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Examining E-Learning Quality Dimensions and Their Influence on Learner Satisfaction: an Empirical Study Using Pls-Sem

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ABSTRACT

Purpose: This study seeks to analyze the influence of service, information, and system quality on e-learning quality, and subsequently assess the effect of e-learning quality on learner satisfaction in Punjab, India.

Design/Methodology/Approach: The data was gathered from a sample of 506 e-learners using purposive and snowball sampling who utilized at least one e-learning platform for a minimum duration of six months, covering test preparation, higher education, online certification, private coaching, re-skilling, correspondence courses, and language courses. A 'structural equation modeling (SEM)' method was used to determine the relationships among variables.

Findings: The research findings demonstrate that service quality, information quality, and system quality have an influence on e-learning quality which in turn impact learner satisfaction. The service quality, information quality, and systems quality exhibit a smaller but significant effect on the overall quality of e-learning. Similarly, e-learning quality has a medium but significant effect on satisfaction.

Research limitations/Implications: The study does not include the behavioural intention and other related variables to better understand how users behave after adopting e-learning and how they stay engaged.

Practical Implications: The results offer significant practical insights for educational organisation, universities, online content providers, and policymakers engaged in the expansion and application of e-learning initiatives.

Originality/Value: This paper highlights the determinants of e-learning quality with satisfaction combined in one model. The study further highlights the transformation in the education sector, where the decline of traditional classroom learning accelerated dependence on e-learning platforms, thereby increasing the importance of high-quality digital learning systems. Additionally, the study offers a comprehensive framework using PLS-SEM to understand learner satisfaction in modern online learning environments.

Keywords: E-learning, Service quality, Information quality, System quality, E-learning quality, Satisfaction, PLS-SEM00

INTRODUCTION

The post-pandemic educational environment created a significant shift from traditional classroom learning to online learning systems. As offline teaching activities declined due to institutional closures and mobility restrictions, dependence on digital learning platforms increased substantially. This educational transformation accelerated the adoption of e-learning technologies and highlighted the importance of maintaining high-quality online learning environments. Consequently, students now place greater emphasis on service quality, information quality, and system quality while evaluating their e-learning experiences and satisfaction levels. There has been a worldwide trend toward online education, which has effectively removed the physical and temporal barriers from the classroom. Online and hybrid learning techniques were quickly adopted by universities around the world because of the abrupt COVID-19 outbreak (Bond et al., 2021; Crawford et al., 2020). Technology

gives us more freedom and access to more information, but the real problem is the quality of e-learning- how well it can really engage, motivate, and improve learning results (Baber, 2021; Sun et al., 2008). But just because digital tools are available doesn't mean students will have positive learning experiences. The education sector experienced a V-shaped transformation during the post-pandemic period, where the decline in offline classroom learning accelerated the rapid adoption and dependence on e-learning platforms, thereby increasing the importance of maintaining high-quality digital learning environments. A growing body of evidence shows that the quality of students' online learning experiences affects their motivation, engagement, and performance in the classroom (Baber, 2021; Eom & Ashill, 2016). If the platforms aren't well made, teachers don't get enough help, and students can't do much, digital classrooms could become passive, which could negatively impact students' satisfaction and success (Aristovnik et al., 2020; Patricia Aguilera-Hermida, 2020).

The quality of an online course can be measured in several ways, including its technological stability, instructional design, topic appropriateness, evaluation methods, and student assistance (Fatani, 2020; Rapanta et al., 2020). The 'National Education Policy (NEP) 2020' in India outlines a comprehensive framework for education that is technology-enabled, inclusive, and focused on outcomes. It highlights the importance of digital infrastructure, open educational resources, and platforms like SWAYAM and DIKSHA (Ministry of Education, 2020). Nevertheless, policy initiatives by themselves cannot guarantee effective learning; the implementation of high-quality e-learning systems is essential for transforming the vision of the NEP into impactful student experiences.

Therefore, it is both necessary and timely to understand what drives the quality of e-learning. To help institutions create better, more policy-aligned online education environments, this study looks at how student satisfaction is affected by the quality of e-learning function.

Literature Review

E-LEARNING

The term "e-learning" describes the integration of various forms of electronic media into the educational process to broaden the scope of standard classroom instruction. Mixed instructional approaches, online learning environments, and learning management systems (LMS) are all part of it (Bond et al., 2021; Dhawan, 2020). Improvements in information and communication technology, higher internet coverage, and the need for more adaptable educational alternatives particularly in the wake of the COVID-19 pandemic have all contributed to the rapid growth of online education (Coman et al., 2020). Evidence from studies shows that online education is essential in today's universities because it allows students more flexibility in their study schedules, greater access to course materials, and more individualized attention (Al-Fraihat et al., 2020; Bolliger & Martin, 2018). But the success of e-learning isn't just based on the tools that are used; it's also based on the quality and pedagogy aspects that affect how well people learn and how they observe it (Babiker, 2015; Lee et al., 2019). As a result, researchers emphasize the value of understanding online education as an integrated whole, with instructional, technological, and support elements all working together to provide students with the best possible learning environment (Li & Zhu, 2022; Rapanta et al., 2020).

2.1.1 E-Learning Quality

A comprehensive concept, e-learning quality refers to how well online education satisfies students' expectations, learning objectives, and performance criteria (Sun et al., 2008; Freeze et al., 2010; Al-Fraihat et al., 2020). Based on studies in service quality and information systems, e-learning quality can be defined as the extent to which the provided online learning experience meets or surpasses learners' expectations, indicating connection between perceived performance and expected standards. Drawing on the SERVQUAL model (Parasuraman et al., 1998), the expectation-perception gap perspective has been extensively adapted for use in online and digital learning settings in the field of current empirical studies (Pham et al., 2019; Udo et al., 2011). In line with this perspective, the information systems success framework highlights the importance of high-quality systems, information, and services as important factors that determine the effectiveness of their perceptions of learning(Al-Fraihat et al., 2020; Delone & Mclean, 2003).It should be noted that the quality of online education is subjective and depends on factors such as the qualities of the learners, the circumstances in which they take the course, and the technology used (Limbu & Pham, 2023; Zawacki-Richter et al., 2019).

