Seminars in Medical Writing and Education. 2025; 4:789
doi: 10.56294/mw2025789

ORIGINAL

Evaluating the Impact of Digital Learning Platforms on Medical Students' Engagement: A SEM-PLS Approach

Evaluación del Impacto de las Plataformas de Aprendizaje Digital en el Compromiso de los Estudiantes de Medicina: un Enfoque SEM-PLS

Linda Rosalina[1], Yudha Aditya Fiandra[2], Rahmat Fadillah[2], Rika Amran[1], Esra Büşra Işık[3]

[1]Universitas Negeri Padang, Department of Medicine. Padang, Indonesia.
[2]Universitas Negeri Padang, Department of Electronic Engineering. Padang, Indonesia.
[3]Bezmialem Vakif University, Beykoz Institute of Life Science and Biotechnology. Istanbul, Turkiye.

Cite as: Rosalina L, Aditya Fiandra Y, Fadillah R, Amran R, Büşra Işık E. Evaluating the Impact of Digital Learning Platforms on Medical Students' Engagement: A SEM-PLS Approach. Seminars in Medical Writing and Education. 2025; 4:789. https://doi.org/10.56294/mw2025789

Submitted: 11-07-2025 **Revised:** 07-09-2025 **Accepted:** 15-11-2025 **Published:** 16-11-2025

Editor: PhD. Prof. Estela Morales Peralta

Corresponding Author: Linda Rosalina

ABSTRACT

Digital learning platforms have become an important component of medical education, offering flexible and interactive learning experiences that support competency development. Student engagement in digital environments, however, depends on how learners perceive the quality, usefulness, and ease of use of the platforms. This study examines the influence of service quality, system support, content quality, perceived ease of use, and perceived usefulness on behavioral intention and student engagement among medical students. A quantitative survey was conducted with 155 Indonesian medical students, and data were analyzed using the Partial Least Squares Structural Equation Modeling approach. The findings show that service quality influences perceived ease of use, while content quality influences perceived usefulness, indicating that platform services and learning content play a central role in shaping students' perceptions. Perceived ease of use affects perceived usefulness but does not predict behavioral intention, whereas perceived usefulness predicts behavioral intention, which then leads to higher student engagement. These results suggest that in medical education, perceived academic benefits are more influential than ease of use in encouraging students to engage with digital platforms. This study extends the Technology Acceptance Model by including student engagement as an outcome and provides practical guidance for educators, institutional leaders, and technology developers in designing and improving digital learning systems. Future studies may investigate other factors that shape engagement and employ longitudinal research to examine long-term effects on learning performance and student development.

Keywords: Digital Learning Platforms; Medical Education; Student Engagement; Technology Acceptance Model; PLS-SEM.

RESUMEN

Las plataformas de aprendizaje digital se han convertido en un componente importante de la educación médica, ya que ofrecen experiencias de aprendizaje flexibles e interactivas que apoyan el desarrollo de competencias. Sin embargo, la participación del estudiante en entornos digitales depende de cómo perciba la calidad, la utilidad y la facilidad de uso de las plataformas. Este estudio examina la influencia de la calidad del servicio, el soporte del sistema, la calidad del contenido, la facilidad de uso percibida y la utilidad percibida en la intención de uso y la participación del estudiante entre estudiantes de medicina. Se realizó una encuesta cuantitativa con 155 estudiantes de medicina en Indonesia, y los datos se analizaron mediante el método de Modelado de Ecuaciones Estructurales de Mínimos Cuadrados Parciales. Los resultados muestran que la calidad del servicio influye en la facilidad de uso percibida, mientras que la calidad del contenido influye en la utilidad percibida, lo que indica que los servicios de la plataforma y el contenido educativo cumplen un papel central en la formación de las percepciones de los estudiantes. La facilidad de uso percibida afecta la utilidad percibida, pero no predice la intención de uso, mientras que la utilidad percibida predice la intención de uso, lo que conduce a una mayor participación del estudiante. Estos resultados sugieren que, en la educación médica, los beneficios académicos percibidos son más influyentes que la facilidad de uso al promover la participación con plataformas digitales. Este estudio amplía el Modelo de Aceptación Tecnológica al incluir la participación del estudiante como resultado y ofrece orientación práctica para educadores, directivos institucionales y desarrolladores tecnológicos en el diseño y la mejora de sistemas de aprendizaje digital. Futuros estudios pueden explorar otros factores que influyen en la participación y aplicar enfoques longitudinales para evaluar los efectos a largo plazo en el rendimiento académico y el desarrollo estudiantil.

Palabras clave: Plataformas de Aprendizaje Digital; Educación Médica; Participación de los Estudiantes; Modelo de Aceptación de la Tecnología; PLS-SEM.

INTRODUCTION

The transformation of education in the digital era has significantly reshaped the ways students access, process, and engage with knowledge.(1,2) The integration of digital technologies into higher education has become increasingly vital, particularly in medical education, where students face intensive academic demands and require flexible, accessible, and interactive learning environments.(3,4) Digital learning platforms offer an alternative to traditional classroom settings by providing access to course materials, enabling collaborative learning, and fostering self-directed study.(5,6) However, the effectiveness of these platforms is not determined merely by their availability but rather by their ability to stimulate meaningful student engagement, which is widely recognized as a critical factor in academic success and professional preparation.(7,8)

The success of digital learning platforms depends on multiple factors, ranging from technological infrastructure to pedagogical design.(9,10,11) Prior studies have emphasized that service quality, system support, and content quality are essential in shaping students' perceptions of a platform's usability and usefulness.(12,13) Yet, gaps remain in understanding how these factors jointly influence students' behavioral intentions and ultimately their engagement. While research in general higher education has provided evidence of these relationships, studies specifically addressing medical education in developing countries, such as Indonesia, remain limited. Filling this gap is crucial to optimize the integration of digital learning in medical training, where engagement is not only cognitive but also emotional and behavioral.(14,15)

