Asian Association of Open Universities Journal

Incorporating face-to-face and online learning features to propose blended learning framework for Post-COVID classrooms in India

Md. Tauseef Qamar
School of Advanced Sciences and Languages, VIT Bhopal University, Sehore, India
Abdullah Malik
Department of Commerce, Jain Online, Jain (Deemed to be University), Bengaluru, India
Juhi Yasmeen
School of Advanced Sciences and Languages, VIT Bhopal University, Sehore, India
Mohd. Sadiqe
Dr Rammanohar Lohia Avadh University, Ayodhya, India, and
Mohd Ajmal
Department of Commerce, Aligarh Muslim University, Aligarh, India

Received 7 August 2023
Revised 18 January 2024
11 April 2024
Accepted 10 May 2024

Abstract

Purpose – This study examines learner readiness and satisfaction with blended learning systems in India's post-vaccine classrooms, focusing on the relationship between face-to-face (F2F), online learning (OL), and blended learning (BL) indicators and identifying which predictors within these systems most significantly affect learners' satisfaction (LS).

Design/methodology/approach – An online survey was conducted with 451 students from both public and private universities in India. The data were analyzed using factor analysis and confirmatory factor analysis, followed by multiple regression to test the hypotheses.

Findings – The findings reveal a significant positive correlation between learners' satisfaction and online learning and blended learning, with β values of 28.3 and 27.2, bearing a p-value of 0.000. In contrast, face-to-face (F2F) learning was insignificant, with a β value of 0.070 and a p-value of 0.119. These insights underscore the effectiveness of online and blended learning formats in enhancing learner satisfaction in higher education while also suggesting a re-evaluation of the role of traditional F2F learning methods. The research supports the integration of online learning in higher education due to its balanced mix of teacher-led and student-centered instruction, alongside the practical benefits of reduced travel costs and access to independent study resources.

Practical implications – This study provides insights into student perceptions and attitudes towards blended learning in India's post-vaccine classrooms. It highlights the importance of tailoring blended learning strategies to meet colleges' and universities' diverse learning needs and goals in this evolving context. The findings serve as a valuable resource for educators and administrators, aiding in designing effective blended learning frameworks suited explicitly for higher education in India.

Asian Association of Open Universities Journal
Emerald Publishing Limited
e-ISSN: 2414-6994
p-ISSN: 1858-3431
DOI 10.1108/AAOUJ-08-2023-0097

Originality/value – While there is extensive literature on F2F, OL, and BL, limited research compares these learning approaches and their impact on learner satisfaction within the Indian higher education context. This study fills this gap by providing valuable insights for shaping educational strategies in India's post-vaccine classrooms.

Keywords Blended learning, Face-to-face learning, Learners' perceptions, Online learning, Post-COVID-19 class

Paper type Research paper

1. Introduction

Throughout history, the highly infectious coronavirus has significantly impacted human life, confining us indoors, causing millions of deaths, and halting many aspects of life, including global education (Singh *et al.*, 2021; Aristovnik *et al.*, 2023; Tang, 2023; Dedeilia *et al.*, 2023). The education sector suffered immensely due to skyrocketing coronavirus cases and faced numerous challenges in teaching and learning, which necessitated a rapid transformation in educational methodologies. This situation increased the workload for teachers and faculty at institutions like schools, colleges, and universities (Dhawan, 2020; Rapanta *et al.*, 2020). The rising death toll and ongoing spread of the virus raised concerns among students, teachers, and educators regarding the timely reopening of educational institutions, further extending the reliance on online education. Previous works have documented the progression of coronavirus from an epidemic to a pandemic, suggesting that COVID-19 would not quickly disappear and emphasizing the need for persistent COVID-19-safe practices to prevent its spread (Singh *et al.*, 2021). This scenario has intensified fear and anxiety about the future of in-person learning worldwide. Nonetheless, there has been promising news from the scientific community regarding the development of vaccines to boost the human body's defence against the virus. Studies indicate that vaccines provide essential antibodies to disrupt the virus's transmission chain. However, even with vaccination, it is strongly recommended that students continue to exercise caution and adhere to COVID-19 safety guidelines in educational settings (Powell *et al.*, 2021). In these circumstances, a blended or hybrid learning model, combining in-person and online learning, emerges as a viable solution to meet educational needs amid these precautions and restrictions.

Teaching-learning practice is rapidly changing due to the consecutive waves of COVID-19. Institutes are quickly reshaping their pedagogical methods and moving towards blended learning (BL) and remote learning environments if some have not done the same (Ehrlich *et al.*, 2020; Moszkowicz *et al.*, 2020). The BL is a pedagogical method that combines online and traditional or face-to-face learning opportunities (Garrison and Kanuka, 2004; Garrison and Vaughan, 2008). This technique offers several key features: (1) learner-centric instruction, where learning contents are designed according to the student's individual preference; (2) focus given on the enhancement of teacher-learner, learner-learner, learner-educational contents, and learner-other stakeholders interactions, including learner-supplementary materials; and (3) continuous collection of formative and summative testing results to upgrade the courses (Watson, 2008).

Due to the continuous COVID-19 waves, BL is being rapidly adopted as a pedagogical method globally. Nevertheless, it is an overnight change and hassle-free. Though BL is an old practice in developed nations, developing countries still face numerous challenges regarding its smooth and effective application. Because BL's effectiveness greatly depends on several factors, one such problem is ensuring the hassle-free accessibility of technology to learners (Hofmann, 2014). He further mentioned that the difficulty in technology accessibility might lead to both users' abundance of learning and the failure of the technical learning applications. According to a report, 16% of learners have negative attitudes towards blended learning, whereas 26% believe the course won't be completed (The Oxford Group, 2013).

Learners are the key participants in teaching-learning activities. As a result, it is vital to determine their readiness and perceptions for effective pedagogical implementation that fits well with their backgrounds and abilities, especially in a BL context, as some learners may not cope with the new design and tools. Hence, their academic performance may be negatively impacted. Therefore, the existing study examines university learners' perceptions of adopting BL, which is also likely to happen in post-COVID classrooms in India. In this regard, students' demographic profiles have been inquired to assess learners' attitudes towards it in post-COVID classes concerning the prior experience of BL, required technical skills, use of technology for teaching-learning activities, education level, age, gender, etc. Furthermore, we have also investigated the content quality, content design, and features such as flexibility and anytime/anywhere, including their role in goal achievement that attracts learners towards BL. Furthermore, overall attitudes towards traditional teaching (F2F learning), pure online learning (OL), and blended learning and their overall impact on learners' academic satisfaction.

2. Theoretical underpinnings and study framework

COVID-19 profoundly impacted academia, presenting unprecedented challenges during the 2020–2021 academic session. Teachers, learners, and educational administrators faced significant barriers due to the pandemic (Singh *et al.*, 2021). Despite the widespread administration of vaccines, transitioning back to traditional in-person classrooms was fraught with challenges, influenced by the ongoing impact of the coronavirus (Dorn *et al.*, 2020).

Before the pandemic, the educational landscape predominantly operated in a traditional or pure face-to-face (F2F) format. This approach offered several benefits, such as direct interaction between instructors and learners, fostering lively in-class discussions, and enabling immediate question-and-answer sessions (Paul and Jefferson, 2019). However, those accustomed to F2F learning found online learning challenging, as it often required extended periods of computer use (Roval and Jordan, 2004; Qamar *et al.*, 2023). Numerous studies have highlighted that F2F learning can significantly benefit students, from enhancing motivation and fostering community-building bonds to enabling teachers to make decisions and choose the right content and instructional methods (Paul and Jefferson, 2019).

