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RESEARCH ARTICLE

Integration of TAM and ISSM into Student Satisfaction with AI Learning Intervention: Empirical Evidence from Islamic Studies

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ABSTRACT

This study integrates TAM and ISSM to explain student satisfaction with AI learning intervention. Such integration relates the typical ISSM success factors of information quality, system quality, and service quality to the endogenous variable of student satisfaction via the mitigating mechanism of the TAM variable of perceived usefulness. The study employs a sample of 258 students at the college of Arabic language at the Islamic university of Medina where an optional AI-powered Quran and Hadith reader head (Maqraa) is adopted. Maqraa underscores features of personalized learning and intelligent tutoring systems by allowing students to pace their own learning by tapping into a wide variety of reading styles and a multitude of dialects. The study results show that the impact of information quality, system quality, and service quality on student satisfaction with Maqraa is positive and strongly significant. The study further shows that whereas perceived usefulness strongly influences student satisfaction, such perception is significantly driven by information quality, system quality, and service quality. The results thus suggest that perceived usefulness tends to strongly mediate the impact of information quality, system quality, and service quality on student satisfaction. The results reported in this study, however, establish full mediation for service quality, and fall short of the full mediation criterion for information quality and system quality.

INTRODUCTION

The adapted learning aspect to AI interventions in higher education Islamic studies is hardly distinguishable from the fundamental intelligent tutoring systems (ITS systems) (Brown et al., 2020). Such systems collectively and categorically serve as the information and communication technology and AI-powered tools via which the true genesis of personalized learning in terms initialized instruction and tailored assessment and feedback may be carried out (Crompton et al., 2020). Moreover, ITS systems often employ training algorithms of machine learning and natural language processing to design adaptive learning mechanisms that represent students' learning needs and reproduce their learning styles and preferences (Popenici and Kerr, 2017). ITS systems in higher education Islamic studies thus accommodate a plethora of computer-based and AI-themed learning environments that expresses the learning experiences of students in terms of underlying learning requirements, learning preferences, and learning styles (Almazrooie et al., 2020). It follows that, the importance of understanding and specifying the extent to which ITS systems are accepted and adopted by users can hardly be overstated (Marikyan and Papagiannidis, 2023). In fact, a latitude of theoretical frameworks exists in the extant literature with respect to explaining student utilization and acceptance of intelligent technologies in higher education (Celik et al., 2022). For instance, the technology acceptance model (**TAM**) specifies technology acceptance in terms of perceived usefulness (**PU**), and perceived ease of use (**PEU**), and the information systems success model (**ISSM**)

explains utilization in terms of information quality, system quality, and information quality (Marikyan and Papagiannidis, 2023). In this vein, TAM is often integrated with ISSM since the later may incorporate into the former with variables such as information quality, system quality, and service quality, which may exogenously determine PU and PEU (Sabeh et al., 2021).

In view of the preceding, this study employs an integrated version of TAM and ISSM advanced in (Adeyemi and Issa, 2020). Such version integrates the ISSM variables of information quality, system quality, and service quality as exogenous to PU, and lets PEU to be totally subsumed within PU when explaining student satisfaction with the AI learning intervention. The AI intervention captured in this study constitutes an optional AI-powered Quran and Hadith reader head (Maqraa) introduced at the Islamic University of Medina to underscore features of personalized learning and intelligent tutoring systems. Toward this end, the study advances the following research questions:

RQ1: What is the extent to which perceived usefulness mitigates the relationship between information quality and student satisfaction?

RQ2: What is the extent to which perceived usefulness mitigates the relationship between system quality and student satisfaction?

RQ3: What is the extent to which perceived usefulness mitigates the relationship between service quality and student satisfaction?

In light of the above introduction, the rest of the study is presented in terms of literature review, research design, data analysis and empirical results, and concluding remarks.

