

Mediating effect of e-learning quality on learning outcomes through student satisfaction in nursing education



Review

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Received: 8 September 2022; Accepted: 15 December 2022; Published: 20 September 2023

Abstract: **Objective:** This study aimed to determine the relationships between e-learning quality, student satisfaction, and learning outcomes and the mediating effect of student satisfaction.

Methods: A cross-sectional quantitative correlational study using a predictive design and multivariate analysis method was employed in this study. A sample of 241 nursing students were recruited through an online survey based on a stratified random sampling technique. The variance-based Partial Least Squares Structural Modeling analysis method was used to test the possible relationship and mediating effect among the variables.

Results: The findings revealed statistically significant relationships between e-learning quality, student satisfaction, and learning outcomes. A mediating effect of 37.2% is predicted for e-learning quality on learning outcomes through student satisfaction.

Conclusions: This study emphasizes the learning needs of working nurses and the impact on their learning outcomes in e-learning nursing undergraduate programs. Advances in e-learning education have assisted nurses to be more self-sufficient in their pursuit of lifelong learning.

Keywords: *system quality • information quality • service quality • learning outcome • student satisfaction*

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1. Introduction

There has been a steady increase in the prevalence of online programs offered in higher institutions nationwide. In 2020, internet access among the Malaysian population has accelerated to 91.7%.¹ Of these, 98.6% of users were using mobile phones and 77.6% were using computers for online access. These statistics indicate a tremendous increase in utilization and access to the internet by the younger population in Malaysia. Similarly, the demand for online education such as e-learning program in nursing education is increasing as a result of Malaysia's Ministry of Higher Education (MOHE)

initiatives. Many nursing professionals have been motivated by the MOHE's 2020 strategy to advance their education from a diploma to a bachelor's degree. Various studies support the advantages of e-learning programs in enhancing nurses' knowledge, skill, and caring behavior toward quality patient care.²⁻⁴ Pursuing a higher nursing education through e-learning programs is therefore important for nurses to promote their professional development and core values of caring.

The MOHE reported that only 33% (n = 119,873) of students in the undergraduate programs (online and

How to cite this article: Chang WC, Siew WF, Yee BL. Mediating effect of e-learning quality on learning outcomes through student satisfaction in nursing education. *Front Nurs*. 2023;3:261-272.

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conventional) had completed their studies in Malaysia's educational institutions.⁵ The local higher education institutions face a considerably greater challenge in keeping the students engaged and completing online learning successfully than they do in conventional learning. Similarly, the attrition rate and delayed graduation for online undergraduate programs remain high in the undergraduate programs and nursing bachelor programs in many countries.^{6,7} Only 2% of Malaysia's nurses possessed a bachelor's degree, according to reports.⁸ The data are worrying as the percentage of bachelor's degree holders is much lower than the targeted number set by the MOHE.

E-learning education allows flexibility for adult learners to pursue higher degrees while working full time. E-learning is defined as electronic learning, an education course conducted using information and communication technologies for teaching and learning.⁹ E-learning is also known as online learning, blended learning, hybrid learning, distance-learning, or internet-based learning.¹⁰ In this study, the term e-learning is used to describe 70% of course content facilitated using online-mediated learning and 30% face-to-face classroom learning. Adult learners can benefit from an e-learning platform that leverages web-based technology as an engagement strategy for teaching and learning. It is an integration of teaching methods using both the synchronous (online) and asynchronous (offline) modes for flexible learning in meeting individuals' learning styles and needs. Varying the flexibility of online learning activities with a blend of synchronous and asynchronous learning modes could be an effective strategy to promote quality learning experiences for students. Such instructional design is not only beneficial in terms of enhancing learning outcomes in e-learning education but also accommodates students' diverse learning styles.

2. Literature Review

According to the literature review, the effects of e-learning in nursing are inconsistent. However, there is a great possibility for nursing students to gain lifelong learning through online education, and the positive effect of e-learning remains an important topic for future research in higher education. A systematic review by Rouleau et al.³ revealed several negative factors to e-learning among nurses such as lack of computer and internet efficacy, technical difficulties, preference for face-to-face learning approach, and challenges in time, access, and navigation to e-learning management systems. Out of the 22 reviews, 13 reviews (59%) of past studies reported improved knowledge using e-learning; but 7 reviews (32%) of studies found no effect of e-learning intervention on nurses' knowledge.

