the appropriateness of digital platforms. This research addresses these gaps by identifying SCs through a systematic literature review (SLR), analysing their association with digital platforms via variance analysis, and assessing their impact on OAE success using eta-squared analysis. Furthermore, it examines the relationship between architectural course types in OAE and the digital platforms used. This inclusive approach is designed to guide strategic planning for sustainable AE.

Similar to previous studies, this research employed an online survey. However, it differed from earlier work by basing the survey questions on an SLR, which ensured greater objectivity. Additionally, it uniquely classified the impact of OES on AE by scope and defined critical success factors for OAE. Hypothesis testing was utilised to establish confidence intervals and examine the relationships between variables. Furthermore, eta-squared analysis was used to quantify the effect size of these factors on OAE success. This comprehensive methodology notably distinguishes this research from prior studies in the relevant literature.

3 Materials and methods

This study employed a mixed approach, integrating both qualitative and quantitative methods. The qualitative aspect is based on an SLR, while the quantitative part was conducted using statistical analysis. The adopted mixed method consists of four successive phases, as presented in Figure 1.

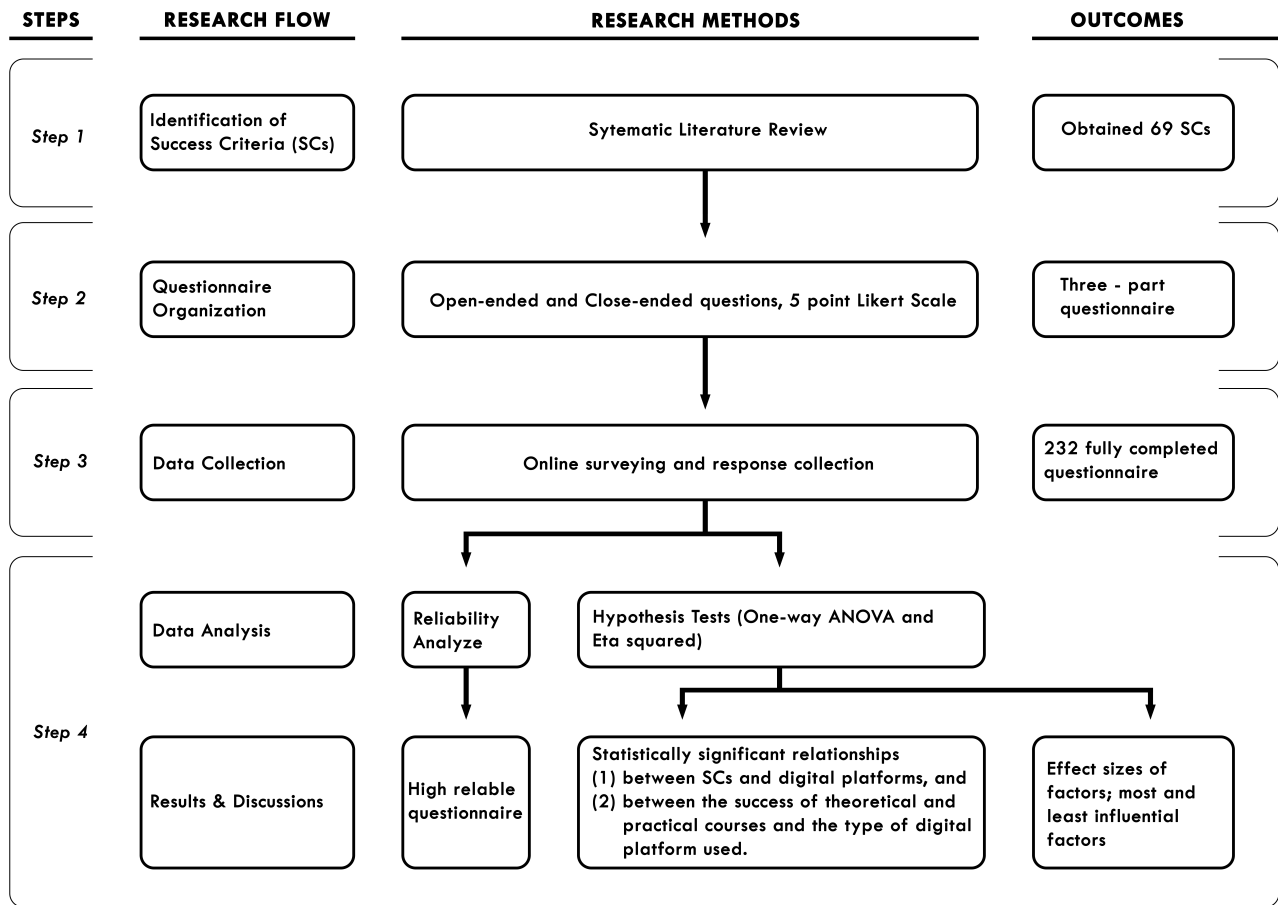


Fig. 1: Research methodology framework. SCs, success criteria.

3.1 Identification of SCs

The initial stage of the current study focused on identifying the criteria influencing the success of OAE. These potential criteria were gathered through an SLR, a method considered objective by many scholars such as Ayat et al. (2021) and Gupta et al. (2019).

Various review methods are available for analysing existing literature. The *systematic literature review* is a research technique designed to evaluate relevant literature critically and gather data in this context (Liberati et al. 2009). To ensure systematic, transparent, unbiased and reproducible data collection from the literature, this study employed the SLR method advised by Macpherson and Jones (2010), Tranfield et al. (2003), and Denyer et al. (2008). SLR is an effective method for evaluating published work in the scientific field.

This study utilised a three-step approach to determine the possible criteria, which included the stages of *identification, review, and inclusion*.

The research question was defined in the identification phase, followed by developing a review protocol.

Primary studies were identified, selected, extracted, analysed and synthesised during the review stage. The results obtained from the literature were then presented as a report in the evaluation and inclusion phase (Figure 2).

The Web of Science (WoS) database, recognised for its extensive coverage and integrated analytics (Yu et al. 2020), was utilised to identify relevant studies. The search query applied in the WoS database was: (ALL FIELDS) ‘architectural education’ AND (‘online learning’ OR ‘distance education’ OR ‘distance learning’ OR ‘online education’), yielding 465 records. The search was restricted to English-language articles and review papers published in academic journals, deliberately excluding conference papers due to concerns about peer-review quality.

After duplicates were removed, 464 articles were evaluated. Additional filtering based on specific parameters, such as field (AE), publication language (English) and publication type, excluded 79 records. Well-defined inclusion and exclusion criteria were implemented, and all studies were reviewed in full text. This process resulted in the selection of 44 articles.

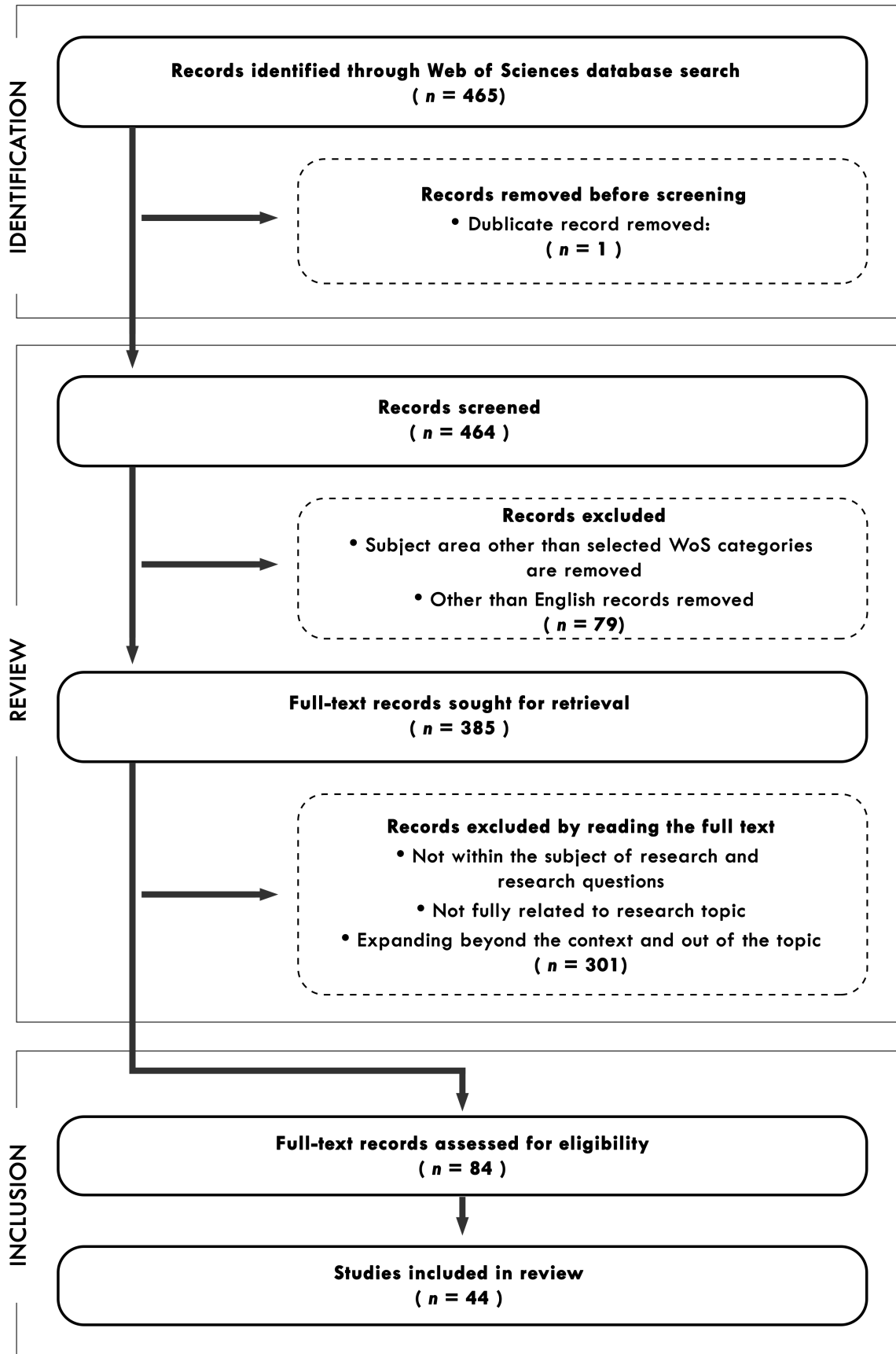


Fig. 2: Flow diagram of the research protocol within the scope of SLR. SLR, systematic literature review.

