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Assessing Learning Management System success in the UAE universities: how quality measures linked to students' academic performance

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Learning Management Systems (LMS) have become widely recognized tools for university learning worldwide and identifying the factors affecting students' academic performance has always been a major focus in both academia and practice. This study aims to develop a research model based on the Delone and McLean Information System Success Model to investigate the effects of quality measures on students' perceived usefulness, satisfaction, actual usage, and academic performance. Data collected from 118 business school students at two universities in the United Arab Emirates (UAE) were analyzed using the PLS-SEM approach to validate the research model. The data analysis revealed that eight combined quality measures have a positive and significant effect on students' perceived usefulness, perceived satisfaction, and actual use. In turn, each factor—perceived usefulness, perceived satisfaction, and actual use—has a positive and significant impact on students' academic performance. Further, we find that the following impact factors (perceived usefulness, perceived satisfaction, and actual use) mediate the relationship between quality measures and students' academic performance. Interestingly, this group of four variables—quality measures, perceived usefulness, perceived satisfaction, and actual usage—explains 84.9% of students' overall academic performance. Therefore, educational institutions seeking to achieve greater benefits from LMS should pay considerable attention to quality measures that directly impact students' usefulness, satisfaction, and actual usage, ultimately resulting in improved academic performance. These factors play a significant role in enhancing the overall quality of LMS and university education in the UAE and potentially in other countries as well.

KEYWORDS

Learning Management System (LMS), quality measures, perceived usefulness, perceived satisfaction, actual use, students' academic performance, United Arab Emirates (UAE)

1 Introduction

Learning management system (LMS) has become a prevalent aspect of the education sector and is extensively utilized in higher education course delivery systems (Al-Fraihat et al., 2020; Turnbull et al., 2022). Consequently, LMS is a key education enabler of the 21st century which significantly influences educational environments (Aparicio et al., 2016). An increasing reliance on the web and the Internet by students has prompted educational institutions to transition from traditional learning and teaching methods (Al-Adwan et al., 2021). In the present era, LMS has become a widespread learning medium,

leveraging digital technology to deliver materials, syllabi, questions, and discussion forums (Firman et al., 2021). However, LMS or E-learning systems use different systems such as (e.g., Moodle, Blackboard, Canvas, developed in-house or any other platform). These various systems provide students a comprehensive and interactive learning environment with features such as discussion rooms, announcements, online assignment submission, checking the Turnitin, and publish the students' marks. LMS provide teachers and students with an online classroom that enhances learning processes. In virtual classroom settings, LMS support both teachers and students in their learning journey (Bradley, 2021). The benefits of LMS remain uncertain in many Arab countries' universities (Snoussi, 2019). Hence, it is vital for academics in these institutions to take a leading role in fostering technological innovation by endorsing and implementing integrated programs as contemporary teaching and learning tools (Snoussi, 2019). Despite the successful implementation of LMS in many universities across the Arab Gulf Countries (AGC), there has been limited focus on investigating the usage of these systems (Sulaiman, 2024).

Our study is driven by a pressing need, as the universities in the United Arab Emirates (Abdellatif et al., 2023; Shahin and Arfaj, 2022; Shishakly, 2021) are increasingly recognizing the direct link between the quality measures of the e-learning system and the learners' performance (Shahin and Arfaj, 2022). While the developed world has a wealth of literature on the importance of university e-learning system quality, our aim is to contribute to this body of knowledge and provide insights specific to the United Arab Emirates (UAE) context. In the UAE, the government's substantial investments in education have paved the way for implementing e-learning in many universities. However, despite this progress, there are significant challenges and gaps in the e-learning system. Reports of low adoption and acceptance and high dropout rates seem to be alarming. Moreover, there is a clear gap in the empirical literature about how the e-learning system measures success and affects student academic performance in the UAE (Vuckovic et al., 2023).

In addition to the above argument, this research comes as a result of research problems emanating from conceptualization of quality measures. For instance, Al-Fraihat et al. (2020), considered seven factors measuring the quality measures while (Al-Adwan et al., 2021) considered six factors. On the one hand, Mohammadi (2015) considers five factors Seta et al. (2018) using four factors to conceptualize e-learning system quality (Technical System Quality (TSQ), Educational System Quality (ESQ), Service Quality (SQU), and content information quality). Al Mulhem (2020) examines three factors from quality measures [Course Content Quality (CCQ), ESQ, and SQU]. He recommends in future research, the model could be expanded by incorporating additional constructs to better align with various application domains and the rapidly evolving nature of e-learning technologies (Al Mulhem, 2020).

The primary challenge researchers encounter in developing LMS success model is managing the extensive number of measurements across dependent and independent variables (Al-Fraihat et al., 2020). Unfortunately, the assessment of e-learning system excellence is not highly developed currently because of the rapid expansion and constant evolution of student learning and institutional advancement. Empirical studies have utilized learning quality to uphold satisfaction with e-learning (Muhammad et al., 2020).

The aim of this study is to investigate the influence of e-learning quality measures on students' academic performance in the two UAE universities. Specifically, we identified the study objectives as follows:

1. To construct a comprehensive concept to measure LMS quality.
2. To examine the effect of quality measures on students' perceived usefulness, perceived satisfaction, and actual use, and their subsequent impact on students' academic performance.
3. To explore the mediating role of perceived usefulness, perceived satisfaction, and actual use in the relationship between quality measures and students' academic performance.

Based on the aim and objectives of this study, we formulate our main research question (RQ), considering the well-documented relationship between LMS quality measures and students' academic performance in literature. Given this information, we formulate the research questions: Which factors can be combined to measure the quality of LMS, and through which mechanisms are LMS quality measures linked to students' academic performance?

From theoretical perspective, our study considered extending the Technology Acceptance Model (TAM). This model has been the most commonly-used framework by researchers in LMS studies within the Arab Gulf Countries (Sulaiman, 2024). TAM has demonstrated significant effectiveness in the information systems literature for forecasting user acceptance and usage behavior (Davis and Venkatesh, 1996). However, using TAM to assess how related constructs influence students' intentions to continue in an educational environment (Ashrafi et al., 2022).