Despite the advantages of F2F learning, the pandemic necessitated a swift shift to online learning for schools, colleges, and universities to maintain uninterrupted education (Singh *et al.*, 2021; Singh and Matthees, 2021). Online learning provides benefits like self-regulated learning, improved time management, collaborative learning, flexibility, and cost-effectiveness (Singh and Matthees, 2021; Smith and Hardaker, 2000). The persistent surge in COVID-19 cases meant that online education remained a primary learning mode. With the advent of vaccinations, the situation gradually started to relax, leading to the adoption of flipped, hybrid, or blended learning models. These models enabled learners to participate in education with appropriate COVID-19 safety measures, as health experts predicted that more virus waves would potentially restrict outdoor activities (Singh and Matthees, 2021).

The pandemic-induced transition in the education sector has effectively transformed the higher education structure. Every learning format, whether traditional, online, or blended, has advantages and disadvantages. In the post-pandemic scenario, numerous educational institutions have transitioned from a purely online format to a blended learning approach. Blended learning combines traditional F2F classroom sessions with online learning sessions, offering students the advantages of both formats. This includes flexible schedules, self-paced homework, and assignments (Singh *et al.*, 2021). This instructional approach is a paradigm shift, allowing educators to redesign and update educational content to suit students' specific needs, especially in courses requiring more engaging learner experiences, which is challenging to achieve in purely F2F or online formats (Dhawan, 2020).

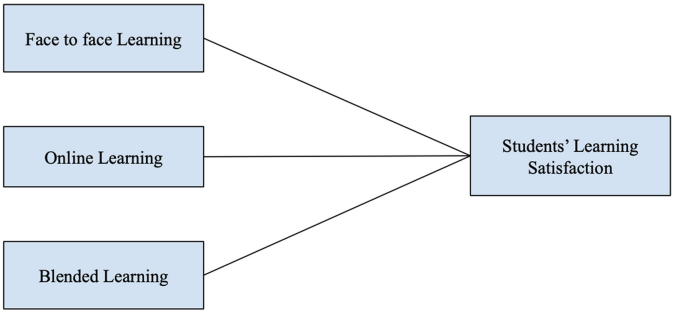
Our study aims to identify key indicators for effectively implementing blended learning. These indicators are crucial for understanding how blended learning affects learner satisfaction during pandemics and how educators can utilize these indicators while planning post-pandemic teaching strategies (see Figure 1). While there is a rich body of literature on the effectiveness of F2F and online learning, there is a notable gap in studies focusing on blended learning effectiveness indicators. These indicators are essential for providing a meaningful learning environment in higher education. Systematic investigation of these indicators can significantly benefit the teaching-learning community, especially with the resumption of in-person education and the possibility of future COVID-19 waves. Such research will assist educational institutes, app developers, and other stakeholders in providing continuous education through blended learning while adhering to COVID-19-appropriate behavior.

Therefore, we propose a state-of-the-art model based on our study's key findings. This model outlines implementing blended learning effectively in higher education settings (see Figure 5). The existing literature shows only a few studies focusing on blended learning effectiveness indicators, which instructors can leverage to provide high-quality education to learners. Our research seeks to fill this gap by offering a comprehensive view of these indicators, explicitly based on quantitative and qualitative analyses. At the same time, extensive literature covers the advantages and disadvantages of both F2F and online learning formats. It is pertinent to systematically investigate blended learning key effectiveness indicators that could facilitate instructors in providing a meaningful learning environment, especially in higher education. Such findings will surely benefit teaching-learning communities, particularly as we transition back to in-person education due to the declining trend in COVID-19 cases. Additionally, as health experts predict more waves in the future, our study will help educational institutes, app developers, and other stakeholders provide continued education through blended learning along with appropriate COVID-19 behaviour wherever and whenever necessary.

3. Related works and hypothesis development

3.1 Face-to-face learning and learners' satisfaction

Over the past 2 decades, classroom scenarios have undergone significant changes due to the integration of technology and its inevitable penetration into human life (Tratnik *et al.*, 2019). With the COVID-19 outbreak, the education system experienced a dramatic shift from offline to online modalities (Lee *et al.*, 2021), leading to exponential growth in various online courses. The nature of online courses differs considerably from face-to-face courses, primarily in that students typically have more freedom to control their learning progress. In contrast, face-to-face learning is generally more teacher-centric, offering students less control over their



Source(s): Literature review

Figure 1.
Conceptual framework

learning process (Tratnik *et al.*, 2019; Hamid, 2001). Despite teachers showing significant progress in interest and creativity in online courses (see Otter *et al.*, 2013; Weber and Lennon, 2007; Zhang *et al.*, 2010), the literature comparing pure face-to-face and pure online learning courses has recorded mixed learner reactions. Few studies reported higher satisfaction with face-to-face learning (Allen and Seaman, 2004; Roach and Lemasters, 2006; Tallent-Runnels *et al.*, 2006), others preferred online learning (Hui *et al.*, 2008), and some found no statistical difference between the two formats (Sitzmann *et al.*, 2006; Zhang *et al.*, 2004; Tratnik *et al.*, 2019). Consequently, this study compares students' overall satisfaction with all three face-to-face, online, and blended learning formats among Indian university learners. Specifically, this paper seeks to identify key effectiveness indicators affecting students' learning satisfaction in relation to education content, delivery of material, course features, the role of the teacher, teacher-student interaction frequency, self-regulation, and student-student interactivity. Therefore, face-to-face learning is considered a critical indicator of students' learning satisfaction with the system, leading to the following hypothesis:

H1. Face-to-face learning positively affects students' learning satisfaction.

3.2 Online learning and learners' satisfaction

Previous studies highlight the critical role of learner satisfaction—shaped by attitudes, system usability, and experiences—in sustaining engagement and determining success in online learning environments, ultimately influencing learning outcomes (Dhawan, 2020; Moore and Kearsley, 2012; Parahoo *et al.*, 2016; Ke and Kwak, 2013).

The pandemic-induced transition to online learning prompted research into educational needs and learner sentiment, identifying eight barriers to satisfaction: technical issues, administrative challenges, inadequate pedagogical and technical skills, interactivity problems, poor connectivity, accessibility issues, low motivation, internet cost concerns, limited availability, and insufficient study support. These factors are critical to understanding and improving the online learning experience (Hew *et al.*, 2020; Jiang *et al.*, 2021; She *et al.*, 2021; Muilenburg and Berge, 2005).

Baber (2020) compared perceptions of online learning system satisfaction indicators between Indian and South Korean undergraduate students. The findings indicated that students' learning satisfaction was influenced by factors such as classroom interactivity, engagement, course flow, instructor skills, and positive teacher attitudes. Additionally, aspects related to system support, information, and the quality of the online platform's services were significant. Students also noted that self-control, advanced digital skills, prior system knowledge, and readiness to use smart tools were crucial for satisfaction in online courses (Lee *et al.*, 2011; Jan, 2015; Jiang *et al.*, 2021).

Thus, the current study recognizes online learning as a key indicator of students' learning satisfaction and hypothesizes that:

H2. Online learning positively affects students' learning satisfaction.

3.3 Blended learning and learners' satisfaction

Blended Learning (BL) combines traditional classroom instruction with online learning and is emerging as a popular, flexible instructional strategy. This approach, often seen in flipped classrooms, shifts the focus from teacher-led to learner-driven experiences, allowing students to learn at their own pace through online materials and in-person sessions. BL emphasizes collaborative learning in face-to-face sessions through group activities and problem-solving, thereby enhancing critical thinking and cognitive skills. This evolution from conventional to more interactive and student-focused learning methodologies underscores BL's role in modernizing educational practices (Lin *et al.*, 2022; McCarthy, 2016a, b).