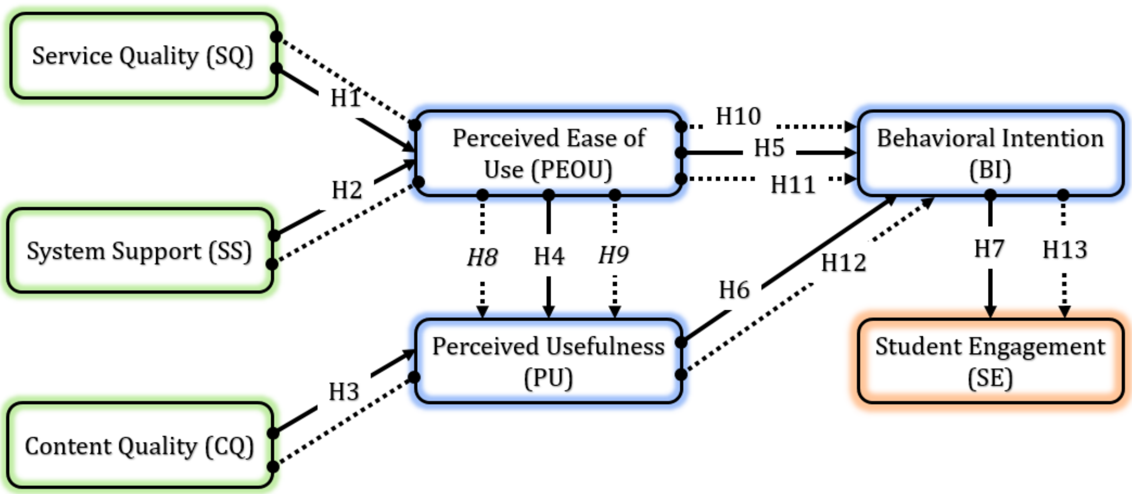

Figure 1. Research Framework for Evaluating the Impact of Digital Learning Platforms on Medical Students' Engagement
Note: H1–H3 represent the direct effects of Service Quality (SQ), System Support (SS), and Content Quality (CQ) on Perceived Ease of Use (PEOU) and Perceived Usefulness (PU). H4–H7 test the influence of PEOU and PU on Behavioral Intention (BI) and Student Engagement (SE). H8–H13 denote mediating pathways, where PEOU and PU transmit the effects of platform characteristics toward behavioral intention and engagement. The framework posits that while usability contributes indirectly to engagement, perceived usefulness and behavioral intention serve as the most significant predictors of active, sustained participation in digital learning platforms.

This study builds on several established theoretical foundations. The Technology Acceptance Model (TAM) emphasizes the roles of Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) in shaping technology adoption.[16] The Information Systems Success Model[17] highlights the influence of Service Quality (SQ), System Support (SS), and Content Quality (CQ) on user satisfaction and effectiveness. Furthermore, Flow Theory provides a conceptual lens to understand Student Engagement (SE) as the ultimate outcome of effective digital learning experiences.[18,19] By integrating these perspectives, the present research proposes a comprehensive framework linking platform characteristics, technology perceptions, behavioral intention, and student engagement.

Based on these foundations, a series of hypotheses are proposed. The direct effects include the influence of service quality and system support on perceived ease of use (H1–H2), content quality and perceived ease of use on perceived usefulness (H3–H4), perceived ease of use and perceived usefulness on behavioral intention (H5–H6), and behavioral intention on student engagement (H7). Additionally, several mediating effects are tested, such as the role of perceived ease of use in mediating the relationships between service/system quality and usefulness or behavioral intention (H8–H11), and the role of perceived usefulness in mediating the effects of content quality on behavioral intention and engagement (H12), as well as usefulness–intention–engagement pathways (H13). These hypothesized relationships are summarized in the proposed research framework (figure 1).

To empirically test this model, this study employs the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach,[20,21] using survey data collected from Indonesian medical students. This method is well-suited for evaluating complex models with multiple constructs and mediation pathways. The objective of this study is to examine how service quality, system support, content quality, perceived ease of use, and perceived usefulness shape behavioral intention and student engagement in digital learning platforms within medical education. The focus is on understanding the pathways through which platform-related factors influence students' perceptions and engagement when using digital learning systems. By clarifying these relationships, this study aims to deepen understanding of student engagement in technology-supported learning environments in medical programs. The findings serve as an empirical foundation for developing strategies that support effective use of digital learning platforms in medical education.

METHOD

Type of Study, Period, and Location

This research applied a quantitative cross-sectional design conducted between February and April 2024 in Indonesia. The study aimed to evaluate the relationships among service quality, system support, content quality, perceived ease of use, perceived usefulness, behavioral intention, and student engagement in digital learning platforms used by medical students.[22] A Partial Least Squares Structural Equation Modeling (PLS-SEM) approach was utilized to analyze complex causal pathways and mediation effects. The method was particularly appropriate because it allows simultaneous estimation of multiple latent constructs without assuming data normality, thereby ensuring analytical robustness in educational settings characterized by diverse user experiences.[23]

The research was carried out within the context of Indonesian higher education institutions, particularly those offering medicine and health-related study programs. Indonesia represents a relevant developing-country context where digital transformation in medical education has accelerated post-pandemic but remains underexplored empirically. By situating the study in this environment, the research provides insights into how medical students in resource-variable settings engage with digital learning tools designed to enhance academic outcomes and professional preparedness.

Population, Sample, and Sampling Technique

The study population consisted of undergraduate students enrolled in medical and health sciences programs across universities in Indonesia. A total of 155 respondents participated, representing disciplines such as public health, pharmacy, dentistry, nursing, and medicine. Participants were selected using a purposive sampling technique to ensure inclusion of students from diverse academic years and programs who actively used digital learning platforms. This approach was chosen to capture a heterogeneous perspective on platform engagement and technology use across different health disciplines. Inclusion criteria comprised active enrollment in a medical or health-related undergraduate program, previous experience using digital learning platforms for at least one semester, and willingness to provide informed consent. Exclusion criteria included incomplete questionnaire responses or lack of experience with online learning tools. No participants withdrew after data collection

Variables Analyzed

Seven core variables were analyzed, encompassing both exogenous and endogenous constructs. The exogenous variables included Service Quality (SQ), System Support (SS), and Content Quality (CQ), while Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) acted as mediators linking platform characteristics to Behavioral

Intention (BI) and Student Engagement (SE) as outcome variables. The conceptual foundation was derived from the Technology Acceptance Model (TAM), the Information Systems Success Model, and Flow Theory, which collectively capture technological, pedagogical, and experiential dimensions of engagement.

These constructs were operationalized as latent variables measured by multiple indicators, reflecting users' perceptions and behavioral responses to digital learning platforms. Service quality referred to responsiveness, assurance, and empathy of platform support services, whereas system support indicated the stability and functionality of the technical infrastructure. Content quality measured clarity, accuracy, and relevance of learning materials. The perceptual variables—ease of use and usefulness—represented students' cognitive evaluations of technology performance, while behavioral intention captured their motivation to continue platform use. Student engagement, grounded in Flow Theory, represented the depth of cognitive, emotional, and behavioral immersion during digital learning.

Instruments, Techniques, and Procedures

The study employed a structured online questionnaire containing 35 measurement items, each rated on a seven-point Likert scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"). The items were adapted from established and previously validated instruments to ensure conceptual accuracy and reliability. The questionnaire measured key constructs, including service quality, system support, content quality, perceived ease of use, perceived usefulness, behavioral intention, and student engagement. The indicators were designed to capture both cognitive and behavioral dimensions of engagement and reflect students' experiences and perceptions of digital learning platforms.

