Pandemic Re-Envision Students' Perception Towards Learning Numerical-Based Paper Through Blended Learning

Dr. Gurpreet Kaur, Dr. Smita Barik, Prof. Neha Sabharwal

Assistant Professor, Department of Management, Institute of Technology & Science, Mohan Nagar, Ghaziabad.

DOI: https://dx.doi.org/10.47772/IJRISS.2025.903SEDU0539

Received: 02 September 2025; Accepted: 08 September 2025; Published: 11 October 2025

ABSTRACT

This study examines the impact of blended learning on students' perspectives, with a particular emphasis on numerically based courses during the COVID-19 pandemic. The research explores four major factors using Exploratory Factor Analysis (EFA): online learning, fostering self-directed learning, classroom learning, and online engagement, which are critical in shaping students' views towards blended learning environments. The majority of students preferred classroom learning, despite their enthusiasm for digital platforms, highlighting the significance of in-person interactions in the educational process. The study recommends emphasizing classroom involvement while presenting blended learning as a balanced approach that encourages students to pursue self-directed learning. It underscores educators' importance in integrating digital platforms and effective communication tools to enhance student engagement and learning outcomes. The study advocates for a student-centered design in blended learning programs and highlights the importance of technological adaptation, learning management, and e-readiness. Although the study provides valuable insights into students' preferences and behaviors, it acknowledges its limitations due to its timing during the pandemic and its geographical focus.

Keywords: Blended learning, student perception, numerical paper, e-readiness, Student engagement

INTRODUCTION

A drastic change in the education field came after the pandemic in 2020. The coronavirus pandemic began in Wuhan, China, and swiftly spread worldwide. The covid-19 arrived in India on January 27, 2020, and spread like wildfire across the country. To halt the Covid 19 outbreak, the Indian government declared a national emergency on March 23, 2020. The pandemic struck every region of India, creating new and difficult situations for the entire country. The education sector was also severely impacted, putting all public and private schools and higher education institutions in crisis mode. They attempted to overcome the lockdown phase by rotating between classroom, online, home-schooling, learning pods (Andersson & Willems, 2024), hybrids, and combinations of these instruction modes (Stahl, 2021). The conventional learning situation in the education sector has greatly transformed, necessitating the usage of E-Learning to bridge the gap between teachers and students and offset the catastrophic effect of Covid-19 on student and teacher kinship.

To be sure, the COVID-19 epidemic has had a significant impact on the teaching methods of school and college teachers who are accustomed to classroom instruction (Zhang, W., Wang, Y., Yang, L., & Wang & J, 2020). As the majority of teachers in developing nations are unfamiliar with the virtual model of education, the transition from face-to-face classroom teaching to online teaching practices significantly impacts school teachers. (Noor et al., 2020).

The emergence of covid -19 has fundamentally transformed the landscape of India's traditional education system. To reduce the risk of covid on the learners, there was a shift from offline to online learning. Our goal is to assess the attitudes of higher education apprentices towards blended learning after they have

experienced both modes of learning, particularly for a subject that is heavily reliant on numerical data. Additionally, we aim to identify the factors that influence blended learning through exploratory factor analysis.

Research Objective

1. To determine the latent variable of the student's readiness towards blending learning while studying the numerical paper through exploratory factor analysis.
2. What perspectives on blended learning are considered the most crucial?

LITERATURE REVIEW

The traditional methodology of teaching and learning composite of teacher-student interaction, student-student interaction, teacher's knowledge (Borkar et al., 2017)(Lin et al., 2017), student wiliness, and many other components. Our traditional way of teaching and learning is evolving. E-learning brought a revolution in the teaching-learning process(Maheshwari et al., 2021). E-Learning means learning electronically. This can be delivered by computer, internet, satellite, or other remote technologies. Firstly, e-learning was used for training in the organization (Thornbory, 2003). Gradually, it is becoming a part of the education sector.

Generally, synchronous and asynchronous are the two classifications of E-Learning (Assareh & Hosseini Bidokht, 2011). Synchronous is defined as the delivery of lecture and learning events that occur simultaneously, for example, webinars. Further, in the case of asynchronous learning, when you opt for an online course, the course content and communication regarding it do not occur at the same time(Amiti, 2020).