In BL environments, the role of the student is amplified; they have increased opportunities to interact with teachers, peers, and other students. Teachers act as facilitators or collaborators, providing enhanced guidance, mentoring, tutoring, and interaction, contributing to students' increased satisfaction with the course (McCarthy, 2016a, b; Moffett, 2015). Previous studies have identified factors that could hinder the effectiveness of BL learning outcomes and reduce student satisfaction. These factors are primarily categorized into pedagogical and technological components. Issues such as poor quality of educational content design, video production quality, and video resolution have been cited as reasons for student dropout (Akçayır and Akçayır, 2018; McCarthy, 2016a, b; Milman, 2012), as well as the degree of learning from these videos (Milman, 2012).

Findings from previous research on BL have been varied, depending on the constructs used to measure student satisfaction. Some studies have noted enhanced performance and satisfaction with BL courses (Låg and Sæle, 2019; Strelan *et al.*, 2020) compared to pure face-to-face and online learning. However, other students have expressed higher dissatisfaction and lower academic performance in BL courses than in traditional learning settings (Van Alten *et al.*, 2019). In this context, our study aims to compare the components of pure face-to-face, online, and blended learning to uncover nuanced insights into students' perceptions of BL. We hypothesize that:

H3. Blended learning positively affects students' learning satisfaction.

4. Method

4.1 Sample, data collection, and questionnaire development

In the evolving landscape of Indian education, particularly in post-vaccine classrooms, the transition from traditional face-to-face (F2F) to online learning (OL) during the initial COVID-19 lockdown has significantly shifted the psychological barriers of educational stakeholders toward technology in teaching. Despite a wealth of literature on F2F and OL, there's a notable gap in studies comparing these methods to develop blended learning (BL) in India. Recognizing this, the University Grants Commission (UGC) has advocated for integrating BL into educational institutions. This study aims to merge factors from F2F, OL, and BL, assessing their impact on student satisfaction to formulate an effective BL framework for India.

The research delves into the existing literature on F2F, OL, and BL (Singh *et al.*, 2021; Gherheş *et al.*, 2021; Bowden, 2022; Atwa *et al.*, 2022; Singh *et al.*, 2022) to develop a comprehensive research instrument. A questionnaire focusing on educational material quality, content delivery, and interactivity was created to measure its impact on student satisfaction. A pilot study with 76 students refined the questionnaire, which two experienced teachers, one in language and another in statistics, further improved. Both experts, familiar with F2F and online courses during the pandemic, rigorously validated the questionnaire, leading to the deletion of four items due to semantic redundancy and the addition of one item related to system ease of use.

The finalized questionnaire, consisting of 28 items, aimed to assess students' learning satisfaction across F2F, OL, and BL, reflecting their experiences through pre-pandemic, pandemic, and post-vaccine phases. It also included demographic queries. A preliminary test with three students ensured the clarity and consistency of the questions.

Subsequently, 560 students from two Indian universities – a private university in Bengaluru and another in New Delhi – participated in the survey. All respondents had experience with all three learning formats. The survey introduction clarified the study's objectives, data usage, and confidentiality. The data collection spanned from January 2021 to August 2022. Responses were ranked on a 5-point Likert scale from complete agreement to

total disagreement. After the data collection, 13 unsuitable responses were excluded, leaving 451 for quantitative analysis to identify key determinants of F2F, OL, and BL.

5. Data analysis

5.1 Demographics

Tha data for the study were gathered from 451 participants, comprising 281 males and 170 females, all aged between 21 and 38 years. Seventy-six (76) were married, and 375 were unmarried. The educational background revealed 183 graduates, 247 postgraduates, and 21 doctorates. In the following sections, an analysis of the data is presented.

5.2 Reliability analysis

The reliability analysis for the face-to-face learning items resulted in the retention of six variables post-deletion in the Exploratory Factor Analysis (EFA), yielding a Cronbach's alpha of 0.732. In contrast, the original compositions of the online and blended learning items were maintained, each consisting of 10 items, with Cronbach's alpha values of 0.860 and 0.832, respectively. This indicates a 73.2%, 86%, and 83.2% consistency under the independent variable category. Moreover, the dependent variable, learning satisfaction, demonstrated high consistency with a Cronbach's alpha of 0.946. (see Table 1).

5.3 Exploratory factor analysis – face-to-face, online, and blended learning

Exploratory Factor Analysis (EFA) of variables from literature-based questions identified key factors for face-to-face, online, and blended learning. Four items in the face-to-face category were excluded due to poor fit. EFA outcomes showed a Kaiser-Meyer-Olkin (KMO) measure of 0.632 for face-to-face learning, indicating moderate sampling adequacy, and a Bartlett's test of sphericity was not significant ($p > 0.05$), suggesting items may not be interrelated as expected. The total variance explained was 61.4% for face-to-face learning. Online and blended learning analyses yielded better KMO values of 0.846 and 0.797, respectively, both with Bartlett's test of Sphericity results also above the 0.05 threshold, and total variances explained by their factors were similarly high at 61.3 and 61.4%. Variables across all learning modes were grouped into two distinct categories under the rotated component matrix, indicating good data quality for further causal relationship assessment toward learner satisfaction. The precise categorization and full statistical details are provided in Table 2 of the study.

5.4 Measurement model – face-to-face, online, and blended learning

5.4.1 Measure for the goodness of fit and estimates. In the initial model run, the face-to-face learning model exhibited the following indices: CMIN/DF = 3.04, Chi-square = 65.9,

	No of items	Cronbach's alpha value
Independent variables		
Face-to-face learning	6	0.732
Online learning	10	0.860
Blended learning	9	0.832
Dependent variables		
Learning satisfaction	12	0.946

Source(s): Primary data

Table 1. Reliability analysis

KMO and Bartlett's test

Face-to- face learning			Online learning			Blended learning		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.632	Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.846	Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.797
Bartlett's Test of Sphericity	Approx. Chi-Square	230.808	Bartlett's Test of Sphericity	Approx. Chi-Square	903.664	Bartlett's Test of Sphericity	Approx. Chi-Square	709.608
	Df	15		Df	45		Df	36
	Sig	0.000		Sig	0.000		Sig	0.000
Total variance explained (%)		61.47	Total variance explained (%)		61.31	Total variance explained (%)		61.40

Rotated component matrix[a]

Face-to- face learning			Online learning			Blended learning		
	Components			Components			Components	
Indicators	1	2	Indicators	1	2	Indicators	1	2
FTF7	0.874		OL5	0.804		BL5	0.824	
FTF6	0.826		OL6	0.784		BL6	0.822	
FTF8	0.710		OL7	0.784		BL7	0.758	
FTF1		0.834	OL8	0.746		BL10	0.717	
FTF3		0.685	OL9	0.720		BL9	0.650	
FTF5		0.601	OL10	0.707		BL1		0.821
			OL1		0.871	BL2		0.777
			OL2		0.838	BL3		0.732
			OL3		0.800	BL4		0.635

Note(s): Extraction method: principal component analysis rotation method: varimax with Kaiser normalization

[a]Rotation converged in 3 iterations

Source(s): Primary data

Table 2. Exploratory factor analysis

p-value = 0.000, GFI = 0.939, NFI = 0.863, CFI = 0.875, and RMSEA = 0.041. The online learning model showed CMIN/DF = 3.19, Chi-square = 199.9, p-value = 0.000, GFI = 0.899, NFI = 0.880, CFI = 0.893, and RMSEA = 0.037. The blended learning model reported CMIN/DF = 5.87, Chi-square = 177.8, p-value = 0.000, GFI = 0.919, NFI = 0.911, CFI = 0.922, and RMSEA = 0.053. These results indicated a relatively poor fit in the parsimonious model run.