These studies served as the foundation for developing a questionnaire. A detailed analysis led to the identification of 69 SCs influencing the success of OES in AE. These SCs were classified into seven main categories: ‘technical and technological infrastructure’; ‘health and psychology’; ‘pedagogy’; ‘interaction, satisfaction and communication’; ‘educational adaptation’; ‘economic factors’; and ‘other factors’, according to their characteristics, focus, scope and nature.

In determining the factors and categorising the SCs, the areas of impact of the defined items were considered. The 69 SCs directly related to these seven factors are detailed in Table 1.

3.2 Organising the questionnaire

A questionnaire derived from the SLR findings was administered to architecture students studying at universities in Turkey. It consisted of two sections.

The first section involved evaluating 69 SCs outlined in Table 1, categorised as follows: 11 for technical and technological infrastructure (TT), 12 for health and psychology (HP), 9 for pedagogy, 10 for interaction, communication and satisfaction (ICS), 22 for educational adaptation (EA), 3 for economic factors (EF) and 2 for other factors (OF). Participants rated the importance of these SCs using a five-point Likert-type scale, ranging from 1 (‘None’) to 5 (‘Very Highly’), based on their OAE experiences and expectations.

The second section gathered sociodemographic information from the participants, such as age, gender, education level and university type.

3.3 Data collection

The current study focused on architecture students in Turkey who had taken theoretical and design courses online. The sample included students with more than one semester of online course experience. Data were collected through online questionnaires.

Turkey has 118 architecture departments within 208 universities. Researchers obtained permission from 118 universities to distribute the questionnaire to their architecture students. Data were gathered from 20 architecture departments from those that granted permission between 30 April and 28 June 2022. The questionnaire was emailed to 2,258 architecture students who had completed at least one semester entirely through OES.

A total of 232 fully completed questionnaires were received, representing a response rate of 10.27%. Response

rates for web surveys tend to be lower than traditional mail surveys (Crawford et al. 2001). However, according to Iacobucci (2010), sample sizes ranging from 50 to 100 can be sufficient, and the conventional rule of requiring at least 200 samples is considered ‘conservative’ and ‘simplistic’. This study’s 232 fully completed responses are deemed adequate within this context.

3.4 Data analysis

Participant responses were analysed using the IBM Statistical Package for Social Sciences (SPSS) 26.0 software, incorporating various statistical tests such as normality tests, reliability analysis, one-way ANOVA and eta-squared.

Reliability analysis was conducted to evaluate the internal consistency of the questionnaire, following guidelines by Nunnally and Bernstein (2007). Cronbach’s alpha coefficient, which ranges from 0 to 1, was used to measure internal consistency, with a threshold of 0.7 considered acceptable for reliability (Cronbach 1951; Taber 2018).

Data normality was assessed to determine the appropriateness of parametric or non-parametric statistical methods. Skewness and kurtosis values were calculated to evaluate data distribution, with values within the range of -3 to $+3$ accepted as indicative of normal distribution.

Hypothesis tests were performed to examine potential statistically significant relationships in two areas of OAE: first, between SCs and the digital platforms used, and second, between the success of theoretical and practical courses and the type of digital platform employed. Various factors, including demographic variables, psycho-social profiles, course types, accessibility of requirements and digital platform features, influence OAE’s success. While demographic characteristics are not modifiable, selecting the appropriate digital platform for OAE is feasible. The current study aimed to identify a suitable platform for AE based on its structure and characteristics using hypothesis tests.

Given the normal distribution of data, the parametric one-way ANOVA was employed to analyse group means and determine whether statistically significant differences existed among groups. The Tukey Honestly Significant Difference (HSD) post-hoc test was applied to identify significant differences between group means.

Finally, effect size analysis quantified the proportion of variance in the dependent variable explained by the independent variable through eta-squared (η^2). Effect size measures the significance and strength of observed effects, ranging from 0.00 to 1.00, with interpretations as follows: small effect (0.01–0.06), medium effect (0.06–0.14) and

Tab. 1: Criteria that affect the success of OAE

Factors	Code of SC	SCs	Source
TT	T1	Lack of an adequate technical background to solve networking and software-related issues	Koenig and Schneider (2019), Muilenburg and Berge (2005), Newman et al. (2018) and Nubani and Lee (2022)
	T2	Technical issues	Bakir and Alsaadani (2022), Brzezicki (2020), Megahed and Hassan (2022) and Peimani and Kamalipour (2021b)
	T3	Lack of fast and stable Internet connection	Alnusairat et al. (2021), Bakir and Alsaadani (2022), Bhandari et al. (2020), Brzezicki (2020), Headley et al. (2015), Ibrahim et al. (2021), Jimenez-Vicario et al. (2022), Khan and Thilagam (2022), Miller (2001), Milovanović et al. (2020), Muilenburg and Berge (2005) and Peimani and Kamalipour (2021b, 2021a)
	T4	Opportunity to access recorded lectures and juries at any time	Al Maani et al. (2021), Alnusairat et al. (2021), Bakir and Alsaadani (2022), Ceylan et al. (2021a), George (2018), Iranmanesh and Onur (2021), Newman et al. (2018) and Peimani and Kamalipour (2021b)
	T5	Low-screen resolution quality - The screen resolution makes it difficult to see the design work in detail	da Silveira (2008), Miller (2001) and Sahuc (2021)
	T6	Flexibility to run the applications on a variety of devices (e.g. mobile devices, tablets and laptops)	Alnusairat et al. (2021), Jimenez-Vicario et al. (2022) and Scatena et al. (2021)
TT	T7	The emergence of cyber security risks	Koenig and Schneider (2019), Mayer (2021), Peimani and Kamalipour (2021b) and Schwarz et al. (2020)
	T8	Insufficient screen resolution to accurately display and critique scaled drawings	Brzezicki (2020), da Silveira (2008) and Sahuc (2021)
	T9	Lack of the possibility of drawing or sketching on the screen; difficulties with using the mouse for sketching	Akçay Kavakoğlu et al. (2022), Bakir and Alsaadani (2022), Brzezicki (2020) and Sahuc (2021)
	T10	Issues with the availability of up-to-date and appropriate hardware and software platforms	Akçay Kavakoğlu et al. (2022), Khan and Thilagam (2022), Koenig and Schneider (2019), Mayer (2021), Milovanović et al. (2020), Muilenburg and Berge (2005), Nubani and Lee (2022), Peimani and Kamalipour (2021a), Sahuc (2021), Tandon et al. (2022) and Varma and Jafri (2021)
	T11	The need for user-friendly interfaces and applications to make e-learning easy	Alnusairat et al. (2021), Koenig and Schneider (2019) and Tandon et al. (2022)
HP	HP1	Lack of guidance and support	Al Maani et al. (2021), Alnusairat et al. (2021), Asadpour (2021), Bakir and Alsaadani (2022), Mayer (2021) and Travis (2022)
	HP2	Lack of privacy (felt by both teachers and students)	Asadpour (2021), Bakir and Alsaadani (2022), Becker et al. (2013), Ibrahim et al. (2021) and Koenig and Schneider (2019)
	HP3	Time and workload management (i.e. an increase in the number of tasks)	Alnusairat et al. (2021), Bakir and Alsaadani (2022), Bhandari et al. (2020), Ibrahim et al. (2021) and, Varma and Jafri (2021)
	HP4	Increased sense of isolation and disconnection from peers and colleagues	Bakir and Alsaadani (2022), George (2018), Megahed and Hassan (2022), Muilenburg and Berge (2005), Nubani and Lee (2022) and Sahuc (2021)
	HP5	Psychological problems/negative feelings that could lead to alienation, uncertainty, confusion and identity loss	Al Maani et al. (2021), Alnusairat et al. (2021), Ceylan et al. (2021a), Ibrahim et al. (2021), Megahed and Hassan (2022), Nubani and Lee (2022), Peimani and Kamalipour (2021a) and Reza Saghafi et al. (2012)
	HP6	The dissolved boundaries between the work environment and home environment (i.e. struggle with establishing boundaries between work and family)	Ibrahim et al. (2021), Jimenez-Vicario et al. (2022), Megahed and Hassan (2022) and Schwarz et al. (2020)

(Continued)