In the past two decades, there has been tremendous growth in the higher education sector in online courses. In India, the government is also facilitating education from reputed institutes like IIT, IIM, IGNU etc. So that, the best teaching-learning resources can be accessed by anyone, anywhere at any time. Nowadays, online courses are gaining popularity among students. This enhances the number of online universities. Covid also plays an important role in uplifting this count significantly (*The Pandemic Pushed Universities Online. The Change Was Long Overdue.*, n.d.) (*UGC Approved 38 Universities to Offer Online Degree Program*, n.d.).

Despite its expansion, it is still difficult to teach mathematically demanding courses online. Course design must take learners' preferences for numerical papers into account. Bandura's self-regulation theory (Bandura, 1991) emphasises encouraging goal-setting and self-monitoring to promote persistence, while Garrison's Community of Inquiry (CoI) (Garrison et al., 1999) emphasises cognitive and teaching presence as crucial for comprehension.

Blended learning is one more pedagogy. This is also known as a hybrid model (Powell et al., 2015). This methodology is a combination of online learning and face-to-face learning (Bonk & Graham, 2006). In India blended learning is in boom.

Table1. Comparative Table: Connecting Previous Research to Conceptual Models

Study	**Key Insight**	**Linked Framework**	**Application to Numerical Subjects**
Borkar et al. (2017); Lin et al. (2017)	Emphasize teacher–student interaction and peer collaboration.	Garrison's CoI – *Social & Teaching Presence*	Reinforces need for collaborative problem-solving in blended settings.
Maheshwari et al. (2021)	E-learning revolutionized teaching–learning methods.	Garrison's CoI – *Cognitive Presence*	Demonstrates online content must engage higher-order thinking.

Amiti (2020)	Highlights flexibility of asynchronous formats.	Bandura – *Self-Regulation Theory*	Requires scaffolding for self-monitoring in math-based courses.
Powell et al. (2015); Bonk & Graham (2006)	Advocates hybrid learning models.	Both CoI & Self-Regulation	Suggests combining synchronous sessions with guided online practice.

METHODOLOGY

The questionnaire was created based on the six elements of preparation for learning proposed by Tang (Tang, 2013) and the concept of preparedness for adopting blended learning suggested by Osman and Hamzah (Osman & Hamzah, 2017).

The questions in the questionnaire were adapted from their research and categorized into seven sections: classroom learning (6 items), online learning (7 items), online interaction (3 items), technology (3 items), learning flexibility (3 items), learning management (2 items), and readiness for blended learning (4 items). There were a total 28 questions in the adapted questionnaire for the survey. A 5-point Likert scale (1 = strongly disagree, and 5 = strongly agree) was used as the measurement tool. The statements were refined based on feedback from a small group of potential respondents to ensure clarity and comprehension of the questionnaire content.

A total of 350 valid responses were collected from students in the NCR region. These students represented both private and government universities and had experienced nearly two years of online classrooms due to the pandemic. Therefore, their insights into learning aspects using blended learning were valuable.

The reliability and validity of the instruments were assessed by administering the questionnaire to a sample of 20 students. The results indicated a strong internal consistency, as evidenced by a Cronbach's Alpha value of 0.94.

DATA COLLECTION

The data collection process was initiated in 2021, with the main goal of assessing student perceptions of blended learning in the post-pandemic era.

There were 350 valid responses gathered from students attending Higher Educational Institutes in the NCR region of India. The research was conducted in October 2021 and focused on students who had participated in online classes from July 2020 to August 2021. The data acquired was related to Numerical papers and comprised learners from diverse stages of their academic careers. The collected information underwent Descriptive Statistical Analysis and Exploratory data analysis using SPSS.

In order to determine the demographic data of the students from the first part of the questionnaire, frequency and percentage were utilized. It is given in table 2.