Subsequently, an improved model run was conducted, where two items were deleted for online and blended learning. The revised fit indices indicated a good model fit for all three independent variables. The face-to-face learning showed improved results with CMIN/DF = 2.17, Chi-square = 62.7, p-value = 0.000, GFI = 0.958, NFI = 0.869, CFI = 0.880, and RMSEA = 0.037. The online learning model also demonstrated a good fit with CMIN/DF = 2.81, Chi-square = 196.2, p-value = 0.000, GFI = 0.919, NFI = 0.877, CFI = 0.888, and RMSEA = 0.033. Finally, the blended learning model yielded favorable results with CMIN/DF = 2.59, Chi-square = 138.4, p-value = 0.000, GFI = 0.940, NFI = 0.931, CFI = 0.940, and RMSEA = 0.011 (see Table 3).

5.4.2 Convergent and discriminant validity. Convergent validity was measured using the Average Variance Extracted (AVE) and Construct Reliability (C.R.). In face-to-face learning, across two factors, FTF-1 and FTF-2, the AVE values were 0.49 and 0.39, with construct reliability at 0.73 and 0.52, respectively. Online learning exhibited AVEs of 0.52 and 0.67 for OL 1 and OL 2 and constructed reliability of 0.86 and 0.82. The analysis of blended learning revealed that the Average Variance Extracted (AVE) for the constructs BL 1 and BL 2 was

0.48 and 0.46, respectively. Additionally, the construct reliability for BL 1 and BL 2 was found to be 0.81 and 0.77, respectively (see Table 4).

Further, discriminant validity assessments showed that for all latent variables, the Average Variance Extracted (AVE) exceeded the squared inter-construct correlations, confirming discriminant validity (as shown in Table 4). These results collectively affirm the validity of the constructs used in the questionnaire, emphasizing the robustness of the measurement instruments employed in this study (see Figures 2–4).

6. Face-to-face, online, and blended learning impact on students' satisfaction

This study utilized multiple regression analysis to assess the impact of Face-to-Face (F2F), Online, and Blended Learning approaches on learner satisfaction, aiming to inform the development of an effective Blended Learning (BL) model (see Figure 5) for post-COVID Indian classrooms. The model summary reported a correlation coefficient (R) of 0.529, accounting for 53% (approx.) of the variance. The determination coefficient (R^2) stood at 0.280, suggesting that these learning modes explain 28% of the variance in learning satisfaction. The adjusted coefficient of determination (adjusted $R^2 = 0.275$) was slightly lower, providing a more accurate representation of the model's fit in predicting satisfaction.

The coefficient table summary highlighted the varying impacts of these learning modalities on learning satisfaction. F2F learning showed a minimal and statistically insignificant effect, contributing only 7% to the variance in learning satisfaction ($\beta = 0.070$, p-value = 0.119). On the other hand, Online learning had a significant positive effect, explaining 28.3% of the variance in learning satisfaction ($\beta = 0.283$, p-value = 0.000). Similarly, Blended Learning exhibited a significant positive relationship with learning satisfaction, accounting for 27.2% of the variance ($\beta = 0.272$, p-value = 0.000). These insights, detailed in Table 5, underscore the differential influence of learning approaches on student satisfaction.

7. Discussions and implications

This study aimed to devise an effective blended learning (BL) framework for post-vaccine classrooms in India by investigating face-to-face (F2F) and online learning factors. Guided by two primary questions - "Did we really learn from the COVID-19 virus?" and "Are we really prepared with appropriate pedagogical techniques for post-vaccine education in India?" - we examined university students' perceptions and satisfaction with three learning approaches:

Face to face learning			Online learning		Blended learning	
Model fit elements	Parsimonious Model	Improved model	Parsimonious model	Improved model	Parsimonious model	Improved model
CMIN/DF	3.04	2.17	3.19	2.81	5.87	2.59
χ^2	65.9	62.7	199.9	196.2	177.8	138.4
DF	8	7	25	22	24	21
p-value	0.000	0.000	0.000	0.000	0.000	0.000
GFI	0.939	0.958	0.898	0.919	918	0.940
NFI	0.863	0.869	0.880	0.877	0.911	0.931
CFI	0.875	0.880	0.893	0.888	0.922	0.940
RMSEA	0.041	0.037	0.046	0.033	0.053	0.011

Source(s): Primary data

Table 3. Goodness of fit measures of face-to-face, online and blended learning

Face-to-face learning	Estimates (Standardized)	*p*-value	Online learning	Estimates (Standardised)	*p*-value	Blended learning	Estimates (Standardised)	*p*-value
FTF6 ← F1	0.831	0.000	OL5 ← F1	0.717	0.000	BL5 ← F1	0.781	0.000
FTF7 ← F1	0.709	0.000	OL6 ← F1	0.752	0.000	BL6 ← F1	0.766	0.000
FTF8 ← F1	0.441	0.000	OL7 ← F1	0.699	0.000	BL7 ← F1	0.701	0.000
FTF1 ← F1	0.497	0.000	OL8 ← F1	0.652	0.000	BL9 ← F1	0.556	0.000
FTF3 ← F1	0.415	0.000	OL9 ← F1	0.781	0.000	BL10 ← F1	0.621	0.000
FTF5 ← F1	0.626	0.000	OL10 ← F1	0.744	0.000	BL1 ← F2	0.742	0.000
			OL1 ← F2	0.875	0.000	BL2 ← F2	0.804	0.000
			OL2 ← F2	0.821	0.000	BL3 ← F2	0.666	0.000
			OL3 ← F2	0.629	0.000	BL4 ← F2	0.483	0.000

Convergent validity

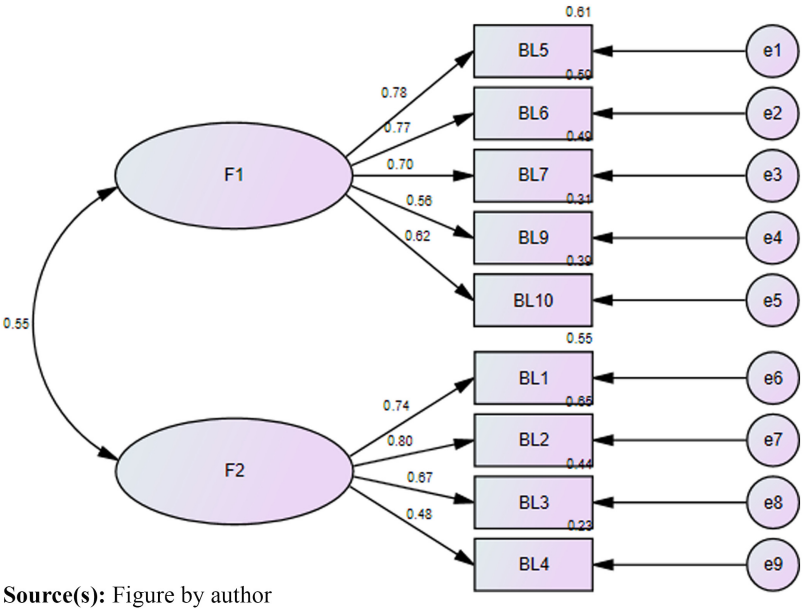
Face-to-face learning				Online learning				Blended learning			
Dimensions	Items	Average variance extracted	Construct reliability	Dimensions	Items	Average variance extracted	Construct reliability	Dimensions	Items	Average variance extracted	Construct reliability
Face-to-Face Learning	FTF1	0.49	0.73	Online Learning	OL1	0.52	0.86	Blended Learning	BL1	0.48	0.81
	FTF2	0.37	0.52		OL2	0.61	0.82		BL2	0.46	0.77