Concerning nursing skill performance, 9 reviews (41%) of past studies documented a positive outcome among nurses who participated in e-learning education. The findings are in line with Latif who reported that academic achievement has improved using online learning among student nurses in Malaysia.¹¹ In contrast, Hjorth-Johansen et al.¹² revealed that there was no significant difference in academic achievement between classroom learning and e-learning nursing.

Many past works of literature adopting the DeLone and McLean Information Systems (D&M IS) success model reported that the success of e-learning system is influenced by student satisfaction. Marjanovic et al.¹³ reported a strong significant impact of system quality on student satisfaction; as well as between student satisfaction and e-learning outcome. A study by Cidral et al.¹⁴ revealed that system quality significantly impacted student satisfaction and individual impact. Yet, Yakubu and Dasuki¹⁵ indicated no significant impact of system quality on student satisfaction. It is possible that students from developed countries are well supported with advanced technologies and system interfaces. Whereby, the usability, speed, effectiveness as well as design of the courses are readily available to meet the demands of both teachers and students. Nevertheless, user satisfaction in e-learning environment could be influenced by many contributing factors that need further exploration in various contexts.

In a study, Kunjukunju et al.¹⁶ revealed a positive correlation between information quality and e-learning quality among Malaysian nurses. The study supports a well-designed e-learning Moodle in ensuring positive student experiences and satisfaction in institutions of higher education. The quality of the e-learning information was the most important attribute of an online learning study related to course design and satisfaction.¹⁷ However, Yakubu and Dasuki¹⁵ revealed no statistically significant effect of information quality on student satisfaction. Their findings imply that student satisfaction is not influenced by the quality of the information provided in the e-learning course.

On the other hand, service quality is reported as a significant predictor of satisfaction when nurses found the information system is easy to be used.¹⁸ This finding is supported by Kunjukunju et al.¹⁶ that service quality such as empathy, reliability, assurance, and responsiveness of faculty are associated positively with student satisfaction in e-learning nursing program. The availability, responsiveness, and timely services from information technology personnel are equally important in gaining student confidence in using the e-learning system and thus increasing their satisfaction. In contrast to earlier findings, however, no statistically significant effect of service quality on student satisfaction and the individual impact was found.¹⁴

Another study by Goh et al.¹⁹ on the relationship between learning experience, student satisfaction, and learning outcomes in e-learning found that course design and interaction with faculty and peers are significant predictors of student satisfaction and learning outcomes. Through regression analysis, the study indicated that peer interaction is the most important factor that affects the satisfaction and learning outcomes of students. The study implies that an online virtual environment does not limit interaction, but it allows students and faculty to share information and exchange ideas. These findings have important implications for developing e-learning programs in a way to promote active learning and guide the students for better knowledge acquisition, satisfaction, and learning outcomes.

Despite the inconsistencies of past research findings, many works of literature support the positive impact of student satisfaction on learning outcomes in an e-learning system. Cidral et al.¹⁴ indicate a strong positive effect of user satisfaction on individual impact. In the study, the effect between satisfaction and e-learning outcome is shown to be the highest among all other factors in the information systems success dimensions. Another study on a public university in Malaysia reported a significant association between student satisfaction and academic achievement in undergraduate students.²⁰ These findings are also supported by

Shahzad et al.²¹ that student satisfaction has a strong impact on e-learning success among Malaysian university students. The findings of the past studies suggest that student satisfaction can serve as a valid determinant for e-learning outcomes when students' expectations are met in an online learning environment. Putting together, student satisfaction has been identified as a major contributing factor to the relationship between system quality, information quality, service quality, and learning outcome. Many past studies have hypothesized that linking e-learning quality to student satisfaction is the most effective way to explain students' learning outcomes in e-learning education.

3. Research Model and Hypotheses

3.1. Research model

The conceptual framework developed for the study was an adaption model which evaluate the three stages of e-learning systems development, i.e., system design, system delivery, and system outcome that is relevant to the e-learning nursing context based on D&M IS Success model. This visual representation is illustrated in Figure 1. Following the process approach, the success of the system design is determined by system quality, information quality, and service quality. The success of