The following section delves into the conceptual framework, expanding on the foundational context introduced earlier. It outlines the specific relationships between various quality measures and their hypothesized effects on key outcomes, such as perceived usefulness, satisfaction, actual usage, and academic performance. The literature review and the development of hypotheses are further discussed below.

2 Literature review and hypotheses development

In early 2020, COVID-19 caused the closure of schools and universities worldwide, leaving ∼1.2 billion learners outside the classroom (El Said, 2021). Technology became an essential tool for promoting reliable and efficient assessments. The rapid advancement of technology resulted in the extensive integration of digital platforms and devices into various aspects of daily life. During pandemics like COVID-19, educational institutions around the world leveraged these technological advancements, transforming the landscape of higher education and driving the global adoption of online learning as a primary teaching method (Wahas and Syed, 2024). Although many theoretical and opinion papers have been published on the impact of COVID-19 on higher education services, there remains a limited number of empirical studies that explore the factors influencing students' attitudes and intentions toward using remote learning technologies (Camilleri and Camilleri, 2022). The COVID-19 pandemic significantly accelerated digital transformation, driving an urgent shift to remote learning methods (Allam et al., 2024). Thus, the implementation of pandemic restrictions and emergency lockdowns to control

the spread of COVID-19 forced higher education institutions worldwide to adapt to and maintain online education standards while ensuring the quality of learning experiences remained consistent (Al-Nuaimi et al., 2023). The supportive environment and effective tools for using LMS significantly enhanced university students' positive perceptions of LMS during the COVID-19 pandemic. This, in turn, influenced their engagement with LMS for learning and reinforced a commitment to sustainable education. Additionally, perceived usefulness and ease of use was positively correlated with Learning Engagement, highlighting the importance of user-friendly systems in maintaining student involvement during this period (Alturki and Aldraiweesh, 2021). Additionally, an empirical study explored the factors influencing e-learning adoption during the COVID-19 era from students' perspectives, identifying perceived usefulness, perceived ease of use, and attitude toward the LMS as key predictors of LMS adoption (Dampson, 2021). The development of hypotheses is discussed below.

2.1 The relationship between quality measures on one side and perceived usefulness, perceived satisfaction, and actual use on the other

The quality measures are influenced by many factors (e.g., perceived usefulness). Perceived usefulness refers to how users perceive the benefits or advantages of a specific tool or system (Nasir et al., 2021). Research conducted in developed countries indicates that various indicators of school quality significantly influence students' literacy and numeracy skills (Rawlings et al., 2024). Studies reveal that students taught by highly qualified instructors tend to find it useful and excel academically (Engida et al., 2024). Furthermore, students' perceptions of teacher quality are closely linked to their levels of engagement, with these relationships generally following predictable patterns (Bonney et al., 2015). Moreover, the research highlights a positive correlation between effective management practices and student achievement in public secondary schools (Parveen et al., 2024). The results suggest that teacher quality is closely tied to instructional quality and student usefulness, reinforcing the importance of quality measures in relation to academic outcomes (Blömeke et al., 2016). Perceived usefulness is considered a core element in the TAM and its later adaptations (Alsabawy et al., 2016). TAM posits that individuals' perceptions of new technology play a pivotal role in determining their willingness to adopt and utilize it. The theory suggests that users' decisions are shaped by their evaluation of available information and intentions, allowing them to make informed and rational choices (Nasir et al., 2021).

Service quality emerged as a crucial factor influencing student satisfaction in higher education. It was noted that service quality, along with expectations and perceived value, significantly contributed to achieving student satisfaction (Keržič et al., 2021). An empirical study aimed to explore the relationship between perceived quality and satisfaction in higher education. The results confirmed a positive relationship between perceived quality and satisfaction (Kanwar and Sanjeeva, 2022). Student motivation plays a crucial role in determining the effectiveness and quality of the educational process in an e-learning environment (Zhang et al., 2020). Additionally, technical features such as the platform's reliability, user-friendliness, and accessibility are critical in determining students' satisfaction with online learning experiences. An empirical study revealed a strong and direct connection between e-service quality, system usage, and user satisfaction among 254 students (Shams et al., 2022). An empirical study for 250 university students in Saudi Arabia indicates that quality factors, including course content quality, system quality, and service quality, positively and significantly influence students' satisfaction with the e-learning system (Al Mulhem, 2020).

Student actual use with LMS is a vital factor influencing motivation and learning outcomes. A key contributor is the quality measures (e.g., teaching, learning materials, support services) particularly their clarity and alignment with learning objectives. Furthermore, meaningful interactions between students and instructors facilitated through LMS platforms play a significant role in shaping students' actual usage for LMS. The relationship between school quality measures—such as classroom experience and composition—and access to resources, as well as how students actually use those resources, is significant (Rawlings et al., 2024). Research shows that students with access to highly qualified teachers tend to perform better academically (Engida et al., 2024). Furthermore, another study indicates that the availability of internet-connected computers, the quality of educational materials, and access to education can also affect students' academic use and success (Dey, 2017).

An empirical study by Belo et al. (2024) involved 503 participants who were users of an e-learning platform at an accredited aviation educational institution in the Philippines. The results indicated that system and information quality had a significant influence on perceived usefulness and student satisfaction. Another study conducted at a Malaysian university involving 280 students revealed that system quality positively influences student satisfaction, although it does not impact students' usage (Shahzad et al., 2021). Overall, these findings imply that the connection between quality measures and students' academic outcomes is influenced by how resources are utilized. Based on the previous arguments we formulate the following three hypotheses:

H1. Quality measures is positively related to student's perceived usefulness.

H2. Quality measures is positively related to student's perceived satisfaction.

H3. Quality measures is positively related to student's actual use.

2.2 The relationship between (perceived usefulness, perceived satisfaction, and actual use) and students' academic performance

Perceived usefulness relates to students' academic performance across different quality measures (Nugroho et al., 2018). Perceived usefulness has been recognized at the student level, reflecting the belief that using the e-learning system during COVID-19 would enhance performance (Alyoussef, 2021). A study conducted with 158 university instructors in the UAE demonstrated that

perceived usefulness significantly influenced their satisfaction and their intention of use with the blackboard (Mouakket and Bettayeb, 2015). In comparison to the aforementioned study, a similar study conducted on 397 students in Saudi Arabia revealed that both perceived usefulness and actual usage had a positive and significant relationship with students' academic performance during the COVID-19 pandemic (Alam et al., 2021). Another research question focused on the relationship between students' perceived satisfaction and their performance in online education. The results showed a connection between perceived satisfaction and academic performance (Badr et al., 2024). In conclusion, perceived satisfaction is a key factor to student academic performance. Students who report higher satisfaction with the quality of their e-learning experience tend to exhibit greater overall satisfaction with their education, which in turn positively impacts their perceived academic performance (Keržič et al., 2021).