2.1 System Quality

System quality measures the usability and technical performance of e-learning platforms. This includes features like accessibility, security, responsiveness, ease of navigation, and reliability (Delone & Mclean, 2003; Petter et al., 2008). High system quality guarantees uninterrupted access to course contents, functionalities, and learning activities, all of which are essential for ongoing participation in online settings (Limbu & Pham, 2023). Research found that the quality of a system has a big impact on how people evaluate it cognitively. This aspect includes how they perceive its utility and how easy it is to use. In turn, this aspect affects how learners feel about and value the digital learning environment (Abdullah et al., 2016; Tarhini et al., 2014).Additionally, prior research illustrates that students have more faith in e-learning systems when they have positive experiences with them, such as when the platform is easy to use, responds quickly, and has low error rates. Investing in strong infrastructure and user-friendly interfaces is vital for ensuring the long-term viability of e-learning delivery, since these technical performance qualities promote trustworthiness and reliability (Cheng, 2019; McKnight et al., 2011).

2.2 Information Quality

The quality of information that are important in online learning settings include its timeliness, truthfulness, depth, clarity, and alignment with the objectives of the courses (Li & Zhu, 2022; Ghasemaghaei, 2015; Shahzad

et al., 2021). High-quality information is important for learners because it helps them learn in a meaningful way, encourages critical thinking, and builds knowledge. This is a crucial factor in how learners feel about the educational experience as a whole (Rapanta et al., 2020; Zhang et al., 2004). Studies indicate that well-structured, clear or unambiguous, and academically rigorous information enhances cognitive engagement and facilitates deeper understanding among learners (Aparicio et al., 2016; Cidral et al., 2018). Students may lack confidence in digital instruction and struggle to learn from materials of poor information quality, such as those that are outdated, contain irrelevant examples, or lack proper structure. Perceived e-learning quality and learner satisfaction are strongly impacted by information quality, which includes timeliness, accuracy, clarity, and relevance (Al-Fraihat et al., 2020; Pham et al., 2019). Furthermore, models that have been modified from SERVQUAL highlight the significance of ongoing content review and alignment with learning outcomes, as well as the fact that information quality is a fundamental factor that impacts assessments of e-learning service delivery (Uppal et al., 2018).

LEARNER SATISFACTION

There are several facets to learner satisfaction, which reflects how effectively students evaluate and interpret their online learning experiences. Emotional, cognitive, and evaluative aspects all come together to show how well the learning environment meets the expectations of students and how well they feel it helps them achieve their academic goals (Baber, 2021; Patricia Aguilera-Hermida, 2020). As an important outcome variable, learner satisfaction is frequently utilized in empirical research to evaluate the efficacy of online platforms and instructional strategies (Elshami et al., 2021). Several empirical models show that learner satisfaction in virtual educational settings is significantly affected by information and system quality. This phenomenon is especially true of models that are based on the 'DeLone and McLean Information Systems Success' paradigm. Expanding on this idea, integrated IS-TAM models propose that quality aspects boost perceived utility and perceived simplicity of use, leading to greater satisfaction among pupils (Cheng, 2019; Delone & Mclean, 2003; Raza et al., 2021; Salloum et al., 2019). Learners express more overall satisfaction, increased engagement, and enhanced impressions of the educational experience when e-learning systems deliver reliable technology and high-quality material, according to studies across multiple contexts (Al-Fraihat et al., 2020; Pham et al., 2019; Joo et al., 2018). In light of these results, contentment should be considered as a primary metric in studies examining the quality of online education.

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Conceptual model and hypotheses development

The suggested conceptual model for this study investigates the impact of service, information, and system quality on e-learning quality, which influences learner satisfaction. In this approach, service quality, as assessed by the 'SERVQUAL' framework, includes the support and responsiveness of instructors and the institution, including prompt feedback, guidance, and assistance in overcoming technical or academic challenges. 'Information quality' refers to the educational information supplied through the platform, including correctness, relevance, clarity, completeness, and timeliness, to ensure that learners obtain meaningful and well-structured knowledge to fulfill their learning objectives. 'System quality' refers to the technical and functional characteristics of the e-learning platform, such as the course website's usability, navigation, accessibility, reliability, and responsiveness, which collectively determine how effectively learners can access and interact with online learning resources. These three dimensions (service, information, and system quality) are viewed as important predictors of online learning quality, with good performance in each component enhancing the overall perceived quality of the e-learning experience. Online learning quality, in turn, is expected to have a significant influence on learner satisfaction, reflecting learners' overall assessment of their e-learning experience, including cognitive engagement, perceived utility, and acceptance of the online platform. Thus, the model integrates technical, content, and service dimensions to better understand the determinants of effective online learning, emphasizing that improvements in course website functionality, content quality, and service responsiveness all contribute to a high-quality online learning environment, which leads to increased learner satisfaction

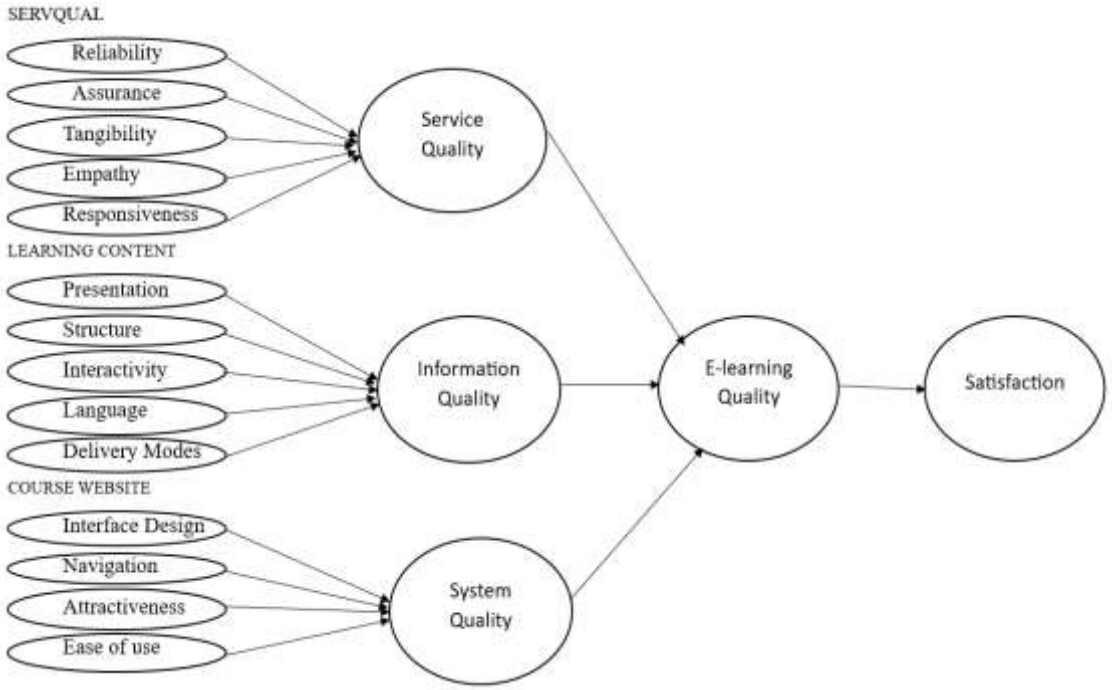

Figure 1 Conceptual Model of the study (Udo et al., 2011; Uppal et al., 2018)