LITERATURE REVIEW

The impact of AI on student related variables in higher education can be addressed from a multitude of models and theoretical frameworks (Marikyan and Papagiannidis, 2023). For instance, Davis (1989) proposes TAM where the willingness attitude of Islamic studies students toward AI intervention can be expressed as a function of PU and PEU (Al-Rahmi et al., 2021). TAM rests on the theory of reasoned action where attitudes are fully explained in terms of beliefs (Al-Matoouk et al., 2020). In this fashion, TAM is a model of technology suitability (as opposed to technology success) where the willingness attitude of students toward a technological intervention is hypothesized to sum up their underlying behavioral intention to use it (Murillo et al., 2021). Whereas, PU defines the performance belief that using AI intervention will directly translate into improved performance outcomes, PEU characterizes the effort belief that using the intervention is not cumbersome or annoying (Sabeh et al., 2021). Moreover, according to TAM several, yet theoretically unnamed exogenous variables may drive both PU and PEU (Celik et al., 2022). In this regard, the extant literature often employs the typical technology success variables of information quality, service quality, and system quality (Pham et al., 2019). Such variables are advanced by DeLone & McLean (1992) when synthesizing the extant literature to introduce ISSM. For instance, information quality describes the course content quality in terms of substance, accuracy, relevance, presentation, and adaptability (Martins et al., 2019). Information quality, thus, is expected to have an impact on student satisfaction irrespective of the type of intelligence technology medium employed in the delivery of such information (Al-shargabi and Aljawarneh, 2021). System quality underlines the type of quality perceived by students with respect to the usefulness and usability of the system (Sabeh et al., 2021). System quality typically covers the technical and interface aspects governing system's ease of use and user friendliness along with content ease of learning (Al-Rahmi et al., 2021). Toward this end, service quality complements both information quality and system quality through the technical support provided by technical, engineering, and IT staff in the form of training students to use the system and providing all technical interventions necessary for the smooth operations of the system (Martins et al., 2019). Along these lines, the empirical evidence integrating TAM and ISSM is overwhelming (see, e.g., Sabeh et al., 2021). Here, Atici et al. (2022) underline that joint assessment of TAM and ISSM defines a set o variable that are both non-trivial and non-redundant when examining the success of intelligent and e-learning platforms. Alyoussef (2021) evaluates based on UTAUT that TAM variables of PU and PEU along with ISSM variables of system quality, information quality, and service quality critically affect the level of student acceptance of intelligent and mobile learning in higher education. Al-Azawei et al. (2017) employ an extended TAM model and show that

student learning style may exogenously determine PU and PEU in AI blended learning systems. Al-Fraihat et al. (2020) integrate TAM and ISSM to evaluate the success of intelligent learning systems. They show that success depends on the extent to which PU and PEU are driven by the typical ISSM success factors of system quality, information quality, and service quality. Al-Sabawy (2013) proposes a conceptual framework that reflects TAM and ISSM features to examine the effectiveness of intelligent learning system, and reports that PEU tends to be fully replicated in PU. Abbad et al. (2021) apply UTAUT via synthesizing TAM and ISSM among other models, and show that expected performance in terms of PU and expected effort in terms of PEU tend to have a significant impact on student intention to use intelligent learning systems. Chen (2011) extend TAM and ISSM, and conclude that the compatibility and expectancy of intelligent learning systems influence learning acceptance. Alshehri et al. (2019) adopt UTAUT, which represents and integration between TAM and ISSM, and report Saudi evidence that system quality and information critically influence student attitudes toward intelligent learning management systems. Aparicio et al. (2016) advance a theoretical framework of intelligent and e-learning systems where use perceptions and system qualitative variables predict the levels of student acceptance of and student satisfaction with the system. Chen et al. (2012) incorporate TAM variables of PU and PEU along with ISSM variables of system quality, information quality, and service quality to explain the acceptance of intelligent e-learning systems. Chiu et al. (2005) model student decision to learn via intelligent learning tools in terms of PU, system quality, and information quality. Cidral et al. (2018) argue that PU, PEU, and system quality factors are critical success components to intelligent e-learning systems. Dağhan and Akkoyunlu (2016) contend that student intention to utilize intelligent learning systems is specified in terms of PU, PEU, system quality, and information quality. Machado-da-silva et al. (2014) explain the effectiveness of intelligent and virtual learning systems in terms of PU, system quality, and information quality. Mohammadi (2015) integrate TAM and ISSM to model the perceptions of students and faculty with respect to intelligent and e-learning systems. Šumak et al. (2011) conduct an integrated analysis of the variable of student acceptance of intelligent learning systems, and find that type of user and type of system greatly impact such acceptance. Sun et al. (2008) evaluate that PU, PEU, system quality, information quality, and service quality are significantly replicated in student satisfaction with AI learning interventions. The research uses Semantic feature analysis to classify Quran verses into various topics, aiming to enhance the accuracy of this classification based on their thematic content. The method aims to provide a more accurate and nuanced classification of Quranic topics compared to traditional keyword-based methods. (Mediamer, G.2024). These are online Islamic law libraries, theology databases that provide Hadith compilations, Qur'anic translations, philosophy articles, history books, and other academic works in Islamic studies (Alimron A, et al., 2023).