Actual use in the context of this study refers to how students engage with and utilize e-learning resources within the selected universities (Shishakly, 2021). The use of LMS can be applied across different levels of education, yielding positive outcomes in classroom learning (Prahani et al., 2022). LMS users anticipate obtaining high-quality and beneficial educational services (Alsabawy et al., 2016). Understanding how these metrics interact with academic results is essential for evaluating university effectiveness and identifying areas needing improvement. Extrinsic factors, which are often overlooked in basic assessments of school standards, such as students' engagement with the material, can also play a significant role in academic success (Bonney et al., 2015). Furthermore, there is evidence of improved academic performance among students who maintain a school-wide average daily attendance, suggesting that a positive school environment and a culture of consistent attendance contribute to overall student achievement (Blömeke et al., 2016). Finally, with regard to how students engage with learning resources, a total of 1,875 responses were collected from Romanian university students who participated in online courses during the COVID-19 pandemic. The study revealed a positive and significant relationship between behavioral intent to use and students' academic performance (Fülöp et al., 2023).

Thus, the utilization of LMS and its various features can engage students and enhance their academic performance (Oguguo et al., 2021). Consequently, we formulate the following three hypotheses:

H4. Perceived usefulness is positively related to students' academic performance.

H5. Perceived satisfaction is positively related to students' academic performance.

H6. Actual use is positively related to student' academic performance.

2.3 The mediating roles of (perceived usefulness, perceived satisfaction, and actual use) in the relationship between quality measures and students' academic performance

Various studies have highlighted different factors influencing students' academic performance in online learning environments. Consequently, it is essential to explore the elements impacting academic outcomes when utilizing LMS to enhance and refine online education in higher education. In most universities, students' overall evaluation scores are commonly used to measure their academic performance (Pang and Veloo, 2024). The connection between quality measures and student academic performance has been extensively studied. Our study highlighted the importance of perceived usefulness, satisfaction, and actual use as key mediators. Quality measures, including course content, teaching methods, and technological support have a direct effect on students' learning experiences (Moore and Kearsley, 2012). However, the relationship between these quality measures and academic performance is complex and can be influenced by psychological and behavioral factors such as perceived usefulness, perceived satisfaction, and actual use (Venkatesh et al., 2003).

Perceived usefulness is defined as the extent to which students feel that the resources provided (like course materials and technology) improve their learning outcomes (Davis, 1989). When students view educational resources as beneficial, their academic performance often improves. Likewise, perceived satisfaction, which pertains to students' overall happiness with the learning environment, is vital in mediating this relationship (Salisbury, 2009). Higher satisfaction levels are frequently linked to greater engagement and enhanced academic results.

Moreover, actual use, which refers to how actively students engage with the resources available to them, has been shown to mediate the link between quality measures and academic performance. Researchers suggest that even if students find resources useful and satisfactory, their actual engagement is what ultimately determines whether these resources lead to better academic outcomes (Ferrer, 2018).

To exemplify further, data was gathered from students utilizing e-learning systems at universities in China, with a total of 504 participants, revealing that attitudes, subjective norms, and facilitating conditions significantly impact students' intentions to adopt e-learning (Yang and Qian, 2025). Additionally, data collected from 283 high school students in a suburban area in Indonesia highlights significant relationships, emphasizing the pivotal roles of technology self-efficacy and system use in driving user satisfaction and overall e-learning success (Winarno and Legowo, 2024). Lastly, for a sample of 388 students in Ghana, perceived learner satisfaction serves as a mediator between the factors influencing satisfaction and the learning outcomes of distance education students (Bossman and Agyei, 2022).

In summary, as illustrated in Figure 1, quality measures influence student academic performance through a mediation process involving perceived usefulness, perceived satisfaction, and actual use. Understanding these mediators is crucial for designing educational interventions aimed at enhancing student academic performance. Based on this, we formulate our final hypothesis:

H7. The relationship between quality measures and student's academic performance is mediated by perceived usefulness, perceived satisfaction, and actual use

3 Materials and methods

This study aims to investigate the effect of (PUS, PSA, and AUSE) on the relationship between quality measures and