First order construct are SERVQUAL dimensions, Learning content and Course website. Indicators namely 'Reliability,''Assurance,''Tangibility,''Empathy,' and 'Responsiveness' are used to assess service quality. Learning content indicators include 'Presentation,' 'Structure,' 'Interactivity,' 'Language,' and 'Delivery Modes.' Additionally, Course website indicators pertaining to 'Interface Design,' 'Navigation,' 'Attractiveness,' and 'Ease of use' are used to evaluate system quality. Second order construct are 'Service quality,' 'Information quality,' and 'System quality' which is measured using SERVQUAL, learning content and course website, respectively. 'E-learning quality' and 'satisfaction' are the dependent variables that influence their decision to apply an e-learning system.

HYPOTHESES DEVELOPMENT

Based on the conceptual model, this study claims that 'service quality,' 'information quality,' and 'system quality' are important predictors of 'e-learning quality,' which in turn influences learner satisfaction.

Service quality and e-learning quality: The SERVQUAL framework measures service quality in terms of responsiveness, reliability, assurance, empathy, and the tangibility of help provided to learners (Baber, 2021). According to prior research, excellent learner support and timely help improve the perceived quality of e-learning experiences, leading to increased engagement and satisfaction with the platform (Cidral et al., 2018).

H1: Service quality has a significant effect on e-learning quality.

Information quality and e-learning quality: Information quality refers to the accuracy, clarity, relevance, completeness, and timeliness of learning content given via e-learning systems (Aparicio et al., 2016; Li & Zhu, 2022). High-quality material ensures that learners attain relevant knowledge and believe the online course is useful and beneficial (Rapanta et al., 2020).

H2: Information quality has a significant effect on e-learning quality.

System quality and e-learning quality: System quality encompasses the technical and functional components of an e-learning platform, such as the course website's readability, accessibility, responsiveness, and reliability (Al-Fraihat et al., 2020; Cidral et al., 2018; Shahzad et al., 2021). Prior research has shown that platforms with excellent system quality improve learners' ease of use and interaction with course contents, resulting in higher perceived online learning quality (Gopal et al., 2021; Limbu & Pham, 2023).

H3: System quality has a significant effect on e-learning quality.

E-learning quality and satisfaction: Online learning quality refers to the overall perception of the effectiveness, usability, and worth of the e-learning experience. According to studies, greater quality online learning has a favorable impact on learner satisfaction because students view the platform to be encouraging, interesting, and conducive to attaining learning objectives (Baber, 2021; Rapanta et al., 2020). Based on this, it is hypothesized

H4: e-learning quality has a significant effect on learner satisfaction.

All of these theories create a mediated model where the quality of service, information, and system indirectly affects learner satisfaction through online learning settings. This model provides a detailed framework for considerate how technology, content, and service components contribute to successful online learning environments.

Objective

The purpose of this study is to examine the impact of service quality, information quality and system quality on the e-learning quality and then to examine the impact of e-learning quality on learner satisfaction among students in Punjab

RESEARCH METHODOLOGY

This study uses a cross-sectional survey design and a quantitative research method to look at how service quality, information quality and system quality effect the e-learning quality, which subsequently impacts learner satisfaction. A sample of 550 university students from among target population from Punjab were selected who have used at least one e-learning platform for a minimum of six months. These students used e-learning platforms for private coaching, higher education, test preparation, online certification, re-skilling, online correspondence courses, and language-related learning. A purposive and snowball sampling method was employed to ensure comprehensive representation of Punjab, India. Data was gathered by using a structured questionnaire. The data gathering process started with a brief description of the study's objectives, followed by an initial assessment of participants' familiarity with e-learning. This was done by asking a simple question: 'Are you familiar with e-learning?' Only those who answered 'Yes' were invited to proceed with the survey. To ensure that only genuine learners participated, an additional screening question, 'How long have you been using the e-learning platform?' was included in the questionnaire. The respondents were made aware in advance that their input was fully voluntary and that they may exit at any stage of procedure. Using this methodology, 506 valid responses were collected in last two quarters of year 2024. The items were adapted from various relevant scales (Table 1). The 'Likert scale' responses varied from 'Strongly Disagree' to 'Strongly Agree' on a scale of 1 to 5

Table 1. Measurement sources and adaptation basis

Construct	Adaptation basis	No of Items	Key sources
Service quality	SERVQUAL and e-learning service-quality research	22	Parasuraman et al. (1988); Udo et al. (2011); Sumi & Kabir (2021)
Information quality	E-learning and information-quality research	18	Freeze et al. (2010); Cidral et al. (2018); Al-Fraihat et al. (2020)
System quality	Website, usability and e-learning research	15	Kishabale (2021); Sternad Zabukovšek et al. (2022)
E-learning quality	Quality-of-experience measure	04	Kunjukunju et al. (2020)
Satisfaction	Satisfaction scale	07	Promtep & Arcand (2019);Chandra et al. (2018); Seo & Um (2023); Harsasi & Susatwijaya (2018); Puriwat & Tripopsakul (2021)

SQ follows the SERVQUAL tradition through reliability, assurance, tangibility, empathy, and responsiveness. IQ captures presentation, structure, interactivity, language, and delivery mode. SYQ captures interface design, navigation, attractiveness, and ease of use. ELQ contains four items assessing the overall e-learning experience. Satisfaction contains seven items addressing level of satisfaction of students from overall e-learning quality.