Tab. 1: Continued

Factors	Code of SC	SCs	Source
HP	HP7	When feedback is delayed, students feel stress, frustration and confusion	Alnusairat et al. (2021), Bakir and Alsaadani (2022), da Silveira (2008) and Travis (2022)
	HP8	The lack of emotional connection	Akçay Kavakoğlu et al. (2022), Alnusairat et al. (2021), Bakir and Alsaadani (2022), Nubani and Lee (2022) and Senyapili and Karakaya (2009)
	HP9	Insufficiency of self-discipline and concentration issues	Bhandari et al. (2020), Peimani and Kamalipour (2021b), Tandon et al. (2022) and Varma and Jafri (2021)
	HP10	Extended working hours for instructors	Alnusairat et al. (2021), Jimenez-Vicario et al. (2022) and Megahed and Hassan (2022)
	HP11	Instructors are struggling to keep students concentrated throughout the lesson	Alatni et al. (2021), Ibrahim et al. (2021), Jimenez-Vicario et al. (2022), Mayer (2021) and Varma and Jafri (2021)
	HP12	Instructors are struggling to motivate students to ask questions	Alatni et al. (2021), Jimenez-Vicario et al. (2022), Mayer (2021) and Nubani and Lee (2022)
P	P1	Online learning enables students to customise their experience based on their learning style	Khan and Thilagam (2021), Newman et al. (2018), Nubani and Lee (2022) and Travis (2022)
	P2	Enabling students to discover their potential and develop their abilities	Alnusairat et al. (2021), Bakir and Alsaadani (2022), Shannon et al. (2013) and Travis (2022)
	P3	Students are deprived of this opportunity because the university is unable to create a campus culture and university spirit online	Mayer (2021), Nubani and Lee (2022) and Reza Saghafi et al. (2012)
	P4	It helps students realise their productive ability under suddenly changing conditions	Alnusairat et al. (2021), Ceylan et al. (2021a), Shannon et al. (2013) and Travis (2022)
	P5	Participants' designs and presentations become rather dull without facial expressions and body language	Bakir and Alsaadani (2022), Mayer (2021), Miller (2001) and Scatena et al. (2021)
	P6	Expectations from students to be more responsible for their education	Al Maani et al. (2021), Alnusairat et al. (2021), Asadpour (2021), Bakir and Alsaadani (2022), Ceylan et al. (2021a), Iranmanesh and Onur (2021), Khan and Thilagam (2022), Newman et al. (2018), Reza Saghafi et al. (2012), Soccio et al. (2021), Tandon et al. (2022) and Travis (2022)
	P7	Opportunity to improve computer skills	Alnusairat et al. (2021), Bakir and Alsaadani (2022) and Nubani and Lee (2022)
P	P8	Lack of skills to utilise devices or facilities (the need for more time and practice to use new software and applications)	Akçay Kavakoğlu et al. (2022), Alnusairat et al. (2021), Jimenez-Vicario et al. (2022) and Nubani and Lee (2022)
	P9	Instructors' inability to integrate technology or insufficient software skills (which influences the efficiency of the course)	Akçay Kavakoğlu et al. (2022), Alnusairat et al. (2021), Asadpour (2021), Khan and Thilagam (2022), Megahed and Hassan (2022), Newman et al. (2018), Reza Saghafi et al. (2012) and Varma and Jafri (2021)
ICS	ISC1	Students need help in understanding online lectures, design juries and critiques	Asadpour (2021), Bakir and Alsaadani (2022), Nubani and Lee (2022), Scatena et al. (2021), Tandon et al. (2022) and Travis (2022)
	ISC2	Lack of peer learning	Akçay Kavakoğlu et al. (2022), Al Maani et al. (2021), Mayer (2021), Megahed and Hassan (2022), Newman et al. (2018), Nubani and Lee (2022), Peimani and Kamalipour (2021a), Reza Saghafi et al. (2012), Scatena et al. (2021), Senyapili and Karakaya (2009) and Taslı-Pektas (2012)

(Continued)

Tab. 1: Continued

Factors	Code of SC	SCs	Source
	ISC3	Students are uncomfortable because they cannot view their classmates' progress and projects	Bakir and Alsaadani (2022), George (2018), Nubani and Lee (2022), Peimani and Kamalipour (2021a) and Scatena et al. (2021)
	ISC4	Lack of interaction, communication and cooperation among students	Akçay Kavakoğlu et al. (2022), Bakir and Alsaadani (2022), Becker et al. (2013), Brzezicki (2020), Masdéu and Fuses (2017), Mayer (2021), Muilenburg and Berge (2005), Nubani and Lee (2022), Peimani and Kamalipour (2021a) and Scatena et al. (2021)
	ISC5	Low interaction and communication issues among students and between students and instructors	Akçay Kavakoğlu et al. (2022), Al Maani et al. (2021), Alnusairat et al. (2021), Bakir and Alsaadani (2022), Becker et al. (2013), Brzezicki (2020), Ibrahim et al. (2021), Masdéu and Fuses (2017), Mayer (2021), Muilenburg and Berge (2005), Nubani and Lee (2022), Peimani and Kamalipour (2021a), Scatena et al. (2021), Senyapili and Karakaya (2009) and Taslı-Pektas (2012)
ICS	ISC6	The potential to collaborate with institutions and professionals all around the world	Akçay Kavakoğlu et al. (2022), da Silveira (2008), Koenig and Schneider (2019), Masdéu and Fuses (2017), Megahed and Hassan (2022), Shannon et al. (2013), Travis (2022) and Yu et al. (2022)
	ISC7	Removal of geographic barriers	Akçay Kavakoğlu et al. (2022), da Silveira (2008), Headley et al. (2015), Ibrahim et al. (2021), Khan and Thilagam (2022, 2021), Masdéu and Fuses (2017), Miller (2001), Milovanović et al. (2020), Newman et al. (2018), Peimani and Kamalipour (2021b), Sahuc (2021), Scatena et al. (2021), Schwarz et al. (2020), Senyapili and Karakaya (2009), Travis (2022) and Varma and Jafri (2021)
	ISC8	The difficulties in understanding teachers' instructions online	Al Maani et al. (2021), Alnusairat et al. (2021), Asadpour (2021), Bakir and Alsaadani (2022), Muilenburg and Berge (2005), Nubani and Lee (2022), Scatena et al. (2021), Tandon et al. (2022) and Travis (2022)
	ISC9	It increases cooperation and interaction between universities and students nationally and internationally	Akçay Kavakoğlu et al. (2022), Ibrahim et al. (2021), Kukina et al. (2016), Masdéu and Fuses (2017), Shannon et al. (2013) and Travis (2022)
	ISC10	Students' previous familiarity with the tutors positively affects lessons, projects and assignments	Asadpour (2021), Ibrahim et al. (2021) and Shannon et al. (2013)
EA	EA1	It provides convenience for students to deliver course outputs (homework, etc.) to instructors	Akçay Kavakoğlu et al. (2022), George (2018) and Vásquez De Velasco (2007)
	EA2	Working with 3D models and animations without hand sketches or physical models makes expressing design ideas difficult	Akçay Kavakoğlu et al. (2022), Al Maani et al. (2021), Bakir and Alsaadani (2022), Mayer (2021) and Sahuc (2021)
	EA3	Inadequacy of critique frequency and quantity	Al Maani et al. (2021), Alnusairat et al. (2021), Asadpour (2021), George (2018), Shannon et al. (2013) and Travis (2022)
	EA4	Student assessment issues	Jimenez-Vicario et al. (2022), Khan and Thilagam (2022), Mayer (2021), Megahed and Hassan (2022) and Tandon et al. (2022)
	EA5	Lack of immediate access to teachers' help	Bakir and Alsaadani (2022), da Silveira (2008) and Newman et al. (2018)
EA	EA6	Concerns about cheating	Deshmukh (2021), Jimenez-Vicario et al. (2022) and Newman et al. (2018)
	EA7	Providing flexibility	George (2018), Jimenez-Vicario et al. (2022), Khan and Thilagam (2022, 2021), Megahed and Hassan (2022), Newman et al. (2018), Nubani and Lee (2022), Schwarz et al. (2020), Shannon et al. (2013), Travis (2022) and Yu et al. (2022)

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Tab. 1: Continued

Factors	Code of SC	SCs	Source
	EA8	Increased time spent on lectures and design critiques	Alnusairat et al. (2021), Bakir and Alsaadani (2022), Jimenez-Vicario et al. (2022) and Megahed and Hassan (2022)
	EA9	Students are dissatisfied with the new assessment criteria adapted to online education	Al Maani et al. (2021), Jimenez-Vicario et al. (2022) and Mayer (2021)
	EA10	It allows students considerable flexibility in arranging and attending tutorials	Akçay Kavakoğlu et al. (2022), Headley et al. (2015), Jimenez-Vicario et al. (2022), Reza Saghafi et al. (2012), Shannon et al. (2013) and Varma and Jafri (2021)
	EA11	Adequate and reliable assessment tools are needed due to unsupervised exams, projects and assignments	Ibrahim et al. (2021), Jimenez-Vicario et al. (2022) and Mayer (2021)
	EA12	It allows students to take as many courses as they like within the curriculum	Schwarz et al. (2020), Tandon et al. (2022) and Travis (2022)
	EA13	It causes stereotypical designs that are far from aesthetic	Bakir and Alsaadani (2022), Mayer (2021) and Tandon et al. (2022)
	EA14	There will be a biased evaluation as the students' names are visible to the evaluators on screen while evaluating	Jimenez-Vicario et al. (2022), Khan and Thilagam (2022) and Tandon et al. (2022)
	EA15	The focus is on learning the technology rather than on the information taught	Peimani and Kamalipour (2021a), Soccio et al. (2021) and Tandon et al. (2022)
	EA16	Ability to allow an unlimited number of participants to participate in courses	George (2018), Milovanović et al. (2020) and Travis (2022)
	EA17	Unfamiliarity with quiz/exam formats	Alatni et al. (2021), Jimenez-Vicario et al. (2022) and Mayer (2021)
	EA18	Instructors need to find out whether the students understand the lesson topics and contents	Alatni et al. (2021), Jimenez-Vicario et al. (2022) and Nubani and Lee (2022)
	EA19	Instructors cannot agree among themselves on student work or reconciling grades	Alatni et al. (2021), Khan and Thilagam (2022), Mayer (2021) and Megahed and Hassan (2022)
EA	EA20	Instructors are having difficulty preparing, publishing and administering online exams	Alatni et al. (2021), Jimenez-Vicario et al. (2022) and Megahed and Hassan (2022)
	EA21	Having students' cameras turned on during online lecture sessions will significantly benefit their learning experience	Bakir and Alsaadani (2022), Nubani and Lee (2022) and Peimani and Kamalipour (2021b)
	EA22	Working with drawings and 3D models in a digital environment without an adequate hand sketch prevents the designs from reaching the expected maturity level	Akçay Kavakoğlu et al. (2022), Alnusairat et al. (2021), Bakir and Alsaadani (2022) and Mayer (2021)
EF	EF1	Lack of access to resources	Al Maani et al. (2021), Alnusairat et al. (2021), Bakir and Alsaadani (2022), Brzezicki (2020), Khan and Thilagam (2022), Koenig and Schneider (2019), Mayer (2021) and Scatena et al. (2021)
	EF2	A decrease in both the expenses for printing and its impact on the environment	Al Maani et al. (2021), Alnusairat et al. (2021), Milovanović et al. (2020), Scatena et al. (2021), Schwarz et al. (2020) and Tandon et al. (2022)
	EF3	The absolute need for accessibility to hardware such as tablets and computers	Akçay Kavakoğlu et al. (2022), Alnusairat et al. (2021), Asadpour (2021), Ibrahim et al. (2021), Khan and Thilagam (2021), Koenig and Schneider (2019), Mayer (2021), Nubani and Lee (2022) and Varma and Jafri (2021)

