



Assessing e-learning platforms in higher education with reference to student satisfaction: a PLS-SEM approach

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Abstract In the wake of the digital revolution transforming the landscape of higher education, e-learning has emerged as a pivotal model for knowledge dissemination, reshaping traditional pedagogical methodologies and fostering an unprecedented transition to virtual learning environments. This transformative shift, necessitated by global crises and the rapid evolution of technology, has spotlighted the urgency to evaluate and enhance the effectiveness and user satisfaction of online learning platforms. Particularly in the context of Indian higher education, where the demographic expanse and diverse educational needs present unique challenges and opportunities, understanding the drivers of student satisfaction in e-learning is paramount. This empirical investigation explores the factors influencing students' satisfaction with online education in Indian universities and higher education institutions. Data were collected from 460 postgraduates and undergraduates across 30 institutions offering programs in management, engineering, and commerce. Utilizing

Structural Equation Modeling, the study identified key variables impacting learner satisfaction: learner inspiration and motivation, potential obstacles to e-learning, group and professor interaction, and the use of technology (including AI and other tools) in e-learning. Results indicate that potential obstacles to e-learning and the integration of technology had the most significant impact on student satisfaction, emphasizing the importance of overcoming barriers and leveraging technology effectively in e-learning environments. This study offers insights for higher education institutions seeking to enhance virtual learning experiences and underscores the imperative of addressing technological challenges to ensure sustained student satisfaction.

Keywords E-learning platform · Student satisfaction · PLS-SEM · Use of technology (AI and other tools) in e-learning

1 Introduction

As e-learning has become more prevalent in higher education in recent years. In recent years we have witnessed the instances of e-learning platform for efficient functioning of education system. In recent time traditional universities also had to switch from a primarily face-to-face teaching mode to the online mode overnight. This required a fundamental change in core teaching and assessment processes. (Limniou et al. 2022) Over past few years, there has been a great deal of research interest in the area of e-learning platforms, their implementation by educational institutions around the world and satisfaction of learners and educators who are using these advanced, new age learning platforms. E-learning is considered as a new model of knowledge exchange in modern education. Along with the unpredictable effects of the

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global pandemic, this is considered an opportunity to promote the development of e-learning globally. System quality was the most important factor in their satisfaction with the e-learning system, followed by transformational leadership and finally self-efficacy. As a result, private organizations, developers, software designers, or even trainers trained in transformation can focus on building a system of processes to effectively implement learning online for students (Le et al. 2023).

Previously there have been many misconceptions regarding e-learning system specially with regards to their effectiveness and usefulness in comparison to traditional learning system. But in many developed as well as developing countries, with rapid advancement in technology and internet facilities, e-learning has created many new opportunities and facilities in the lives of people. So, this revolution has forced many other countries as well to create proper synergy between online and offline learning system so that learners may get advantages of both (Suhandiah et al. 2022). Numerous studies supported the fact that e-learning is not only having economic advantages to the provider, but it is also very effective in achieving satisfaction of learners and educators using it. But achieving satisfaction of user is not that simple, for this purpose our system needs to be very effective, useful and user friendly. This requirement is even more important in developing countries and especially in countries with huge populations where prospect users are huge in numbers. (Singh et al. 2023a, b, c). Therefore, research on factors driving the satisfaction of users with respect to e-learning platforms has become more and more necessary (Nurkhin et al. 2022).

1.1 Importance and significance of e-learning

E-learning has become an important part of the current education system, but it is even less explored by older academics. We have seen the role of e-learning as a game changer and saviour of the education system specially during last decade. One important aspect that becomes very difficult in an e-learning environment is the level of student satisfaction when using the e-learning platform. Along with learner preparation in the form of knowledge of these technology-based platforms and confidence to use these systems effectively is also critical to the overall success of the system. e-learning system (Gupta et al. 2023). The e-learning readiness aspect is tied to student satisfaction with the overall experience in the e-learning environment. Readiness can refer to a student's proficiency in managing e-learning, while satisfaction refers to a learner's perception of the overall curriculum experience. (Hasim and Yusof 2023). Student's readiness to use e-learning system is combinedly derived by key factors like availability of attributes to use online system, time management skills of the learners to utilize

the e-learning system effectively, basic technical knowledge required to use the e-learning platform and basic online communication skills required to interact with peers and tutors during e-learning. If student is equipped with these skills, his readiness to use the e-learning system will be very will in line to achieve satisfaction in e-learning. (Rafsanjani et al. 2022).

E-learning may or may not be very useful in some areas of education like medical science, nursing, midwifery etc. where face to face experiential learning is very essential. But with the kind of technological advancements evolving day by day AI, Machine learning and other technological tools have made e-learning very effective in these areas too. Some studies revealed that in these areas even with limited scope, e-learning has achieved tremendous amount of satisfaction among users due to new learning possibilities associated with it (Addae et al. 2022; Singh et al. 2023a, b, c). Some studies revealed that learners prefer those online platforms which has capability to get synced with existing traditional learning system. Their satisfaction in e-learning system is also affected by the training programs provided to them to use these online systems effectively. If online system is complex and difficult to understand by learners then it can directly affect the acceptability of system among learners. Affordability of system is also an important factor which may drive user's satisfaction with regards to e-learning system (Gupta et al. 2023). In developing and under developed countries where IT infrastructure is still not up to the mark, accessibility of IT infrastructure by mass is not that much cost effective. So, if the online teaching platform is available at affordable terms than it may also help in accelerating the satisfaction of learners (Tuan and Tram 2022).