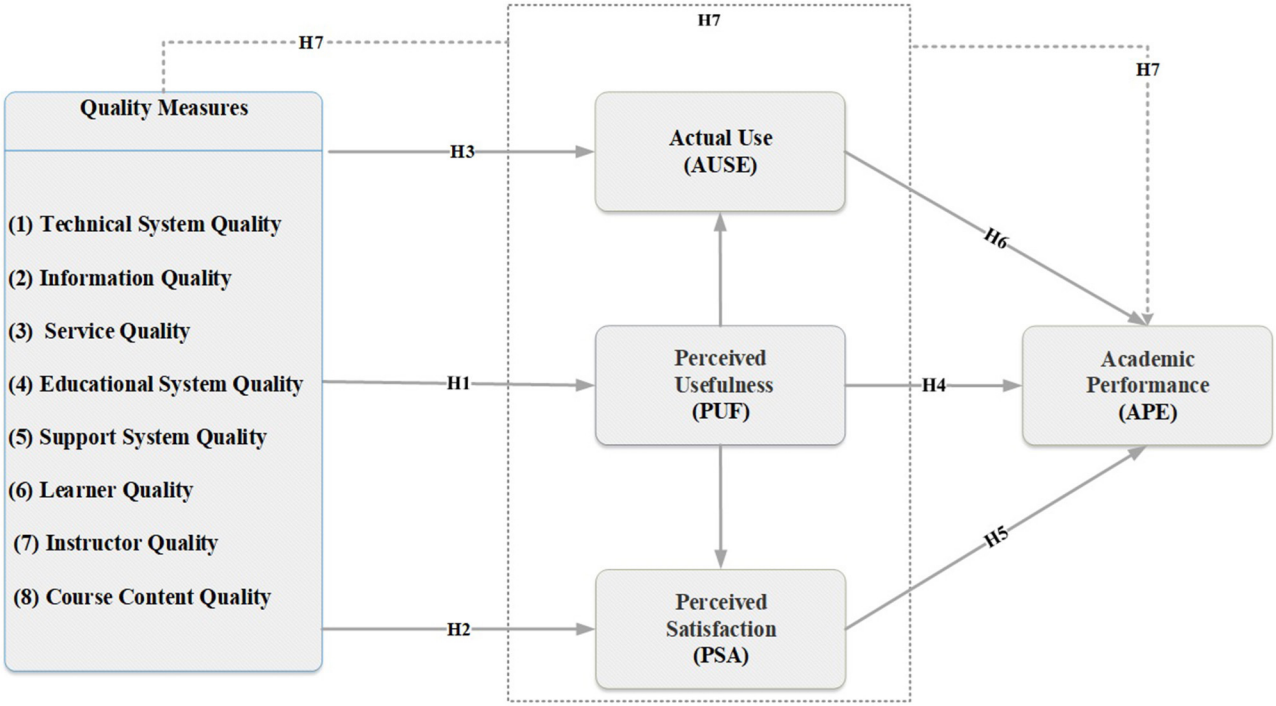

FIGURE 1
Hypothesized framework.

student academic performance. To achieve this goal, a quantitative analysis using PLS-SEM was conducted to assess the proposed conceptual model.

3.1 Measurements

The measurements contain five main constructs: quality measures, perceived usefulness, perceived satisfaction, actual use, and academic performance). The complex nature of Information Systems (IS) success requires careful definition and measurement of each aspect (DeLone and McLean, 2003). Based on this recommendation, we came up with detailed definition for each construct and dimension. In this study, we used LMS, which could be Moodle, Blackboard, Canvas, or any in-house developed system within an academic institution. Learning Management System (LMS): "A Learning management system is a technology tool that provides functionalities beyond the instructional contest such as management tracking, personalized instruction, and facilitative learning" (Bradley, 2021, p. 92).

3.1.1 Quality measures

This construct contains eight different dimensions with 36 items (Technical system quality, information quality, service quality, educational system quality, support system quality, learner quality, instructor quality, and course content quality). The questions evaluated by the students pertain to their perception of the success of LMS at their university, using the following statements on a 7-point Likert scale from "strongly disagree (1)" to "strongly agree (7)." The Cronbach's alpha for full scale with eight dimensions was 0.947. Below, we explain each dimension, its source, item source. Details about the remaining questions for the entire survey can be found in Appendix A.

1.1 Technical System Quality [TSQ; 4 items adopted from Al-Adwan et al. (2021)], and originally taken from Seta et al. (2018). A sample item from this dimension is: "It is easy to understand the structure of Learning Management System (LMS) and how to use it."

1.2 Information Quality [IQU; 5 items adopted from Al-Fraihat et al. (2020)]. A sample item from this dimension is: "Learning Management System (LMS) has provided me with sufficient and required information."

1.3 Service Quality [SQU; 5 items adopted from Al-Fraihat et al. (2020)]. A sample item from this dimension is: "Learning Management System (LMS) provides proper online assistance and help."

1.4 Educational System Quality (ESQ; 4 items adopted from Al-Fraihat et al. (2020)). A sample item from this dimension is: "Learning Management System (LMS) provides interactivity and communication facilities such as chat, forums, and announcements."

1.5 Support System Quality [SSQ; 4 items adopted from Al-Fraihat et al. (2020)]. A sample item from this dimension is: "Learning Management System (LMS) provides appropriate information about plagiarism issues when submitting assignments through the system."

1.6 Learner Quality [LQU; 5 items adopted from Al-Fraihat et al. (2020)]. A sample item from this dimension is: ": I believe it is good to use Learning Management System (LMS)."

1.7 Instructor Quality [INQU; 5 items adopted from Al-Fraihat et al. (2020)]. A sample item from this dimension is: "I think communicating and interacting with instructors are important and valuable in Learning Management System (LMS)."

1.8 Course Content Quality [CCQ; 4 items adopted from Al-Adwan et al. (2021)], and originally taken from Al Mulhem (2020). A sample item from this dimension is: "The content and information available in Learning Management System (LMS) is timely."

3.1.2 Student impact

This part contains four different constructs with 16 items (Perceived Usefulness, Perceived Satisfaction, Actual Use, and academic performance). The questions evaluated by the students pertain to their impact of the LMS at their university, using the following statements on a 7-point Likert scale from "strongly disagree (1)" to "strongly agree (7)." Below, we explain each construct, its source, item sample, and the results of Cronbach's alpha. Details about the remaining questions for the entire survey can be found in Appendix A.

2.1 Perceived Usefulness [PUF; adopted from Al-Fraihat et al. (2020)]. A sample item from this dimension is: "Using Learning Management System (LMS) enables me to accomplish my tasks more quickly." The Cronbach's alpha for this dimension with four items was 0.815.

2.2 Perceived Satisfaction [PSA; adopted from Al-Fraihat et al. (2020)]. A sample item from this dimension is: "I am satisfied with the performance of Learning Management System (LMS)." The Cronbach's alpha for this dimension with four items was 0.900.

2.3 Actual Use [AUSE; adopted from Al-Fraihat et al. (2020)]. A sample item from this dimension is: "I use Learning Management System (LMS) frequently." The Cronbach's alpha for this dimension with four items was 0.927.

2.4 Academic Performance [APE; adopted from Al-Adwan et al. (2021)]. A sample item from this dimension is: "Learning Management System (LMS) has helped me to achieve the learning goals of the module." The Cronbach's alpha for this dimension with four items was 0.906.