(Continued)

Tab. 1: Continued

Factors	Code of SC	SCs	Source
OF	OF1	There is a lack of privacy and a proper work environment (home, dormitory, etc.)	Asadpour (2021), Bakir and Alsaadani (2022), Ibrahim et al. (2021), Jimenez-Vicario et al. (2022), Peimani and Kamalipour (2021a) and Scatena et al. (2021)
	OF2	Interruptions of online lessons due to family members or environmental factors	Becker et al. (2013), Muilenburg and Berge (2005) and Peimani and Kamalipour (2021a)

EA, educational adaptation; EF, economic factors; HP, health and psychology; ICS, interaction, communication and satisfaction; OAE, online architectural education; OF, other factor; P, pedagogy; SCs, success criteria; TT, technical and technological infrastructure.

Tab. 2: Results of reliability and normality analysis

Code of factors	Factor	Number of items	Cronbach's alpha	Skewness	Kurtosis
TT	Technical and technological infrastructure	11	0.930	-0.580	-0.556
HP	Health and psychology	12	0.959	-0.381	-0.916
P	Pedagogy	9	0.908	-0.874	0.162
ISC	Interaction, communication and satisfaction	10	0.926	-0.750	-0.048
EA	Educational adaptation	22	0.958	-0.606	-0.018
EF	Economic factors	3	0.835	-0.787	-0.385
OF	Other factors	2	0.930	-0.398	-1.126

large effect (0.14 and above). Effect sizes calculated for individual factors in this study assessed their contribution to total variance.

4 Results

4.1 Respondent profile

In terms of the demographic characteristics of the sample group, there were 45 (19.4%) first-year architecture students, 54 (23.3%) second-year students, 50 (21.6%) third-year students and 83 (35.8%) fourth-year students. Among the participants, 148 (63.8%) were enrolled in private universities, while 84 (36.2%) attended state universities.

Regarding the digital platforms used for OAE, 155 participants (66.8%) used Zoom, 53 (22.8%) utilised Microsoft Teams, 13 (5.6%) opted for Google Meet and 11 (4.7%) participants used other platforms.

Finally, concerning the duration of education received through OES, 46 students (19.8%) completed one semester, 76 (32.8%) completed two semesters, 72 (31.0%) completed three semesters, 23 (9.9%) finished four semesters and 15 (6.5%) completed five semesters entirely through OES.

4.2 Reliability and normality analysis

The Cronbach's alpha coefficients, which assess the reliability of the dataset, were all above the minimum threshold of 0.7, indicating excellent internal consistency of the responses (Table 2).

Additionally, verifying that the data follow a normal distribution is crucial before conducting statistical tests. Consequently, the skewness and kurtosis values for the variables were calculated, revealing that all data obtained from the questionnaires exhibited a normal distribution, as presented in Table 2.

4.3 Statistical analysis of SCs and factors

Participants' responses to the 69 SCs affecting the success of OAE, rated on a five-point Likert scale, were examined for total factor scores, means and standard deviations (SDs) and are presented in Table 3.

4.4 Hypothesis tests

Hypothesis tests were used to investigate whether there was a statistically significant relationship between SCs and the digital platforms used and between the success

Tab. 3: Factor scores of SCs

Classification of SCs	The mean of the total factor score	Code of SCs	\bar{X}	SD
TT	38.83	T1	3.10	1.32
		T2	3.23	1.31
		T3	3.42	1.40
		T4	3.69	1.42
		T5	3.19	1.44
		T6	3.78	1.25
		T7	2.68	1.26
		T8	3.08	1.39
TT	38.83	T9	3.33	1.40
		T10	3.09	1.38
		T11	3.25	1.31
HP	37.73	HP1	3.26	1.40
		HP2	2.76	1.28
		HP3	3.03	1.41
		HP4	3.17	1.41
		HP5	3.10	1.42
		HP6	3.12	1.41
		HP7	3.41	1.39
		HP8	3.15	1.40
		HP9	3.16	1.37
		HP10	3.24	1.41
		HP11	3.24	1.35
		HP12	3.11	1.32
P	29.87	P1	3.22	1.27
		P2	3.09	1.27
		P3	3.46	1.44
		P4	3.02	1.29
		P5	3.27	1.37
		P6	3.17	1.28
		P7	3.48	1.25
		P8	3.56	1.30
		P9	3.60	1.30
ICS	33.29	ISC1	3.22	1.31
		ISC2	3.32	1.41
		ISC3	3.06	1.39
		ISC4	3.37	1.36
		ISC5	3.30	1.37
		ISC6	3.43	1.29

(Continued)

Tab. 3: Continued

Classification of SCs	The mean of the total factor score	Code of SCs	\bar{X}	SD
		ISC7	3.60	1.25
		ISC8	3.25	1.31
		ISC9	3.28	1.31
		ISC10	3.47	1.29
EA	69.32	EA1	3.55	1.29
		EA2	2.99	1.37
		EA3	3.19	1.35
		EA4	3.08	1.32
		EA5	3.29	1.34
		EA6	3.19	1.40
		EA7	3.44	1.35
		EA8	3.25	1.34
		EA9	2.86	1.25
		EA10	3.31	1.26
EA	69.32	EA11	3.24	1.33
		EA12	3.44	1.34
		EA13	3.03	1.36
		EA14	2.81	1.34
		EA15	2.84	1.36
		EA16	3.31	1.34
		EA17	2.97	1.31
		EA18	3.25	1.37
		EA19	3.04	1.28
		EA20	3.01	1.29
		EA21	3.06	1.28
		EA22	3.19	1.38
EF	10.60	EF1	3.20	1.33
		EF2	3.66	1.40
		EF3	3.74	1.35
OF	6.63	OF1	3.30	1.40
		OF2	3.34	1.45

EA, educational adaptation; EF, economic factors; HP, health and psychology; ICS, interaction, communication and satisfaction; OF, other factors; P, pedagogy; SCs: success criteria; SD, standard deviation; TT, technical and technological infrastructure; \bar{X} , mean.

of theoretical and practical courses and the type of digital platform.

Given that the data followed a normal distribution, one-way ANOVA, a parametric hypothesis test, was

conducted, and the hypotheses outlined below were established.

H_{01} : There is no significant relationship between the main factors influencing the successful implementation of OAE and the digital platform used.

H_{02} : There is no significant relationship between the success of theoretical and practical courses in OAE and the type of digital platform used.

H_{03} : The main factors affecting the successful implementation of OAE and the digital platform used have a significant relationship.

H_{04} : There is a significant relationship between the success of theoretical and practical courses in OAE and the type of digital platform used.

One-way ANOVA was employed to test the hypothesis for the variable of the digital platform used in OAE, which involves multiple groups. Any variables with significance levels (p) of 0.05 or less were considered significant. A significance level (p) below 0.05 indicates the rejection of the null hypotheses (H_{01} , H_{02}) and the acceptance of the alternative hypotheses (H_{03} , H_{04}), signifying a statistically significant relationship between variables.

4.4.1 Determining the relationship between factors and digital platforms

Hypothesis testing for one-way ANOVA with the factors was carried out by calculating the total scores of the SCs within each factor (Table 4).

Based on the one-way ANOVA results in Table 4, the significance values for TT (Sig = 0.000), HP (Sig = 0.000), P (Sig = 0.000), ISC (Sig = 0.000), EA (Sig = 0.000), EF

(Sig = 0.004) and OF (Sig = 0.000) are all <0.05. Therefore, there is insufficient evidence to accept the H_{01} hypothesis. This indicates a statistically significant relationship between all the factors influencing the success of OAE and the digital platforms used by the participants.

Additionally, Table 5 presents the multiple comparisons (post hoc)-Tukey (HSD) test results based on the group means of the factors with identified relationships.

Post-hoc test results revealed that architecture students using Microsoft Teams for OAE encountered more technology and technical infrastructure problems than those using Zoom and other applications. Analogously, architecture students who used Google Meet faced more issues than users of other platforms, except Zoom and Microsoft Teams.

Additionally, architecture students using Google Meet and Microsoft Teams reported more significant health and psychological problems than those using Zoom and other platforms.

Furthermore, architecture students using Zoom, Google Meet and Microsoft Teams experienced more difficulties related to pedagogy, EA, interaction, satisfaction and communication than those using other applications. Microsoft Teams users faced more of these challenges than Zoom users.

Finally, architecture students using Microsoft Teams for OAE encountered more economic and other related issues than those using Zoom and other applications.

4.4.2 Investigating the correlation between course types and digital platforms

Whether the type of digital platform used in OAE affects the success of theoretical and practical courses was examined using one-way ANOVA (Table 6).