1.2 Technological advancement and growth of e-learning

The rapid advancement of technology is changing the way the global education industry operates, where educational services can be delivered in person or online. But as the same time attitude and intention of the learners is generally derived by the fact that online system should be ease to use and should be useful to the learners in solving their queries and providing better learning environment. For achieving these outcome developers of e-learning platform need to make sure that information quality, content and system quality is up to mark and at par with the satisfaction level of learners (Wong et al. 2023). Events which happened in past few years around the globe have forced higher education institutions to shift from face-to-face teaching to fully e-learning, although e-learning has not yet been fully implemented in many countries and institutions. Main reason for this partial shift is acceptability of e-learning among learners in different part of the world. There are no questions with

regards to effectiveness and technology assisted dynamic orientation of e-learning systems but learners' satisfaction specially in those institutions where use of technology was very limited in teaching before the pandemic is still an area of concern (Li and Zhu 2022; Ginting et al. 2022).

Technology in higher education now includes a significant amount of mobile learning (M-learning) through new generation technologies and software. M-learning is not different from e-learning, it is a part of e-learning where through mobile technology it may can be made more reachable and affordable to the mass. Also, it allows students to use the Internet and technology to research, work in groups, and share ideas (Fearnley et al. 2022). In addition, to use the M-learning system, students and teachers must accept M-learning. However, very few studies have been conducted in Saudi Arabia to determine how satisfied students are with their actually using mobile learning for educational purposes. Therefore, it is very important to investigate students' behavioral intentions to use mobile learning, their satisfaction with the technology as well as their impressions of how they actually use learning system on mobile devices.

RQ-1 What are the key factors of e-learning systems driving student satisfaction in higher education?

The authors have managed questionable and inadequate information to answer the above RQ. Further, the authors have conducted a rigorous review of existing literature in this area by going through key articles and studies in the field of e-learning in higher education. Understanding these studies has helped in identifying the key variables affecting satisfaction of learners with reference to e-learning platforms. Various factors of learner's satisfaction in e-learning system have been identified based on an analysis of the available literature.

R-Q2 What is the significance of e-learning systems in higher education institutions?

To address RQ-2, further review of the existing research has been conducted. Previous studies in the field of e-learning in higher education led us identify key importance and significance of e-learning systems for various higher education institutions. It is observed and presented by author that e-learning systems are not only useful in delivering quality education but also very useful in designing content for delivery, creating effective communication among the users and, research & innovation in higher education.

RQ-3 How can the relative and overall importance of various factors of student satisfaction be identified, assessed and priority of focus established for the current theme in assessing e-learning systems in higher education institutions?

To acknowledge the RQ3, this cross-sectional study employed a structured questionnaire to collect data among the 1200 students from various higher education institutions and universities of India through online mode. Questionnaire responses were imported to Excel for analysis using R

programming (Seminar, Lavaan, Haven, Sem Plot). Data was cleaned, formatted, and assessed for internal reliability and validity using Cronbach's alpha, CFA, and SEM for factor loadings.

2 Literature review

The necessary literature on the evaluation of e-learning systems within the framework of higher education, student satisfaction regarding e-learning systems, definitions of the factors that are inferred from student satisfaction, theoretical details on the factors, and research contributions made by this study are all contained in this section.

2.1 E-learning systems in higher education

E-learning platforms have proved very effective and useful during pandemic period. Out of these system qualities of learning platform is the most important factor followed by transformational leadership and self-efficacy (Le T.M.H. et al. 2023). So, it becomes very crucial for educational institutions to design a system of process to get an effective e-learning platform. Understanding readiness and satisfaction level among undergraduate students in e-learning environment is very crucial for the success of learning platform. Readiness and satisfaction are strongly correlated with each other hence for ensuring success of e-learning platform it is very important to incorporate readiness of the learner while designing the e-learning platform to achieve highest degree of satisfaction while using it. As when readiness is achieved it drives self-determination among the learner to use and accept the e-learning platform (Hasim and Yusof 2023). Students feel that e-learning system is useful but at the same time they were not satisfied with user friendliness of these e-learning platforms. They are also happy with technical system used in these platforms (Wong et al. 2023).