The response rate was 92%, which meant that a sample of 506 students were chosen for the study. There were 237 male (46.84%) and 269 females who answered (53.16%). The demographic profile of respondents comprised of age, gender, level of education, location, and type of course (Table 2)

Table 2 Demographic Information of Respondents

Characteristics		Frequency	Percentage	Cumulative %
Age (in Years)	18-25	221	43.7	43.7
	26-34	219	43.3	87.0
	Above 35	66	13.0	100.0
Gender	Male	237	46.84	46.8

	Female	269	53.16	100.0
Educational	Undergraduate	234	46.2	46.2
Qualification	Postgraduate	187	37.0	83.2
	Doctorate	85	16.8	100.0
Geographical Area	Rural	215	42.5	42.5
	Urban	291	57.5	100.0
Course Type	Recorded	116	22.9	22.9
	Live	86	17.0	39.9
	Both	304	60.1	100.0

The questionnaire was tested by expert review for content validity, and then PLS-SEM was used to evaluate 'internal consistency' and 'construct validity.' 'AVE,' 'Cronbach's alpha,' 'composite reliability (CR),' and 'discriminant validity' (employing the 'Fornell-Larcker criterion and the HTMT ratio') comprise the assessments. The data analyses used descriptive statistics to describe the attributes of the respondents. Then, 'structural equation modeling (SEM)' was used to evaluate hypothesized correlations among 'service quality,' 'information quality,' 'system quality,' and 'learner satisfaction.' Path coefficients, t-values, and p-values were used to determine significance of the hypothesized relationships. As for the model's strength and predictive power, predictive relevance (Q^2) and effect size (f^2) were quantified.

5 RESULTS

The suggested model anticipates the inter connection of the constructs as well as the influence of the outlined dimensions on e-learning quality and students' satisfaction. For exploratory causal modeling and prediction, partial least squares (PLS) are better than covariance-based structural equation modelling (Hair et al., 2019; Henseler et al., 2009). In addition, PLS can evaluate complicated models and overcome issues with small sample size(Hair et al., 2019; Marcoulides & Saunders, 2006). For that reason, we analyzed the data using the Smart PLS4 software (Ringle et al., 2015). This study used the two-phase evaluation method for PLS outcomes (Hair et al., 2022). The initial step consists of measuring the measurement model, which defines the connections between latent constructs and their observed items. The structural model, which in phase two lays out the possible connections between the dependent and independent components, is than examined.

5.1 Measurement model

The measurement model was evaluated using indicators of reliability, internal consistency reliability, convergent validity, and discriminant validity (Hair et al., 2022). The 'average variance extracted (AVE),''composite reliability (CR),' and 'Cronbach's alpha values.' Are calculated(Table 3). All the item loadings in their respective constructs varied from 0.6 to 0.876, were significant, and met the minimum required threshold of 0.6, indicating satisfactory indicator reliability (Nunnally, 1978). 'Internal consistency' was measured using'CR and Cronbach's alpha' values. All the 'CR and Cronbach's alpha' values surpass the acceptable level of 0.7, showing 'internal consistency'. Convergent validity was determined using AVE, which should have a minimum acceptable value of 0.5(Hair et al., 2022). All the 'AVEs' achieved their recommended values, showing acceptable convergent validity
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Table 3. Result (AVEs, Cronbach's Alpha, and CRs) of the measurement model

Construct	(AVE)	Cronbach's Alpha	CR
Reliability	0.590	0.769	0.852
Assurance	0.578	0.818	0.872
Tangibility	0.571	0.813	0.869
Empathy	0.585	0.764	0.849
Responsiveness	0.611	0.788	0.862
Presentation	0.568	0.746	0.840
Structure	0.686	0.774	0.867

Interactivity	0.529	0.777	0.849
Language	0.637	0.716	0.840
Delivery Mode	0.676	0.762	0.862
Interface Design	0.593	0.829	0.879
Navigation	0.578	0.757	0.845
Attractiveness	0.690	0.775	0.870
Ease of Use	0.690	0.776	0.870
E-learning quality	0.532	0.707	0.819
Satisfaction	0.517	0.845	0.882

The 'Fornell-Larcker criterion' and the 'heterotrait-monotrait ratio of correlations (HTMT)' were used to assess discriminant validity(Table 4 & 5). The HTMT ratios were below the cut off value of 0.85 (Henseler et al., 2015), and the square root of the AVE for each construct was larger than the correlations with other constructs (Fornell and Larcker 1981), indicating that the constructs were distinct.

Table 4. Discriminant Validity Assessment

Construct	ASS	ATTRA	DEL_MD	EAS_USE	ELQ	EMP	INTAC	INTF	LAN	NAVI	PRE	REL	RES	SAT	STR	TAN
ASS	.760															
ATTRA	.402	.831														
DEL_MD	.368	.457	.822													
EAS_USE	.277	.562	.428	.831												
ELQ	.442	.408	.413	.386	.729											
EMP	.658	.363	.383	.309	.431	.765										
INTAC	.427	.423	.505	.386	.406	.406	.727									
INTF	.351	.558	.507	.519	.427	.346	.457	.770								
LAN	.404	.394	.561	.410	.402	.449	.529	.448	.798							
NAVI	.299	.519	.440	.437	.403	.284	.398	.536	.408	.760						
PRE	.435	.459	.547	.413	.436	.402	.616	.418	.486	.423	.753					
REL	.664	.298	.356	.216	.433	.588	.425	.263	.352	.259	.391	.768				
RES	.557	.350	.371	.277	.409	.592	.516	.324	.368	.288	.452	.575	.782			
SAT	.352	.321	.231	.265	.389	.383	.273	.239	.243	.158	.271	.341	.363	.719		
STR	.342	.378	.465	.398	.384	.384	.411	.393	.504	.371	.582	.352	.351	.195	.828	

Construct	ASS	ATTRA	DEL_MD	EAS_USE	ELQ	EMP	INTAC	INTF	LAN	NAVI	PRE	REL	RES	SAT	STR	TAN
TAN	.610	.467	.398	.372	.405	.566	.436	.386	.375	.305	.445	.571	.501	.373	.364	.755

Note: Assurance (ASS), Attractiveness (ATTRA), Delivery Modes (DEL_MD), Ease of Use (EAS_USE) E-learning Quality (ELQ), Empathy (EMP), Interactivity (INTAC), Interface Design (INTF), Language (LAN), Navigation (NAVI), Presentation (PRE), Reliability (REL), Responsiveness (RES), Structure (STR), Tangibility (TAN), Satisfaction (SAT)

*Every construct's' square root of the AVE' is represented by the values in the across (bold) values. The non-diagonal parts stand for these factor correlation coefficients.