Table 2: Demographics Analysis

		Number	**Percentage**
Gender	Female	133	38
	Male	217	62
Course	B. tech	15	4.3
	B.Sc.	38	10.9
	BCA	26	7.4
	Management	256	73.1
	MCA	15	4.3

Year	I year	177	50.6
	II year	110	31.4
	III year	45	12.9
	IV year	18	5.1
Residential Location	Rural Area	92	26.3
	Urban Area	258	73.7

(Source: SPSS 20)

Table 2 displays samples of demographic data from several universities and streams in the NCR region. Five separate courses comprised the 350 participants. The majority of participants (256, or 73%) were from the Management course. Additionally, almost 81% of the total respondents, or most of them, were in the first or second year of their studies. The proportion of female respondents was 38%, while the male proportion was 62%. This indicates that HEIs have a gender-based demographic division. Additionally, the bulk of respondents—roughly 73%—lived in metropolitan areas, which was seen as a sign that they had easy access to online learning environments.

DATA ANALYSIS AND RESULTS

Initially to assess the students' readiness towards blended learning in six different aspects. The six aspects are classroom learning, online learning, learning flexibility, online interaction, technology, and learning management. A summary of the items in each construct is given in Table 3.

Table 3 Summary of the constructs

Constructs	Number of items	Items
Classroom Learning (CL)	6	1.Classroom sessions of Numerical paper help me to generate ideas to do course assignment.
		2. In offline Numerical paper class, I have a chance to get supports or feedbacks from my teacher and peers immediately.
		3. I learn Numerical paper better through teacher-directed classroom-based activities.
		4. I learn Numerical paper better when I collaborate with others in classroom
		5. I believe offline learning of Numerical paper is more effective than online learning.
		6. I am bored when learning Numerical paper in classroom
Online Learning (OL)	7	7. I do not resist having my lessons online.
		8. Learning Numerical paper online during covid 19 was interesting.
		9. I feel comfortable with self-directed learning when I learn Numerical paper online during covid 19.
		10. I like learning Numerical paper online as it provides richer instructional content (e-books/ppts/ notes/external links).
		11. I would like to have online class for the Numerical paper course rather than in the offline classroom.
		12. I am bored when learning Numerical paper online.
		13. I feel that online learning reduces chance of favouritism and partiality.

Learning Flexibility(LF)	3	14. I can organize my time efficiently in learning Numerical paper.
		15. I would like to study the Numerical paper without limits of time and place
		16. I like to study Numerical paper lessons at my own pace.
Online Interaction	3	17. I would like to interact with my teacher when I learn Numerical paper online.
		18. I would like to interact with my classmates when I learn Numerical paper online.
		19. I am able to communicate effectively with others using online technologies (e.g. email, chat, discussion board).
Technology	3	20. I think online learning platforms used in Numerical paper is easy to adapt
		21. Online quizzes helped me to learn effectively.
		22. I am comfortable using Web technologies during online classes
Learning Management	2	23. Learning Numerical paper in both offline and online learning mode motivate me to be more self-disciplined and responsible for my learning.
		24. Learning Numerical paper in both offline and online mode encourage me to set up my own learning plans and goals.

(Source: SPSS 20)

Exploratory Factor analysis

In the development of assessment instruments, exploratory factor analysis (EFA) is a commonly used technique (Courtney, 2013). It is used to reduce the dimensions of the constructs (Watson, 2017). It enables researchers to find intricate, hidden patterns in variable correlations that might not be obvious at first glance. The primary objective of EFA is not to reduce the dimensions of the construct but to uncover the underlying core structure behind the collected data.

Research question 1: To determine the latent variable of the student's readiness towards blending learning while studying the numerical paper through exploratory factor analysis.

Principal Component Analysis (PCA) was utilized to analyze the students' responses to 24 items, employing varimax rotation. In this research, the Kaiser-Meyer-Oklin (KMO) test was administered to evaluate the sampling adequacy of each variable in the survey(Shrestha, 2021). The KMO value of 0.923, exceeding 0.8, indicates that the sampling is adequate for factor analysis (Shrestha, 2021)(Birbal et al., 2018).

Bartlett's test of sphericity yielded a chi-square value of 4171.167 with 276 degrees of freedom, resulting in a p-value of 0.000 ($p < 0.005$), indicating a significant result. Therefore, conducting an exploratory factor analysis (EFA) on the given dataset may be beneficial (Tang, 2013).

The scree plot shown in **Figure 1** revealed five factors (Figure 1), and the total variance explained by the five factors was 63.369%. Every eigenvalue greater than 1 is considered, and its value is listed in Table 4. Items with a factor loading above 0.5 (Tang, 2013) (Antwi-Boampong, 2022) were retained for further analysis. Constructs with factor loading less than 0.5 or cross-loading were removed from the item list. Each item from the online learning (13. I am bored when learning Numerical paper online) and learning flexibility was removed (14. I feel that online learning reduces the chance of favoritism and partiality) as there was no factor loading on these items.