2.2 Satisfaction level of learner in e-learning systems

Student satisfaction in e-learning is significantly affected by applicable tuition fee in e-learning, skills of teaching staff delivering lectures through online platform, facilities associated with these platforms for creating ease of use and effectiveness, availability of proper training programs so that learners may get used to online platform and finally the capability of e-learning system to work in line with existing system were the key factors affecting student satisfaction in e-learning system (Tuan and Tram 2022). One of the indicators of the success of an educational programme is the degree to which individual students report being satisfied with their experiences, regardless of whether those experiences take place in a traditional or virtual setting (Zeng and

Wang 2021; Alavi et al. 1995; Eom et al. 2006). It is an essential concept in higher education, as well as the thorough examination of it can drive to advancements in online teaching practices, greater academic performances, and the retention of learners in their educational programmes, (Cole et al. 2013). In addition to this, it is an essential component that may be applied to the process of determining how successful online education is (Alqurashi 2019). System quality and information quality have significant impact on learner's satisfaction with regards to e-learning system. This satisfaction further drives ease of use and usefulness which further increase attitude and intention of the learners while using e-learning platform (Li and Zhu 2022).

Numerous researches have been conducted to study the factors that determine the level of satisfaction that learners have with online education. Therefore, the responsibility of the teacher (An 2009; Ladyshevsky 2013), instructor-learner interaction (Baker 2010), the essence of the core curriculum (Liaw 2008), the composition of the curriculum, the contribution of advanced technologies (Dinh and Nguyen 2020), student motivation (Artino 2007), student perception (Alqurashi 2019), self-regulated studying, educational environment, and assessment techniques (Dinh and Nguyen 2020) are some of the major indicators of learner's satisfaction. Attitude of the students towards e-learning platform is the key factor affecting learning satisfaction. Attitude of the learners is further derived by many sub factors like learning inspiration and motivation to use online platform, support provide by teachers in online classes, technological support available to enhance the experience of the learners etc. (Zhao et al. 2022).

In the present research, based on previous research, we classify the various factors that determine satisfaction level of learners based on the following 4 headings: Learner Inspiration and Motivation, Possible challenges to E-Learning, Interaction with group and professor, Use of technology (AI and other tools) in e-learning.

2.3 Possible challenges to e-learning

When compared to traditional classroom instruction, learning during the global epidemic through online means presents a significantly greater number of obstacles. Some of these include troubles in attending lectures because of technical issues (Yeung and Yau 2021), maintaining focus throughout a lecture (Zeng and Wang 2021), having insufficient knowledge of information technology, having limited possibilities for collaboration, that ultimately resulted in a feeling of isolation (Eom, and Ashill 2016), and not having opportunity to advance skills and knowledge, which several subjects require for academic success (Means and Neisler 2020). Learners in many different types of online

educational facilities have reported that among the most common technical challenges they face is poor internet access, which makes it challenging for them to consistently participate in synchronous meetings of online instruction (Means, and Neisler 2020; Dinh and Nguyen 2020; Chung et al. 2020). Additionally, learners find it easier to keep their concentration and attention during a lecture when they are present in physical learning space. This is because the teacher is physically present, there is eye contact, instructional tools are used, and there is the appearance of fellow students (Zeng and Wang 2021). However, this has been cited as a difficulty that is involved with e-learning in a number of research studies.

Therefore, to summaries, there are a variety of difficulties that accompany online education, particularly when it is practiced during the global epidemic; these difficulties can have a significant impact on learners' satisfaction levels in an academic program (Means and Neisler 2020).

2.4 Learner inspiration and motivation in e-learning

In any kind of educational setting, the overall of learning that is accomplished is directly proportional to the level of motivation present among the learners. Learners who are self-motivated are distinguished from their peers by their tendency to cultivate a self-motivated learning style, exhibit self-directed behavior, and possess an internal sense of control. Study on education consistently reaches the conclusion that a learner's level of self-motivation is one of the most important factors in determining both their level of accomplishment and their level of contentment with online education (Wang et al. 2013). Therefore, based on our examination of student motivation in online education, we hypothesize that learners who have a greater degree of self-motivation will have a greater positive experience overall with their time spent engaged in online education. Even after many constraints like high cost of data and unavailability of internet and computer facilities at home, students of higher education in many parts of the world are very keen to learn and adopt this new system and they were very happy with the kind of facilities available on online platform which help them in collecting and grasping new information in textual as well as graphical form available on e-learning.

2.5 Use of technology (AI and other tools) in e-learning

The application of artificial intelligence to the field of online education has a beneficial impact on students of all ages, as well as on their teachers and the institutions in which they are educated. Learners can learn at their preferred pace and benefit from connectivity to a high-quality education that is more widely available. AI-driven methods can address

student's questions, suggest personalized resources and grade papers (Tomar et al. 2023).

2.6 Articulation of theoretical framework

Establishing theoretical connections to address the major research problems posed by this study was another goal of the literature evaluation that was carried out for it. Theoretical connections were made for resolving the research issues of the current study by carefully reviewing the prior work.