3.2 Sample and data collection

A sample size calculation for PLS-SEM analysis was performed using G*Power, targeting an effect size (f^2) of 15%, a power of 95%, and a 5% margin of error. The calculation determined that a sample of 112 respondents was necessary, given four predictor variables. The survey was distributed online to two universities in the UAE. Convenience sampling as non-probability test was utilized to improve accessibility for the researcher, following the recommendations of Etikan et al. (2016). The survey link was shared with relevant students using Smart Survey, resulting in 118 responses by November 2024. The participants were business school students from two different universities in the UAE. The researcher obtained approval for the study under [Application No. USTF/REC/2024-10/04]. Participants were provided with the following information to ensure informed consent for this study. "You are invited to participate in this web-based survey, which aims to assess the success of e-learning systems in the UAE for academic purposes only. The objective of this study is to explore the relationship between e-learning quality measures and students' academic performance. Participation is restricted to students (e.g., higher education) at the time of completing the survey. Your participation is entirely voluntary, and you may withdraw at any point without prior notice. All responses will remain anonymous and confidential, and the data collected will be used exclusively for research purposes. There are no right or wrong answers, and participation involves no risks beyond those typically encountered in daily life. Please answer all questions to the best of your ability. By clicking the next link below, you confirm that you have read and understood the information provided about the survey, its purpose, and that you consent to participate in this study."

TABLE 1 Demographic information.

Factor	Category	Number	Percentage (%)
Gender	Male	45	38.14
	Female	73	61.86
Age	<21	21	17.80
	21–30	60	50.85
	>30	37	31.36
Enrolled course	Undergraduate	78	66.10
	Postgraduate	40	33.90
Experience with E-learning	Less than a year	14	11.86
	1–2 years	28	23.73
	More than 2 years	76	64.41

Table 1 presents the demographic information of 118 business school students in the UAE. The majority of respondents are female (61.86%), compared to male respondents (38.14%). Most respondents fall within the 21–30 age group (50.85%), then, ages >30 group constitutes 31.36%, while 17.80% of respondents are aged <21. A significant majority (66.10%) of respondents are undergraduate students, compared to 33.90% who are postgraduate students. The largest group of respondents (64.41%) have more than 2 years of experience using the e-learning system, indicating familiarity with the platform among a substantial portion of users. A majority of respondents (63.56%) have taken one module, suggesting a preference for or limited engagement with single-course enrolment on the platform. While 36.44% have taken more than one module, indicating a smaller but significant group of frequent users.

Table 2 shows that the correlation (r) indicates that gender is the only demographic factor showing a statistically significant relationship with actual use, with a correlation of 0.209, significant

TABLE 2 Correlations between Demographic Variables and Actual Use of LMS.

Variables	Gender	Age	Enrolled course	Experience with E-learning	Actual USE
Gender	1				
Age	−0.337**	1			
Enrolled course	−0.307**	0.533**	1		
Experience with E-learning	−0.093	0.305**	0.133	1	
Actual USE	0.209*	0.078	−0.017	0.151	1

**Correlation is significant at the 0.01; *Correlation is significant at the 0.05.

TABLE 3 Cronbach Alpha, composite reliability, average variance extracted.

Variables	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Academic performance _(APE)	0.906	0.916	0.935	0.782
Actual use _(AUSE)	0.927	0.931	0.948	0.820
Perceived satisfaction _(PSA)	0.900	0.904	0.930	0.769
Perceived usefulness _(PUF)	0.815	0.816	0.878	0.643
Course content quality (CCQ)	0.868	0.869	0.910	0.717
Educational system quality (ESQ)	0.736	0.777	0.881	0.788
Instructor quality (INQU)	0.718	0.754	0.841	0.641
Information quality (IQU)	0.742	0.749	0.853	0.659
Service quality (SQU)	0.678	0.682	0.861	0.756
Learner quality (LQU)	0.746	0.746	0.840	0.569
Support system quality (SSQ)	0.697	0.712	0.868	0.766
Technical system quality (TSQ)	0.881	0.884	0.918	0.737

at the 5% level. Given that gender is coded as 1 for male and 2 for female, the positive correlation of 0.209 suggests that as the gender value increases (from male = 1 to female = 2), the actual USE score slightly rises. The other demographic factors, such as Age ($r = 0.079$), enrolment status (undergraduate or postgraduate; $r = -0.017$), and Experience with e-learning (r = 0.151), show no meaningful correlations with actual use, and their relationships are not statistically significant." As the algorithm for obtaining PLS-SEM solutions is not based on minimizing the divergence between observed and estimated covariance matrices, the concept of Chi-square-based model fit measures and their extensions—as used in CB-SEM—are not applicable (Hair et al., 2019, p. 7)."

4 Results

For complex structural models with numerous components, indicators, and relationships, the use of PLS-SEM is recommended (Hair et al., 2019). Accordingly, we employed PLS-SEM, a variance-based structural equation modeling method, as it offers strong explanatory power and overcomes several limitations of covariance-based SEM (Legate et al., 2023). To check for potential outliers, we evaluated the variance inflation factor (VIF) values, which ranged from 1.266 to 4.723, all below the threshold of five. This confirms the absence of collinearity issues among the predictor constructs (Hair et al., 2019). Moreover, this study utilized the extended repeated measures method to analyze the second-order observed variables. This research emphasized Quality measures characterized as a second-order hierarchical reflective construct, comprising eight first-order reflective variables (Aldabbas and Blaique, 2025; Gooderham et al., 2008).

4.1 Measurement model

Cronbach's alpha values for the main variables are above 70%, except for one dimension of the quality measures, specifically Support System Quality (SSQ), which is at 68%. Meanwhile, the overall quality measure across eight dimensions is 0.947. Convergent validity was evaluated by analyzing factor loadings, calculating the average variance extracted (AVE), and determining composite reliability (CR). As shown in Table 3, all main variables met the required criteria. With CR values exceeding 0.70, the results confirm that convergent validity has been achieved. Furthermore, the square root of the AVE for each variable was greater than its correlations with other variables, confirming discriminant validity as shown in Table 4 (Gefen and Straub, 2005).

TABLE 4 Heterotrait-monotrait ratio (HTMT)—Matrix.