The fifth factor had to be dropped as there was one item (12. I am bored when learning Numerical paper online) loaded with 0.808 (Samuels, 2016). A single item is not sufficient to explain a factor. The two items (i.e. 13 and 14) and the fifth factor were dropped. The new KMO value was calculated and the value 0.915

was still greater than 0.8 and Bartlett's test of sphericity was significant ($\chi^2 = 3709.636, df = 210, p < 0.5$).

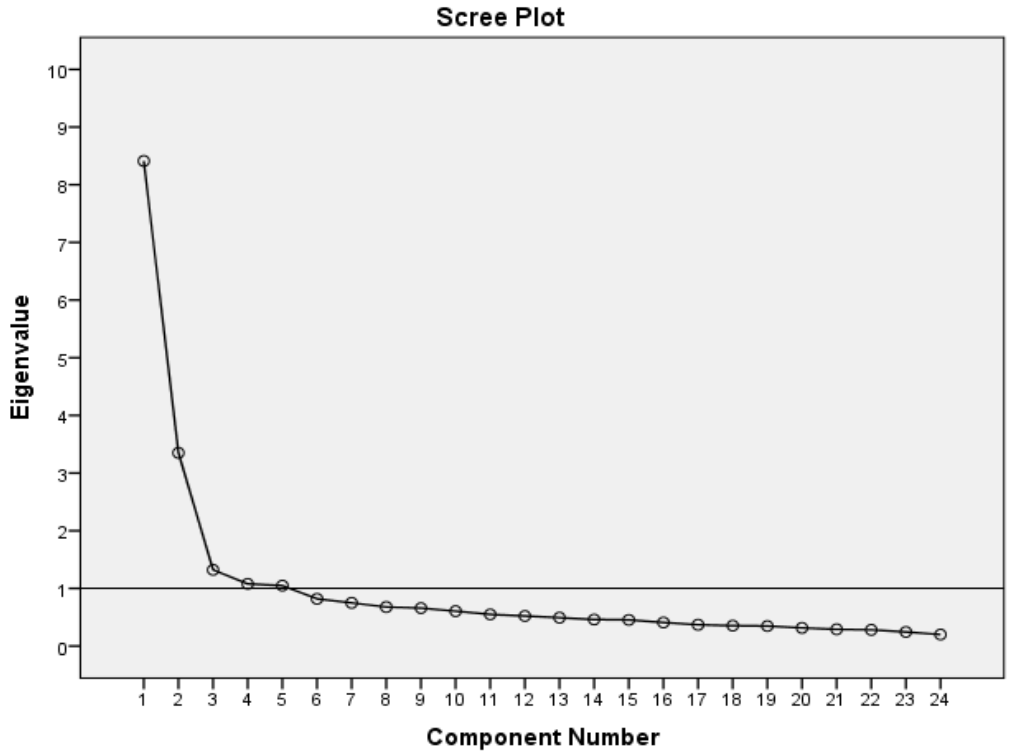

Fig. 1 Scree Plot

The internal consistency of each of the five factors was calculated using Cronbach alpha all were above 0.75 (Table 4). Reliability for the entire instrument was 0.907.

The summary of five factors can be seen in Table 4

Table 4 Factor Summerization

Item No.	**Items**	**Mean**	**S.D.**	Factors **1**	**2**	**3**	**4**
	Factor-1 (Online learning)						
11	I would like to have online class for the Numerical paper course rather than in the offline classroom.	2.691	1.471	0.851			
8	Learning Numerical paper online during covid 19 was interesting.	2.889	1.423	0.794			
10	I like learning Numerical paper online as it provides richer instructional content (e-books/ppts/ notes/external links).	3.117	1.392	0.78			
9	I feel comfortable with self-directed learning when I learn Numerical paper online during covid 19.	3.134	1.334	0.761			
20	I think online learning platforms used in Numerical paper is easy to adapt	3.077	1.342	0.694			
6	I am bored when learning Numerical paper in classroom	2.691	1.411	0.596			
7	I do not resist having my lessons online.	3.349	1.241	0.517			