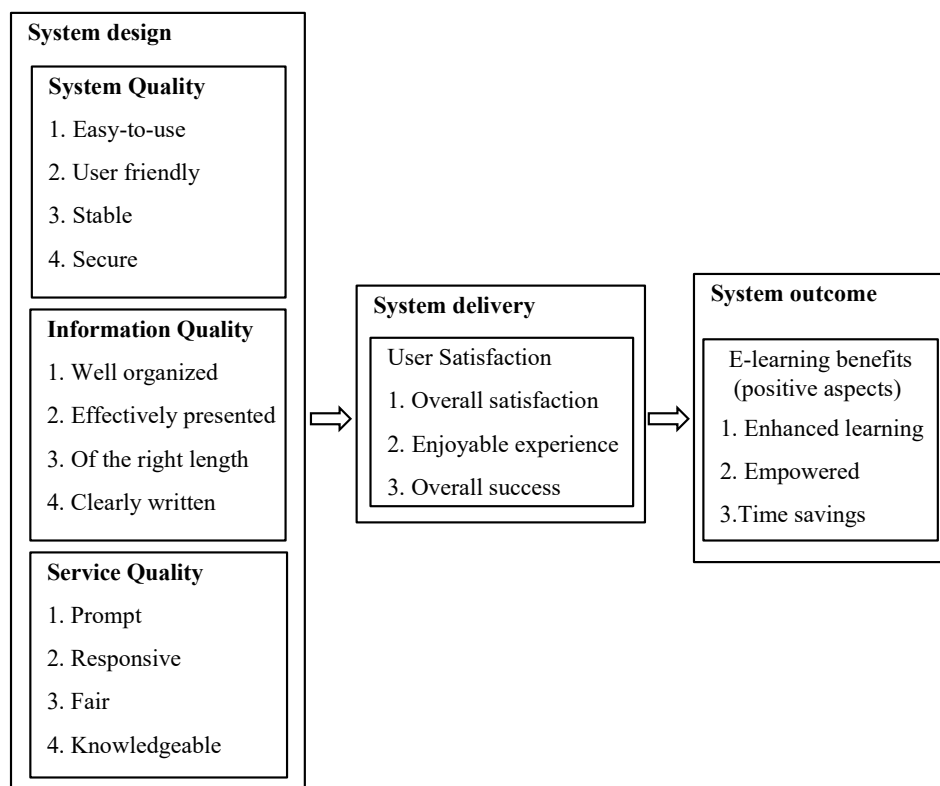


Figure 1. The stages of e-learning systems (source adapted from Holsapple and Lee-Post²²).

the system delivery is measured using user satisfaction, while the outcome of the system is evaluated using the positive aspects of the benefits of using the system. The overall success of the system design is fundamental to system delivery, which in turn, will influence the success of system outcome for users. The three stages of the e-learning system are also represented in activity theory that is in line with the interaction process among subject (system design), mediating tool (system delivery), and object (system outcome). These support the relevant use of D&M IS Success model and the three stages of e-learning systems in this study.

Conceptual framework of the study, e-learning quality (system quality, information quality, and service quality) is identified as the exogenous variable indicating its direct effects on the endogenous variables as shown in Figure 2. The endogenous variables of the study are student satisfaction and learning outcomes. In the partial least squares (PLS) model, endogenous is a variable that is influenced directly or indirectly by the exogenous variable; and exogenous is a variable that is the causal factor to another construct.²³ Student satisfaction is also identified as a mediating variable that is possible to intervene in the relationship between the exogenous variable (e-learning quality) and endogenous variable (learning outcomes) in the model. In this study, relationships between e-learning quality, student satisfaction, and learning outcome are measured to identify the direct effect (straight arrow for H1 to H3) and indirect effect (dotted arrow for H4) on the e-learning environment success. The possible effects on the relationships

among the variables studied were analyzed using the variance-based partial least squares structural modeling (PLS-SEM) method.

In this study, learners' perception of e-learning quality is evaluated using the e-learning quality dimension in the e-learning course evaluation survey questionnaire. System quality is operationalized as the desired characteristics of the e-learning system at the technical level such as easy-to-use, stable, secure, user friendly, fast, and interactive. Technical support such as information communications technology and information technology are also part of the system quality provided to the students. The second element of e-learning quality is service quality which is identified as the desirable characteristics of faculty support and student-faculty interactions such as responsiveness, promptness, fairness, faculty availability, and knowledgeability. Third, information quality refers to the desired characteristic outputs of an e-learning system such as the systematic organization of course information, effective presentation, clearly written, useful, of the right length, and up to date.