The model that is represented in Fig. 1 illustrates a causal pattern in which it is hypothesized that Satisfaction level of learner is impacted by Possible challenges to E-Learning, Learner Inspiration and Motivation Interaction with group and professor, and Use of technology (AI and other tools) in e-learning platforms (Addae et al. 2022). Learner characteristics is the most examined factor followed by other key factors like engagement and course delivery through e-learning platform, quality of e-learning platform, assessment methodology and support provided to the learners (Martin and Bolliger 2022). Students in different domains are having quite same opinion about e-learning system. there is a significant difference in learning environment of different domain of study but majority of students are comfortable with face-to-face learning system. So, in order to make e-learning system more acceptable and satisfactory, universities, policy makers and educators need to work upon these areas (Limniou et al. 2022).

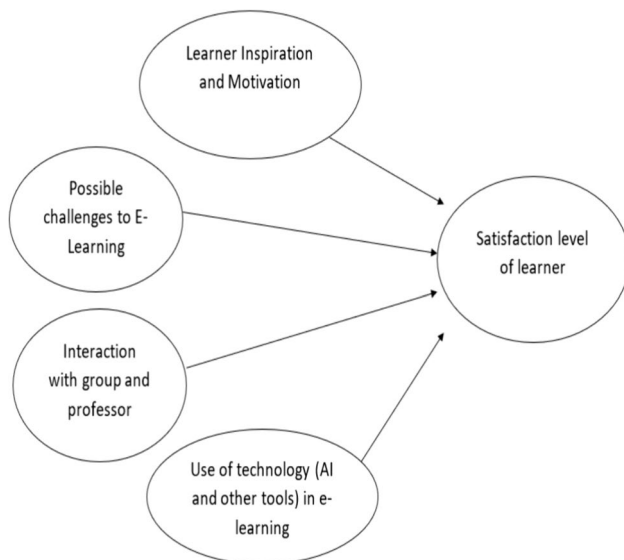


Fig. 1 Conceptual framework of the study

3 Materials and methods

3.1 Research design

The design of this research was based on the application of quantitative methods, specifically Partial least squares Structural Equation Modeling (PLS-SEM). Learner Inspiration and Motivation (LIM), Possible Challenges to E-Learning (PCE), Interaction with Group and Professor (IWGP), and Use of Technology (AI and Other Tools) in E-Learning (UTE) were treated as exogenous variables. Satisfaction Level of Learners (SLL) was used as the endogenous variable.

This cross-sectional study employed a structured questionnaire with 2 main sections to gather data. Part A of the questionnaire contained the data on the demographic characteristics. Gender, age, educational background, academic year, and kind of undergraduate/graduate program were among these attributes. Part B of the questionnaire comprised of the endogenous variable (learner satisfaction level) and 4 exogenous variables (learner motivation and inspiration, potential e-learning obstacles, group and professor interaction, and use of technology (AI and other tools) in e-learning). The dependent variable, Learners' Satisfaction Level (SLL), was estimated using eight different items adapted from (Baker 2010; Dinh and Nguyen 2020; Eom and Wem 2006; Khan et al. 2021) and each relate to a different aspect of online education which include: Instructor's use of technology in the classroom, Instructor's level of preparation for class, interaction between the instructor and the students, interaction with other classmates, continuous assessment method, final evaluation method, shared learning resources, Instructor's feedback to the students.

In case of exogenous variables, Learner Inspiration and Motivation (LIM) is comprised of 5 items: students' desire in attending the class, the instructor's presentation style in class, unstable internet access, the environment at home, and peers' actual absences. These items were adapted from Means and Neisler (2020), Pelikan et al. (2021), and Rovai et al. (2007). Next exogenous variable Possible challenges to E-Learning (PCE) also consists of 5 items adapted from Eom and Ashlil (2016), Means and Neisler (2020), Richardson et al. (2017) and Zielinski (2000): Technological difficulties in e-learning, maintaining attention while listening to a lecture, literacy in the use of information technology, impacted by social isolation, Absence real-world experience. The third exogenous variable Interaction with group and professor (IWGP) consists of 3 items based on Moore's (1989) famous classification of interaction in distance learning: interaction of students with instructor, interaction of students with students, digital tools available for instruction. The fourth exogenous variable Use of technology (AI and other tools) in e-learning (UTE) consists of 4 items which

was adopted from Doğan et al. (2023) and Koval (2023): AI improves e-learning tools, Audiovisual aid and AI have made e-learning more engaging and exciting. Machine learning and AI techniques improve theory and fact visualization, AI and other technical tools improve e-learning environments, which benefits students. On a Likert scale of 5 points (1–5), each variable was rated according to how strongly they agreed or disagreed with the statement (Strongly Disagree-1, Disagree -2, Neutral-3, Agree-4, Strongly Agree-5).

For each latent construct tested in a study, 3 or more indications are needed for a meaningful PLS-SEM, according to Hair et al. (2013). Consequently, at least 3 items were used to measure each component in this study: satisfaction level of learner (SLL: 8 items), learner inspiration and motivation (LIM: 5 items), potential obstacles to e-learning (PCE: 5 items), group and professor interaction (IWGP: 3 items), and use of technology (AI and other tools) in e-learning (UTE: 4 items) are all included in this list.