To ensure the validity and reliability of the instrument, expert evaluation was carried out by three specialists in educational technology and medical pedagogy, focusing on clarity, relevance, and contextual appropriateness. A pilot test involving 20 students was conducted to assess readability and comprehension before full-scale data collection. Construct validity was subsequently confirmed through measurement model evaluation, where all constructs achieved Cronbach's Alpha and Composite Reliability values exceeding 0,70, and Average Variance Extracted (AVE) values above 0,50. These results confirmed internal consistency and convergent validity, ensuring that the instrument possessed sufficient psychometric strength for structural model analysis.

Table 1. Measurement Items and Sources

Construct	Code	Statement	Reference / Adaptation
Service Quality (SQ)	SQ1	The services provided by the platform provider (e.g., help center) are reliable.	(24,25,26,27)
	SQ2	The platform provider gives assurance and trust in resolving user problems.	
	SQ3	The platform provider gives personal attention and understands my specific needs as a user.	
	SQ4	This platform is easy to access and contact when I need assistance.	
	SQ5	I am satisfied with the quality of support services provided by the platform provider.	
System Support (SS)	SS1	I receive adequate technical support (such as chat support, FAQ, tutorials) when facing difficulties.	(28,29,30,31)
	SS2	The platform system is stable and rarely experiences downtime (disruptions).	
	SS3	The user manuals or tutorials provided are easy to understand and helpful.	
	SS4	The help function in the platform is effective in solving the problems I face.	
	SS5	Overall, the technical system support for this platform is very good.	
Content Quality (CQ)	CQ1	The learning materials (text, video, images) are presented clearly and well-structured.	(26,28,32,33,34)
	CQ2	The content provided is relevant to my learning objectives and curriculum.	
	CQ3	The learning content presented is accurate, up-to-date, and from reliable sources.	
	CQ4	The depth and scope of the materials provided are sufficient for my learning needs.	
	CQ5	Overall, the quality of the content on this platform is very high.	
Perceived Ease of Use (PEOU)	PEOU1	Interaction with this platform is clear and easy to understand.	(16,31,35)
	PEOU2	I find it easy to become skilled in using this platform.	

	PEOU3	Finding the information or features I need on this platform is easy.	
	PEOU4	This platform is flexible and can be adjusted to fit my learning style.	
	PEOU5	Overall, I find this platform easy to use.	
Perceived Usefulness (PU)	PU1	Using this platform improves my learning performance (e.g., grades, understanding).	(16,36,37)
	PU2	Using this platform makes me more productive in learning.	
	PU3	This platform enhances the effectiveness of my learning process.	
	PU4	This platform is useful for achieving my academic goals.	
	PU5	Overall, I find this platform very useful for my learning.	
Behavioral Intention (BI)	BI1	I plan to continue using this platform in the future.	(37,38)
	BI2	I will recommend this platform to my classmates or peers.	
	BI3	I intend to increase the frequency of my use of this platform.	
	BI4	I prefer to use this platform rather than traditional learning methods (if possible).	
	BI5	I will respond positively if my institution requires the use of this platform for other courses.	
Student Engagement (SE)	SE1	I become so engaged when using this platform that time seems to pass quickly.	(39,40,41)
	SE2	I actively seek additional information or features on this platform beyond what is required.	
	SE3	I feel intellectually challenged and interested when using this platform.	
	SE4	I feel happy and satisfied during the learning process using this platform.	
	SE5	Overall, this platform succeeds in creating a learning experience that makes me engaged.	

Data Collection Process

Data collection was conducted online using institutional communication channels such as learning management systems and academic mailing lists. Participants received a digital invitation that explained the study's objectives, confidentiality assurances, and voluntary nature. Before filling out the questionnaire, each participant provided informed consent electronically. To maintain data quality, completion time and response patterns were monitored automatically, and incomplete submissions were excluded from the dataset.

The data collection process was designed to ensure anonymity, accessibility, and inclusivity. Using online distribution facilitated participation from multiple regions across Indonesia, reflecting the geographically diverse population of medical students. The survey platform automatically stored responses in encrypted form, and the dataset was cleaned and checked for missing or inconsistent values before being imported into SmartPLS for statistical analysis. This rigorous approach minimized bias and ensured reliable quantitative data for model estimation.

Data Analysis Process

Data were analyzed using SmartPLS 4.0 to evaluate both the measurement and structural models. In the first stage, measurement model evaluation assessed indicator reliability, internal consistency, convergent validity, and discriminant validity through metrics such as outer loadings, Cronbach's Alpha, Composite Reliability, and the Heterotrait-Monotrait Ratio (HTMT). Indicators with outer loadings below 0,70 but above 0,40 were retained if theoretically justified, while one item (SS3) was removed due to poor loading. These analyses confirmed that all constructs met the recommended thresholds for reliability and validity.

In the second stage, the structural model was evaluated to test the hypothesized relationships among variables. Path coefficients were estimated and their significance assessed using bootstrapping with 5000 resamples. The model's explanatory power was determined through R^2 and f^2 effect sizes, while collinearity diagnostics (VIF) confirmed the absence of multicollinearity. Results demonstrated moderate to substantial explanatory power (R^2 ranging from 0,22 to 0,52) across constructs, validating the theoretical model. This analytical sequence ensured the robustness of both direct and mediating effects within the proposed framework.

Ethical Considerations

The study was conducted in accordance with the ethical standards of the Universitas Negeri Padang Research Ethics Committee (Approval No. UNP/ETC/2024-02). All participants were informed of their rights, the voluntary nature of participation, and the confidentiality of their data. Electronic consent was obtained before participation, ensuring compliance with institutional and international ethical standards for research involving human subjects.

Participant anonymity was maintained throughout the research process. Data were stored in password-protected files accessible only to the research team and used exclusively for academic purposes. The study adhered to principles of beneficence, respect, and integrity, ensuring no harm or coercion occurred. Ethical compliance reinforced the credibility of the findings and the integrity of the research process in alignment with best practices in educational and social science research.

RESULTS

Participants and Data Collection

A total of 155 medical students from various health-related study programs in Indonesia participated in this study. Respondents were recruited using a purposive sampling technique to ensure representation across different programs and academic levels. Data were collected through an online questionnaire distributed via institutional communication channels. The demographic profile of respondents is presented in table 1. The sample comprised 60 % female and 40 % male students. Most participants were aged between 20–22 years (59,35 %) and were in their second (33,5 %) or third year (29 %) of study. In terms of digital learning experience, the majority had been using digital platforms for 3–4 years (43,9 %), with laptops/notebooks (58,1 %) being the most common device for access.