In consideration of the foregoing, this study empirically integrates TAM and ISSM following the conceptual framework advanced in (Adeyemi and Issa, 2020) where ISSM variables of information quality, system quality, and service quality are hypothesized to be channeled into student satisfaction via the mediating role of PU.

Research design

This study adopts the traditional scientific paradigm to explain student satisfaction with Maqraa in terms of ISSM variables of information quality, system quality, and service quality via the mediating effect of PU. In this fashion, the study maintains all relevant ontological, epistemological, and axiological assumptions underlying the quantitative paradigm (Creswell, 2003). Ontologically, the holds that the variables of information quality, system quality, service quality, PU, and student satisfaction are observable and objectively measurable. Epistemologically, the study assumes that the individual impacts of information quality, system quality, and service quality on PU and student satisfaction can be objectively measured and tested. Axiologically, the study adopts that examining and measuring the effect of information quality, system quality, and service quality on student satisfaction will inform improved future design of AI educational interventions in higher education. Along the same lines, the study further assumes that documenting the impact of PU on student satisfaction will inform learning theory and models of technology adoption and acceptance.

Study sample

The study employs a sample size of 258 students at the college of Arabic language at the Islamic University of Medina. The study applies Cochran's (1977) sample size determination framework to a total student population of 776 at a 95% confidence interval, 5% margin of error, and 50% population proportion as follows: 313 = [(1.96^2) *0.5*(1-0.5) *(0.05^-2)] / [1 + {(1.96^2) *0.5*(1-0.5) *(0.05^-2) *(776^-1)}].

Variables' measurement and coding

Information quality is measured according to the validated scale measurement of believability, completeness, concise information, objectivity, and relevance (Lee et al., 2002) (Table 1). System quality is measured according to the validated scale measurement of accessibility (Lee et al., 2002), ease of operation (Lee et al., 2002), enjoyment (Venkatesh and Bala, 2008), compatibility (Tung and Chang, 2008), and security (Lee et al., 2002) (Table 2). Service quality is measured according to the validated scale measurement of SERVQUAK (Parasuraman et al., 1985) (Table 3). PU is measured according to the original measurement scale reported in Davis (1989) (Table 4). Student satisfaction is measured according to the validated scale measurement of satisfaction (Roca et al., 2006) (Table 5). All items to variable measurements are captured on a five-point Likert-type scale. All variables are measured based on average item score and are coded as 1 for lowest score, 2 for lower score, 3 for average score, 4 for high score, and 5 for highest score.

Table 1: Measurement of information quality

CATEGORY	MEASUREMENT
BELIEVABILITY	INFORMATION IS BELIEVABLE. INFORMATION IS TRUSTWORTHY. INFORMATION IS CREDIBLE.
COMPLETENESS	INFORMATION IS COMPLETE. INFORMATION IS SUFFICIENT. INFORMATION IS FORMATTED COMPACTLY.
OBJECTIVITY	INFORMATION IS OBJECTIVE. INFORMATION IS BASED ON FACTS. INFORMATION REPRESENTS IMPARTIAL VIEW.
CONCISE INFORMATION	INFORMATION IS FORMATTED COMPACTLY. INFORMATION IS PRESENTED CONCISELY.
RELEVANCE	INFORMATION IS RELEVANT TO MY STUDY. INFORMATION IS IMPORTANT TO MY STUDY. INFORMATION IS APPROPRIATE FOR MY STUDY. INFORMATION IS APPLICABLE TO MY STUDY.

Table 2: Measurement of system quality

Category	**Measurement**
Accessibility	Information is easily retrievable. Information is easily accessible. Information is easily obtainable. Information is quickly accessible when needed.
Ease of operation	Information is easy to manipulate to meet my needs. Information is easy to aggregate. Information is easy to combine with other information.
Enjoyment	I find using the system enjoyable. The actual process of using the system is pleasant. I have fun using the system.
Compatibility	Using the system is compatible with most of my learning. Using the system is appropriate for my lifestyle. Using the system is appropriate for my learning.

Security	Information is protected against unauthorized access. Information is protected with adequate security.