3.2 The equation for PLS-SEM model

The structural relationships between latent variables as measured by manifest variables can be modeled using partial least squares structural equation modeling, or PLS-SEM (Chin et al. 2020; Hair and Alamer 2022; Magno et al. 2022).

The proposed PLS-SEM model equation can be represented as linear regression between dependent variable SLL and independent variable LIM, PCE, IWGP and UTE.

$$SLL = a_1 * LIM + a_2 * PCE + a_3 * IWGP + a_4 * UTE \quad (1)$$

Where, a_1 , a_2 , a_3 and a_4 are the coefficients associated with variables LIM, PCE, IWGP, and UTE.

3.3 Data collection and analysis

The questionnaire was converted into google form and circulated among the 1200 students from various higher education institutions and universities of India through online mode. We have chosen 30 Indian universities and institutions which provide technical and management education (both online and offline). A total of 462 responses received (38.5% response rate). All the respondents in this study were volunteers and were not forced to response and any point of time. The period of data collection is Dec-Jan 2024.

The responses of questionnaire were imported to excel file for the purpose of further analysis. The data was analyzed with the help of R programming in R Studio with help of packages: Semnr, Lavaan, Haven and Sem Plot. The procedure of reviewing the data comprised cleaning the data and putting it into a format that could be used. Both the missing value assessment and the outlier detection were carried out

during this procedure; however, neither the missing values nor the outliers identified. For the purpose of determining the internal reliability and validity of each scale, Cronbach's alpha and confirmatory factor analysis (CFA) were utilized. After that, PLS-SEM was utilized to figure out the factor loadings. This was the most effective estimating approach for interdependent connections with many scaled variables.

4 Results

Table 1 provides the demographic information for the 462 participants in the sample. According to the data presented in the table, most respondents to the research were male (71%), while the proportion of female respondents was somewhere around 29%. This reflects the proportion of both male and female learners who are enrolled in Commerce, Engineering, and Management courses in colleges and universities in India. In terms of age, most of the respondents were under 25 age (91%) and 9% were in 25–35 age group. In regard to their age, the vast majority of respondents (91%) were under the age of 25, while just 9% belonged to the age group ranging from 25 to 35.

Table 2 shows the descriptive statistics of 4 exogenous variables and one dependent variable of this study. For the analysis purpose we have combined the response strongly disagree and disagree as one response disagree, and strongly agree and agree were merged in to one response agree.

In the case of the endogenous variable known as "Satisfaction level of learners," the Table 2 reveals that the highest percentage of learner responses was for the instructor's preparedness for the online lecture (69%). This indicates

Table 1 Sample Respondents' Demographics

	Total Response	Response rate
Gender		
Male	330	71%
Female	132	29%
Total	462	100%
Education level	Total Response	Response rate
Under-Graduate	388	84%
Postgraduate	74	16%
Total	462	100%
Academic program type	Total Response	Response rate
Commerce	43	9%
Engineering	97	21%
Management	322	70%
Total	462	100%
Age	Total response	Response rate
25–35	42	9%
Below 25	420	91%
Total	462	100%

Table 2 Descriptive statistics related to endogenous and exogenous variables

		Agree (N)	Agree (%)
<i>Satisfaction level of learner</i>			
SLL1	The professor made good use of technology in the classroom	180	39%
SLL2	The Professor was well prepared for their time spent teaching online	320	69%
SLL3	The online sessions offered a sufficient number of possibilities for interaction between the instructor and the students	192	42%
SLL4	The online sessions offered a sufficient number of possibilities for interaction with other participants	204	44%
SLL5	The continuous assessment was both reasonable and useful	203	44%
SLL6	The final evaluation seemed reasonable and applicable	203	44%
SLL7	The way in which learning resources were shared was an effective strategy	197	43%
SLL8	The professor was quite good at providing feedback to the students	176	37%
<i>Learner inspiration and motivation</i>			
LIM1	Attending my virtual classes was always a priority for me	203	44%
LIM2	The professor's presentation style enticed me to participate in live sessions	275	42%
LIM3	I was disinclined to participate in online classes due to unreliable internet access	198	43%
LIM4	My home atmosphere encouraged me to participate in online sessions	191	41%
LIM5	My desire to participate in online classes was diminished by my classmates' physical absence	198	43%
<i>Possible challenges to E-Learning</i>			
PCE1	Technological difficulties in e-learning	310	67%
PCE2	Maintaining Attention While Listening to a Lecture	210	45%
PCE3	Literacy in the use of information technology	192	42%
PCE4	Impacted by social isolation	202	44%
PCE5	Absence real-world experience	314	68%
<i>Interaction with group and professor</i>			
IWGP1	There wasn't a lot of time for questions and answers in the online sessions I attended	212	46%
IWGP2	In my experience with online education, I have found that there are, few digital tools available for instruction	207	45%
IWGP3	Because of the nature of online education, I only got to know a few of my classmates	211	46%
<i>Use of technology (AI and other tools) in e-learning</i>			
UTE1	Use of AI has made e-learning tools more effective and constructive	196	42%
UTE2	technological advancement and AI has made e-learning more interesting and fun with the inclusion of Audio visual aid	198	43%
UTE3	Various tools of machine learning and artificial intelligence helps in better graphical representation of theories and facts	194	42%
UTE4	Artificial intelligence and other technological tools help in creating aggregate learning environment in e-learning which is very beneficial for learners	203	44%