Table: 5. HTMT ratio of correlations for Discriminant Validity Assessment

Construct	ASS	ATTRA	DEL_MD	EAS_USE	ELQ	EMP	INTAC	INTF	LAN	NAVI	PRE	REL	RES	SAT	STR	TAN
ASS	—															
ATTRA	.509	—														
DEL_MD	.474	.593	—													
EAS_USE	.346	.722	.555	—												
ELQ	.574	.546	.548	.513	—											
EMP	.838	.464	.491	.397	.574	—										
INTAC	.529	.538	.653	.487	.541	.516	—									
INTF	.426	.697	.628	.644	.550	.424	.567	—								
LAN	.531	.528	.758	.541	.556	.605	.698	.570	—							
NAVI	.381	.678	.581	.562	.547	.362	.518	.673	.548	—						
PRE	.559	.607	.730	.538	.598	.523	.805	.530	.660	.561	—					
REL	.835	.385	.467	.276	.583	.760	.545	.329	.470	.339	.520	—				
RES	.693	.445	.481	.342	.543	.758	.653	.395	.486	.371	.590	.734	—			
SAT	.421	.396	.279	.324	.493	.471	.325	.283	.309	.193	.336	.411	.434	—		
STR	.437	.489	.595	.512	.501	.493	.518	.479	.660	.487	.767	.455	.451	.234	—	
TAN	.748	.584	.501	.469	.524	.720	.540	.470	.486	.385	.574	.717	.618	.442	.457	—

5.2 Structural model

The bootstrapping method employed 5000 bootstrap samples to evaluate the relevance of the proposed links inside the study model. The model's multicollinearity was assessed initially. Multicollinearity arises when two or more predictor variables exhibit high correlation, resulting in bias in the calculation of path coefficients. Consequently, variance inflation factor (VIF) analyses were conducted in this study. All VIF values for the two dependent constructs, namely e-learning quality and satisfaction, were smaller than the maximum threshold of 3, signifying the absence of multicollinearity (Hair et al., 2011)(Table

Table: 6 Variance inflation factor (VIF) values

Independent variables		Dependent variables	
E-learning quality (ELQ)	SATISFACTION (SAT)		
Service quality	1.641	-	
Information quality	2.280	-	
System quality	1.843	-	
E-learning quality	-	1.000	

Following the assessment of the measurement model the 'standardized root mean square residual (SRMR)' assesses model fit quality by assessing the variation between actual correlations and those predicted by the model (Hair et al., 2022). The SRMR value must be less than 0.08. The estimated model's SRMR value in this study was 0.073, signifying a good fit and absence of model specification problems. The outcomes of the hypothetical connections are illustrated in Table 7 and Figure 2.

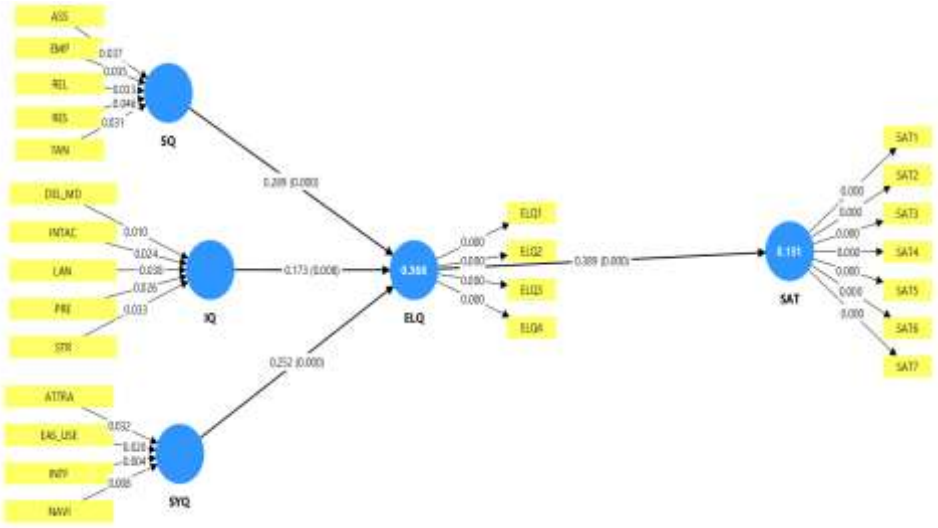

Figure 2 Structural model showing relationship between constructs and satisfaction

The criteria of p-value between 0.05 and 0.1 was regarded as marginally significant, while a p-value less than 0.05 was utilized as the threshold for determining if the proposed connection was statistically significant (Zambrano et al., 2022). Based on statistical significance, H1, H2, H3, and H4 are supported (Table 7). The impact of an exogenous variable on an endogenous variable is shown by the f^2 value. Based on Cohen's thresholds (Cohen, 1988), Small, medium, and high impacts are shown by f^2 values of 0.02, 0.15, and 0.35, respectively. Table 6 also shows the effect magnitude of the f^2 value for each association. e-learning quality significantly effect satisfaction whereas service quality, system quality, and information quality has a small effects on e-learning quality.

Table 7: Results of path analysis and hypothesis testing

H	path	β coefficient	SE	t-value	p-value	Decision	f^2
H1	SQ→ELQ	0.289	0.057	5.085	0.000	Accepted	0.082
H2	IQ→ELQ	0.173	0.065	2.671	0.008	Accepted	0.020
H3	SYQ→ELQ	0.252	0.060	4.223	0.000	Accepted	0.054
H4	ELQ→SAT	0.389	0.049	7.890	0.000	Accepted	0.178

Findings of the structural model and the explained variance (R^2) for each dependent construct show that the model accounts for 36.8% of the variance in e-learning quality and 15.1% in user satisfaction(Figure 2 and Table 8). The predictive relevance, indicating the model's efficacy in precisely forecasting the endogenous construct, is moderate one. Furthermore, the Q^2 predicted value for satisfaction is 0.139, reflecting low yet significant predictive relevance. Predictive relevance is classified as small for Q^2 levels exceeding zero, modest between 0.25 and 0.50, and significant when exceeding 0.50(Hair et al., 2019).As all Q^2 values were greater than zero, this indicates that the model exhibits robust prediction skills for outcomes that exceed the sample data.

The findings correspond to R^2 values of 0.368 and 0.151, indicating a modest yet significant degree of explanatory power. The R^2 and Q^2 findings collectively indicate that the proposed model effectively accounts for variance in e-learning quality and user satisfaction, enabling precise predictions and underscoring the model's resilience and practical relevance.