Another variable of the study is student satisfaction that consists of four aspects namely, overall satisfaction, overall success, enjoyable experience, and recommended to others, which is related to the level of satisfaction perceived by the students using the e-learning system. Finally, the learning outcome is defined as the extent to which the e-learning systems are useful to the students to accomplish a degree. The elements of learning outcomes measured are empowerment,

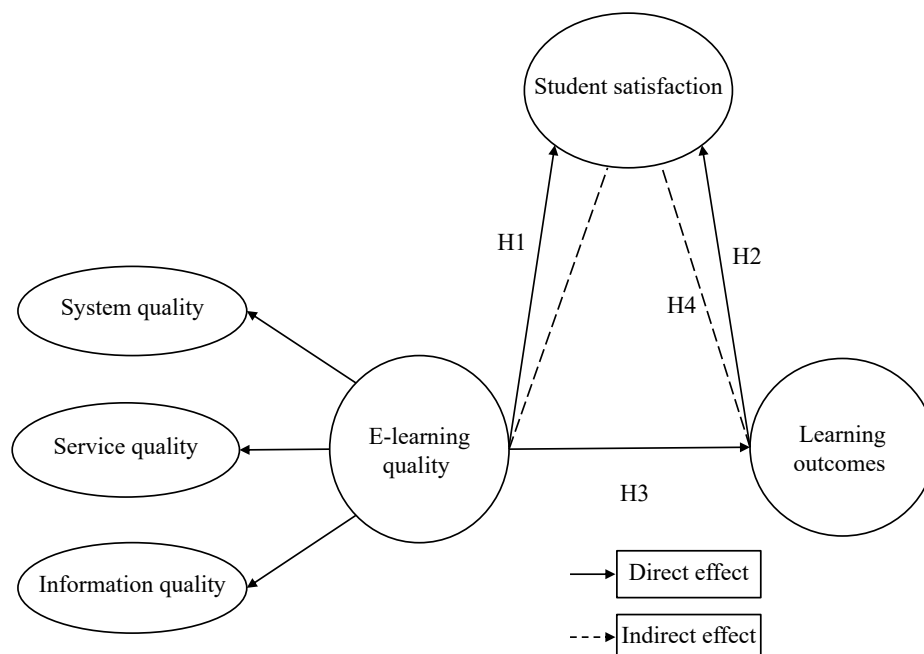


Figure 2. Conceptual framework of the study.

enhanced learning, time-saving, and academic success. More precisely, “empowered” measures the perceived control of the learner on when and where to learn; “enhanced learning” means the course strengthens the learner’s ability to analyze and evaluate his or her learning; “time-saving” evaluates the learner’s perception in learning material/information in less time; and “academic success” indicates perceived benefit of the learner using the e-learning system to achieve individual learning outcomes.

3.2. Purpose of the study

The main objective of this study was to investigate the predicting success factors of the information systems model in an e-learning nursing context. We predict that quality in e-learning system design would improve system delivery in meeting students’ needs and the overall outcomes of using the e-learning information system. The success of such efforts is therefore well guided by the 3-stages e-learning systems development process approach in D&M IS Success model.

3.3. Research hypotheses

Below are the four hypotheses to be tested based on the conceptual framework of the study:

- H1:** There is a statistically significant effect of e-learning quality on student satisfaction among nursing students in e-learning education.
- H2:** There is a statistically significant effect of student satisfaction on learning outcomes among nursing students in e-learning education.
- H3:** There is a statistically significant effect of e-learning quality on learning outcomes among nursing students in e-learning education.
- H4:** There is a statistically significant mediating effect of student satisfaction for the relationship between e-learning quality and learning outcomes among nursing students in e-learning education.

3.4. Method and instrument

This study employed a cross-sectional quantitative correlational survey with predictive design and multivariate analysis method to examine the (1) relationships between variables of e-learning quality (system quality, information quality, and service quality), student satisfaction, and learning outcomes, (2) mediating effect of student satisfaction for the relationship between e-learning quality and learning outcomes. The population of the study consists of 1100 working nurses enrolled in the e-learning undergraduate post-registration nursing programs at

12 learning centers across East and West in Malaysia. Participants in this study had met the inclusion criteria of being Malaysian nurses enrolled in a Bachelor of Nursing (Post-registration) Undergraduate program at the study sites, using an e-learning approach, and having completed at least one course (module) from the program. Furthermore, they must have participated in the program’s online teaching and learning activities. Students who are newly enrolled in the program but have not completed at least one course are excluded from the study. Using stratified random sampling, 241 students responded to the online survey through a self-administered questionnaire.