Tab. 4: Hypothesis test results of digital platforms and factors

Factor	Digital platforms												Sig.
	Zoom			Google Meet			Microsoft Teams			Other			
	\bar{X}	n	SD	\bar{X}	n	SD	\bar{X}	n	SD	\bar{X}	n	SD	
TT	33.91	155	11.33	40.84	13	9.58	42.28	53	7.87	25.81	11	13.82	0.000
HP	35.21	155	14.06	45.38	13	11.18	45.23	53	9.17	28.27	11	13.69	0.000
P	29.24	155	9.29	31.08	13	8.18	33.30	53	5.95	20.82	11	9.55	0.000
ICS	32.22	155	10.42	34.77	13	11.30	38.19	53	6.94	23.18	11	11.28	0.000
EA	67.86	155	22.37	74.54	13	18.94	76.51	53	12.93	49.18	11	25.96	0.000
EF	10.28	155	3.66	11.77	13	3.44	11.75	53	2.41	8.27	11	4.71	0.004
OF	6.25	155	2.75	7.15	13	2.97	7.92	53	2.16	5.27	11	3.23	0.000

Note(s): $p \leq 0.05$.

EA, educational adaptation; EF, economic factors; HP, health and psychology; ICS, interaction, communication, and satisfaction; n , population; OF, other factors; P, pedagogy; SD, standard deviation; TT, technical and technological infrastructure; \bar{X} , mean.

Tab. 5: Multiple comparison test (Tukey HSD)

Dependent variable	I	J	I-J	SD	Sig.
TT	Zoom	Google Meet	-6.93	3.08	0.114
		Microsoft Teams	-8.36*	1.69	0.000*
		Other	8.09	3.33	0.074
	Google Meet	Zoom	6.93	3.08	0.114
		Microsoft Teams	-1.43	3.30	0.972
		Other	15.02*	4.37	0.004*
	Microsoft Teams	Zoom	8.36*	1.69	0.000*
		Google Meet	1.43	3.30	0.972
		Other	16.46*	3.53	0.000*
	Other	Zoom	-8.09	3.33	0.074
		Google Meet	-15.02*	4.37	0.004*
		Microsoft Teams	-16.46*	3.53	0.000*
HP	Zoom	Google Meet	-10.17*	3.73	0.035*
		Microsoft Teams	-10.01*	2.05	0.000*
		Other	6.93	4.03	0.317
	Google Meet	Zoom	10.17*	3.73	0.035*
		Microsoft Teams	0.158	4.00	1.000
		Other	17.11*	5.30	0.008*
	Microsoft Teams	Zoom	10.01*	2.05	0.000*
		Google Meet	-0.15	4.00	1.000
		Other	16.95*	4.28	0.001*
	Other	Zoom	-6.93	4.03	0.317
		Google Meet	-17.11*	5.30	0.008*
		Microsoft Teams	-16.95*	4.28	0.001*
P	Zoom	Google Meet	-1.83	2.48	0.881
		Microsoft Teams	-4.06*	1.37	0.017*
		Other	8.42*	2.68	0.010*
	Google Meet	Zoom	1.83	2.48	0.881
		Microsoft Teams	-2.22	2.66	0.837
		Other	10.25*	3.52	0.020*
	Microsoft Teams	Zoom	4.06*	1.37	0.017*
		Google Meet	2.22	2.66	0.837
		Other	12.48*	2.85	0.000*
	Other	Zoom	-8.42*	2.68	0.010*
		Google Meet	-10.25*	3.52	0.020*
		Microsoft Teams	-12.48*	2.85	0.000*
ICS	Zoom	Google Meet	-2.54	2.84	0.806
		Microsoft Teams	-5.96*	1.56	0.001*
		Other	9.03*	3.07	0.018*
	Google Meet	Zoom	2.54	2.84	0.806
		Microsoft Teams	-3.41	3.04	0.675
		Other	11.58*	4.03	0.023*
	Microsoft Teams	Zoom	5.96*	1.56	0.001*
		Google Meet	3.41	3.04	0.675
		Other	15.00*	3.26	0.000*

(Continued)

Tab. 5: Continued

Dependent variable	I	J	I-J	SD	Sig.
ICS	Other	Zoom	-9.03*	3.07	0.018*
		Google Meet	-11.58*	4.03	0.023*
		Microsoft Teams	-15.00*	3.26	0.000*
EA	Zoom	Google Meet	-6.67	5.95	0.676
		Microsoft Teams	-8.64*	3.28	0.044*
		Other	18.68*	6.43	0.021*
	Google Meet	Zoom	6.67	5.95	0.676
		Microsoft Teams	-1.97	6.38	0.990
		Other	25.35*	8.44	0.016*
	Microsoft Teams	Zoom	8.64*	3.28	0.044*
		Google Meet	1.97	6.38	0.990
		Other	27.32*	6.83	0.000*
	Other	Zoom	-18.68*	6.43	0.021*
		Google Meet	-25.35*	8.44	0.016*
		Microsoft Teams	-27.32*	6.83	0.000*
EF	Zoom	Google Meet	-1.49	1.00	0.443
		Microsoft Teams	-1.47*	0.55	0.039*
		Other	2.00	1.08	0.250
	Google Meet	Zoom	1.49	1.00	0.443
		Microsoft Teams	0.01	1.07	1.000
		Other	3.49	1.42	0.068
	Microsoft Teams	Zoom	1.47*	0.55	0.039*
		Google Meet	-0.01	1.07	1.000
		Other	3.48*	1.15	0.014*
	Other	Zoom	-2.00	1.08	0.250
		Google Meet	-3.49	1.42	0.068
		Microsoft Teams	-3.48*	1.15	0.014*
OF	Zoom	Google Meet	-0.90	0.77	0.640
		Microsoft Teams	-1.67*	0.42	0.001*
		Other	0.97	0.83	0.647
	Google Meet	Zoom	0.90	0.77	0.640
		Microsoft Teams	-0.77	0.83	0.787
		Other	1.88	1.09	0.315
OF	Microsoft Teams	Zoom	1.67*	0.42	0.001*
		Google Meet	0.77	0.83	0.787
		Other	2.65*	0.88	0.016*
	Other	Zoom	-0.97	0.83	0.647
		Google Meet	-1.88	1.09	0.315
		Microsoft Teams	-2.65*	0.88	0.016*

Note(s): $p \leq 0.05$.

The asterisk '**' indicates that the difference between the group means is statistically significant.

EA, educational adaptation; EF, economic factors; HP, health and psychology; ICS, interaction, communication, and satisfaction; OF, other factor; P, pedagogy; SD, standard deviation; TT, technical and technological infrastructure.

Tab. 6: Hypothesis test results of course types and digital platforms

Course types	Digital platforms												Sig.
	Zoom			Google Meet			Microsoft Teams			Other			
	\bar{X}	<i>n</i>	SD	\bar{X}	<i>n</i>	SD	\bar{X}	<i>n</i>	SD	\bar{X}	<i>n</i>	SD	
Theoretical courses	3.81	155	0.84	3.62	13	0.76	3.49	53	1.06	3.09	11	1.04	0.068
Practical courses	3.55	155	1.05	3.15	13	0.98	2.83	53	1.13	2.82	11	1.32	0.000

Note(s): $p \leq 0.05$.

n, Population; SD, standard deviation; \bar{X} , Mean.

Tab. 7: Multiple comparison test (Tukey HSD)

Dependent variable	<i>I</i>	<i>J</i>	<i>I-J</i>	SE	Sig.
Theoretical courses	Zoom	Google Meet	0.19	0.26	0.874
		Microsoft Teams	0.32	0.14	0.116
		Other	0.72	0.28	0.054
	Google Meet	Zoom	-0.19	0.26	0.874
		Microsoft Teams	0.12	0.28	0.970
		Other	0.52	0.37	0.492
	Microsoft Teams	Zoom	-0.32	0.14	0.116
		Google Meet	-0.12	0.28	0.970
		Other	0.40	0.30	0.543
	Other	Zoom	-0.72	0.28	0.054
		Google Meet	-0.52	0.37	0.492
		Microsoft Teams	-0.40	0.30	0.543
Practical courses	Zoom	Google Meet	0.39	0.31	0.588
		Microsoft Teams	0.71*	0.17	0.000*
		Other	0.73	0.33	0.137
	Google Meet	Zoom	-0.39	0.31	0.588
		Microsoft Teams	0.32	0.33	0.769
		Other	0.33	0.44	0.874
	Microsoft Teams	Zoom	-0.71*	0.17	0.000*
		Google Meet	0.32	0.33	0.769
		Other	0.01	0.35	1.000
	Other	Zoom	-0.73	0.33	0.137
		Google Meet	-0.33	0.44	0.874
		Microsoft Teams	-0.01	0.35	1.000

Note(s): $p \leq 0.05$.

The asterisk ** indicates that the difference between the group means is statistically significant.

Based on the one-way ANOVA results in Table 6, the H_{03} hypothesis is not accepted since the significance value for practical courses (Sig = 0.000) is <0.05 .

In this context, it was determined that the success of practical courses in OAE is affected by the type of digital platform used, while that of theoretical courses is not. In

other words, there is a statistically significant relationship between course type and the digital platforms used by the participants.

Table 7 shows the multiple comparisons (post hoc) results based on the group means of the variables where a relationship was identified.

Tab. 8: Effect sizes of factors

Code of factor	Factor	Number of items	η^2	%
TT	Technical and technological infrastructure	11	0.140	14
HP	Health and psychology	12	0.130	13
P	Pedagogy	9	0.087	8.7
ICS	Interaction, communication and satisfaction	10	0.106	10.6
EA	Educational adaptation	22	0.075	7.5
EF	Economic factors	3	0.057	5.7
OF	Other factors	2	0.077	7.7

Note(s): $p \leq 0.05$.

According to post-hoc test results (Table 7), Zoom was more successful than Microsoft Teams for practical courses in OAE. This preference was reflected in architecture students’ perceptions, as they expressed a stronger preference for using Zoom over Microsoft Teams in applied courses in OAE.