Table 8: Results of R^2 and Q^2 level assessment.

Endogenous Construct	R^2	Interpretation (R^2)	Q^2 predict	Interpretation (Q^2)
E-learning Quality	0.368	Weak explanatory power	0.334	Medium predictive relevance
Satisfaction	0.151	Weak explanatory power	0.139	Small predictive relevance

Endogenous R^2 Interpretation (R^2) Q^2 predict Interpretation (Q^2)
CONSTRUCT
E-learning Quality 0.368 Weak explanatory power 0.334 Medium predictive relevance
Satisfaction 0.151 Weak explanatory power 0.139 Small predictive relevance

All independent factors, namely service quality, information quality, and system quality, show strong overall impacts on e-learning quality, which in turn, together with these independent variables, significantly influence satisfaction (Table 9

Table: 9 Direct, indirect, and total effects on e-learning quality and satisfaction

_Dependent variables_____						
E-learning quality			___Satisfaction			
Independent Variables	direct	indirect	total	direct	indirect	total
SQ	0.289	-	0.289	-	0.112	0.112
IQ	0.173	-	0.173	-	0.067	0.067
SYQ	0.252	-	0.252	-	0.098	0.098
ELQ	-	-	-	0.389	-	0.389

DISCUSSION AND CONCLUSION

This study analyzes the factors influencing overall e-learning quality and their impact on user satisfaction in the post-COVID-19 online learning environment, based on existing e-learning quality frameworks. As digital platforms have evolved from additional tools to fundamental educational frameworks, knowing how learners assess e-learning systems has gained paramount significance. This study specifically examines the impact of service quality, system quality, and information quality on e-learning quality and, in turn, user satisfaction.

The results indicate that service quality, system quality, and information quality each have positive impact on e-learning quality. These findings validate that learners' opinions of platform efficacy are multidimensional. When these three elements operate properly, they together enhance learners' comprehensive assessment of the e-learning environment. This suggests that successful digital education relies on equitable advancement in technology infrastructure, superior academic content, and ongoing institutional support.

The importance of service quality, information quality, and system quality in this study is significant, since these elements are essential factors influencing digital platform efficacy and satisfaction for users. The findings indicate that, in a online environment, service quality, information quality, and system quality collectively and similarly influence learners' assessments of e-learning quality, underscoring their integrated importance in modern digital education systems. The findings indicate that the overall quality of e-learning significantly impacts user satisfaction, aligning with previous studies that show perceived effectiveness of the system directly predicts satisfaction in digital learning contexts (Al-Fraihat et al., 2020; Cidral et al., 2018; Eom & Ashill, 2016). This study empirically validates that service quality, system quality, and information quality collectively influence overall e-learning quality, which subsequently affects user satisfaction, thereby reinforcing and expanding the relevance of IS success theory in a completely digital and non-voluntary educational context(Teo et al., 2019; Al-Fraihat et al., 2020; Cidral et al., 2018; Delone & Mclean, 2003). The findings confirm the adaptability of IS success theory and illustrate its contextual adaptation within modern higher education institutions.

The results indicate that higher education institutions should refrain from concentrating on a single aspect of platform enhancement from a practical standpoint. Learners' satisfaction may not be adequately enhanced by investments that are focused on technical enhancements, content enhancement, or support services. Rather,

institutions should implement an integrated quality management strategy that simultaneously improves the quality of instructional content, system reliability, and service responsiveness. In contemporary digital education settings, such coordinated enhancements are more likely to boost the overall quality of e-learning and guarantee sustained individual satisfaction.

To sum up, this empirical examination illustrates that the e-learning quality is primarily determined by the quality of service, system quality, and quality information, which serve as the fundamental elements of learner satisfaction. In the post-pandemic higher education landscape, learners' satisfaction is significantly influenced by their comprehensive assessment of the system, as digital platforms serve as the foundation of learning. Therefore, it is important to strengthen these interconnected quality dimensions in order to achieve long-term success in e-learning.

6.1 Theoretical Implications

The outcomes of this research are going to produce numerous substantial theoretical contributions in the realm of educational technology and e-learning. Initially, the study expands upon existing frameworks, including the 'DeLone & McLean Information Systems Success' model and the 'SERVQUAL model', within the realm of higher education by incorporating quality of service, information, and system as experiences of online learning quality. Although previous research has frequently studied these dimensions individually, this study insight a comprehensive, multidimensional comprehension of the collective impact of technical, content, and service-related factors on the e-learning quality, thereby providing a more comprehensive perspective on the effectiveness of digital education.

Secondly, the study strengthens theoretical models for execution of e-learning and acceptance by specifically connecting e-learning quality to learner satisfaction, emphasizing satisfaction as a critical outcome of perceived learning quality. This relationship substantiates theories including the 'Technology Acceptance Model (TAM)' and the 'Unified Theory of Acceptance and Use of Technology (UTAUT)' by illustrating that learners' evaluation of the virtual educational setting is directly influenced by their perception of system functionality, content relevance, and service support.

Third, the research underlines the importance of explaining quality dimensions. System quality is characterized as the efficacy of the course website, information quality as the authenticity and usefulness of the content, and service quality is evaluated using the SERVQUAL dimensions. This offers a theoretically grounded framework for assessing the e-learning quality in higher level education, which can be modified and verified across diverse educational environments.

This study provides empirical evidence regarding the interconnections between quality dimensions, online learning quality, and learner satisfaction, thereby addressing a gap in e-learning research. It illustrates that technological framework, high-quality content, and responsive support services are interdependent and collectively enhance the overall learning experience. These theoretical insights can guide future research on digital education, learner engagement, and instructional design, providing a basis for enhancing current models of online learning efficacy and satisfaction.

6.2 Practical Implications

This research provides valuable practical perspectives for educational organisations, instructional designers, and policymakers trying to enhance online learning efficacy. The study indicates that service quality significantly impacts e-learning quality, with learner assistance being a vital factor in determining satisfaction. Institutions must establish effective support systems that incorporate quick feedback, attentive teacher contact, and readily available technical assistance, aligned with the SERVQUAL qualities of reliability, assurance, responsiveness, empathy, and tangibility. Enhancing service quality and student engagement may be attained by training teachers in online pedagogy and communication skills.