that the majority of learners are pleased with the way in which the instructor well prepares for lecture. While the learner's response is lowest towards instructor's feedback to students (37%), professor's use of new technology in class (39%). Similar percentage of responses received in case of opportunity to interact between instructor and student (42%), interaction between students (44%), reasonableness and usefulness of continuous assessment (44%), evaluation of final term exam (44%), availability of e-learning material (43%). For independent variable Learner Inspiration and Motivation, highest number of learners (60%) respond that professor's presentation style enticed them to participate in live

sessions, 44% respond that Attending the online classes was always a priority, 43% learners agreed that they disinclined to participate in online classes due to unreliable internet access., 41% learners respond that their home atmosphere encouraged to participate in online sessions, 43% said that their desire to participate in online classes was diminished by classmates' physical absence. When asked about potential obstacles to e-learning, 68% of respondents said that the lack of practical experience is the biggest problem, while 67% said that technological difficulties in e-learning are the biggest obstacle to taking online courses. In addition, 45% of respondents said that it is difficult to pay attention

during lectures, 42% said that using information technology requires literacy, and 44% said that social isolation has a negative impact on learning. In response to the variable "Interaction with group and professor," 46% of students said that there wasn't much time for questions and answers in the online sessions I attended, 45% said there weren't enough digital tools available for instruction, and 46% said they got to know a few classmates because of online education. In response to a question about the variable use of technology (AI and other tools) in e-learning, 44% said that artificial intelligence and other technological tools help in creating an overall learning environment in e-learning that is very beneficial for learners, 43% said that technological advancement and AI has made e-learning more interesting and fun with the addition of audiovisual aid, and 42% said that different tools of machine learning and artificial intelligence help. 42% claimed that using AI has improved and improved the effectiveness of e-learning tools.

4.1 Estimation of the measurement model

4.1.1 Reliability of measurement model

This section will detail the assessment of the quality of the measurement model that was developed by PLS-SEM. This assessment will concentrate on both the reliability and validity of the model.

Cronbach's alpha measurement is used to check the internal consistency and reliability of measurement construct. Table 3 shows the result of Cronbach's values for each construct used in the study. As per George and Millery (2003) value of Cronbach's alpha more than 0.7 indicates the acceptable value and value between 0.8 and 0.9 is considered to be good. The Table 3 shows the value of Cronbach's alpha greater than 0.8 which is good and acceptable for the study. In summary, one can get the conclusion that each of the latent constructs was distinguished by high internal consistency, which made it possible to conduct further tests.

Table 3 Reliability analysis

Variable	Cronbach's alpha
Learner Inspiration and Motivation (LIM)	0.854
Possible challenges to E-Learning (PCE)	0.896
Interaction with group and professor (IWGP)	0.836
Use of technology (AI and other tools) in E learning (UTE)	0.856
Satisfaction level of learners (SLL)	0.896

4.1.2 Model fit indices

The model fit indices values are shown in Table 4. The model fit Chisq (χ^2) value is 1170.97 and Df = 265 so CMIN/DF = 4.41 which is less than the threshold value (<5) so the model is acceptable. The RMSEA value is 0.042 which is acceptable and satisfied for the proposed model fit. RMR value is 0.045, which is less than critical value 0.05. GFI is 0.92 and AGFI is 0.905 which is greater than 0.9, which provides indication that the measurement model fits the data quite well. The value of measured CFI is 0.907, which is greater than the threshold value 0.9 indicates that measurement model has good overall fit. The value of NFI is 0.905 which is greater than threshold value 0.9, indicate a good incremental fit of the model. Value of TLI (0.91) is also more than 0.9.

4.1.3 Validity of the measurement model

The convergent validity of the measurement model is verified by estimating the AVE (Average variance extracted) value, standard loadings, and CR (construct reliability) values for all the variables in the study. As per Table 5, the value of AVE is 0.744 for SLL, 0.733 for LIM, 0.798 for PCE, 0.793 for IWGP, and 0.778 for UTE. The value of CR is 0.787 for SLL, 0.729 for LIM, 0.743 for PCE, 0.825 for IWGP, and 0.752 for UTE, which is above than the cut-off value of 0.7. The estimated values of AVE and CR indicate that all the factor loadings are significant. This proves that the convergent validity of the measurement model is sufficient.

Table 6 shows the comparison of square root values of AVE and the correlation between the various factors. Diagonal values in the table represent the square-root value of AVE and values below that show the correlation between factors. The correlation value of the variable is less than the estimated value of square root of AVE, which shows the support of discriminant validity in the present study.