The e-learning course evaluation survey was adapted from Holsapple and Lee-Post²² with permission to measure the e-learning quality in terms of system quality, information quality, and service quality, learning outcomes, and satisfaction among students in e-learning nursing undergraduate programs. The instrument contains 25 items across five dimensions namely system quality (6 items), information quality (6 items), service quality (5 items), student satisfaction (4 items), and learning outcomes (4 items). The e-learning course evaluation survey is using a 5-point Likert scale ranging from 1, Strongly Disagree, to 5, Strongly Agree. A high score will indicate a high level of e-learning quality, student satisfaction, and learning outcomes perceived by the students.

Before the main study, 30 respondents were randomly selected from a learning center for a pilot test. The e-learning course evaluation survey was validated (*I-CVI* of 0.83 to 1.00) for its relevancy by a panel of 6 content experts involved in e-learning teaching or instructional designs. The Item-level Content Validity Index scores ranged between 0.83 and 1.00 for each item indicating an excellent validity. Cronbach’s α values of 0.864 (system quality), 0.851 (information quality), 0.834 (service quality), 0.849 (student satisfaction), and 0.820 (learning outcomes) suggest a good internal consistency of the instrument.

4. Results and Discussion

Demographic data of the participants consist of age, gender, marital status, working experience, working position, current clinical area, past experience in online learning, and current grade point average (CGPA) in Bachelor of Nursing Science (Honors) Post-Registration undergraduate programs. Findings show that majority of the respondents are females (93.4%, $n = 225$), holding a position as staff nurse (83%, $n = 200$), assigned at the non-critical care areas (56.8%, $n = 137$), and experienced in online learning before studies (68.5%, $n = 165$).

More than half of them were single (59.8%, $n = 144$); within the middle age group ($M = 32$ years), have fairly long working experience ($M = 9$ years), and have moderate CGPA scores ($M = 3.44$) at the point of data collection.

We assessed the indicator reliability, internal consistency reliability, discriminant validity, and convergent validity using Smart PLS 3 analytical software. As illustrated in Table 1, those indicators that have met the loadings of at least 0.70 are retained for further analysis. With that, indicators from the system quality (SQ2, SQ6), service quality (SEQ5), and information quality (IQ3, IQ6) were removed in this stage. In the next analysis, the results show that the indicators for Cronbach's α were between 0.723 and 0.881, for rho_A

Construct	Indicator loadings	Cronbach's	rho_A	CR	AVE
E-learning quality		0.881	0.882	0.910	0.627
System quality		0.773	0.778	0.898	0.815
	SQ1	0.913			
	SQ3	0.825			
	SQ4	0.746			
	SQ5	0.892			
Information quality		0.800	0.800	0.909	0.833
	IQ1	0.911			
	IQ2	0.804			
	IQ4	0.915			
	IQ5	0.823			
Service quality		0.723	0.725	0.878	0.783
	SEQ1	0.755			
	SEQ2	0.878			
	SEQ3	0.796			
	SEQ4	0.891			
Student satisfaction		0.874	0.874	0.941	0.888
	SS1	0.910			
	SS2	0.941			
	SS3	0.943			
	SS4	0.910			
Learning outcomes		0.870	0.871	0.939	0.885
	LO1	0.899			
	LO2	0.939			
	LO3	0.942			
	LO4	0.918			

Table 1. Measurement model for the relationships among e-learning quality, student satisfaction and learning outcomes.

was between 0.725 and 0.882, for composite reliability was between 0.878 and 0.941, and for AVE was >0 . These findings suggest that all remaining indicators for system quality, information quality, service quality, student satisfaction, and learning outcomes meet internal reliability and convergent validity requirement for the study model. Using the Heterotrait-Monotrait (HTMT) ratio of correlations, discriminant validity was evaluated if a construct is truly distinct from other constructs in a model. The results of the analysis for e-learning quality, student satisfaction, and learning outcomes are between HTMT of 0.699 and 0.764, confirming discriminant validity among the three constructs. Therefore, the reflective model of this study has met the standard requirement of internal consistency, convergent validity, and discriminant validity.

In the next evaluation, structural model evaluation, collinearity assessment (variance inflation factor [VIF]), significance and relevance of path coefficients (Bootstrapping), in-sample predictive power assessment (R^2), and out-of-sample predictive power assessment were tested. The VIF values for the constructs e-learning quality, student satisfaction, and learning outcomes were examined for lateral multicollinearity between indicators. A VIF value ranging between 1.0 and 2.4 indicates no correlation problem in the study model.

