LÁSZLÓ BERÉNYI – NIKOLETT DEUTSCH

MOODLE – AN INFORMATION SYSTEM SUCCESS VIEW
A MOODLE ÉRTÉKELÉSE INFORMÁCIÓS RENDSZERKÉNT

Digitalisation has become essential for higher education institutions. Sustaining complex information systems must enable faster, more convenient administration while also improving learning outcomes. Understanding the users' opinions can make a relevant contribution to developing these systems. The study focuses on students' opinions of Moodle, a popular virtual learning environment at universities. The framework model is based on the DeLone and McLean Model of Information Systems Success; the analysis used the PLS-SEM method. A non-representative sample of 309 students was available from various universities in Hungary. The results reveal that the benefits of Moodle can be derived from the information provided by the system and the satisfaction of the users. The information success approach to Moodle offers a new perspective on decisions on digitalisation improvements in higher education. Extending the model to other systems may offer a comprehensive evaluation framework.

Keywords: **Moodle, digitalisation, PLS-SEM, DeLone-McLean IS Success Model**

A digitalizáció a felsőoktatási intézmények számára nélkülözhetetlenné vált. A komplex információs rendszerek a gyorsabb és kényelmesebb ügyintézést szolgálják, valamint hozzájárulnak az tanulási eredmények javításához. A felhasználói véleményének vizsgálata jelentősen hozzájárulhat a rendszerek fejlesztéséhez. A tanulmány a hallgatók véleményét vizsgálja a Moodle rendszerrel kapcsolatban, amely az egyetemek körében elterjedt virtuális tanulási környezet. A keretmodell a DeLone-McLean információs rendszer sikermodellre épült, az elemzés PLS-SEM-módszert használt. A kutatáshoz 309 hallgatóból álló, nem reprezentatív minta állt rendelkezésre különböző magyarországi egyetemekről. Az eredmények azt mutatják, hogy a Moodle előnyei a rendszer által nyújtott minőségi információkból és a felhasználók elégedettségéből vezethetők le. A Moodle-nak információs rendszerként történő értelmezése és sikerességének vizsgálata új perspektívát kínál a felsőoktatás digitalizációs fejlesztéseivel kapcsolatos döntésekhez, a modell kiterjesztése más rendszerekre pedig átfogó értékelési keretet nyújthat.

Kulcsszavak: Moodle, digitalizáció, PLS-SEM, DeLone és McLean IS-sikermodell

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Digitalization is no longer a vision or the objective of strategies to take the first steps. This phenomenon permeates our everyday activities, including communication, public administration, shopping, and learning. According to the interpretation of quality as achieving customer satisfaction (Berényi, 2023), the challenge lies in the efficient and effective utilization of digitalization. It is a key element of organizational viability and survival (Hess et al., 2020). The rapidly changing world is both a consequence and an engine of digital development: the development of new technologies, procedures, and products has been accelerated. Statistics show that the essential conditions of the digital world are available in the 21st century. Access to tools and systems, especially the Internet, does not indicate a barrier; the fact that over 90% of people in the EU used the Internet at least once a week in 2023 (Eurostat, 2024) suggests the availability of the technical background as well.

Nevertheless, the bottleneck of the system is human. Eurostat published that 44% of the EU citizens – within that 41% of Hungarians – lack basic digital skills. It is beyond debate that digital disruption must be managed (Skog et al., 2018). Complex sociotechnical systems are affected by the changes, and the time is limited to analyze the causality and develop appropriate measures because the technologies are rapidly evolving. The sociotechnical network of digital technologies and actors (Kallinikos et al., 2013; Adomavicius et al., 2008) covers different generations, purposes, readiness levels, tools, and software working together.

Still, understanding the relations is an essential information source, but a comprehensive overview goes far beyond one study. Review attempts (Halász, 2024) and local case studies with a narrower scope can contribute to the knowledge base and offer lessons learned to decision-makers, including teachers, instructors, IT staff, and university management at any level.