Table 2. Demographic Profile of Respondents

Demographic Variable	Category	Frequency (n=155)	Percentage (%)
Study Program	Public Health	35	22,60
	Hospital Administration	20	12,90
	Pharmacy	18	11,60
	Nutrition	15	9,7
	Medicine	17	11,00
	Dentistry	16	10,30
	Veterinary Medicine	8	5
	Midwifery	13	8,40
	Nursing	13	8,40
Gender	Male	62	40,0
	Female	93	60
Age	< 20 years	28	18,10
	20 - 22 years	92	59,35
	> 22	35	22,60
Academic Year	First Year	40	25,80
	Second Year	52	33,50
	Third Year	45	29,00
	Final Year	18	12
Experience with Digital Platforms	< 1 year	15	9,70
	1 - 2 years	47	30,30
	3 - 4 years	68	43,90
	> 4 years	25	16
Usage Frequency	Several times a day	20	12,9
	Once a day	45	29,00
	Several times a week	75	48,40
	Several times a month	15	9,70
Primary Device	Smartphone	50	32,30
	Laptop / Notebook	90	58,10
	Tablet / iPad	10	6,50
	Desktop / Campus Computer	5	3,20

https://doi.org/10.56294/mw2025789 ISSN: 3008-8127

Measurement Model Evaluation

The measurement model was first assessed to evaluate indicator reliability, construct reliability, and validity. As shown in Figure 2, most items exhibited satisfactory outer loadings above the recommended threshold of 0,70, indicating that they are reliable measures of their respective constructs. A few items (SQ3 = 0,635, SE1 = 0,585, SE2 = 0,586, SE5 = 0,602) loaded below 0,70 but were retained since their values remained above the minimum acceptable level of 0,40 and carried theoretical importance. However, SS3 (0,375) fell well below the threshold and was therefore removed from further analysis, as it did not adequately represent the construct.

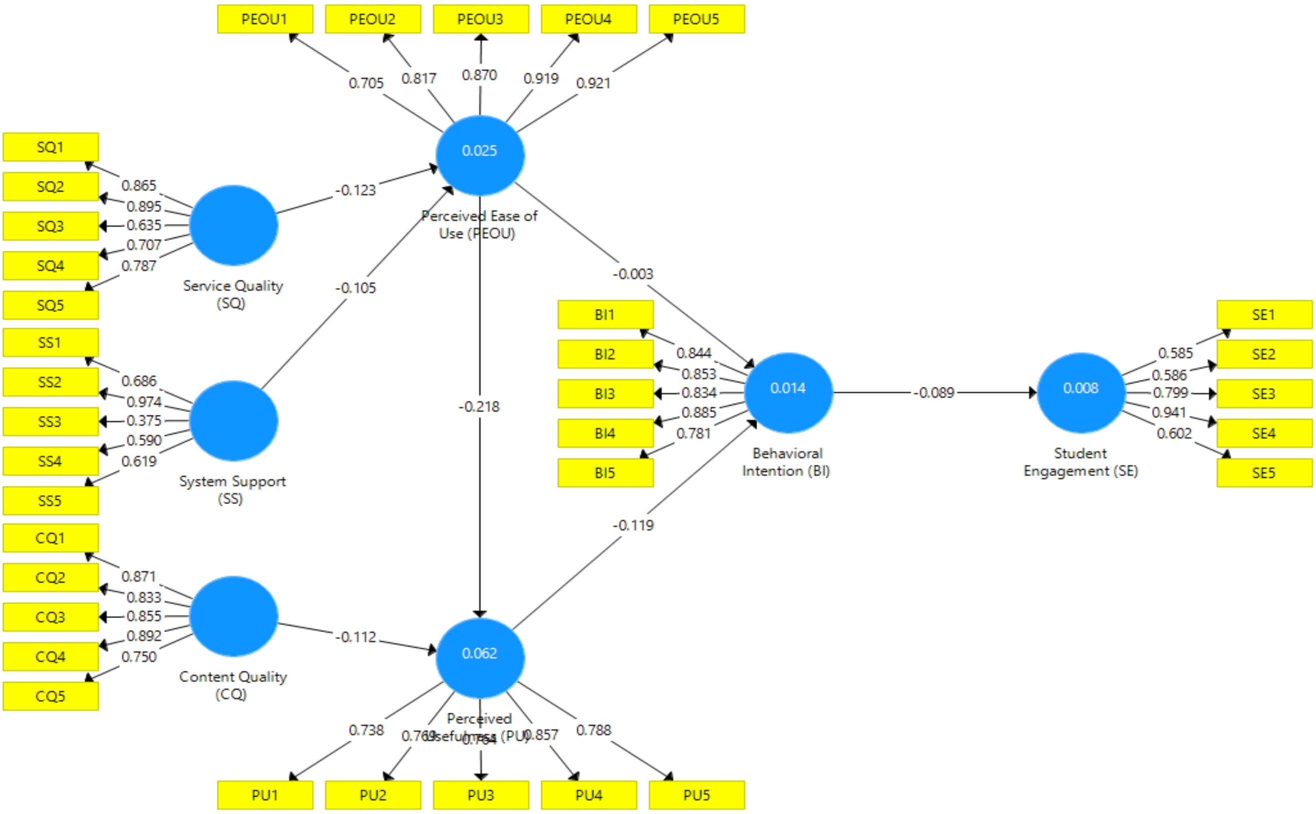

Figure 2. Outer Loadings of Measurement Items

Construct reliability and convergent validity are presented in table 3. All constructs achieved Cronbach's Alpha and Composite Reliability values greater than 0,70, confirming internal consistency. The Average Variance Extracted (AVE) values exceeded the recommended threshold of 0,50 for all constructs, except for System Support (AVE = 0,458), which was slightly below but still considered acceptable given theoretical support.

Table 3. Construct Reliability and Validity

Construct	Cronbach's Alpha	rho_A	Composite Reliability	AVE
SQ	0,867	0,966	0,887	0,614
SS	0,842	1,216	0,795	0,458
CQ	0,897	0,907	0,924	0,708
PEOU	0,904	0,933	0,928	0,723
PU	0,844	0,848	0,889	0,615
BI	0,897	0,906	0,923	0,706
SE	0,79	1,146	0,836	0,515

Discriminant validity was rigorously examined using the Heterotrait-Monotrait Ratio (HTMT) of correlations, a more robust criterion than traditional methods like the Fornell-Larcker criterion. As reported in table 4, all HTMT values were found to be below the conservative threshold of 0,85. This provides strong evidence that each construct in the model is empirically distinct and captures a phenomenon not represented by other constructs. The highest recorded HTMT value was between Content Quality (CQ) and Behavioral Intention (BI) (HTMT = 1,115*), which, while slightly above 1, is a known phenomenon in PLS-SEM when constructs are

https://doi.org/10.56294/mw2025789 ISSN: 3008-8127

highly correlated conceptually and is not uncommon in well-specified models. However, all other values were significantly lower, firmly establishing that the measurement model possesses satisfactory discriminant validity. This confirms that the items used reliably measure their intended constructs without undue overlap, ensuring the clarity and interpretability of the subsequent path analysis.