	Factor 2 (Fostering Self-Directed Learning)						
24	Learning Numerical paper in both offline and online mode encourage me to set up my own learning plans and goals.	3.789	1.063		0.76		
23	Learning Numerical paper in both offline and online learning mode motivate me to be more self-disciplined and responsible for my learning.	3.797	1.042		0.741		
21	Online quizzes helped me to learn effectively.	3.586	1.240		0.623		
16	I like to study Numerical paper lessons at my own pace.	3.571	1.120		0.622		
15	I would like to study the Numerical paper without limits of time and place	3.657	1.114		0.576		
22	I am comfortable using Web technologies during online classes	3.514	1.213		0.567		
	Factor 3 (Classroom Learning)						
3	I learn Numerical paper better through teacher-directed classroom-based activities.	4.209	0.978			0.803	
2	In offline Numerical paper class, I have a chance to get supports or feedbacks from my teacher and peers immediately.	4.26	0.935			0.778	
1	Classroom sessions of Numerical paper help me to generate ideas to do course assignment.	3.986	0.968			0.753	
4	I learn Numerical paper better when I collaborate with others in classroom	4.097	1.050			0.745	
5	I believe offline learning of Numerical paper is more effective than online learning.	4.326	1.039			0.586	
	Factor 4 (Online Interaction)						
18	I would like to interact with my classmates when I learn Numerical paper online.	3.549	1.242				0.822
17	I would like to interact with my teacher when I learn Numerical paper online.	3.734	1.146				0.694
19	I am able to communicate effectively with others using online technologies (e.g. email, chat, discussion board).	3.474	1.257				0.502
	Eigen Value			8.412	3.35	1.321	1.048
	Variance			35.050	13.960	5.504	4.491
	Cronbach Alpha			0.885	0.836	0.832	0.777

FINDINGS & DISCUSSION

This study identified four factors after conducting a factor analysis on the six factors we hypothesized for blended learning: classroom learning (6 items), online learning (7 items), learning flexibility (3 items), online interaction (3 items), technology (3 items), and learning management (2 items).

Two items from the online learning factor were eliminated: item number 12. "I am bored when learning the Numerical paper online" and 13. "I feel that online learning reduces the chance of favouritism and partiality."

In contrast, one item from the technology aspect of online learning, specifically item 20 "I think the online learning platforms used for the Numerical paper are easy to adapt," and another item from classroom learning—item 6, "I am bored when learning the Numerical paper in the classroom"—were incorporated into the online learning category.

The fostering self-directed learning factor was developed by integrating the factors of learning management, technology, and learning flexibility. The classroom learning factor consisted of five items; however, one item was removed and added to the online learning factor.

Research Question 2. What perspectives on blended learning are thought to be the most crucial?

This study utilized descriptive statistics to assess students' attitudes toward the elements of blended learning that they considered most important. Means and standard deviations were calculated for comparison. Among the four variables, students rated classroom learning as the most significant aspect of blended learning, with a mean score of 4.17. Fostering self-directed learning followed with a mean of 3.65, and communication during online sessions ranked third with a mean of 3.58. The online environment was rated as the least significant element, with a mean score of 2.99 (see Table 5).

Table 5. Perspectives Towards Blended Learning

Factors	**N**	**Mean**	**Std. Deviation**
Online learning	350	2.9927	1.05708
Fostering Self-Directed Learning	350	3.6524	.84077
Classroom Learning	350	4.1754	.76916
Online Interaction	350	3.5857	1.01130
Valid N (listwise)	350		

The study identified four principal factors influencing blended learning in numerical based courses: **Online Learning**, **Fostering Self-Directed Learning**, **Classroom Learning**, and **Online Interaction**. The enduring appeal of classroom learning (M-4.1754) remains particularly evident in courses involving numerical content. This finding suggests that bending learning designs for numerical papers should maintain real-time interaction, a structured learning environment, social engagement, personalized attention, hands-on learning opportunities, teamwork, and collaboration (Alawamleh et al., 2020)(Jaggars, 2014)(Aimah et al., 2023).