Table 4 Model fit indices of measurement model

Model fit Indices	Index value	Comment
RMSEA	0.042	Accepted
GFI	0.92	Accepted
RMR	0.045	Accepted
AGFI	0.905	Accepted
CFI	0.907	Accepted
NFI	0.905	Accepted
TLI	0.91	Accepted
CMIN/DF	4.41	Accepted

Table 5 Value of Standard loadings, AVE (Average variance extracted), and CR (construct reliability)

	SLL	LIM	PCE	IWGP	UTE
SLL1	0.996	0	0	0	0
SLL2	0.591	0	0	0	0
SLL3	0.72	0	0	0	0
SLL4	0.692	0	0	0	0
SLL5	0.735	0	0	0	0
SLL6	0.701	0	0	0	0
SLL7	0.746	0	0	0	0
SLL8	0.71	0	0	0	0
LIM1	0	0.777	0	0	0
LIM2	0	0.736	0	0	0
LIM3	0	0.741	0	0	0
LIM4	0	0.73	0	0	0
LIM5	0	0.68	0	0	0
PCE1	0	0	0.731	0	0
PCE2	0	0	0.768	0	0
PCE3	0	0	0.874	0	0
PCE4	0	0	0.805	0	0
PCE5	0	0	0.804	0	0
IWGP1	0	0	0	0.831	0
IWGP2	0	0	0	0.777	0
IWGP3	0	0	0	0.769	0
UTE1	0	0	0	0	0.731
UTE2	0	0	0	0	0.77
UTE3	0	0	0	0	0.854
UTE4	0	0	0	0	0.753
AVE	0.744	0.733	0.798	0.793	0.778
CR	0.787	0.729	0.743	0.825	0.752

Table 6 Comparison of the square-root of AVE and correlation between factors

	SLL	LIM	PCE	IWGP	UTE
SLL	0.74				
LIM	0.7	0.73			
PCE	0.65	0.65	0.79		
IWGP	0.52	0.71	0.62	0.79	
UTE	0.72	0.68	0.76	0.761	0.77

4.1.4 The structural equation model

The graphical representation of SEM model is shown in Fig. 2 and Table 7 shows standardized path estimates of the SEM model. The result in Table 7 indicates that all the path estimates and significant and 5% level of significance. The result shows that LIM($\beta=0.137$), PCE($\beta=0.382$), IWGP ($\beta=0.18$) and UTE($\beta=0.328$) has direct and positive relationship with dependent variable SLL.

Path coefficients(β) of independent variables estimated from PLS-SEM are mentioned in Table 7. The satisfaction level of learners through e-learning (SLL) is positively influenced by all 4 independent variables: learner inspiration and motivation (LIM) (0.137), possible challenges to e-learning (PCE)(0.382), interaction with group and professor (IWGP) (0.18), and use of technology (artificial intelligence and other tools) in e-learning (UTE) (0.328). while possible challenges to e-learning (PCE) (0.382) influence the most.

The PLS-SEM equation as per Eq. 1 can be represented as follows:

$$SLL = 0.137 * LIM + 0.382 * PCE + 0.18 * IWGP + 0.328 * UTE$$

5 Discussion

The primary objective of this study was to investigate the factors that influence the level of satisfaction that students have with online teaching in the higher education institutions in India. On the basis of the literature review that has been conducted on the topic of e-learning and student satisfaction, we came up with the hypothesis that the level of satisfaction that students have with e-learning can be broken down into 3 main categories: learner inspiration and motivation (LIM), possible challenges to e-learning (PCE), interaction with group and professor (IWGP), and use of technology (artificial intelligence and other tools) in e-learning (UTE). The proposed model was examined and evaluated by Factor Analysis and Structural Equation Modelling (SEM). The analysis of the results showed that each of the 4 independent factors has a substantial impact on student satisfaction. This outcome is in agreement with previous research that was conducted on the topic of online education and student satisfaction for the purpose of this study (Means and Neisler 2020; Eom et al. 2006; Dinh and Nguyen 2020; Wang et al. 2013).

Possible challenges to e-learning (PCE) have the highest significant impact on the satisfaction level of learners. The positive association between the 2 variables demonstrates that when challenges for e-learning reduce, the learner’s satisfaction increases, a result in line with empirical research conducted across numerous circumstances (Means and Neisler 2020; Wang et al. 2013). Another independent variable “Use of technology in E-learning (UTE)” has the second highest impact on the satisfaction level of learners it means the use of technological advancement and AI tools in online teaching has made e-learning more interesting and fun with the inclusion of Audio-visual aid, graphical representation of theories and facts. Artificial intelligence and other technological tools help in creating an aggregate learning environment in e-learning which is very beneficial for learners (Doğan et al. 2023; Koval 2023).