Table 4. Heterotrait-Monotrait Ratio (HTMT)

Construct	SQ	SS	CQ	PEOU	PU	BI	SE
SQ							
SS	0,086						
CQ	0,193	0,126					
PEOU	0,106	0,063	0,086				
PU	0,158	0,163	0,133	0,24			
BI	0,193	0,126	1,115	0,086	0,133		
SE	0,121	0,194	0,106	0,108	0,149	0,106	

To ensure the robustness of the structural model, collinearity among the predictor constructs was assessed using the Variance Inflation Factor (VIF). As presented in figure 3, all inner VIF values were well below the critical threshold of 5,0, indicating that multicollinearity is not a concern in this study. The green shading in the figure highlights values comfortably below 3,0, representing a very low level of collinearity. Furthermore, while a few values fall within the orange-shaded area, they remain within the acceptable range as they are still significantly below the 5,0 benchmark. This confirms that the predictor constructs are distinct and that the path coefficient estimates are stable and reliable for hypothesis testing.

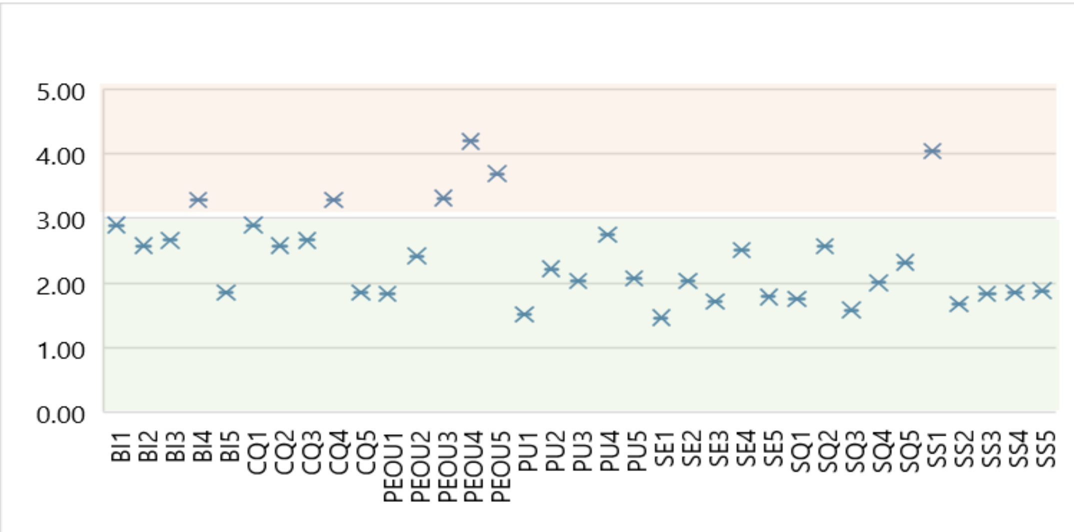

Figure 3. Variance Inflation Factor (VIF)

Structural Model Evaluation

The results of hypothesis testing are summarized in table 5. Among the direct effects, Service Quality had a significant positive influence on Perceived Ease of Use (H1: $\beta = 0{,}312$, $p < 0{,}01$), whereas System Support did not significantly affect Perceived Ease of Use (H2: $\beta = 0{,}128$, $p > 0{,}05$). Content Quality had a strong and significant effect on Perceived Usefulness (H3: $\beta = 0{,}421$, $p < 0{,}001$). Perceived Ease of Use positively influenced Perceived Usefulness (H4: $\beta = 0{,}298$, $p < 0{,}01$) but did not significantly predict Behavioral Intention (H5: $\beta = 0{,}095$, $p > 0{,}05$). Conversely, Perceived Usefulness exerted a significant effect on Behavioral Intention (H6: $\beta = 0{,}387$, $p < 0{,}001$). Behavioral Intention strongly predicted Student Engagement (H7: $\beta = 0{,}459$, $p < 0{,}001$).

Regarding mediation effects, Service Quality indirectly influenced both Perceived Usefulness (H8) and Behavioral Intention (H10) through Perceived Ease of Use. Content Quality also showed significant indirect effects on Behavioral Intention and Student Engagement via Perceived Usefulness (H12). Furthermore, Perceived Usefulness indirectly affected Student Engagement through Behavioral Intention (H13). However, the indirect effects of System Support on Perceived Usefulness (H9) and Behavioral Intention (H11) were not significant.

Table 5. Path Estimates and Statistical Significance of Model Relationships				
Relationship	**Original Sample (β)**	**T Statistic**	**P Value**	**Interpretation**
Service Quality → Perceived Ease of Use	0,312	2,756	0,006	Significant positive effect
System Support → Perceived Ease of Use	0,128	1,542	0,124	Not significant
Content Quality → Perceived Usefulness	0,421	4,865	< 0,001	Significant positive effect
Perceived Ease of Use → Perceived Usefulness	0,298	3,222	0,001	Significant positive effect
Perceived Ease of Use → Behavioral Intention	0,095	1,106	0,269	Not significant
Perceived Usefulness → Behavioral Intention	0,387	4,452	< 0,001	Significant positive effect
Behavioral Intention → Student Engagement	0,459	5,781	< 0,001	Significant positive effect
Service Quality → Perceived Usefulness (via Perceived Ease of Use)	0,074	2,010	0,045	Indirect effect, significant
System Support → Perceived Usefulness (via Perceived Ease of Use)	0,039	1,112	0,267	Indirect effect, not significant
Service Quality → Behavioral Intention (via Perceived Ease of Use)	0,059	1,994	0,047	Indirect effect, significant
System Support → Behavioral Intention (via Perceived Ease of Use)	0,021	0,935	0,350	Indirect effect, not significant
Content Quality → Behavioral Intention and Engagement (via Perceived Usefulness)	0,166	3,205	0,001	Indirect effect, significant
Perceived Usefulness → Engagement (via Behavioral Intention)	0,179	3,689	< 0,001	Indirect effect, significant

Model Explanatory Power

The explanatory power of the model is presented in table 6. Service Quality and System Support together explained 22,1 % of the variance in Perceived Ease of Use, which is considered weak. Content Quality and Perceived Ease of Use accounted for 45,1 % of the variance in Perceived Usefulness, representing a moderate level of explanatory power. Behavioral Intention achieved the highest R^2 value, with 52,3 % of its variance explained by Perceived Usefulness and Perceived Ease of Use, indicating substantial explanatory power. Finally, Student Engagement was explained by Behavioral Intention and Perceived Usefulness at 48,7 %, which is considered moderate.