During the pandemic, online learning became a necessity. Studies indicate that online learning proved beneficial for certain courses due to its flexibility (Anuradha & Hema, 2021) and the promotion of self-regulation (Paechter & Maier, 2010). However, research suggests that learning numerical subjects online posed challenges.

In this study, online learning scored the lowest mean score as 2.99, it is was not preferred in the case of numerical based paper (Jaggars, 2014) , yet its contribution of over 35% to total variance indicates it plays a central role in shaping blended learning. This implies that online environments must be strengthened rather than minimized—by improving platform usability, incorporating adaptive tools for numerical problem-solving, and ensuring prompt instructor support to reduce disengagement and boredom.

The positive perception of fostering self-directed learning (M = 3.65), despite its relatively modest variance contribution (13.96%), underscores students' readiness to assume responsibility for their learning when afforded autonomy and flexibility. Educators can capitalize on this by incorporating Bandura's self-regulation (Bandura, 1991) strategies—goal-setting, self-monitoring, and reflection—into online modules, while also providing scaffolding to mitigate cognitive overload(Nungu et al., 2023)(Hwang et al., 2021)(Roschelle et al., 2016) (Abdullahu & Vokshi, 2023). Similarly, embedding Garrison's Community of Inquiryg(Garrison et al., 1999) elements (teaching, social, and cognitive presence) into online interactions can sustain motivation and enhance understanding in numerically intensive contexts.

Practical strategies include combining recorded lectures with live Q&A sessions, designing peer-collaboration tasks to enhance online interaction (M = 3.58), and utilizing analytics to identify struggling learners early. These approaches align statistical evidence with actionable improvements, ensuring that both the strengths of classroom learning and the potential of online environments are fully realized.

The findings suggest that blended learning strategies should be designed to balance structured offline support with opportunities for self-directed and interactive online experiences.

CONCLUSION

The study underscores a harmonious integration of traditional classroom settings with online learning modalities, demonstrating a comprehensive understanding of students' perspectives on blended learning in numerically focused courses. Students place significant value on the in-person interactions provided by classroom learning, indicating that these interactions form the foundation of the educational process and are irreplaceable(Adha et al., 2024). The flexibility and autonomy offered by online resources that support self-directed learning complement this (Nikolopoulou & Zacharis, 2023); students recognize and value this aspect for its contribution to their educational experience. Furthermore, effective communication and teamwork in virtual environments is emphasized, highlighting the need to create online learning environments that encourage participant involvement.

Despite the acknowledged advantages of virtual education, the research offers a nuanced perspective in which virtual resources are deemed most beneficial when they supplement the robust foundation provided by in-person learning opportunities rather than serving as standalone educational resources. These findings highlight the necessity for educational institutions to carefully evaluate how to most effectively integrate in-person and virtual learning environments to maximize student learning. It also opens avenues for further research into innovative blended learning strategies that can enhance the effectiveness of numerically focused courses while considering students' preferences for a well-rounded education. Ultimately, the study advocates for a student-centered design in blended learning programs, emphasizing the importance of technological adaptation, learning management, and e-readiness as the cornerstones of an effective learning environment.

LIMITATIONS AND FUTURE AVENUE

This study had a few limitations. Most of the respondents were from the Management domain, which resulted in a data set that was skewed towards a specific field, rather than proportionately representing the various courses offered in higher education institutions (HEIs). Additionally, the majority of the students were in their first or second year of study and had experienced online sessions from the start due to the pandemic. As a result, they did not have a valid basis for comparing offline and online sessions. Instead, they were only able to draw comparisons based on their previous experiences in schools or undergraduate colleges.

While this study provides valuable insights into learners' perceptions of blended learning in numerically intensive subjects, several avenues warrant further exploration. Comparative studies across various subject domains could ascertain whether the challenges and strategies identified herein are unique to numerically intensive courses or have broader applicability. Longitudinal tracking of student perceptions and performance would elucidate how engagement evolves over time. Incorporating qualitative methods, such as interviews or focus groups, could complement the quantitative findings with more nuanced insights. Future research should also emphasize factors that currently exhibit weaker impacts on blended learning. Applying targeted techniques and theoretical frameworks to enhance these areas could render blended learning more effective for numerically based courses. Additionally, examining self-regulation strategies and social presence within blended environments may refine instructional design and improve learner outcomes.

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