Table 3: Measurement of system quality	
Category	**Measurement**
Reliability	Support services provided as promised Support team dependable in handling student service problems Services performed right the first time Services performed at the promised time
Responsiveness	Support team keeps students informed when services will be performed Support team willing to help students Support team ready to respond to student inquiries
Assurance	Support team instills confidence in students Support team makes students feel safe while using the intervention Support team members have the knowledge to answer student questions
Empathy	Support team gives students individual attention Support team members deal with students in caring fashion Support team members have convenient work hours Support team members understand student needs
Tangibles	Support team members have neat professional appearance Support team members use visually appealing facilities

Table 4: Measurement of PU
Using the system in my studies would enable me to accomplish tasks more quickly Using the system would improve my performance Using the system in my studies would increase my productivity Using the system would enhance my effectiveness Using the system would make it easier I would find the system useful

Table 5: Measurement of Satisfaction
I am satisfied with the performance of the Maqraa. I am pleased with the experience of using the Maqraa. My decision to use the Maqraa was a wise one

Mediating variable

This study employs the mitigating mechanism of PU to explain the impact of system quality, information quality, and service quality on student satisfaction. The study, therefore, tests whether PU is significantly influenced by information quality, system quality, and information quality, and meanwhile has a well-pronounced impact on student satisfaction with Maqraa.

DATA ANALYSIS, DISCUSSION & EMPIRICAL RESULTS

To answer RQ1, RQ2, and RQ3, the study estimates three linear models to explain: [1] student satisfaction with Maqraa in terms of information quality, system quality, and service quality (Table 6), [2] PU in terms of information quality, system quality, and service quality (Table 7), and [3] student satisfaction in terms of PU (Table 8). The study tests whether PU fully mediates the impact of exogenous ISSM variables on student satisfaction by regressing student satisfaction on information quality, system quality, service quality, and PU on student satisfaction (Table 9).

FF *(1): student satisfaction = f (information quality, system quality, service quality)*

FF (2): PU = f (information quality, system quality, service quality)

FF (3): student satisfaction = f (PU)

FF (4): student satisfaction = f (information quality, system quality, service quality, PU)

The models are specified as follows while assuming that the underlying data generating processes satisfy the Gauss-Markov properties of correct specification and identically and independently distributed error terms with zero mean and constant variance:

*SF (1): student satisfaction (i) = b0 + b1*information quality (i) + b2*system quality (i) + b3*service quality (i) + e (i)*

*SF (2): PU (i) = b0 + b1*information quality (i) + b2*system quality (i) + b3*service quality (i) + e (i)*

*SF (3): student satisfaction (i) = b0 + b1*PU (i) + e (i)*

*SF (4): student satisfaction (i) = b0 + b1*information quality (i) + b2*system quality (i) + b3*service quality (i) + b4*PU (i) + e (i)*

Where (i) is an index for the student included in the dataset and takes discrete values between 1 and 313; b0 is an intercept parameter estimate; b1, b2, b3, and b4 are coefficients or parameter estimates; and e is a Gauss-Markov error term with an average value of zero and constant variance everywhere across the study sample.

The statistical model outputs show that the models have significant explanatory power as measured by adjusted R squared (see Table 6, Table 7, Table 8, and Table 9). In particular, the statistical output shows that the TAM variable of PU replicates the ISSM variables of information quality, system quality, and service quality. Moreover, the results also show that PU is replicated in student performance with well-pronounced parameter estimates at all traditional levels of statistical significance. This suggests that PU significantly mediates the individual impact of information quality, system quality, and service quality on student satisfaction with Maqraa. Furthermore, though the study establishes that PU fully mediates the impact of service quality on student satisfaction, full mediation couldn't be established for the respective impacts of information quality and system quality (Table 9). This corroborates the statistical output that when PU is allowed along with information quality, system quality, and service quality to explain student satisfaction, only the parameter estimate corresponding to service quality becomes insignificant at the 5% level of statistical significance.

Table 6: Regressing student satisfaction on information quality, system quality, service quality, and PU.

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.626085							
R Square	0.391983							
Adjusted R Square	0.384801							
Standard Error	0.853905							

Observations	258							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	119.3998	39.79992	54.58376	2.9E-27			
Residual	254	185.2049	0.729153					
Total	257	304.6047						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.209671	0.199818	6.05387	5.05E-09	0.81616	1.603182	0.81616	1.603182
Information Quality	0.269166	0.056803	4.738549	3.59E-06	0.1573	0.381032	0.1573	0.381032
System Quality	0.232389	0.059528	3.903882	0.000121	0.115158	0.349619	0.115158	0.349619
Service Quality	0.185458	0.065462	2.833045	0.004981	0.05654	0.314376	0.05654	0.314376

Table 7: Regressing PU on information quality, service quality, and system quality.