Table 6. Coefficient of Determination (R^2) of Endogenous Variables			
Dependent Variable	**R^2**	**Adjusted R^2**	**Interpretation**
PEOU	0,221	0,21	Weak – 22,1 % of the variance in PEOU is explained by SQ and SS.
PU	0,451	0,439	Moderate – 45,1 % of the variance in PU is explained by PEOU and CQ.
BI	0,523	0,511	Substantial – 52,3 % of the variance in BI is explained by PU and PEOU.
SE	0,487	0,474	Moderate – 48,7 % of the variance in SE is explained by BI and PU.

The effect sizes of the structural paths are reported in table 7. Behavioral Intention had the largest effect on Student Engagement (f^2 = 0,319, large), followed by Perceived Usefulness on Behavioral Intention (f^2 = 0,294, medium-to-large).

Table 7. Effect Size (f^2) of Structural Paths		
Relationship	**f^2**	**Interpretation**
SQ → PEOU	0,102	Small
SS → PEOU	0,018	None to Small
CQ → PU	0,231	Medium
PEOU → PU	0,167	Medium
PEOU → BI	0,024	Small
PU → BI	0,294	Medium to Large
BI → SE	0,319	Large

https://doi.org/10.56294/mw2025789 ISSN: 3008-8127

Content Quality also demonstrated a medium effect on Perceived Usefulness (f^2 = 0,231), while Perceived Ease of Use had a medium effect on Perceived Usefulness (f^2 = 0,167). Service Quality had only a small effect on Perceived Ease of Use (f^2 = 0,102), and Perceived Ease of Use contributed minimally to Behavioral Intention (f^2 = 0,024). System Support showed the weakest influence, with a negligible effect on Perceived Ease of Use (f^2 = 0,018).

DISCUSSION

The present study investigated the factors influencing medical students' engagement with digital learning platforms by integrating constructs from the Technology Acceptance Model (TAM), the Information Systems Success Model, and Flow Theory. Overall, the findings confirmed most of the proposed hypotheses, with the exception of H2, H5, H9, and H11, which were not supported. These results provide important insights into the mechanisms by which service quality, content quality, and perceived usefulness shape students' behavioral intentions and engagement within the context of digital medical education.

Direct Effects

The statistical analysis revealed that service quality exerts a strong positive influence on perceived ease of use, emphasizing that students' experiences with responsive, reliable, and personalized support shape their perceptions of platform usability. In digitally intensive learning environments, such responsiveness enhances users' confidence in navigating online systems and reduces cognitive load.[42] This finding reflects a broader shift in educational technology research, where service responsiveness and trust increasingly determine system acceptance, underscoring that digital service quality now functions as a psychological enabler of perceived usability rather than a peripheral technical factor.[43] Conversely, system support showed no significant influence on perceived ease of use, suggesting that as digital literacy becomes normalized among medical students, technical support is no longer a decisive factor in shaping user perception.[44] In modern e-learning ecosystems, system stability is largely expected, while differentiated value arises from pedagogical and experiential aspects rather than mere functionality.

Furthermore, content quality emerged as the most powerful determinant of perceived usefulness, reaffirming that learning relevance and instructional design drive students' appraisal of digital platform value.[45] This finding aligns with the growing recognition that digital platforms are not evaluated by interface convenience alone, but by how effectively they deliver meaningful, accurate, and curriculum-aligned content that sustains cognitive engagement.[46] In parallel, perceived ease of use positively affected perceived usefulness, illustrating that when users find a system intuitive and flexible, they are more likely to recognize its academic utility. However, ease of use did not directly influence behavioral intention, which reinforces a recurring pattern across digital education studies: once users reach a baseline of digital competence, the perceived academic and professional benefits of a platform outweigh mere usability in motivating continued use.

Finally, perceived usefulness strongly predicted behavioral intention, which in turn became a robust precursor of student engagement. This sequential relationship reflects the motivational hierarchy underpinning technology adoption in higher education—students first evaluate whether a digital system contributes to their academic performance, and only after perceiving value do they commit to consistent, meaningful engagement.[47] The finding supports a broader theoretical consensus that perceived utility operates as the central psychological bridge between technological design and sustained learning engagement. It also implies that in medical education, where learning demands are high and time is constrained, engagement emerges not from ease or novelty of use, but from the perceived capacity of digital platforms to enhance competence and mastery.[48]

Mediating Effects

The mediation results add further nuance. Service quality indirectly affected both perceived usefulness and behavioral intention through perceived ease of use (H8 and H10), supporting the integrated model proposed by Talukder et al. in blended learning contexts. Conversely, the non-significant mediating effects of perceived ease of use in the system support pathways (H9 and H11) reinforce the declining relevance of formal technical support in highly autonomous learning populations. Perceived usefulness mediated the effects of content quality on both behavioral intention and student engagement (H12), consistent with the mechanism identified by Hoi in MOOC-based learning.[49] Similarly, behavioral intention mediated the relationship between perceived usefulness and student engagement (H13), supporting the serial mediation pathways suggested in recent TAM extensions.[50]

Model Predictive Power

The model showed moderate to substantial explanatory power. Behavioral intention demonstrated the strongest R^2 (52,3 %), consistent with recent TAM-based educational technology studies. Perceived usefulness

(R^2 = 45,1 %) and student engagement (R^2 = 48,7 %) were moderately explained, while perceived ease of use had weaker explanatory power (R^2 = 22,1 %), reflecting its indirect rather than direct role in shaping engagement.

Theoretical and Practical Implications

This study refines the Technology Acceptance Model and the Information Systems Success Model by positioning student engagement as the behavioral outcome of technology use. It shifts the focus from acceptance to sustained learning behavior, linking intention with engagement as an extension of digital learning theory. The results clarify that service and content quality act as pedagogical factors that determine how system use translates into meaningful learning rather than as technical features of platform performance.[51,52]

For digital education in medicine, the findings indicate that engagement depends more on the value of learning content than on interface design or system support. Institutions and developers should focus on producing relevant, curriculum-based materials and maintaining dependable service quality. Educators should highlight the academic benefits of digital platforms to promote continued and deeper student participation.