Discriminant validity

Face-to-face learning					Online learning					Blended learning				
Items of dimensions	No. Of items	Average variance extracted	Correlation (squared inter construct correlation)		Items of dimensions	No. Of items	Average variance extracted	Correlation (squared inter construct correlation)		Items of dimensions	No. Of items	Average variance extracted	Correlation (squared inter construct correlation)	
FTF1	3	0.49	*1*	0.014	OL1	6	0.52	*1*	0.272	BL1	5	0.48	*1*	0.216
FTF2	3	0.37	0.120	*1*	OL2	3	0.61	0.522	*1*	BL2	4	0.46	0.465	*1*

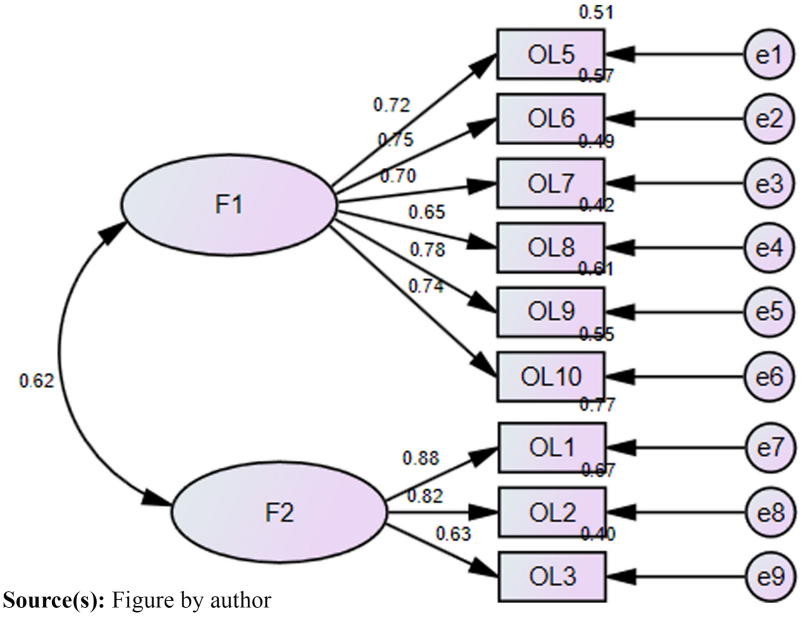
Source(s): Primary data

Table 4.
Goodness of fit measures, convergent and discriminant validity of face to face, online and blended learning



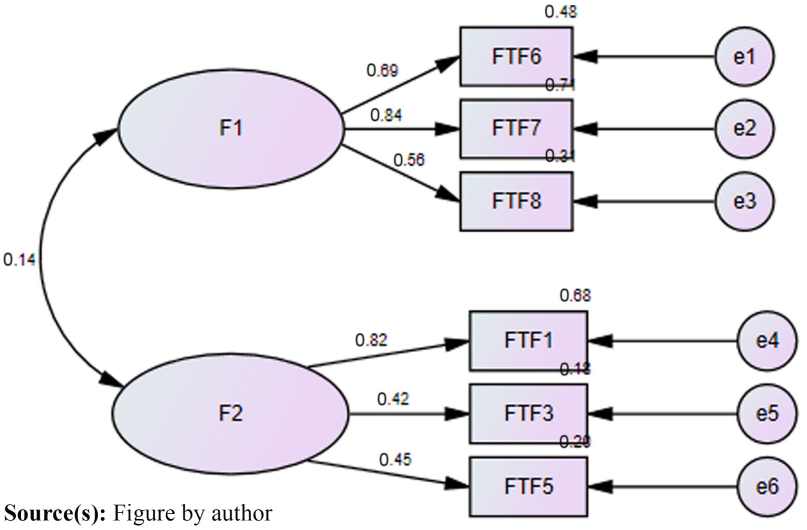
Source(s): Figure by author

Figure 2.
Showing confirmatory factor analysis of blended learning



Source(s): Figure by author

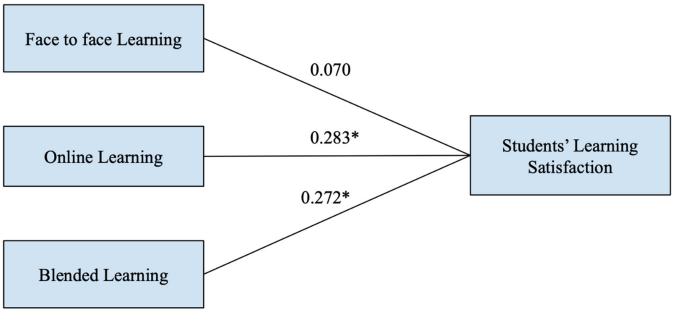
Figure 3.
Showing confirmatory factor analysis of online learning



Source(s): Figure by author

Figure 4.
Showing confirmatory factor analysis of face-to-face learning

F2F (pre-pandemic experiences), online learning (during the initial COVID-19 lockdown), and BL (between COVID-19 waves, post-vaccination). The study focused on aspects such as the teacher's role, educational techniques, and technological integration.



Source(s): Study's result

Figure 5.
Showing the causal relationship of F2F, OL, and BL

	Estimate	Error	Standardised estimates (β)	*t*	Sig. (*p*-value)
Constant	18.863	2.659	–	7.094	0.000
Face to face learning	0.184	0.118	0.070	1.564	0.119
Online learning	0.390	0.075	0.283	5.182	0.000
Blended learning	0.391	0.073	0.272	5.339	0.000

Model summary				
R	R^2	Adjusted R^2	SE of the estimate	Sig. *F* change
0.529	0.280	0.275	7.76392	0.000

Note(s): *Independent variables:* face to face learning, online learning, blended learning
Dependent variables: learning satisfaction
Source(s): Primary data

Table 5.
Regression analysis

The findings revealed a positive significant association between learners' satisfaction and both online learning and BL, with β values of 28.3 and 27.2, respectively, and a *p*-value of 0.000. However, F2F learning showed an insignificant effect on satisfaction (β = 0.070, *p*-value = 0.119). These results align with prior studies (Marriot *et al.*, 2004; Alammary, 2022; Ogbona, 2021) that emphasize the importance of F2F learning in fostering a sense of belonging and the teacher's vital role. Additionally, online learning's impact on student satisfaction was found to be greater than that of BL (see Table 5), resonating with the findings of Singh *et al.* (2021), Tratnik *et al.* (2019), Kintu *et al.* (2017), and She *et al.* (2021).

Regression analysis demonstrates online learning modalities significantly impact learner satisfaction, with an *R*-squared value of 0.280 indicating a considerable variance explanation in satisfaction levels. Key benefits of online learning, including superior internet systems, engaging animations, and flexible learning schedules, contribute to enhanced collaboration, knowledge, and skill development. Interactivity within online platforms is pivotal for forging social connections and boosting course satisfaction, as it positively affects academic skills and self-efficacy, aligning with findings from various studies (Demir Kaymak and Horzum, 2013; Strauß and Rummel, 2020; Aragon, 2003; Kim and Frick, 2011; Nelson *et al.*, 2005; Tekin *et al.*, 2014; Gebauer *et al.*, 2020). Teachers play a crucial role in guiding and fostering growth, with interaction with course content crucial for cognitive skill development (Miller and Brickman, 2004; McMahon *et al.*, 2009; Moore, 1989). Regression coefficients for online and blended learning show positive impacts on satisfaction, with standardized estimates of 0.283 and 0.272, respectively, and *p*-values of

0.000, highlighting the importance of technology, pedagogy, interactivity, face-to-face interactions, content frequency, self-regulation, software quality, and tools in the blended learning system.