4.5 Determination of the effect size of the factors affecting the success

An eta-squared (η^2) analysis was performed to assess the impact levels of the factors influencing the success of OAE. The results indicated that the TT factor accounted for 14% of the total variance, the HP factor for 13%, the P factor for 8.7%, the ISC factor for 10.6%, the EA factor for 7.5%, the EF factor for 5.7% and the OF factor for 7.7% of the total variance (Table 8).

5 Discussion

This study employed quantitative statistical analyses to pinpoint the success factors of OAE. The results offer a comprehensive overview, highlighting the importance of these factors. Accordingly, understanding the relationship between these success factors and the digital platforms used is crucial. Moreover, it is essential to explore the correlation between different types of courses and digital applications to optimise sustainable OAE strategies.

5.1 The relationship between digital platforms used in OAE and factors

The initial hypothesis testing revealed that architecture students using Google Meet, Microsoft Teams and other

applications experienced more difficulties with the applications; privacy and security concerns; psychological and social challenges; pedagogical and technical shortcomings; and issues with interactive, independent and collaborative learning compared with those using Zoom.

Peimani and Kamalipour (2021b) observed that Zoom offers superior usability and higher user satisfaction than other platforms. Supporting this, Alnusairat et al. (2021) and Tandon et al. (2022) concluded that Zoom is more user-friendly than other applications. Ferng (2020) emphasised Zoom’s adaptability, particularly in higher education settings.

Zoom’s widespread use in OES globally is attributed to its ability to cater to specific needs (Zoom 2023a). Its open-source nature facilitates continuous improvement and frequent updates, which are made possible through global developer collaboration.

Peimani and Kamalipour (2021a, 2021b) noted that Zoom provides more digital opportunities than many other online education platforms, distinguishing itself with unique user benefits during sessions.

This study observed that Zoom outperformed other platforms across all identified factors. Consequently, other digital platforms for education need to catch up in critical areas essential for the success of OAE, such as application interfaces, source codes, licensing options and software features. These shortcomings underscore the importance of selecting a robust digital platform like Zoom, which provides sustainable functionality, ensuring the effective delivery and success of OAE.

5.2 Correlation between digital platforms used in OAE and course types

According to the results obtained in subsequent hypothesis testing, architecture students found Zoom more successful than Microsoft Teams for practical courses in OAE.

The traditional concept of AE revolves around delivering education to prospective students through various courses (Ghonim and Eweda 2018). Practical courses (e.g., technology-based courses, artistic courses, architectural design studios) have distinct requirements and methodologies (Ceylan et al. 2021a). Meeting the specific requirements of practical courses becomes crucial when transitioning to OES. In this context, Zoom is more successful than Microsoft Teams in facilitating the transition of practical courses and satisfying architecture students in Turkey.

Zoom’s efficiency in OAE’s practical courses in Turkey can be attributed to several key factors. Its low bandwidth

requirements ensure accessibility for students across diverse regions. Practical courses in AE require significant curriculum hours and active participation (Bakir and Alsaadani 2022). These classes are lengthy and must continue without interruption. Zoom's efficient use of bandwidth and its ability to function smoothly even on lower internet speeds (Zoom 2023b) make it accessible across Turkey, where the internet infrastructure varies significantly (Ceylan et al. 2021b). This ensures that architecture students from diverse regions can participate without significant technical hindrances (Chukwunonso and Nosike 2024).

The core component of AE's practical courses is the architectural design studio, where students work on designs and projects in a collaborative environment (Megahed and Hassan 2022; Metinal and Gumusburun Ayalp 2024). Design studios heavily rely on critique sessions where students present their work and receive feedback (Hettithanthri and Hansen 2022). Zoom's high-quality video and audio capabilities, screen sharing, breakout rooms and annotation features enable effective virtual critiques (Tuç 2023). These features facilitate collaboration, mirroring the interactive nature of a physical studio.

Although tactile experiences such as model making and site visits pose unique challenges in an online format, Zoom can be used in conjunction with supplementary technologies like VR and augmented reality (AR) (Tan et al. 2022). These technologies can be used alongside Zoom to create more immersive learning experiences. For instance, virtual site visits can be conducted using 360-degree videos and VR, which can be shared and discussed in real time on Zoom, providing an alternative to physical site visits.

Zoom's cost-effective options make it an appealing choice for OAE courses in developing countries like Turkey, which face budgetary constraints (Karademir et al. 2020). This is particularly significant in contexts where financial limitations prevail. The widespread integration of Zoom within OAE, especially in Turkey with intensive practical courses such as architectural design studios, has standardised its use, reducing ambiguity and ensuring a unified learning experience across various architectural courses and educational levels.

In recent years, Zoom has been one of the fastest digital platforms to adapt to Turkey's scale (Sünger 2021). With its versatile features, it can be effectively used across all disciplines. It quickly became widespread and adapted easily, maintaining its presence efficiently. Moreover, its ability to integrate with national education platforms widely used in Turkey made Zoom a preferred choice (Ricky 2023; Zoom 2023c).

The results from this study indicate that Zoom satisfies architecture students with its performance in OAE's practical courses. Zoom's combination of accessibility, comprehensive features, cost-effectiveness and support for interactive and practical learning makes it the best digital platform for OAE's practical courses in Turkey. Its ability to facilitate detailed critiques, group work and immersive online experiences addresses the specific needs of AE, ensuring that students continue to receive a high-quality education despite the challenges posed by OES.

5.3 The effect sizes of the factors

The results indicated that SCs related to technology and technical infrastructure significantly impact the success of OAE ($\eta^2 = 0.140$). At the same time, SCs about HP ($\eta^2 = 0.130$); interaction, satisfaction and communication ($\eta^2 = 0.087$); pedagogy ($\eta^2 = 0.106$); EA ($\eta^2 = 0.075$) and OF ($\eta^2 = 0.077$) exert a moderate influence. SCs associated with EF ($\eta^2 = 0.057$) demonstrated a minimal effect.

The critical role of technology in OAE is evident, as its success is closely linked to the technological resources and capabilities available. This is underscored by the ranking of SCs by importance, where technology-related factors emerge as the most and least critical.

As mentioned earlier, EF are significant in developing countries like Turkey. However, the current study found that EF negatively impacted OAE success.

This finding contrasts with previous studies (Brzezicki 2020; Schwarz et al. 2020; Al Maani et al. 2021; Asadpour 2021; Ibrahim et al. 2021; Mayer 2021; Scatena et al. 2021; Varma and Jafri 2021), where EF were deemed significant.

This conclusion can be attributed to government support, social solidarity and adapting to new educational requirements. Strong measures by authorities to support less privileged groups, especially financially disadvantaged students in architectural higher education, played a crucial role in mitigating the impact of EF on OAE.

Additionally, the diversification and widespread adoption of hardware and software for OAE have reduced costs over time. As user numbers grew, new software development led to lower fees, further diminishing the influence of EF on OAE.

6 Conclusion

The rapid shift to OES worldwide has introduced new requirements and responsibilities. Among these is the necessity of selecting the most suitable method and digital

platform to effectively convey knowledge to students at various educational levels and across different disciplines. However, the quick transition without adequate preparation has led to international variations in education delivery standards (Milovanović et al. 2020; Schwarz et al. 2020; Ibrahim et al. 2021). Hence, for the future of AE, developing a common approach or an optimal model to ensure consistency under all conditions is crucial.

Identifying the SCs and selecting the appropriate digital platform is pivotal for the success and sustainability of OAE. This study employed a multistage framework to identify OAE success factors. Initially, 69 SCs influencing OAE success were identified and quantified through a SLR. These SCs were categorised based on their scope and impact, and their sub-dimensions were identified. The study then examined the relationship between these factors and digital platforms and the success of theoretical and practical courses according to the type of digital platform used. Finally, the effect sizes of these factors were calculated, and their impact levels were determined using one-way ANOVA and eta-squared analysis.

The current study concluded that Zoom is the most suitable digital platform for OAE due to the educational technologies and opportunities it offers. Although improvements are needed in student-centred, customisable learning and potential development, Zoom was the best-performing platform among those currently used in OAE. This conclusion is based on its effective performance in the most significant criteria for OAE success, such as ‘flexibility to run the applications on a variety of devices’, ‘opportunity to access recorded lectures and juries at any time’, and ‘the absolute need for accessibility to hardware such as tablets and computers’. For sustainable OAE success, digital platforms with similar software bases and development potential should be preferred. The educational and professional discipline needs should be considered when selecting a digital platform.

Despite significant efforts, this study has several limitations that future research should address. The study was regionally confined to architecture students in Turkey, limiting the generalisability of the findings. Future studies should include other countries to enhance the applicability of the results. Additionally, the research only considered the evaluations of architecture students, excluding the perspectives of instructors, tutors and decision-makers. Future research should explore these stakeholders’ evaluations for cumulative improvement. Furthermore, while this study focused on digital platforms as a crucial variable affecting educational success, other variables such as age, gender and student grade levels should also be considered in future OAE research.

The unique experiences gained from this study provide valuable insights for the future. Properly analysing these experiences and developing solutions can help avoid similar problems in the future.