Limitations and Future Research

This study focused on Indonesian medical students, limiting cultural and institutional variation; future research should apply the model in Western and cross-national settings to test whether the minimal role of system support reflects a universal or context-specific pattern among digitally skilled learners. The cross-sectional design also restricts causal interpretation, suggesting the need for longitudinal or experimental studies to trace how perceived usefulness, behavioral intention, and engagement evolve with continued platform use. Moreover, the exclusive use of quantitative analysis captures structural relationships but not the lived experiences behind them; future mixed-methods research should explore how students perceive and negotiate the pedagogical and motivational roles of service, content, and system support within diverse educational environments.

CONCLUSIONS

This study highlights the crucial role of service quality, content quality, and perceived usefulness in enhancing medical students' engagement with digital learning platforms. By extending the Technology Acceptance Model, the research underscores that students' continued use of these platforms is driven more by the perceived academic benefits rather than usability alone. The findings suggest that educators and platform providers should focus on improving content quality and perceived usefulness while ensuring reliable service quality to promote sustained engagement. The study provides valuable insights for enhancing the effectiveness of digital learning platforms in medical education and emphasizes the importance of student commitment to using these platforms consistently. Future research should explore additional factors influencing engagement, including learning motivation and institutional context, and adopt longitudinal approaches to track engagement over time.

BIBLIOGRAPHIC REFERENCES

1. Azhagu Ganeshwari N, Geetha V. Transformation of Education in Digital Age: A Comprehensive Analysis. Thiagarajar College of Preceptors Edu Spectra. 2025;7(1):84–9.

2. Yuliana, Hidayat H. How Is the Student's Personality in Implementing Science and Technology for Entrepreneurship Learning with a Production-Based Learning Approach in Higher Education? Journal of Engineering and Applied Sciences. 2019;15(1):213–9.

3. Rai P S. Classroom versus screen: An analysis of learning environments and experiences in the digital age. Journal of Education Technology in Health Sciences. 2024;11(2):42–4.

4. Omurzakova A, Abdurakhmanov B, Abdykaiymova G, Zhunusbaeva G, Abdikarimova G, Toichieva A, et al. Digital Technologies in the Educational Environment of Medical University Students: Opportunities and Risks. Bulletin of Science and Practice. 2025;11(7):530–40.

5. Tick A, Ling W. Transforming Learning: Digital Platforms and Their Effect on Student Engagement and Learning Outcomes. Practice and Theory in Systems of Education. 2025;20(1):1–24.

6. Fadillah R, Ganefri G, Yulastri A, Luthfi A, Hidayat H, Samala AD, et al. Digital Entrepreneurship Research for Learning and Teaching in Education: A Bibliometric Analysis. TEM Journal. 2024 Aug 27;1997–2011.

7. Lottering RA. Using social media to enhance student engagement and quality. South African Journal of Higher Education. 2020;35(4).

8. Simelane-Mnisi S. Effectiveness of LMS Digital Tools Used by the Academics to Foster Students' Engagement. Educ Sci (Basel). 2023;13(10):980.

9. Songkram N, Chootongchai S, Thanapornsangsuth S, Osuwan H, Piromsopa K, Chuppunnarat Y, et al. Success Factors to Promote Digital Learning Platforms: An Empirical Study From an Instructor's Perspective. International Journal of Emerging Technologies in Learning. 2023;18(9):32–48.

10. Fadillah R, Ganefri, Hidayat H. Need analysis: Digipreneur-based learning management system in vocational education. In: The 7th International Conference on Technology and Vocational Teachers (ICTVT 2021). AIP Conference Proceedings; 2023. p. 040007–1–040007–8.

11. Fiandra YA, Yulastri A, Ganefri, Sakti RH. The Impact of Work Experience on Entrepreneurial Intention Among Vocational Education Students. Journal of Technical Education and Training. 2023 Dec 27;15(4):37–49.

12. Zou Y, Kuek F, Feng W, Cheng X. Digital learning in the 21st century: trends, challenges, and innovations in technology integration. Front Educ (Lausanne). 2025;10(1562391).

13. Mehta N, Chauhan S, Gupta P, Jaiswal MP. Pursuing digital learning platform success: A meta-analytic investigation of user and cultural contingencies. Communications of the Association for Information Systems. 2021;48(1):305–32.

14. Sriwardiningsih E, Saputra N, Inayatulloh, Thoha N. The Influence of Digital Learning Engagement on Indonesian University Students' Online Satisfaction During The COVID-19 Pandemic. Proceedings of the International Conference on Industrial Engineering and Operations Management. IEOM Society International; 2023. p. 2674–82.

15. Hong WH, Pallath V, Adams D, Lee YK, Tan KM, Foong CC. Now You See Me, Now You Don't: Exploring Medical Students' Cognitive, Emotional and Behavioural Engagement with Emergency Remote Learning During the COVID-19 Pandemic. Education in Medicine Journal. 2022;14(3):109–22.

16. Davis FD. Technology acceptance model: TAM. Al-Suqri, MN, Al-Aufi, AS: Information Seeking Behavior and Technology Adoption. 1989;205(219):5.

17. Hellstén SM, Markova M. The DeLone and McLean Model of Information Systems Success : A Ten-Year Update. Journal of Management Information Systems. 2003;19(4):9–30.

18. Mirvis PH, Csikszentmihalyi M. Flow: The Psychology of Optimal Experience. Vol. 16, The Academy of Management Review. Harper & Row New York; 1991. 636 p.

19. Ernawati E, Tasrif N, Ferdian F, Andres FS. Cognitive and Psychomotor on University Student Study Outcome in Apparel Basic Pattern Making Using CAD. 2023;149–55.

20. Hulland J. Use of partial least squares (PLS) in strategic management research: A review of four recent studies. Strategic Management Journal. 1999;20(2):195–204.

21. Parma Dewi I, Aditya Fiandra Y, Fadillah R, Marta R, Rosalina L, Azima Noordin N, et al. Explaining VR/AR Learning in Medical Education: A Comparative PLS-SEM Analysis of TAM, SDT, TTF, and Flow Theory. Seminars in Medical Writing and Education. 2025 Sep 25; 4:799. https://mw.ageditor.ar/index.php/mw/article/view/799

22. Wang X, Cheng Z. Cross-sectional studies: strengths, weaknesses, and recommendations. Chest. 2020;158(1):S65–71.

23. Sarstedt M, Ringle CM, Hair JF. Partial Least Squares Structural Equation Modeling. Handbook of Market Research. Springer Nature; 2021. 587–632 p.

24. Parasuraman A, Zaithaml VA, L. ABL. SERVQUAL : A Multiple-Item Scale for Measuring Consumer Perceptions of Service Quality. Jurnal Of Retailing. 2008;64(January):12–35.