This study enriches existing knowledge by identifying key factors for effectively implementing Blended Learning (BL) in post-vaccine classrooms in India. For this, we have examined the first-order variable against the second-order variables, focusing on the crucial elements of Face-to-Face (F2F), Online Learning (OL), and BL to evaluate their combined effects on students' learning satisfaction. The research findings indicate that among the three learning modalities—face-to-face (F2F), online learning (OL), and blended learning (BL)—it, OL and BL that had a positive influence on learner satisfaction. This is evidenced by significant beta values ($\beta = 0.283$ for OL and $\beta = 0.272$ for BL) and p-values (0.000 for both OL and BL). Notably, BL factors were the most influential factors for Indian students, surpassing both OL and F2F in terms of impact. This result holds considerable implications for educational strategies within Indian universities.

This study is among the pioneering efforts to evaluate learners' overall educational satisfaction with Face-to-Face (F2F), Online Learning (OL), and Blended Learning (BL) in India's post-vaccine educational landscape. It provides foundational insights into the factors influencing learning satisfaction within a BL framework. By examining learners' perceptions and experiences with F2F, OL, and BL, the study assesses their collective influence on learning satisfaction. These findings lay the groundwork for future research to uncover additional factors crucial for learning satisfaction in BL settings. The study reveals a preference for OL and BL over F2F, highlighting the importance of blending the teacher's role with online learning elements to enrich the academic experience.

The preference for BL, demonstrated in this study, underscores the need for educators, universities, and other stakeholders to prioritize BL factors. The BL framework combines face-to-face and online teaching, allowing students to clarify doubts from online sessions in face-to-face interactions with teachers. In this model, online sessions are delivered through the university's e-system, while F2F sessions take place on campus, necessitating high-quality software and hardware, along with proficient instructors. The study emphasizes the importance of regular software updates, ease of operation by instructors, and training in digital and in-class strategies to ensure smooth course functioning. The study's themes include technological, educational, and interactivity factors.

Dhawan (2020) noted the necessity of computer and technology skills in a BL environment. Our study confirms students' competence in using computers and the internet within BL, diverging from Kintu *et al.* (2017), who found that reluctance and incompetence in these areas led to higher dropout rates in OL and BL courses. Unlike Cohen (2012) findings, issues like family responsibilities, work timing, accessibility, and connectivity did not significantly hinder participation in our study, as most participants were full-time students in a BL course. Our results align with Qamar *et al.*'s (2023) research, showing positive student attitudes towards OL and BL, which are viewed as instrumental to educational success. Therefore, university administrations must implement systems that not only impart academic knowledge but also foster creativity, collaborative skills, and self-efficacy, preparing students for efficient future workplace performance.

8. Conclusion, limitations, and future direction

This study concludes that successful blended learning (BL) implementation in post-vaccine classrooms necessitates the careful integration of technology in both teaching and learning. A thorough examination of face-to-face (F2F) and online learning elements is essential to develop an effective BL framework. Key indicators from online and blended learning

significantly influenced learners' satisfaction. Out of twenty-nine variables in the measurement model (CFA), twenty-four were relevant across the latent variables of F2F, online, and blended learning. Nine variables, each from online and blended learning, significantly contributed to understand the causal relationship with learners' satisfaction. However, six F2F variables showed an insignificant causal link, indicating a need for further research to explore their impact on different educational settings.

Every research permeates through limitations, and this study is no exception. This work gathered its data solely from students at two prominent universities in India—one public and the other private. This sampling does not necessarily capture the diversity of the broader student population. Therefore, generalizing these findings to all Indian university students should be done with caution, considering the limited sample size, distinctive characteristics of the learners, and the specific educational infrastructures of the surveyed institutions. Future research would gain from a broader and more varied sample spanning multiple universities to attain more widely applicable findings. Moreover, this study's use of purposive sampling was specifically chosen to investigate causal relationships between study variables, which may not be as broadly generalizable as those obtained through longitudinal and experimental research designs. Future inquiries are warranted considering factors such as students' perceptions, the attributes of teachers, and the emotional components of blended learning (BL). While this study has focused on quantitative analysis, subsequent research using qualitative methodologies could also provide a deeper, more nuanced comprehension of BL, particularly in addressing aspects not explored in the present study.

References

Akçayır, G. and Akçayır, M. (2018), "The flipped classroom: a review of its advantages and challenges", *Computers and Education*, Vol. 126, pp. 334-345, doi: 10.1016/j.compedu.2018.07.021.

Alammary, A.S. (2022), "How to decide the proportion of online to face-to-face components of a blended course? A delphi study", *SAGE Open*, Vol. 12 No. 4, 215824402211384, doi: 10.1177/21582440221138448.

Allen, I.E. and Seaman, J. (2004), *Entering the Mainstream: The Quality and Extent of Online Education in the United States, 2003 and 2004*, Sloan Consortium, Newburyport, MA.

Aragon, S.R. (2003), "Creating social presence in online environments", *New Directions for Adult and Continuing Education*, Vol. 2003 No. 100, pp. 57-68, doi: 10.1002/ace.119.

Aristovnik, A., Karampelas, K., Umek, L. and Ravšelj, D. (2023), "Impact of the COVID-19 pandemic on online learning in higher education: a bibliometric analysis", *Frontiers of Education*, Vol. 8, pp. 1-13, doi: 10.3389/feduc.2023.1225834.

Atwa, H., Shehata, M.H., Al-Ansari, A., Kumar, A., Jaradat, A., Ahmed, J. and Deifalla, A. (2022), "Online, Face-to-face, or blended learning? Faculty and medical students' perceptions during the COVID-19 pandemic: a mixed-method study", *Frontiers in Medicine*, Vol. 9, p. 15, doi: 10.3389/fmed.2022.791352.

Baber, H. (2020), "Determinants of students' perceived learning outcome and satisfaction in online learning during the COVID-19 pandemic", *Journal of Education and E-Learning Research*, Vol. 7 No. 3, pp. 285-292, doi: 10.20448/journal.509.2020.73.285.292

Bowden, J.L.H. (2022), "Analogues of engagement: assessing tertiary student engagement in contemporary face-to-face and blended learning contexts", *Higher Education Research and Development*, Vol. 41 No. 4, pp. 997-1012, doi: 10.1080/07294360.2021.1901666.

Cohen, K.E. (2012), "Persistence of master's students in the United States: development and testing of a conceptual model", Doctoral dissertation, New York University.

Dedeilia, A., Papapanou, M., Papadopoulos, A.N., Karela, N.R., Androutsou, A., Mitsopoulou, D., Nikolakea, M., Konstantinidis, C., Papageorgakopoulou, M., Sideris, M., Johnson, E.O., Fitzpatrick, S., Cometto, G., Campbell, J. and Sotiropoulos, M.G. (2023), "Health worker education during the COVID-19 pandemic: global disruption, responses and lessons for the future—a systematic review and meta-analysis", *Human Resources for Health*, Vol. 21 No. 1, pp. 1-35, doi: 10.1186/s12960-023-00799-4.

Demir Kaymak, Z. and Horzum, M.B. (2013), "Relationship between online learning readiness and structure and interaction of online learning students", *Educational Sciences: Theory and Practice*, Vol. 13 No. 3, pp. 1792-1797, doi: 10.12738/estp.2013.3.1580.

Dhawan, S. (2020), "Online learning: a panacea in the time of COVID-19 crisis", *Journal of Educational Technology Systems*, Vol. 49 No. 1, pp. 5-22, doi: 10.1177/0047239520934018.

Dorn, E., Hancock, B., Sarakatsannis, J. and Viruleg, E. (2020), "COVID-19 and student learning in the United States: the hurt could last a lifetime", *McKinsey and Company*, Vol. 1, pp. 1-9.