The research emphasizes the significance of information quality, stating that educational content must be accurate, useful, updated, and consistent with course objectives. Educators and content creators must emphasize the development of well-organized, clear and and attractive educational materials, including multimedia and interactive elements where suitable to improve learner understanding and retention.

Third, the findings highlight the essential importance of system quality, stressing that course websites and learning platforms should be created with user-friendly interfaces, logical navigation, accessibility, and technological stability. Institutions must to invest in comprehensive e-learning set-up and perform frequent system audits to mitigate technological concerns that may hinder learning and diminish student participation.

The study underscores the causal interaction between online learning quality and student satisfaction, offering practical guidance and administration of e-learning programs. Institutions may utilize these insights to prioritize investments and enhancements across system, content, and service dimensions, thereby improving overall learner satisfaction, encouraging platform adoption, and facilitating favorable learning outcomes. Collectively, these recommendations may assist higher education providers in delivering high-quality, learner-centered online education that addresses the evolving demands of digital-age students.

6.3 Conclusion

This study illustrates that quality of service, information, and system are critical factors determining e-learning quality, which subsequently has a substantial influence on learner satisfaction in e-learning contexts. The results specify that effectively designed course websites, precise and pertinent information, and responsive, learner-focused support services collectively expand the perceived quality of digital education and promote good student experiences. The research enhances current theoretical frameworks, like the 'DeLone & McLean IS Success Model', the 'Technology Acceptance Model (TAM)', and 'SERVQUAL', by emphasizing the synergistic impact of technical, informational, and service aspects on learner satisfaction. The research offers an in-depth knowledge of the interaction among many quality

aspects that influence successful online learning experiences.

Limitations and future research directions

Considering its merits, this study possesses some drawbacks. This survey's design is cross-sectional, which limits the capacity to cause and effect relationship and may fail to reflect changes in learner views over time. Secondly, the sample is confined to students from Punjab, India, thereby limiting the results' applicability to different cultural, institutional, or geographical settings. Third, the study depends on self-reported measurements, which may include response biases such as societal attractiveness or recollection bias. The study exclusively examines three characteristics of e-learning quality—service, information, and system, while neglecting other potentially impactful factors such as monitoring quality, learning efficacy, or customization. Subsequent research may expand upon this study by utilizing longitudinal or experimental methodologies to document shifts in learner perceptions over time and to demonstrate more robust causal linkages. Broadening the research to include other nations, educational groups, and institutional frameworks may improve the objectivity of the outcomes. Future research may explore more aspects of e-learning quality, covering quality monitoring, learning efficacy, and customization, while also investigating possible moderating variables, including learner motivation, prior digital literacy, course difficulty, and cultural disparities. Integrating objective performance measurements and engagement data with self-reported measures might yield a more comprehensive picture of how quality factors affect learner outcomes. This research will assist universities in creating more efficient, learner-centered e-learning environments that enhance satisfaction and learning efficacy.

Ethical Considerations

The study held to ethical standards in every respect. Participants were apprised of the study's objectives prior to its commencement, and their consent was obtained. Confidentiality and ethical conformance were guaranteed by the absence of any individually identifiable information

REFERENCES

1. Abdullah, F., Ward, R., & Ahmed, E. (2016). Investigating the influence of the most commonly used external variables of TAM on students' Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) of e-portfolios. *Computers in human behavior*, *63*, 75-90.

2. Aguilera-Hermida, A. P. (2020). College students' use and acceptance of emergency online learning due to COVID-19. *International journal of educational research open*, *1*, 100011.

3. Al-Fraihat, D., Joy, M., Masa'deh, R. E., & Sinclair, J. (2020). Evaluating E-learning systems success: An empirical study. *Computers in human behavior*, *102*, 67-86.

4. Aparicio, M., Bacao, F., & Oliveira, T. (2016). An e-learning theoretical framework. *Journal of Educational Technology & Society*, *19*(1), 292-307.

5. Aristovnik, A., Keržič, D., Ravšelj, D., Tomaževič, N., & Umek, L. (2020). Impacts of the COVID-19 pandemic on life of higher education students: A global perspective. *Sustainability*, *12*(20), 8438.

6. Baber, H. (2021). Modelling the acceptance of e-learning during the pandemic of COVID-19-A study of South Korea. *The International Journal of Management Education*, *19*(2), 100503.

7. Babiker, M., &Elmagzoub, A. (2015). For Effective Use of Multimedia in Education, Teachers Must Develop their Own Educational Multimedia Applications. *Turkish Online Journal of Educational Technology-TOJET*, *14*(4), 62-68.

8. Bolliger, D. U., & Martin, F. (2018). Instructor and student perceptions of online student engagement strategies. *Distance education*, *39*(4), 568-583.

9. Bond, M., Bedenlier, S., Marín, V. I., & Händel, M. (2021). Emergency remote teaching in higher education: Mapping the first global online semester. *International journal of educational technology in higher education*, *18*(1), 50.

10. Cheng, Y. M. (2019). How does task-technology fit influence cloud-based e-learning continuance and impact?. *Education+ Training*, *61*(4), 480-499.

11. Cidral, W. A., Oliveira, T., Di Felice, M., & Aparicio, M. (2018). E-learning success determinants: Brazilian empirical study. *Computers & education*, *122*, 273-290.

12. Clark, L. A., & Watson, D. (2016). Constructing validity: Basic issues in objective scale development.

13. Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Erlbaum.

14. Coman, C., Țîru, L. G., Meseșan-Schmitz, L., Stanciu, C., &Bularca, M. C. (2020). Online teaching and learning in higher education during the coronavirus pandemic: Students' perspective. *Sustainability*, *12*(24), 10367.

15. Crawford, J., Butler-Henderson, K., Rudolph, J., Malkawi, B., Glowatz, M., Burton, R., ... & Lam, S. (2020). COVID-19: 20 countries' higher education intra-period digital pedagogy responses. *Journal of applied learning & teaching*, *3*(1), 9-28.

16. DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: a ten-year update. *Journal of management information systems*, *19*(4), 9-30.

17. Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of educational technology systems*, *49*(1), 5-22.

18. Elshami, W., Taha, M. H., Abuzaid, M., Saravanan, C., Al Kawas, S., & Abdalla, M. E. (2021). Satisfaction with online learning in the new normal: perspective of students and faculty at medical and health sciences colleges. *Medical education online*, *26*(1), 1920090.