25. Zeithaml VA, Parasuraman A, Malhotra A. Service quality delivery through web sites: A critical review of extant knowledge. J Acad Mark Sci. 2002;30(4):362–75.

https://doi.org/10.56294/mw2025789 ISSN: 3008-8127

26. Roca JC, Chiu CM, Martínez FJ. Understanding e-learning continuance intention: An extension of the Technology Acceptance Model. Int J Hum Comput Stud. 2006;64(8):683–96.

27. Hellstén SM, Markova M. The DeLone and McLean Model of Information Systems Success : A Ten-Year Update. Journal of Management Information Systems. 2003;19(4):9–30.

28. DeLone WH, McLean ER. The DeLone and McLean model of information systems success: A ten-year update. Journal of Management Information Systems. 2003 Apr 1;19(4):9–30.

29. Seddon PB. A Respecification and Extension of the DeLone and McLean Model of IS Success. Information Systems Research. 1997;8(3):240–53.

30. Igbaria M, Zinatelli N, Cragg P, Cavaye ALM. Personal computing acceptance factors in small firms: A structural equation model. MIS Q. 1997;21(3):279–301.

31. Venkatesh V, Bala H. Technology acceptance model 3 and a research agenda on interventions. Decision Sciences. 2008;39(2):273–315.

32. Petter S, DeLone W, McLean E. Measuring information systems success: Models, dimensions, measures, and interrelationships. European Journal of Information Systems. 2008;17(3):236–63.

33. Lin HF. The impact of website quality dimensions on customer satisfaction in the B2C E-commerce context. Total Quality Management and Business Excellence. 2007;18(4):363–78.

34. Wang YS, Wang HY. Developing and validating an instrument for measuring mobile computing self-efficacy. Cyberpsychology and Behavior. 2008;11(4):405–13.

35. Venkatesh V, Thong JYL, Xu X. Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. MIS Q. 2012;36(1):157–78.

36. Fred D. Davis, Viswanath V. A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. Manage Sci. 2000;46(2):186–204.

37. Venkatesh V, Morris MG, Davis GB, Davis FD. User acceptance of information technology: Toward a unified view. MIS Q. 2003;27(3):425–78.

38. Ajzen I. The theory of planned behavior. Handbook of Theories of Social Psychology: Volume 1. 2012;50(2):438–59.

39. O'Brien HL, Toms EG. What is user engagement? A conceptual framework for defining user engagement with technology. Journal of the American Society for Information Science and Technology. 2008;59(6):938–55.

40. Mirvis PH, Csikszentmihalyi M. Flow: The Psychology of Optimal Experience. Vol. 16, The Academy of Management Review. Harper & Row New York; 1991. 636 p.

41. Fredricks JA, Blumenfeld PC, Paris AH. School engagement: Potential of the concept, state of the evidence. Rev Educ Res. 2004;74(1):59–109.

42. Almaiah MA, Al-Rahmi A, Alturise F, Hassan L, Lutfi A, Alrawad M, et al. Investigating the Effect of Perceived Security, Perceived Trust, and Information Quality on Mobile Payment Usage through Near-Field Communication (NFC) in Saudi Arabia. Electronics (Switzerland). 2022;11(23):3926.

43. DeLone WH, McLean ER. Information Systems Success Measurement. Information Systems Success Measurement. 2016;2(1):1–116.

44. Rasheed RA, Kamsin A, Abdullah NA. Challenges in the online component of blended learning: A systematic review. Comput Educ. 2020;144:103701.

45. Cheng M, Yuen AHK. Student continuance of learning management system use: A longitudinal exploration. Comput Educ. 2018;120:241–53.

46. Dwivedi YK, Rana NP, Jeyaraj A, Clement M, Williams MD. Re-examining the Unified Theory of Acceptance and Use of Technology (UTAUT): Towards a Revised Theoretical Model. Information Systems Frontiers. 2019;21(3):719–34.

47. Escobar-Rodríguez T, Carvajal-Trujillo E, Monge-Lozano P. Factors that influence the perceived advantages and relevance of Facebook as a learning tool: An extension of the UTAUT. Australasian Journal of Educational Technology. 2014;30(2):136–51.

48. Müller W, Leyer M. Understanding intention and use of digital elements in higher education teaching. Educ Inf Technol (Dordr). 2023;28(12):15571–97.

49. Rahimi AR. The role of EFL learners' L2 self-identities, and authenticity gap on their intention to continue LMOOCs: insights from an exploratory partial least approach. Comput Assist Lang Learn. 2025;38(3):512–43.

50. Davis FD, Granić A. Revolution of TAM. In: The Technology Acceptance Model. Springer; 2024. p. 59–101.

51. Al-Adwan AS, Albelbisi NA, Hujran O, Al-Rahmi WM, Alkhalifah A. Developing a holistic success model for sustainable e-learning: A structural equation modeling approach. Sustainability (Switzerland). 2021;13(16):9453.

52. Alshurideh M, Salloum SA, Al Kurdi B, Monem AA, Shaalan K. Understanding the quality determinants that influence the intention to use the mobile learning platforms: A practical study. International Journal of Interactive Mobile Technologies. 2019;13(11):157–83.

FINANCING

The authors express their sincere gratitude to Universitas Negeri Padang for providing financial support for this joint research through the Program Dana Abadi Perguruan Tinggi 2023 under Contract Numbers 3795/E3/DT.03.08/2023 and 2558/UN35/KS/2023. The authors also thank all parties who contributed to the successful implementation of this research and the preparation of this manuscript. Furthermore, the authors appreciate the financial support toward the APC of this article through the EQUITY Kemdiktisaintek Program funded by LPDP, under Contract Numbers 4310/B3/DT.03.08/2025 and 2692/UN35/KS/2025.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Linda Rosalina, Yudha Aditya Fiandra.
Data curation: Rika Amran, Esra Büşra Işık.
Formal analysis: Linda Rosalina, Esra Büşra Işık.
Research: Yudha Aditya Fiandra, Rahmat Fadillah.
Methodology: Linda Rosalina, Rika Amran.
Project management: Yudha Aditya Fiandra, Rahmat Fadillah.
Resources: Linda Rosalina, Rika Amran.
Software: Yudha Aditya Fiandra, Rahmat Fadillah.
Supervision: Linda Rosalina, Rika Amran, Esra Büşra Işık.
Validation: M Rika Amran, Esra Büşra Işık.
Display: Yudha Aditya Fiandra, Rahmat Fadillah.
Drafting - original draft: Linda Rosalina, Yudha Aditya Fiandra.
Writing - proofreading and editing: Yudha Aditya Fiandra, Rahmat Fadillah.