Ehrlich, H., McKenney, M. and Elkbuli, A. (2020), "We asked the experts: virtual learning in surgical education during the COVID-19 pandemic—shaping the future of surgical education and training", *World Journal of Surgery*, Vol. 44 No. 7, pp. 2053-2055, doi: 10.1007/s00268-020-05574-3.

Garrison, D.R. and Kanuka, H. (2004), "Blended learning: uncovering its transformative potential in higher education", *The Internet and Higher Education*, Vol. 7 No. 2, pp. 95-105, doi: 10.1016/j.iheduc.2004.02.001.

Garrison, D.R. and Vaughan, N.D. (2008), *Blended Learning in Higher Education: Framework, Principles, and Guidelines*, John Wiley & Sons.

Gebauer, M.M., McElvany, N., Bos, W., Köller, O. and Schöber, C. (2020), "Determinants of academic self-efficacy in different socialization contexts: investigating the relationship between students' academic self-efficacy and its sources in different contexts", *Social Psychology of Education*, Vol. 23 No. 2, pp. 339-358, doi: 10.1007/s11218-019-09535-0.

Gherheş, V., Stoian, C.E., Fărcaşiu, M.A. and Stanici, M. (2021), "E-learning vs face-to-face learning: analyzing students' preferences and behaviors", *Sustainability*, Vol. 13 No. 8, p. 4381, doi: 10.3390/su13084381.

Hamid, A.A. (2001), "e-Learning: Is it the 'e' or the learning that matters?", *The Internet and Higher Education*, Vol. 4 Nos 3-4, pp. 311-316, doi: 10.1016/S1096-7516(01)00072-0.

Hew, K.F., Jia, C., Gonda, D.E. and Bai, S. (2020), "Transitioning to the 'new normal' of learning in unpredictable times: pedagogical practices and learning performance in fully online flipped classrooms", *International Journal of Educational Technology in Higher Education*, Vol. 17, pp. 1-22, doi: 10.1186/s41239-020-00234-x.

Hofmann, J. (2014), "Blended learning instructional design: a modern approach", *South African Journal of Business*, Vol. 41 No. 2, pp. 29-38.

Hui, W., Hu, P.H., Clark, T.H., Tam, K.Y. and Milton, J. (2008), "Technology-assisted learning: a longitudinal field study of knowledge category, learning effectiveness and satisfaction in language learning", *Journal of Computer Assisted Learning*, Vol. 24 No. 3, pp. 245-259, doi: 10.1111/j.1365-2729.2007.00257.x.

Jan, S.K. (2015), "The relationships between academic self-efficacy, computer self-efficacy, prior experience, and satisfaction with online learning", *American Journal of Distance Education*, Vol. 29 No. 1, pp. 30-40, doi: 10.1080/08923647.2015.994366.

Jiang, H., Islam, A.A., Gu, X. and Spector, J.M. (2021), "Online learning satisfaction in higher education during the COVID-19 pandemic: a regional comparison between Eastern and Western Chinese universities", *Education and Information Technologies*, Vol. 26 No. 6, pp. 1-23, doi: 10.1007/s10639-021-10519-x.

Ke, F. and Kwak, D. (2013), "Online learning across ethnicity and age: a study on learning interaction participation, perception, and learning satisfaction", *Computers and Education*, Vol. 61, pp. 43-51, doi: 10.1016/j.compedu.2012.09.003.

Kim, K.J. and Frick, T.W. (2011), "Changes in student motivation during online learning", *Journal of Educational Computing Research*, Vol. 44 No. 1, pp. 1-23, doi: 10.2190/EC.44.1.a.

Kintu, M.J., Zhu, C. and Kagambe, E. (2017), "Blended learning effectiveness: the relationship between student characteristics, design features and outcomes", *International Journal of Educational Technology in Higher Education*, Vol. 14 No. 1, pp. 1-20, doi: 10.1186/s41239-017-0043-4.

Låg, T. and Sæle, R.G. (2019), "Does the flipped classroom improve student learning and satisfaction? A systematic review and meta-analysis", *AERA Open*, Vol. 5 No. 3, 2332858419870489, doi: 10.1177/2332858419870489.

Lee, S.J., Srinivasan, S., Trail, T., Lewis, D. and Lopez, S. (2011), "Examining the relationship among student perception of support, course satisfaction, and learning outcomes in online learning", *The Internet and Higher Education*, Vol. 14 No. 3, pp. 158-163, doi: 10.1016/j.iheduc.2011.04.001.

Lee, C.A., Tzeng, J.W., Huang, N.F. and Su, Y.S. (2021), "Prediction of student performance in massive open online courses using deep learning system based on learning behaviors", *Educational Technology and Society*, Vol. 24 No. 3, pp. 130-146, available at: https://www.jstor.org/stable/27032861

Lin, Y., Wang, X., Hao, F., Wang, L. and Huang, C. (2022), "Effective knowledge dissemination modeling and regulation in blended learning Networks", *IEEE Transactions on Computational Social Systems*, Vol. 11 No. 1, pp. 51-65, doi: 10.1109/TCSS.2022.3213076.

Marriot, N., Marriot, P. and Selwyn (2004), "Accounting undergraduates' changing use of ICT and their views on using the internet in higher education-A Research note", *Accounting Education*, Vol. 13 No. 4, pp. 117-130, doi: 10.1080/0963928042000310823.

McCarthy, J. (2016a), "Reflections on a flipped classroom in first year higher education", *Issues in Educational Research*, Vol. 26 No. 2, pp. 332-350.

McCarthy, M. (2016b), *The Cambridge Guide to Blended Learning for Language Teaching*, Cambridge University Press, Cambridge.

McMahon, S.D., Wernsman, J. and Rose, D.S. (2009), "The relation of classroom environment and school belonging to academic self-efficacy among urban fourth-and fifth-grade students", *The Elementary School Journal*, Vol. 109 No. 3, pp. 267-281, doi: 10.1086/592307.

Miller, R.B. and Brickman, S.J. (2004), "A model of future-oriented motivation and self-regulation", *Educational Psychology Review*, Vol. 16 No. 1, pp. 9-33, doi: 10.1023/B:EDPR.0000012343.96370.39.

Milman, N.B. (2012), "The flipped classroom strategy: what is it and how can it best be used?", *Distance Learning*, Vol. 9 No. 3, p. 85.

Moffett, J. (2015), "Twelve tips for 'flipping' the classroom", *Medical Teacher*, Vol. 37 No. 4, pp. 331-336, doi: 10.3109/0142159X.2014.943710.

Moore, M.G. (1989), "Three types of interaction", *The American Journal of Distance Education*, Vol. 3 No. 2, pp. 1-6.

Moore, M.G. and Kearsley, G. (2012), *Distance Education: A Systematic View of Online Learning*, 3rd ed., Wadsworth Cengage Learning, Belmont, VA.

Moszkowicz, D., Duboc, H., Dubertret, C., Roux, D. and Bretagnol, F. (2020), "Daily medical education for confined students during coronavirus disease 2019 pandemic: a simple videoconference solution", *Clinical Anatomy*, Vol. 33 No. 6, pp. 927-928, doi: 10.1002/ca.23601.

Muilenburg, L.Y. and Berge, Z.L. (2005), "Student barriers to online learning: a factor analytic study", *Distance Education*, Vol. 26 No. 1, pp. 29-48, doi: 10.1080/01587910500081269.

Nelson, K., Kift, S. and Harper, W. (2005), "'First portal in a storm': a virtual space for transition students", *Proceedings of the Ascilite 2005 Conference: Balance, Fidelity, Mobility: Maintaining the Momentum?*, Australasian Society for Computers in Learning in Tertiary Education, pp. 509-517.

Ogbona, K. (2021), "Rethinking learning in schools: understanding the design of in-class flip blended learning", *FlipTech Latinoamérica 2019: Conectándonos para resignificar la educación Libro de Memorias*, Vol. 26.