Variables	APE	AUSE	CCQ	ESQ	INQU	IQU	LQU	PSA	PUF	Quality Measures	SQU	SSQ
Actual use (AUSE)	0.930											
Course content quality (CCQ)	0.893	0.891										
Educational system quality (ESQ)	0.536	0.472	0.583									
Instructor quality (INQU)	0.833	0.896	1.014	0.756								
Information quality (IQU)	0.570	0.518	0.664	1.053	0.742							
Learner quality (LQU)	0.977	0.918	1.000	0.550	0.975	0.589						
Perceived satisfaction (PSA)	0.962	0.871	0.937	0.472	0.946	0.584	0.920					
Perceived usefulness (PUF)	0.997	0.942	0.986	0.508	0.991	0.553	1.065	0.976				
Quality measures	0.802	0.772	0.925	0.930	1.028	0.966	0.915	0.837	0.860			
Service quality (SQU)	0.582	0.502	0.695	1.054	0.789	1.008	0.569	0.597	0.599	0.957		
Support system quality (SSQ)	0.664	0.715	0.789	0.840	0.905	0.881	0.868	0.828	0.783	1.020	0.829	
Technical system quality (TSQ)	0.519	0.461	0.544	0.846	0.732	0.873	0.476	0.562	0.504	0.878	0.820	0.916

4.2 Structural model

This section evaluates the four main hypotheses presented in Table 5 using Smart PLS-SEM 4 (Ringle et al., 2024). The analysis reveals the following findings. For Hypothesis 1, the relationship between quality measures and students' perceived usefulness is positive and significant ($B = 0.763$, $t = 7.813$, $p < 0.001$). For Hypothesis 2, the relationship between quality measures and perceived satisfaction is positive and significant ($B = 0.342$, $t = 2.287$, $p < 0.05$). For Hypothesis 3, the relationship between quality measures and actual use is positive and significant ($B = 0.253$, $t = 1.998$, $p < 0.05$). For Hypothesis 4, the relationship between perceived usefulness and students' academic performance is positive and significant ($B = 0.253$, $t = 2.510$, $p < 0.05$). For Hypothesis 5, the relationship between perceived satisfaction and students' academic performance is positive and significant ($B = 0.412$, $t = 3.548$, $p < 0.001$). For Hypothesis 6, the relationship between actual use and students' academic performance is positive and significant ($B = 0.319$, $t = 3.148$, $p < 0.01$). Additionally, although the following relationships were not hypothesized, they were found to be positive and significant: perceived usefulness strongly influences actual use ($B = 0.631$, $p < 0.001$) and perceived satisfaction ($B = 0.576$, $p < 0.01$). We conclude that all direct relationships between quality measures and students' academic performance are positive and significant (Table 5). In summary, Table 5 presents the analysis of direct relationships between various factors influencing academic performance, actual use, perceived satisfaction, and perceived usefulness. The results demonstrate significant positive relationships among these variables, highlighting the interconnected impact of quality measures and user perceptions on academic outcomes and system utilization.

For the last Hypothesis 7 we find that the relationship between quality measures and student's academic performance is mediated by perceived usefulness, perceived satisfaction, and actual use ($B = 0.181$, $t = 2.792$, $p < 0.01$). The details of all indirect relationships can be found in Table 6. In Summary, Table 6 provides an analysis of indirect relationships, illustrating how quality measures influence academic performance through mediators like actual use, perceived satisfaction and perceived usefulness. The findings reveal significant indirect effects, emphasizing the importance of these mediating factors in enhancing the impact of quality measures on educational outcomes and system engagement. Additionally, Figure 2 presents the graphical representation of all the structural results.

Figure 2 shows that all the relationships examined in the study are positive and statistically significant at the 5% level. This is an indication that higher quality measures in the LMS are strongly associated with better student outcomes and improved academic performance. The findings can be explained by the mediating roles of perceived usefulness, satisfaction, and actual use. Such findings highlight the importance of focusing on improving LMS components to enhance learning experiences and academic success.

5 Discussion and implications

The first three hypotheses in this study examine the relationships between quality measures and key aspects of students' experiences with e-learning systems. Specifically, the hypotheses propose that quality measures are positively related to students' perceived usefulness (H1), perceived satisfaction (H2), and actual use (H3) of the e-learning system. These interconnected relationships aim to highlight how the quality of the system, content, and services collectively influence students' perceptions and behaviors, laying a foundation for understanding the broader impact of e-learning quality on user engagement and effectiveness. The results provide support for H1, demonstrating that quality measures significantly impact students' perceived usefulness, consistent with findings from previous studies (Blömeke et al., 2016; Engida et al., 2024; Parveen et al., 2024; Tan et al., 2024). Similarly, H2 is supported, indicating that quality measures, such

TABLE 5 Mean, STDEV, T values, *p*-values (Direct relationships).

Direct relationships	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	*P*-values
Actual use -> Academic performance	0.319	0.319	0.101	3.148	0.002
Perceived satisfaction -> Academic performance	0.412	0.404	0.116	3.548	0.000
Perceived usefulness -> Academic performance	0.253	0.264	0.101	2.510	0.012
Perceived usefulness -> Actual use	0.631	0.601	0.134	4.705	0.000
Perceived usefulness -> Perceived satisfaction	0.576	0.548	0.174	3.301	0.001
Quality measures -> Actual use	0.253	0.283	0.127	1.998	0.046
Quality measures -> Perceived satisfaction	0.342	0.369	0.150	2.287	0.022
Quality measures -> Perceived usefulness	0.763	0.758	0.098	7.813	0.000

TABLE 6 Mean, STDEV, T values, *p*-values (Indirect relationships).

Indirect relationships	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	*P*-values
Quality measures -> Perceived usefulness -> Academic performance	0.194	0.200	0.081	2.401	0.016
Quality measures -> Perceived satisfaction -> Academic performance	0.141	0.154	0.084	1.685	0.092
Quality measures -> Perceived usefulness -> Actual use	0.481	0.450	0.100	4.793	0.000
Quality measures -> Actual use > Academic Performance	0.081	0.089	0.048	1.697	0.090
Quality measures -> Perceived usefulness -> Perceived satisfaction	0.440	0.408	0.127	3.461	0.001
Quality measures -> Perceived usefulness -> Perceived satisfaction -> Academic performance	0.181	0.160	0.065	2.792	0.005
Quality measures -> Perceived usefulness -> Actual use -> Academic performance	0.153	0.144	0.058	2.628	0.009

as system quality, service quality, and information quality, are positively and significantly related to student satisfaction, aligning with (Al Mulhem, 2020; Haddad, 2018; Kanwar and Sanjeeva, 2022; Keržič et al., 2021; Shams et al., 2022). Furthermore, H3 is validated, showing that quality measures have a significant impact on students' actual use, as also evidenced by Tan et al. (2024). Additionally, the findings indicate that quality factors significantly impact ease of use, as supported by Al-Nuaimi et al. (2023).