19. Eom, S. B., & Ashill, N. (2016). The determinants of students' perceived learning outcomes and satisfaction in university online education: An update. *Decision sciences journal of innovative education*, *14*(2), 185-215.

20. Fatani, T. H. (2020). Student satisfaction with videoconferencing teaching quality during the COVID-19 pandemic. *BMC medical education*, *20*(1), 396.

21. Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of marketing research*, *18*(1), 39-50.

22. Ghasemaghaei, M., & Hassanein, K. (2015). Online information quality and consumer satisfaction: The moderating roles of contextual factors–A meta-analysis. *Information & Management*, *52*(8), 965-981.

23. Gold, A. H., Malhotra, A., & Segars, A. H. (2001). Knowledge management: An organizational capabilities perspective. *Journal of management information systems*, *18*(1), 185-214.

24. Gopal, R., Singh, V., & Aggarwal, A. (2021). Impact of online classes on the satisfaction and performance of students during the pandemic period of COVID 19. *Education and information technologies*, *26*(6), 6923-6947.

25. Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. Journal of Marketing theory and Practice, 19(2), 139-152. https://doi.org/10.2753/mtp1069-6679190202

26. Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European business review*, *31*(1), 2-24.

27. Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the academy of marketing science*, *43*(1), 115-135.

28. Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing.

29. Joo, Y. J., So, H. J., & Kim, N. H. (2018). Structural relationships among self-determination, satisfaction, and persistence in online learning. *Computers & Education, 122*, 179–189.

30. Kline, R. B. (2015). Principles and practice of structural equation modeling. Guilford publications.

31. Lee, J., Song, H. D., & Hong, A. J. (2019). Exploring factors, and indicators for measuring students' sustainable engagement in e-learning. *Sustainability*, *11*(4), 985.

32. Li, X., & Zhu, W. (2022). System quality, information quality, satisfaction and acceptance of online learning platform among college students in the context of online learning and blended learning. *Frontiers in Psychology*, *13*, 1054691.

33. Limbu, Y. B., & Pham, L. (2023). Impact of E-Learning Service Quality on Student Satisfaction during the COVID-19 Pandemic: A Systematic Review. *Knowledge Management & E-Learning*, *15*(4), 523-538.

34. Marcoulides, G. A., & Saunders, C. (2006). Editor's comments: PLS: a silver bullet?. *MIS quarterly*, *30*(2), iii-ix.

35. Mcknight, D. H., Carter, M., Thatcher, J. B., & Clay, P. F. (2011). Trust in a specific technology: An investigation of its components and measures. *ACM Transactions on management information systems (TMIS)*, *2*(2), 1-25.

36. Ministry of Education. (2020). *National Education Policy 2020*. Government of India. Retrieved from https://www.education.gov.in

37. Nunnally, J. C. (1978). Psychometric theory. McGraw-Hill.

38. Parasuraman, A. B. L. L., Zeithaml, V. A., & Berry, L. (1988). SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality. *1988*, *64*(1), 12-40.

39. Petter, S., DeLone, W., & McLean, E. (2008). Measuring information systems success: models, dimensions, measures, and interrelationships. *European journal of information systems*, *17*(3), 236-263.

40. Pham, L., Limbu, Y. B., Bui, T. K., Nguyen, H. T., & Pham, H. T. (2019). Does e-learning service quality influence e-learning student satisfaction and loyalty? Evidence from Vietnam. *International journal of educational technology in higher education*, *16*(1), 1-26.

41. Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L., & Koole, M. (2020). Online university teaching during and after the Covid-19 crisis: Refocusing teacher presence and learning activity. *Postdigital science and education*, *2*(3), 923-945.

42. Raza, S. A., Qazi, W., Khan, K. A., & Salam, J. (2021). Social isolation and acceptance of the learning management system (LMS) in the time of COVID-19 pandemic: an expansion of the UTAUT model. *Journal of educational computing research*, *59*(2), 183-208.

43. Ringle, C. M., Wende, S., Becker, J.-M. (2015). SmartPLS 3. www. smartpls.com.

44. Salloum, S. A., Al-Emran, M., Shaalan, K., &Tarhini, A. (2019). Factors affecting the E-learning acceptance: A case study from UAE. *Education and information technologies*, *24*(1), 509-530.

45. Sarstedt, M., Ringle, C. M., & Hair, J. F. (2021). Partial least squares structural equation modeling. In *Handbook of market research* (pp. 587-632). Cham: Springer International Publishing.

46. Shahzad, A., Hassan, R., Aremu, A. Y., Hussain, A., & Lodhi, R. N. (2021). Effects of COVID-19 in E-learning on higher education institution students: the group comparison between male and female: A. Shahzad et al. *Quality & quantity*, *55*(3), 805-826.

47. Sun, P. C., Tsai, R. J., Finger, G., Chen, Y. Y., & Yeh, D. (2008). What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & education*, *50*(4), 1183-1202.

48. Tarhini, A., Hone, K., & Liu, X. (2014). Measuring the moderating effect of gender and age on e-learning acceptance in England: A structural equation modeling approach for an extended technology acceptance model. *Journal of Educational Computing Research*, *51*(2), 163-184.

49. Teo, T. S., Srivastava, S. C., & Jiang, L. I. (2008). Trust and electronic government success: An empirical study. *Journal of management information systems*, *25*(3), 99-132.

50. Teo, T., Tsai, L. T., & Yang, C. C. (2019). Applying structural equation modeling to e-learning success. *Interactive Learning Environments, 27*(5–6), 1–14.

51. Udo, G. J., Bagchi, K. K., & Kirs, P. J. (2011). Using SERVQUAL to assess the quality of e-learning experience. *Computers in Human Behavior*, *27*(3), 1272-1283.

52. Uppal, M. A., Ali, S., & Gulliver, S. R. (2018). Factors determining e-learning service quality. *British journal of educational technology*, *49*(3), 412-426.

53. Zambrano, C. N., Lu, W., Johnson, C., Beeber, M., Panitz, A., Ibrahim, S., ... &Ogunwobi, O. O. (2022). Dietary behavior and urinary gallic acid concentration differences among underserved elder racial and ethnic minorities in New York City. *Cancer Causes & Control*, *33*(7), 929-937.

54. Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education–where are the educators?. *International journal of educational technology in higher education*, *16*(1), 39.

55. Zhang, D., Zhao, J. L., Zhou, L., & Nunamaker Jr, J. F. (2004). Can e-learning replace classroom learning?. *Communications of the ACM*, *47*(5), 75-79