Otter, R.R., Seipel, S., Graeff, T., Alexander, B., Boraiko, C., Gray, J., Petersen, K. and Sadler, K. (2013), "Comparing student and faculty perceptions of online and traditional courses", *The Internet and Higher Education*, Vol. 19, pp. 27-35, doi: 10.1016/j.iheduc.2013.08.001.

Parahoo, S.K., Santally, M.I., Rajabalee, Y. and Harvey, H.L. (2016), "Designing a predictive model of student satisfaction in online learning", *Journal of Marketing for Higher Education*, Vol. 26 No. 1, pp. 1-19, doi: 10.1080/08841241.2015.1083511.

Paul, J. and Jefferson, F. (2019), "A comparative analysis of student performance in an online vs face-to-face environmental science course from 2009 to 2016", *Frontiers in Computer Science*, Vol. 1, p. 7, doi: 10.3389/fcomp.2019.00007.

Powell, A.A., Power, L., Westrop, S., McOwat, K., Campbell, H., Simmons, R., Ramsay, M.E., Brown, K., Ladhani, S.N. and Amirthalingam, G. (2021), "Real-world data shows increased reactogenicity in adults after heterologous compared to homologous prime-boost COVID-19 vaccination, March–June 2021, England", *Eurosurveillance*, Vol. 26 No. 28, 2100634, doi: 10.2807/1560-7917.ES.2021.26.28.2100634.

Qamar, M.T., Ajmal, M., Malik, A., Ahmad, M.J. and Yasmeen, J. (2023), "Mobile learning determinants that influence Indian university students' learning satisfaction during the COVID-19 pandemic", *International Journal of Continuing Engineering Education and Life Long Learning*, Vol. 33 Nos 2-3, pp. 245-268, doi: 10.1504/IJCEELL.2023.129212.

Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L. and Koole, M. (2020), "Online university teaching during and after the Covid-19 crisis: refocusing teacher presence and learning activity", *Postdigital Science and Education*, Vol. 2 No. 3, pp. 923-945, doi: 10.1007/s42438-020-00155-y.

Roach, V. and Lemasters, L. (2006), "Satisfaction with online learning: a comparative descriptive study", *Journal of Interactive Online Learning*, Vol. 5 No. 3, pp. 317-332.

Roval, A.P. and Jordan, H.M. (2004), "Blended learning and sense of community: a comparative analysis with traditional and fully online graduate courses", *International Review of Research in Open and Distance Learning*, Vol. 5 No. 2, doi: 10.19173/irrodl.v5i2.192.

She, L., Ma, L., Jan, A., Sharif Nia, H. and Rahmatpour, P. (2021), "Online learning satisfaction during COVID-19 pandemic among Chinese university students: the serial mediation model", *Frontiers in Psychology*, Vol. 12, 743936, doi: 10.3389/fpsyg.2021.743936.

Singh, J. and Matthees, B. (2021), "Facilitating interprofessional education in an online environment during the COVID-19 pandemic: a mixed method study", *Healthcare*, MDPI, Vol. 9 No. 5, pp. 567, doi: 10.3390/healthcare9050567.

Singh, J., Steele, K. and Singh, L. (2021), "Combining the best of online and face-to-face learning: hybrid and blended learning approach for COVID-19, post-vaccine, & post-pandemic world", *Journal of Educational Technology Systems*, Vol. 50 No. 2, pp. 140-171, doi: 10.1177/00472395211047865.

Singh, J., Evans, E., Reed, A., Karch, L., Qualey, K., Singh, L. and Wiersma, H. (2022), "Online, hybrid, and face-to-face learning through the eyes of faculty, students, administrators, and instructional designers: lessons learned and directions for the post-vaccine and post-pandemic/COVID-19 world", *Journal of Educational Technology Systems*, Vol. 50 No. 3, pp. 301-326, doi: 10.1177/00472395211063754.

Sitzmann, T., Kraiger, K., Stewart, D. and Wisher, R. (2006), "The comparative effectiveness of web-based and classroom instruction: a meta-analysis", *Personnel Psychology*, Vol. 59 No. 3, pp. 623-664, doi: 10.1111/j.1744-6570.2006.00049.x.

Smith, D. and Hardaker, G. (2000), "E-learning innovation through the implementation of an internet supported learning environment", *Journal of Educational Technology and Society*, Vol. 3 No. 3, pp. 422-432, available at: https://www.jstor.org/stable/jeductechsoci.3.3.422

Strauß, S. and Rummel, N. (2020), "Promoting interaction in online distance education: designing, implementing and supporting collaborative learning", *Information and Learning Sciences*, Vol. 121 Nos 5/6, pp. 251-260, doi: 10.1108/ILS-04-2020-0090.

Strelan, P., Osborn, A. and Palmer, E. (2020), "The flipped classroom: a meta-analysis of effects on student performance across disciplines and education levels", *Educational Research Review*, Vol. 30, 100314, doi: 10.1016/j.edurev.2020.100314.

Tallent-Runnels, M.K., Thomas, J.A., Lan, W.Y., Cooper, S., Ahern, T.C., Shaw, S.M. and Liu, X. (2006), "Teaching courses online: a review of the research", *Review of Educational Research*, Vol. 76 No. 1, pp. 93-135, doi: 10.3102/00346543076001093.

Tang, K.H.D. (2023), "Impacts of COVID-19 on primary, secondary and tertiary education: a comprehensive review and recommendations for educational practices", *Educational Research for Policy and Practice*, Vol. 22 No. 1, pp. 23-61, doi: 10.1007/s10671-022-09319-y.

Tekin, C., Zhang, S. and van der Schaar, M. (2014), "Distributed online learning in social recommender systems", *IEEE Journal of Selected Topics in Signal Processing*, Vol. 8 No. 4, pp. 638-652, doi: 10.1109/JSTSP.2014.2299517.

The Oxford Group (2013), *Blended Learning–Correct Use, Challenges and Best Practices, Report 2013*, Kineo.

Tratnik, A., Urh, M. and Jereb, E. (2019), "Student satisfaction with an online and a face-to-face Business English course in a higher education context", *Innovations in Education and Teachinginternational*, Vol. 56 No. 1, pp. 36-45, doi: 10.1080/14703297.2017.1374875.

Van Alten, D.C., Phielix, C., Janssen, J. and Kester, L. (2019), "Effects of flipping the classroom on learning outcomes and satisfaction: a meta-analysis", *Educational Research Review*, Vol. 28, 100281, doi: 10.1016/j.edurev.2019.05.003.

Watson, J. (2008), *Blended Learning: the Convergence of Online and Face-To-Face Education. Promising Practices in Online Learning*, North American Council for Online Learning.

Weber, J.M. and Lennon, R. (2007), "Multi-course comparison of traditional versus Web-based course delivery systems", *Journal of Educators Online*, Vol. 4 No. 2, doi: 10.9743/jeo.2007.2.2.

Zhang, D., Zhao, J.L., Zhou, L. and Nunamaker Jr, J.F. (2004), "Can e-learning replace classroom learning?", *Communications of the ACM*, Vol. 47 No. 5, pp. 75-79, doi: 10.1145/986213.986216.

Zhang, A., Cui, L., Pan, G., Li, L., Hussain, Q., Zhang, X. and Crowley, D. (2010), "Effect of biochar amendment on yield and methane and nitrous oxide emissions from a rice paddy from Tai Lake plain, China", *Agriculture, Ecosystems and Environment*, Vol. 139 No. 4, pp. 469-475, doi: 10.1016/j.agee.2010.09.003.

Corresponding author
Abdullah Malik can be contacted at: abdullah.commerce@gmail.com