The second group of hypotheses in this study explores the impact of students' e-learning factors on students' academic performance. Specifically, they propose that perceived usefulness (H4), perceived satisfaction (H5), and actual use (H6) are each positively related to students' academic performance. These hypotheses aim to uncover how these key factors contribute to academic success in the context of e-learning systems. The results provide support for H4, indicating that perceived usefulness has a significant impact on students' academic performance, consistent with findings from Alyoussef (2021) and Mouakket and Bettayeb (2015). Similarly, H5 is supported, showing that perceived satisfaction positively influences students' academic performance, aligning with studies by Badr et al. (2024) and Keržič et al. (2021). Additionally, H6 is validated, demonstrating that actual use significantly impacts students' academic performance, as evidenced by Oguguo et al. (2021). While our study aligns with other research linking LMS actual use and academic performance, some studies have found no significant direct relationship between technology use and academic performance (Rashid and Asghar, 2016). These findings highlight the complex interplay between students' use of technology, their engagement, self-directed learning, and academic outcomes.

These interconnected relationships aim to highlight how the quality of the system, content, and services collectively influence students' perceptions and behaviors, laying a foundation for understanding the broader impact of e-learning quality measures on user engagement and effectiveness. We find support for H7 that quality measures impact student academic performance supported by previous studies (Blömeke et al., 2016; Engida et al., 2024; Parveen et al., 2024). In this study, empirical findings linked the quality measures of LMS with students' academic performance in a higher educational setting. Initially, the study validates the applicability and reliability of the technology acceptance model and the DeLone and McLean model for e-learning (Alfalah, 2023). The study provides new insights into the acceptance level of e-learning by academic participants, particularly students. In addition, it will

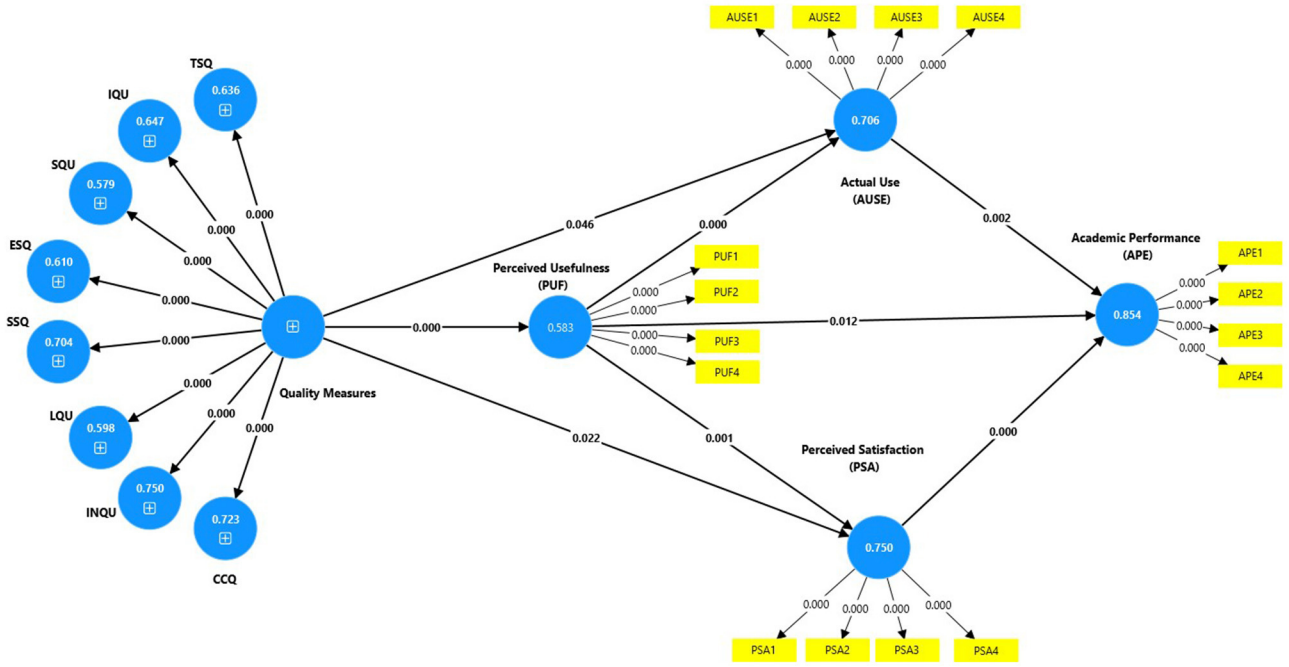

FIGURE 2
PLS-SEM results.

lead to modeling the effectiveness of the e-learning environment by helping to understand the relationship between each aspect of the proposed DeLone and McLean model (Baber, 2021).

In this study, we conceptualize the quality measures as one construct, whereas other studies interpret each quality measure in relation to student satisfaction, actual use, usefulness, and academic performance or benefits for students (Al-Fraihat et al., 2020). However, our study in the UAE context yields similar findings to those of international studies, such as those conducted in the UK, by showing that student satisfaction, usefulness, and actual use are significantly associated with student benefits (Al-Fraihat et al., 2020). This study aligns with other international research conducted in Jordan, where the findings show that quality factors—including instructor effectiveness, the reliability of technical systems, support services, educational systems, and the quality of course content—positively influence students' satisfaction, perceived usefulness, and system usage (Al-Adwan et al., 2021). Additionally, students' satisfaction, perceived usefulness, and system usage are identified as crucial predictors of their academic performance (Al-Adwan et al., 2021). Furthermore, our study is also consistent with another international research. An empirical study conducted with 290 students in business school revealed that factors such as perceived usefulness, perceived ease of use, and attitude significantly impact behavioral intentions to use e-learning system such as smartphone technology (Fuchs, 2022).