The direct hypotheses (H1, H2, H3) and indirect hypothesis (H4) were tested using T-statistics with bootstrapping of 10,000 sub-samples for their significant levels. As depicted in Table 2, all of the direct hypotheses are statistically significant with t -value of ≥ 1.96 , P -values of <0.05 , and Boot Confidence Interval Bias-Corrected without zero values. Significantly, the predictors of e-learning quality ($\beta = 0.327$, $P < 0.001$) and student satisfaction ($\beta = 0.487$, $P < 0.001$) are positively related to learning outcomes, which explained 58.8% of variances in learning outcome ($P < 0.05$). The effect of e-learning quality ($\beta = 0.764$, $P < 0.001$) also indicated a positive relationship with student satisfaction with 58.3% of variance explained. As a result, H1, H2, and H3 are supported. To address H4, we evaluated the findings of H1 and H2. The indirect effects ($\beta = 0.764$ and $\beta = 0.487$) are significant at t -values of 27.125 and 6.089 at 95%. Moreover, the indirect effects at 95% Boot Confidence Interval Bias-Corrected level for H1 ($LL = 0.482$, $UL = 0.685$) and H2 ($LL = 0.224$, $UL = 0.591$) do not contain a zero-value indicating a significant mediation effect of student satisfaction on the relationship between e-learning quality and learning outcomes. Hence, H4 is supported for the study.

We further analyze the mediation effect of the model. The results show that indirect effect ($0.764 * 0.487 = 0.372$) and direct effect (0.327) are significant ($P < 0.05$)

Hypothesis	Relationship	Std. Beta	Std. Error	t-values	Confidence Interval (BC)		P-values	Decision
					LL	UL		
H1	E-learning quality -> Student satisfaction	0.764	0.028	27.125	0.482	0.685	<0.001**	Supported
H2	Student satisfaction -> learning outcomes	0.487	0.080	6.089	0.224	0.591	<0.001**	Supported
H3	E-learning quality -> learning outcomes	0.327	0.037	18.725	0.113	0.422	<0.001**	Supported

Note: * $P < 0.05$.

** $P < 0.01$.

BC, bias corrected; LL, lower level (2.5%); UL, upper level (97.5%)

Table 2. Hypothesis testing for the relationships between e-learning quality, student satisfaction, and learning outcomes.

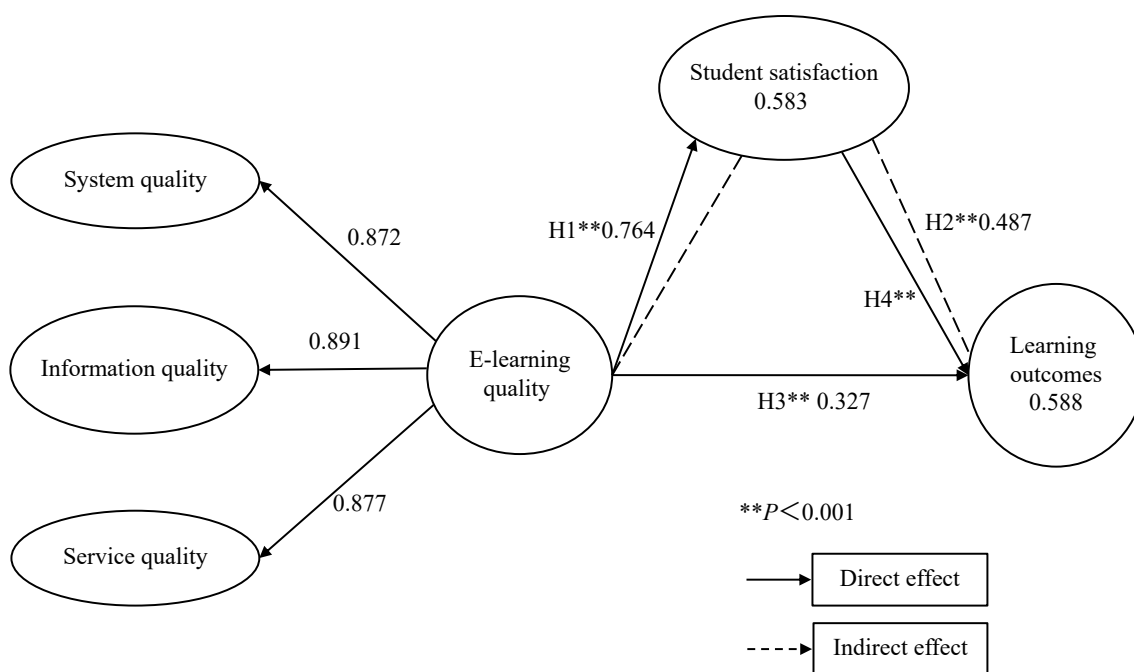


Figure 3. Final structural model of the study.