SUMMARY OUTPUT									
Regression Statistics									
Multiple R	0.627424								
R Square	0.393661								
Adjusted R Square	0.3865								
Standard Error	0.977025								
Observations	258								
ANOVA									
	df	*SS*	*MS*	*F*	*Significance F*				
Regression	3	157.4173	52.47243	54.9693	2.04E-27				
Residual	254	242.4626	0.954577						
Total	257	399.8798							
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*	
Intercept	0.632301	0.228628	2.765626	0.006098	0.182052	1.08255	0.182052	1.08255	
Information Quality	0.134804	0.064994	2.074118	0.039076	0.006809	0.262799	0.006809	0.262799	

System Quality	0.261329	0.068111	3.836839	0.000157	0.127196	0.395463	0.127196	0.395463	
Service Quality	0.393932	0.074901	5.259365	3.07E-07	0.246426	0.541438	0.246426	0.541438	

Table 8: Regressing student satisfaction on PU.

SUMMARY OUTPUT									
Regression Statistics									
Multiple R	0.484032								
R Square	0.234287								
Adjusted R Square	0.231296								
Standard Error	0.954512								
Observations	258								
ANOVA									
	df	*SS*	*MS*	*F*	*Significance F*				
Regression	1	71.365	71.365	78.32904	1.47E-16				
Residual	256	233.2397	0.911092						
Total	257	304.6047							
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*	
Intercept	2.215152	0.172794	12.8196	2.15E-29	1.874873	2.555431	1.874873	2.555431	
Perceived Usefulness	0.422452	0.047733	8.85037	1.47E-16	0.328454	0.516451	0.328454	0.516451	

Table 9: Regressing student satisfaction on information quality, system quality, service quality, and PU

SUMMARY OUTPUT									
Regression Statistics									
Multiple R	0.639909								
R Square	0.409484								
Adjusted R Square	0.400148								
Standard Error	0.843187								
Observations	258								
ANOVA									

	df	*SS*	*MS*	*F*	*Significance F*				
Regression	4	124.7308	31.18269	43.85973	6.0733E-28				
Residual	253	179.8739	0.710964						
Total	257	304.6047							
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*	
Intercept	1.115913	0.200259	5.572364	6.42E-08	0.7215273	1.510299	0.721527	1.510299	
Information Quality	0.249177	0.056563	4.405265	1.56E-05	0.13778186	0.360572	0.137782	0.360572	
System Quality	0.193639	0.06046	3.202768	0.001536	0.07457017	0.312708	0.07457	0.312708	
Service Quality	0.127046	0.06807	1.86641	0.063141	-0.0070094	0.261101	-0.00701	0.261101	
Perceived Usefulness	0.14828	0.05415	2.738298	0.006615	0.04163694	0.254923	0.041637	0.254923	

CONCLUDING REMARKS

The study results display that the impact of information quality, system quality, and service quality on student satisfaction with Maqraa is positive and strongly significant. This study integrates TAM and ISSM to explain student satisfaction with AI learning intervention. Such integration follows the model of (Adeyemi and Issa, 2020) where: [1] the typical ISSM success factors of information quality, system quality, and service quality are related to the endogenous variable of student satisfaction via the mitigating mechanism of the TAM variable of PU, and [2] the other TAM variable of PEU is completely subsumed within PU. The study employs a sample of 258 students at the college of Arabic language at the Islamic university of Medina where an optional AI-powered Quran and Hadith reader head (Maqraa) is adopted. Maqraa underscores features of personalized learning and intelligent tutoring systems by allowing students to pace their own learning by tapping into a wide variety of reading styles and a multitude of dialects. The study further shows that whereas perceived usefulness strongly influences student satisfaction, such perception is significantly driven by information quality, system quality, and service quality. The results thus suggest that perceived usefulness tends to strongly mediate the impact of information quality, system quality, and service quality on student satisfaction. The results reported in this study, however, establish full mediation for service quality, and fall short of the full mediation criterion for information quality and system quality. This suggests that there is more content to the impact of ISSM variables of information quality, system quality, and service quality on student satisfaction with the AI intervention than what is mitigated by PU. Future research may revisit the same subject with the means of possible mitigating influences and endogenous technology adoption and acceptance variables identified in the extant literature.

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