The findings indicate that perceived satisfaction has a stronger effect on academic performance compared to actual use. Specifically, the path coefficient for perceived satisfaction -> academic performance is 0.412, with a t-value of 3.548 ($p < 0.001$). This suggests a significant and robust relationship. In contrast, the path coefficient for actual use -> academic performance is 0.319, with a t-value of 3.148 ($p = 0.002$), which, although positive and significant, is comparatively weaker. These results highlight that while the frequency or duration of tool use (actual use) contributes to academic outcomes, the qualitative aspect of user experience (perceived satisfaction) plays a more critical role in driving performance improvements. Since actual use quantifies how often or how long a tool is used, it doesn't always indicate whether the tool is being used effectively or meaningfully. In contrast, perceived satisfaction provides a qualitative evaluation of how well the tool aligns with student needs, which is more closely tied to outcomes such as academic performance. For instance, a student might regularly log in to a learning platform (actual use) but not engage meaningfully, such as by skipping activities. Conversely, students who perceive the platform as satisfying are more likely to use it purposefully, resulting in improved academic results. This argument is supported by a previous study by Al-Fraihat et al. (2020), which found that satisfaction was a stronger predictor of performance (52%) compared to the predictive power of e-learning system use, which was moderate (25%).

5.1 Practical implications

The study offers several practical insights for practitioners in higher education:

1. Many universities adopt commercial or open-source LMS platforms, and the findings highlight the importance of consistently collecting student feedback. Regular surveys can help identify issues and shortcomings, facilitating continuous

improvements to meet user needs effectively (Al-Fraihat et al., 2020).

2. Quality measures significantly impact perceptions of usefulness, student satisfaction, and actual use of e-learning systems. Providing comprehensive training for instructors before implementing these systems is crucial. Training ensures instructors are familiar with the system's full capabilities and can effectively utilize features like discussion forums for assignments or projects.
3. Raising awareness about the benefits and practical advantages of e-learning systems can enhance their usability and adoption. Workshops and training sessions can improve students' attitudes, self-efficacy, and overall experience with these platforms, increasing perceived usefulness, satisfaction, and engagement. To achieve higher student success rates, intensive training and practice programs are essential for both students and instructors (Alduaij et al., 2024).
4. Faculty and administrators should educate students about academic integrity, including plagiarism and copyright regulations, through dedicated modules. Addressing issues like accessibility, intellectual property, and content permissions will help reinforce trust and compliance (Al-Fraihat et al., 2020).
5. Enhancing LMS features, such as encouraging instructors to use quizzes, can improve engagement and reduce reliance on traditional paper-based assessments. This will support the digitalization of education systems and enhance the interactive nature of e-learning platforms.
6. Provide actionable insights for administrators on improving LMS design and implementation, emphasizing key quality measures (e.g., system reliability, ease of use, content quality).
7. Advocate for regular evaluations of LMS performance based on student feedback to ensure continuous improvement. Ensuring the system adapts to evolving educational requirements and advancements in technology (Allam et al., 2024).
8. The adoption of a LMS in educational institutions requires a well-defined contribution policy for effective management. Such a policy should emphasize the strategic allocation of corporate resources and alignment with the external environment to facilitate a smooth transformation process (Aldabbas and Oberholzer, 2024). This transition not only enhances operational efficiency but also fosters innovation and adaptability, ultimately providing institutions with a competitive edge in the education sector.
9. Accessibility and inclusivity ensure that the LMS accommodates all students, including those with disabilities, by complying with accessibility standards and offering alternative content delivery formats (Allam et al., 2024).
10. Policymakers should encourage regular training for students and instructors to stay updated on the latest trends in online education systems. Thus, online training and skill development workshops should be prioritized to replace on-campus activities (El Said et al., 2021). Additionally, simple and user-friendly systems should be used instead of complicated e-learning platforms (Bossman and Agyei, 2022). This would ensure and enhance ease of use, user satisfaction, and usefulness which would eventually contribute to students achieving their desired learning outcomes (Belo et al., 2024).

6 Limitations and future studies

This study acknowledges several limitations. First, it focused exclusively on university students, suggesting that future research could improve generalizability by including a more diverse population such as community colleges and schools. Second, the study's sample was drawn from a single country (e.g., UAE); future research could encompass additional countries (e.g., GCC) for broader applicability. Third, this study relied on a survey and quantitative methods; future research might employ qualitative approaches, such as case studies and interviews, to gain new insights into the relationship between system quality measures and students' academic performance. Fourth, the study utilized a cross-sectional design; to address this limitation, longitudinal designs are necessary to track changes in students' usefulness, satisfaction, and actual use over time and evaluate the impact on their level of academic performance. Consequently, future research directions should include longitudinal studies to assess changes over time and comparisons across different LMS platforms. Fifth, this study relies on convenience sampling introduces potential bias, as this non-probability method may not accurately represent the broader population. Consequently, the findings might lack generalizability beyond the sampled group. To ensure the reliability of our research findings, we addressed potential common method bias (CMB) due to data collection from a single source (Aldabbas et al., 2024). We conducted Harman's single-factor test, which involves loading all measured variables into an exploratory factor analysis to determine if a single factor accounts for the majority of covariance among the measures (Podsakoff et al., 2003). Our analysis revealed that the first factor explained 43.034% of the variance, well below the 50% threshold, indicating that CMB was not a significant concern in our study. Additionally, to mitigate this limitation, future research should consider employing probability-based sampling techniques, which enhance external validity by ensuring a more representative sample. Sixth, we recognize the limitations of relying on self-reported data. Future research could address these issues by using objective metrics, such as GPA, to provide more reliable insights into academic performance. Seventh, we acknowledge that using a sample exclusively from business school students at two academic universities may limit the generalizability of our findings. Expanding the sample to include students from diverse disciplines and institutions, thus, would provide broader insights and improve the applicability of the results. Lastly, we examined students' perspectives, considering potential challenges arising from the varying ways students engage with LMS features, which may result in differences in the extent and manner of LMS tool utilization (Bravo-Agapito et al., 2021). Future research should explore the critical factors that influence students' academic performance. Additionally, future studies could compare different platforms, such as

Moodle and Blackboard, or developed in house to determine whether significant differences exist in their impact on students' academic performance.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Application No. University of Science and Technology of Fujairah (USTF)/REC/2024-10/04. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

HA: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. AE: Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing. AA: Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing. LG: Data curation, Resources, Writing – original draft, Writing – review & editing.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2025.1554641/full#supplementary-material

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