References

- Akçay Kavakoğlu, A., Güleç Özer, D., Domingo-Callabuig, D., & Bilen, Ö (2022). Architectural design communication (ADC) in online education during COVID-19 pandemic: A comparison of Turkish and Spanish universities. *Open House International*, 47, pp. 361-384. doi: 10.1108/OHI-07-2021-0144
- Al Maani, D., Alnusairat, S., & Al-Jokhadar, A. (2021). Transforming learning for architecture: Online design studio as the new norm for crises adaptation under COVID-19. *Open House International*, 46, pp. 348-358. doi: 10.1108/OHI-01-2021-0016
- Alatni, B. S., Abubakar, I. R., & Iqbal, S. A. (2021). COVID-19 and rapid course adaptations in Saudi Arabia: An experiential learning and recommendations for online education. *Frontiers in Psychology*, 12, p. 643203. doi: 10.3389/fpsyg.2021.643203
- Alkhalil, S. M., Manasrah, A. A., Dabbour, L. M., Bashayreh, E. A., Abdelhafez, E. A., & Rababa, E. G. (2021). COVID-19 pandemic and the E-learning in higher institutions of education: Faculty of engineering and technology at Al-Zaytoonah University of Jordan as a case study. *Journal of Human Behavior in the Social Environment*, 31, pp. 464-475. doi: 10.1080/10911359.2020.1829243
- 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, pp. 219-236. doi: 10.1108/ARCH-09-2020-0195
- Andiyan, A., Rusmana, D., Hari, Y., Sitorus, M., Trinova, Z., & Surur, M. (2021). Disruption of IoT in Adapting online learning during the COVID-19 pandemic. *International Journal of Early Childhood Special Education*, 13, pp. 1331-1341. doi: 10.9756/INT-JECSE/V13I2.211181
- Asadpour, A. (2021). Student challenges in online architectural design courses in Iran during the COVID-19 pandemic. *E-Learning and Digital Media*, 18, pp. 511-529. doi: 10.1177/20427530211022923
- Ayat, M., Imran, M., Ullah, A., & Kang, C. W. (2021). Current trends analysis and prioritization of success factors: A systematic literature review of ICT projects. *International Journal of Managing Projects in Business*, 14(3), pp. 652-679. doi: 10.1108/IJMPB-02-2020-0075
- Bakir, R., & Alsaadani, S. (2022). A mixed methods study of architectural education during the initial COVID-19 lockdown: Student experiences in design studio and technology courses. *Open House International*, 47, pp. 338-360. doi: 10.1108/OHI-09-2021-0206
- Becker, K., Newton, C., & Sawang, S. (2013). A learner perspective on barriers to e-learning. *Australian Journal of Adult Learning*, 53(2), pp. 35-57.
- Bhandari, H., Tandon, U., Bansal, K., & Mittal, A. (2020). Barriers to the adoption of technology in learning and assessment of undergraduate architecture students. In: 2020 *International*

- Conference on Innovation and Intelligence for Informatics, Computing and Technologies (3ICT). IEEE*, pp. 1-5. doi: 10.1109/3ICT51146.2020.9311971
- Brzezicki, M. (2020). Strengths and weaknesses of architectural education on-line classes conducted during COVID-19. *World Transactions on Engineering and Technology Education*, 18, pp. 381-386.
- Ceylan, S., Şahin, P., Seçmen, S., Somer, M. E., & Süher, K. H. (2021a). An evaluation of online architectural design studios during COVID-19 outbreak. *Archnet-IJAR*, 15, pp. 203-218. doi: 10.1108/ARCH-10-2020-0230
- Ceylan, H., Demir, G., & Elri, Z. (2021b). Internet speed issue of Turkey. *International Journal of Engineering and Innovative Research*, 3, pp. 121-132. doi: 10.47933/ijeir.902060
- Chukwunonso, R., & Nosike, J. (2024). Digitalization in developing countries: Opportunities and challenges. *Nigerian Journal of Arts and Humanities (NJAH)*, 4, pp. 1-11.
- Crawford, S. D., Couper, P. C., & Lamias, M. J. (2001). Web surveys perceptions of Burden. *Social Science Computer Review*, 19, pp. 146-162. doi: 10.1177/089443930101900202
- Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests*. *Psychometrika*, 16, pp. 297-334. doi: 10.1007/BF02310555
- da Silveira, V. C. (2008). E-learning by studying: topics for online architectural design teaching. In: S. Roaf & A. Bairstow (Eds.), *In the Oxford Conference: A Re-Evaluation of Education in Architecture*. Southampton, Boston, WIT Press, p. 339.
- Dennis, M. J. (2021). Digital well-being under pandemic conditions: Catalysing a theory of online flourishing. *Ethics and Information Technology*, 23, pp. 435-445. doi: 10.1007/s10676-021-09584-0
- Denyer, D., Tranfield, D., & Van Aken, J. E. (2008). Developing design propositions through research synthesis. *Organization Studies*, 29, pp. 393-413. doi: 10.1177/0170840607088020
- Deshmukh, J. (2021). Speculations on the post-pandemic university campus – A global inquiry. *Archnet-IJAR*, 15, pp. 131-147. doi: 10.1108/ARCH-10-2020-0245
- Elrawy, S., & Abouelmagd, D. (2021). Architectural and urban education in Egypt in the post COVID-19 pandemic. *European Journal of Sustainable Development*, 10, pp. 91-112. doi: 10.14207/ejsd.2021.v10n2p91
- Ferng, J. (2020). Post-zoom: Screen environments and the human/machine interface. *Architectural Theory Review*, 24, pp. 207-210. doi: 10.1080/13264826.2020.1809769
- George, B. H. (2018). Drawing online: A comparative analysis of an online basic graphics course. *Landscape Journal*, 37, pp. 23-37. doi: 10.3368/lj.37.1.23
- Ghonim, M., & Eweda, N. (2018). Investigating elective courses in architectural education. *Frontiers of Architectural Research*, 7, pp. 235-256. doi: 10.1016/j.foar.2018.03.006
- Güler, K. (2023). Structuring knowledge-building in online design education. *International Journal of Technology and Design Education*, 33, pp. 1055-1086. doi: 10.1007/s10798-022-09756-z
- Gupta, S. K., Gunasekaran, A., Antony, J., Gupta, S., Bag, S., & Roubaud, D. (2019). Systematic literature review of project failures: Current trends and scope for future research. *Computers & Industrial Engineering*, 127, pp. 274-285. doi: 10.1016/j.cie.2018.12.002
- Headley, D., Slee, B., & De La Cruz, E., 2015. How do we sketch with someone 1000 miles away?: distance collaboration for designers. In: Crawford, R.H., & Stephan A (Eds.), *49th International Conference of the Architectural Science Association*. Melbourne, 2015, pp. 977-986.
- Hettithanthri, U., & Hansen, P. (2022). Design studio practice in the context of architectural education: A narrative literature review. *International Journal of Technology and Design Education*, 32, pp. 2343-2364. doi: 10.1007/s10798-021-09694-2
- Iacobucci, D. (2010). Structural equations modeling: Fit Indices, sample size, and advanced topics. *Journal of Consumer Psychology*, 20, pp. 90-98. doi: 10.1016/j.jcps.2009.09.003
- Ibrahim, A. F., Attia, A. S., Bataineh, A. M., & Ali, H. H. (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, pp. 2345-2353. doi: 10.1016/j.asej.2020.10.006
- Iranmanesh, A., & Onur, Z. (2021). Mandatory virtual design studio for all: Exploring the transformations of architectural education amidst the global pandemic. *International Journal of Art and Design Education*, 40, pp. 251-267. doi: 10.1111/jade.12350
- Jimenez-Vicario, P. M., Navarro-Moreno, D., Mestre-Martí, M., García-Martínez, P., Ródenas-López, M. A., & Muñoz-Mora, M. J. (2022). COVID-19 and online teaching: Impact on academic results in the subjects of architectural graphic expression at the Polytechnic University of Cartagena. In: Manuel A. Ródenas-López, José Calvo-López & Macarena Salcedo-Galera (Eds.), *Architectural Graphics: Volume 3-Graphics for Education and Thought*. Springer International Publishing, Cham, pp. 42-50. doi: 10.1007/978-3-031-04640-7_5
- Karademir, A., Yaman, F., & Saatçioğlu, Ö (2020). Challenges of higher education institutions against COVID-19: The case of Turkey. *Journal of Pedagogical Research*, 4, pp. 453-474. doi: 10.33902/JPR.2020063574
- Khan, A. R., & Thilagam, N. L. (2021). The confluence approach – A theoretical proposition for effective structuring of architecture studio pedagogy in e-learning mode. *Open House International*, 46, pp. 510-527. doi: 10.1108/OHI-11-2020-0158
- Khan, A. R., & Thilagam, N. L. (2022). The virtual design studio and the key integrals. *Open House International*, 47, pp. 316-337. doi: 10.1108/OHI-05-2021-0113
- Koenig, R., & Schneider, S. (2019). Evaluation of systems for video-based online teaching Create your own MOOC or SPOC. *Challenges – EDUCATION AND RESEARCH*, 1, pp. 109-116.
- Koh, P. C. L., & Wong, S. K. (2021). Students' perception of online learning and institution's engagement during the COVID-19 pandemic: A survey study of Taylor's design, architecture and engineering students. *Journal of Engineering Science and Technology*. 16(1), pp. 635-651.
- Komarzyńska-Świeściak, E., Adams, B., & Thomas, L. (2021). Transition from physical design studio to emergency virtual design studio. Available teaching and learning methods and tools – A case study. *Buildings*, 11(7), p. 312. doi: 10.3390/buildings11070312
- Kukina, I., Unagaeva, N., Kamalova, K., Chui, I., & Fedchenko, I. (2016). E-learning technologies in the international urban design: Educational case studies of the Siberian Federal University and Karlsruhe Institute of Technology. *Architecture and Design Conference Proceedings*, 2, pp. 237-244. doi: 10.5593/SGEMSOCIAL2016/HB42/S07.030