and the total effect ($0.327 + 0.372 = 0.699$) is pointing positively towards the same direction. These represent a complementary partial mediation for the study model which implies that 37.2% of e-learning quality is mediated through student satisfaction. The model of the study suggests that a 69.9% total effect is predicted for e-learning quality on learning outcome through the mediator of student satisfaction among nursing students. As a result, the overall impact of the e-learning success is greater when the mediation effect of student satisfaction is added to the relationship between e-learning quality (system quality, information quality, and service quality) and learning outcomes.

A final model of the study based on PLS-SEM is demonstrated in Figure 3. Referring to Cohen's recommendation for social science research, the R^2 value of

0.583 for student satisfaction and 0.588 for learning outcomes represent a large effect in producing a substantial model for in-sample for the nursing population of the study.²⁴ In summary, these findings suggest that the relationships among system quality, information quality, service quality, and student satisfaction are accurate predictors of the model. As supported in past studies, students' satisfaction has a strong influence on academic achievement in online courses.^{20,25} The current study concurs that if students have a higher level of perceived success in terms of quality support in e-learning systems/information/service, and with a positive satisfaction level, they will achieve a greater outcome in online programs.

For a rigorous analysis, an out-of-sample predictive power assessment was conducted to test the prediction

error in the model. Findings show that the majority of the values of root mean squared error (RMSE) and mean absolute error (MAE) in the predictive error are higher when compared with the values in the linear regression model (LM). This indicated that the model has lacked predictive power for out-of-sample in the study population.²⁶ Future studies may need to re-examine the model in different disciplines.

The findings of the existing study are consistent with various studies which support the effect of system quality¹⁴, information quality²⁷, and service quality¹⁶ on learning outcomes among undergraduates in e-learning education. Quality of the e-learning system features such as ease of use and stability of the system influences individual impact in learning online. In other words, effectiveness in e-learning system support to improve students' experience towards e-learning education, and this further impacts students' perception of the benefits of using the systems and leads to a better learning outcome. Thus, support in e-learning system design and software, grants, and facilities for recording studios are equally crucial to enrich lecturers' and students' experience in the e-learning context. Educational institutions should continue to provide a series of e-learning training workshops to improve faculty competence in creating interactive teaching and learning activities.²⁰ With this, support from information technology and information communication technology personnel is vital for sustaining a successful implementation of e-learning programs in higher educational institutions. Integration of instructor-led instruction with technology-driven strategies is believed to benefit both students and lecturers and has a positive impact on students' academic success.

One possible reason for the significant result is that the sampled study demonstrated no problems with the information delivered through Moodle. When learning materials including course content, reading resources, and online activities are well organized, useful, and presented clearly, students may learn more effectively with the information provided. Providing learning resources that are appropriate to the students, and their levels can also help them to understand the values and meaning of the content, thus enabling them to connect the concepts to real-life practices. These positive contributing factors motivate students to access online content frequently and independently. As a result, the availability of the information and content enhances students' ability to maximize their use of e-learning resources in an online learning education environment.²⁸ Being innovative, responsible, and accountable to learn new technology is increasingly necessary among faculty in higher educational institutions. Therefore, nursing

faculty members involved in e-learning programs play a major role in developing course content, reading materials, learning information, online activities, and assessments.

Although faculty members strive to encourage collaborative interaction among peers, students prefer teacher–student interaction that will benefit their learning. Many students agreed that quality of service in terms of teacher support has a positive influence on individual benefits in achieving academic success. A supportive faculty motivates students to be more independent in planning their learning process, evaluate their learning, identify effective ways to improve, and find useful resources for new learning. It is crucial for faculty to be aware of their online presence in supporting the students during their learning process. Another possible reason is that the demographic background of the students who participated in this study mainly comprises adult learners with work/family commitments. Students may have limited time to participate actively in peer discussions and group activities. Peer learning is, however, an important aspect for nursing students to foster their personal and professional development. Collaborative social learning in peer interactions encourages critical reflection and evaluation of knowledge.²⁹ Motivating and encouraging students to participate actively in online activities creates a positive climate for teamwork, the development of reflective thinking abilities, and communication skills.