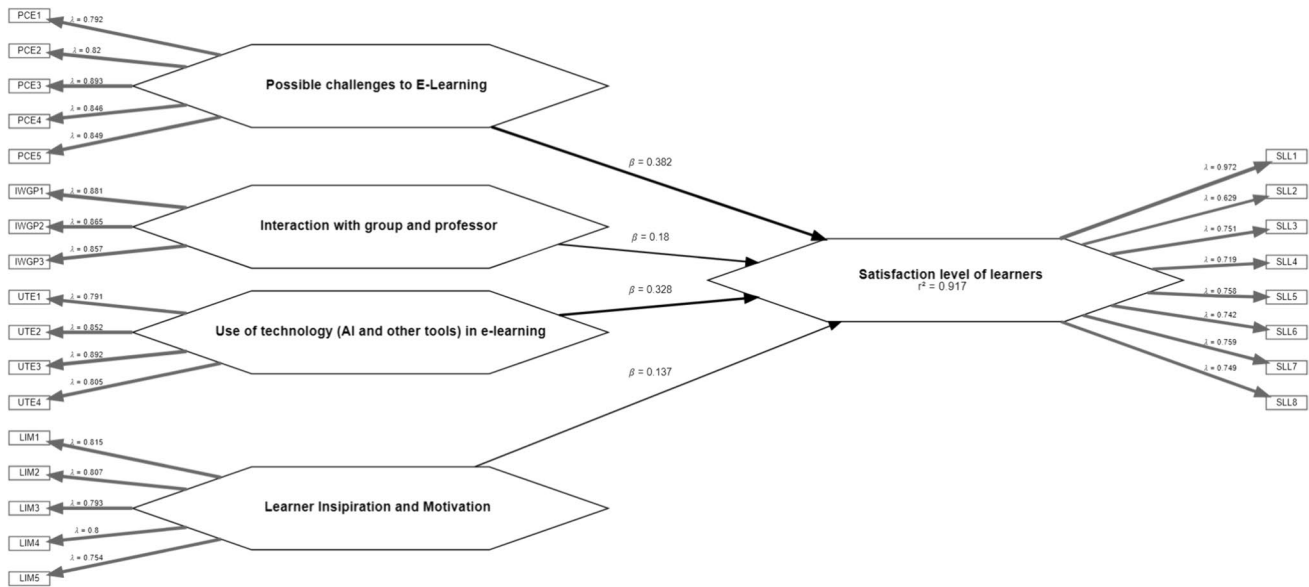


Fig. 2 Research framework for study

Exogenous variable Interaction with group and professor (IWGP) also has a positive impact on the satisfaction level of learners. It means learners are more satisfied in online education if the interaction with the instructor and peer group is more (Moore 1989). The fourth variable Learner Inspiration and Motivation (LIM) also has a positive and significant impact on the satisfaction level of students this relationship suggests that A higher level of motivation in e-learning leads to an increase in the students’ level of satisfaction. This finding should not come as a surprise considering that students are expected to take on extra responsibilities for their own education when participating in online teaching, as opposed to face-to-face education (Means and Neisler 2020; Pelikan et al. 2021; Rovai et al. 2007).

6 Conclusion

Based on the findings of this study, it can be concluded that the level of satisfaction that students experience with online teaching in higher education institutions in India is influenced by several key factors. Through the examination of a proposed model using Factor Analysis and Structural Equation Modelling (SEM), it was determined that learner

inspiration and motivation (LIM), possible challenges to e-learning (PCE), interaction with group and professor (IWGP), and the use of technology (including artificial intelligence) in e-learning (UTE) all significantly impact student satisfaction.

Notably, the analysis revealed that e-learning challenges have the highest significant impact on student satisfaction, followed by the use of technology, interaction with instructors and peers, and learner inspiration and motivation. These findings are consistent with prior research in the field, indicating that addressing challenges inherent in e-learning, such as technological barriers and the lack of interaction, can significantly enhance student satisfaction.

Furthermore, the study underscores the importance of interaction between learners and instructors in the e-learning environment. It suggests that increased interaction can mitigate feelings of isolation often associated with online learning, ultimately leading to higher levels of satisfaction among students. Overall, this research highlights the interconnectedness of various factors in shaping student satisfaction with e-learning and emphasizes the need for continued investigation into addressing challenges and promoting positive interactions to enhance the overall learning experience in online settings.

Table 7 Path coefficients estimated through PLS-SEM

	SLL(β)	P value
LIM	0.137	0.001
PCE	0.382	0.002
IWGP	0.18	0.001
UTE	0.328	0.001

7 Limitation of the study

The limitation attached to this study is the fact that the data was only obtained from students at higher institutes and the universities of India is the first factor that may limit the findings’ potential to be generalized. For this reason, it is

advised that future researchers can do a comprehensive study that includes a sample that is representative of universities of the world population. This study focused on only 4 factors that can influence a student's level of satisfaction with their online education: the learner's inspiration and motivation, possible challenges associated with e-learning, interaction with both the group and the instructor, and use of technology (artificial intelligence and other tools) in e-learning. The relationships of the satisfaction level of learners between additional factors such as course layout, technologies, student performance, independent learning, and style of learning should be pursued by future researchers.

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Declarations

Conflict of interest In our paper, there are no potential conflicts of interest. The paper has been seen by all authors, who have given their approval for submission to your journal. We certify that the manuscript's contents have not been released or submitted for release elsewhere.

Ethical approval This article does not cover studies of human participants and animals.

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