- Leon, I., Sagarna, M., Mora, F., & Otaduy, J. P. (2021). BIM application for sustainable teaching environment and solutions in the context of COVID-19. *Sustainability (Switzerland)*, 13(9), p. 4746. doi: 10.3390/su13094746
- Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P. A., et al. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: Explanation and elaboration. *BMJ*, 339, p. b2700. doi: 10.1136/bmj.b2700
- Macpherson, A., & Jones, O. (2010). Editorial: Strategies for the development of International Journal of Management reviews. *International Journal of Management Reviews*, 12(2), pp. 107-113. doi: 10.1111/j.1468-2370.2010.00282.x
- Masdéu, M., & Fuses, J. (2017). Reconceptualizing the design studio in architectural education: Distance learning and blended learning as transformation factors. *International Journal of Architectural Research Archnet-IJAR*, 11(2), pp. 6-23. doi: 10.26687/archnet-ijar.v11i2.1156
- Mayer, F. (2021). Experiences with digital teaching formats during the COVID-19 pandemic at the Department of Spatial Design at the Faculty of Architecture, RWTH Aachen University, as illustrated by the course Einführen in das Entwerfen (Introduction to Design). *FAMagazine. Ricerche e progetti sull'architettura e la città*, 170-175.
- Megahed, N., & Hassan, A. (2022). A blended learning strategy: Reimagining the post-COVID-19 architectural education. *Archnet-IJAR*, 16, pp. 184-202. doi: 10.1108/ARCH-04-2021-0081
- Metinal, Y. B., & Gumusburun Ayalp, G. (2022). Effects of the COVID-19 pandemic on architectural education: Bibliometric and content analyses. *Open House International*, 47, pp. 657-687. doi: 10.1108/OHI-05-2022-0120
- Metinal, Y. B., & Gumusburun Ayalp, G. (2024). Modeling the critical factors affecting the success of online architectural education to enhance educational sustainability. *Sustainability (Switzerland)*, 16(9), p. 3803. doi: 10.3390/su16093803
- Miller, P. A. (2001). Distance learning: Back to the future. *Landscape architecture. American Society of Landscape Architects*, 91, pp. 54-101.
- Milovanović, A., Kostić, M., Zorić, A., Dordević, A., Pešić, M., Bugarski, J., et al. (2020). Transferring COVID-19 challenges into learning potentials: Online workshops in architectural education. *Sustainability (Switzerland)*, 12(17), p. 7024. doi: 10.3390/su12177024
- Muilenburg, L. Y., & Berge, Z. L. (2005). Student barriers to online learning: A factor analytic study. *Distance Education*, 26(1), pp. 29-48. doi: 10.1080/01587910500081269
- Newman, G., George, B., Li, D., Tao, Z., Yu, S., & Lee, R. J. (2018). Online learning in landscape architecture: Assessing issues, preferences, and student needs in design-related online education. *Landscape Journal*, 37, pp. 41-63. doi: 10.3368/lj.37.2.41
- Nubani, L., & Lee, E. (2022). Sense of classroom community in interior design studios: In-person learning versus online learning approaches. *International Journal of Design*, 47, pp. 51-70. doi: 10.1111/joid.12217
- Nunnally, J. C., & Bernstein, I. H. (2007). *Psychometric Theory*, 3rd edn. McGraw-Hill, New York.
- Peimani, N., & Kamalipour, H. (2021a). Online education in the post COVID-19 era: Students' perception and learning experience. *Education Sciences (Basel)*, 11(10), p. 633. doi: 10.3390/educsci11100633
- Peimani, N., & Kamalipour, H. (2021b). Online education and the COVID-19 outbreak: A case study of online teaching during lockdown. *Education Sciences (Basel)*, 11, pp. 1-16. doi: 10.3390/educsci11020072
- Peimani, N., & Kamalipour, H. (2022). The future of design studio education: Student experience and perception of blended learning and teaching during the global pandemic. *Education Sciences (Basel)*, 12(2), p. 140. doi: 10.3390/educsci12020140
- Reza Saghafi, M., Franz, J., & Crowther, P. (2012). Perceptions of physical versus virtual design studio education. *International Journal of Architectural Research*, 6, pp. 6-22.
- Ricky, H. (2023). Integrating Zoom with Learning Management Systems: A Comprehensive Guide [WWW Document]. EdisonOS. Available at <https://www.edisonos.com/blog/integrating-zoom-with-learning-management-systems-a-comprehensive-guide> [accessed 7 October 2024].
- Sahuc, P. A. (2021). From pencil to mouse, from face to screen. A teaching experience in times of COVID 19. *FAMagazine. Ricerche e progetti sull'architettura e la città*, pp. 192-195. doi: 10.12838/fam/issn2039-0491/n0-2021
- Scatena, D., Gulel, Z., Terracina, S. A., & Volanti, V. (2021). The architectural plan: Teaching and learning methods in social distance's times. *FAMagazine. Ricerche e progetti sull'architettura e la città*, pp. 88-93. doi: 10.12838/fam/issn2039-0491/n0-2021
- Schwarz, M., Scherrer, A., Hohmann, C., Heiberg, J., Brugger, A., & Nuñez-Jimenez, A. (2020). COVID-19 and the academy: It is time for going digital. *Energy Research & Social Science*, 68, p. 101684. doi: 10.1016/j.erss.2020.101684
- Senyapili, B., & Karakaya, A. F. (2009). The future setting of the design studio. *Open House International*, 34, pp. 104-112. doi: 10.1108/OHI-01-2009-B0012
- Shannon, S. J., Francis, R. L., Chooi, Y. L., & Ng, S. L. (2013). Approaches to the use of blended learning in teaching tectonics of design to architecture/design and architectural engineering students. *Architectural Science Review*, 56, pp. 131-140. doi: 10.1080/00038628.2012.744688
- Soccio, P., Tregloan, K., & Thompson, J. (2021). Well-coordinated: Learner-focused coordination tactics beyond the pandemergency. *Archnet-IJAR*, 15, pp. 237-251. doi: 10.1108/ARCH-10-2020-0227
- Sünger, M. (2021). Popular Video Conferencing Softwares: Microsoft Teams, Zoom and Google Meet [WWW Document]. Turkish Red Crescent Academy. Available at <https://kizilayakademi.org.tr/en/popular-video-conferencing-sofwares-microsoft-teams-zoom-and-google-meet/#:~:text=According%20to%20a%20report%20dated,in%20Turkey%20and%20also%20worldwide> [accessed 7 October, 2024].
- Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, 48, pp. 1273-1296. doi: 10.1007/s11165-016-9602-2
- Tan, Y., Xu, W., Li, S., & Chen, K. (2022). Augmented and virtual reality (AR/VR) for education and training in the AEC industry: A systematic review of research and applications. *Buildings*, 12(10), p. 1529. doi: 10.3390/buildings12101529

- Tandon, U., Mittal, A., Bhandari, H., & Bansal, K. (2022). E-learning adoption by undergraduate architecture students: Facilitators and inhibitors. *Engineering. Construction and Architectural Management*, 29, pp. 4287-4312. doi: 10.1108/ECAM-05-2021-0376
- Tang, B., Guo, S., Yeboah, M., Wang, Z., & Cheng, S. (2021). Quality evaluation of online courses during COVID-19 pandemic based on integrated FCE-AHP method. *Journal of Intelligent and Fuzzy Systems*, 41, pp. 1487-1498. doi: 10.3233/JIFS-210362
- Taslı-Pektas, S. (2012). Virtual design studio revisited: A blended approach for the digital natives. *Collaborative Design*, 2, pp. 69-75.
- Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British Journal of Management*, 14(2), pp. 207-222. doi: 10.1111/1467-8551.00375
- Travis, S. (2022). Onsite/online: A case study approach pivots to virtual and back with new strategies learned. *Architecture_MPS*, 22, pp. 1-13. doi: 10.14324/111.444.amps
- Tuç, E. (2023). Distance education during the COVID-19 process in turkey: Implications of web conferencing for open schooling. *Global and Lokal Distance Education- GLOKALde*, 9, pp. 17-26.
- Varma, A., & Jafri, M. S. (2021). COVID-19 responsive teaching of undergraduate architecture programs in India: Learnings for post-pandemic education. *Archnet-IJAR*, 15, pp. 189-202. doi: 10.1108/ARCH-10-2020-0234
- Vásquez De Velasco, G. (2007). A group of friends: The Las Americas network, virtual studios, and distance education in architecture. *International Journal of Architectural Computing*, 5, pp. 455-468. doi: 10.1260/147807707782581765
- Wu, W. L., Hsu, Y., Yang, Q. F., & Chen, J. J. (2021). A spherical video-based immersive virtual reality learning system to support landscape architecture students' learning performance during the COVID-19 era. *Land (Basel)*, 10(6), p. 561. doi: 10.3390/land10060561
- Xi, W., & Cong, W. (2022). Remote practice methods of survey education for HBIM in the post-pandemic era: Case study of Kuiwen Pavilion in the temple of Confucius (Qufu, China). *Applied Sciences (Switzerland)*, 12(2), p. 708. doi: 10.3390/app12020708
- Yu, R., Ostwald, M. J., Gu, N., Skates, H., & Feast, S. (2022). Evaluating the effectiveness of online teaching in architecture courses. *Architectural Science Review*, 65, pp. 89-100. doi: 10.1080/00038628.2021.1921689
- Yu, Y., Li, Y., Zhang, Z., Gu, Z., Zhong, H., Zha, Q., et al. (2020). A bibliometric analysis using VOSviewer of publications on COVID-19. *Annals of Translational Medicine*, 8, pp. 816-816. doi: 10.21037/atm-20-4235
- Zoom. (2023a). Zoom: One Platform to Connect [WWW Document]. Available at <https://zoom.us/> [accessed 7 May, 2024].
- Zoom. (2023b). Limiting Network Bandwidth [WWW Document]. Available at https://support.zoom.com/hc/en/article?id=zm_kb&sysparm_article=KB0059400#:~:text=Zoom%20applications%20are%20designed%20to,to%20calculate%20what%20is%20available [accessed 7 October, 2024].
- Zoom. (2023c). Unified Communication and Collaboration Platform for Schools and Universities [WWW Document]. Available at <https://explore.zoom.us/en/collaboration-tools/solutions/education/> [accessed 7 October, 2024].