The findings of this study show a statistically significant mediation effect on student satisfaction for the relationship between e-learning quality and learning outcomes in e-learning nursing undergraduates. These findings are consistent with Selvaraj³⁰, Shahzad et al.,²¹ and Chang and Maarof³¹ who validated the direct or indirect effect of student satisfaction on the relationship between system quality and e-learning outcome. In their studies, e-learning systems show a positive effect on the depth of learning of students, student productivity, and learning pace when students' satisfaction increases. User satisfaction such as students' experience towards their learning environments, course delivery, faculty support, facilities, and resources are the focus of all educational institutions. Likewise, student satisfaction in e-learning programs is paramount for universities to identify the known and unknown factors that could impact the benefits of the students in completing their studies. Other possibilities may be due to students' positive experiences in the universities that determine their levels of satisfaction. The positive e-learning experiences may positively affect students' belief in which the well-structured course helps them to achieve their learning outcomes in e-learning success.

5. Implications of the Study

The findings of this study have significant implications for learners, educators, and stakeholders in the Malaysian education system, particularly in the nursing field. This study offers insights into what pedagogical and e-learning success strategies are more likely to positively affect student satisfaction and learning outcomes. It will also provide educators with important strategies to ensure the overall success of e-learning education in the nursing context. This study suggests that the quality of e-learning (system quality, information quality, and service quality) is critical in ensuring students' satisfaction with the learning outcomes in e-learning program. The study reveals that based on the variance-based structural equation modelling (VB-SEM) analysis, factors such as e-learning quality and student satisfaction are significant predictors of e-learning outcomes.

The findings of this study will also be useful to policymakers, administrators, and e-learning designers for program development. The universities need to maintain the quality features of the e-learning systems: easy-to-use, user-friendly, stable, secure, fast, and interactive. This is to ensure the system quality is meeting the needs of students in online teaching and learning activities, wherever they may be. Also, there must be appropriate pedagogical methods and technologies to engage students in both the physical and virtual platforms. In addition to face-to-face classroom teaching, the high-quality system in e-learning would facilitate the effective delivery of quality information to learners. Useful, relevant, and recent information, which is well-organized and effectively presented to students, may have a long-term effect on their retention rate. Educators may create interactive teaching materials using e-learning authoring tools and software that could engage active learning among students. As a result, the number of students completing their studies could increase and the attrition rate may subsequently be reduced.

In this study, the model indicates that student satisfaction is a significant mediator. Thus, the institution can take into consideration of the mediation effect in improving student satisfaction and increasing the quality of the e-learning systems for students to have a better chance to achieve their academic success. Stakeholders responsible for designing, implementing, and evaluating the e-learning courses can adopt the proposed model in this study to heighten the success of those important aspects in the e-learning systems. Institutions could also target the aspects they need to focus on in enhancing successful e-learning system adoption in the nursing education.

6. Limitations

There are a few limitations to this study. First, the sample was drawn from two private universities. As more nursing institutions adopt e-learning or online learning modes for undergraduate nursing programs, the population may not be generalized to all states in the future. Second, many confounding variables beyond the researcher's control could have influenced the students' perceptions of the benefits of using the e-learning system for their studies. These uncontrolled variables may include the participants' demographic background, the quality of the e-learning systems, the quality of educators/facilitators, the quality of the university resources and its student support system from each study site.

7. Conclusions

The research framework was found to be a reliable and significant model in this study. Findings of the study reveal that e-learning quality and student satisfaction are accurate predictors of learning outcomes, and student satisfaction is a significant mediator in the model. Most of the findings are consistent with past literature in which system quality/service quality/information quality, student satisfaction, and learning outcomes are positively correlated significantly among nursing undergraduates in e-learning programs. This study enables educators and support staff to leverage the significance of e-learning quality success factors in higher education, particularly, in e-learning nursing context in Malaysia. Future studies are recommended to further explore potential predictors that will further enhance the quality of e-learning nursing education.

Acknowledgement

The study was partially extracted from a PhD project at Asia-e University, Malaysia. The authors thank the institutions and participants for their involvement in the study.

Ethical approval

Ethical issues are not involved in this paper.

Conflicts of interest

The authors have each completed the International Committee of Medical Journal Editors Form for uniform Disclosure of Potential Conflicts of Interest. All contributing authors declare no conflicts of interest.

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