Digitalization of (higher) education (Bowen, 2015) is a complex task in itself. Controlling and administration systems, mailing or file sharing, have been continuously developed in recent decades, as well as learning administration and the digital support of learning. Adaptability to the accelerated digital world and the growing availability of info-communication tools led to new education models (Cobb, 2013). Recently, there are two issues with an apparent impact on the progress. First, the mainstream is about the emerging role of artificial intelligence in communication, problem-solving, and learning (Crompton & Burke, 2023; Bácsi & Dén-Nagy, 2024). However, the maturity of the solutions and the regulations are in question. Despite the visible impacts, the investigations should not focus only on this topic. Second, the COVID-19 lockdown generated several immediate changes and spectacular impacts on every aspect of life (Szabó et al., 2022). The situation drew attention to the need for rethinking higher education (Ewing, 2021). However, the reordering after the lockdown period (László et al., 2024) confirmed that maybe the virus was not the turning point. Rethinking the ownership and financial background of universities in Hungary appeared at that time, but its purpose is not investigated in that paper. Silva et al. (2022) noted visible changes in teaching emerging with the lockdown, but there was ambiguity and disagreement about the workload, content, and methods. The digitalization of higher education has a longer and slower history (Benedek, 2008) than the COVID-19 lockdown; there were numerous attempts and sometimes unclear answers. Bygstad et al. (2022) call dual digitalization in higher education digitalization of education and digitalization of subjects.

The study scope is limited to the Moodle (Modular Object-Oriented Dynamic Learning Environment) system, which is a significant ingredient in the digitalization of higher education. It offers an online learning environment that supports renewing the relations between the students, teachers, and learning materials. It can replace or extend the traditional learning methods. Studies are available about the acceptance of Moodle (Sabeh et al., 2021; Mustafa & Ali, 2023), especially focusing on students' personal attitudes and the influencing factors of use. Popular framework models for researchers are the different and modified versions of the Technology Acceptance Model (TAM) by Davis (1989) and the Unified Theory of Acceptance and Use of Technology (UTAUT) model by Venkatesh et al. (2003), but not limited to them (Gamage et al., 2022). In addition to survey attitudes and satisfaction (Berényi et al., 2021; Berényi & László, 2023; Berényi & László, 2024), our study offers a new perspective with an information system approach to Moodle. A pilot survey was performed among students, and we plan to extend it to other domains and stakeholders.

A PLS-SEM model was developed based on the DeLone and McLean Model for Information Systems Success (DeLone & McLean, 2003) to explore the factors that influence Moodle use and satisfaction among students. The results contribute to a better understanding of the driving forces of digitalization and, through this, develop strategies for effective higher education digitalization.

The remaining sections of the paper are organized as follows. Before setting the research goals, a justification is presented for why Moodle can be considered an information system. The description and validation of the research framework model are followed by the results and discussion. The conclusions section includes the methodological and practical implications and the limitations of the study.

Moodle as an information system

Various computer- and IT-supported solutions have emerged to enhance education and learning over the past 40 years. Among them, not the only one but certainly a widely known tool is Moodle (Modular Object-Oriented Dynamic Learning Environment), introduced in 2002. It is an open-access, multipurpose, and multifaceted Course Management System (CMS). Moodle is ready to run full online courses, but its popularity may be derived from the opportunity that it is a great way to supplement face-to-face teaching in the large and growing higher education market (Benţa et al., 2015).

Above all, it must be noted that there is still a huge diversity of terminology in the field. Tóth and Bessenyei (2008) designated platforms in e-learning as Virtual Learning Environments (VLE). The evolution of these environments was a continuous process. The first versions served as static storage places for digital or digitalized learning materials; newer ones included communication forms, tests and surveys, monitoring tools, and customization opportunities utilizing new technologies. The authors pointed to other titles and approaches, such as Learning Management System (LMS), Learning Content Management System (LCMS), Learning Platform (LP), Managed Learning Environment (MLE), and Learning Support System (LSS). These names emphasize different purposes of analysis, which may be essential in some situations, especially in understanding the intentions of how Moodle will be implemented in the university system. Selim (2017) drew instructor, student, information technology, and university support as key factors in the success and acceptance of e-learning systems. The different names of the learning environment essentially reflect the idea of which of these factors are at a greater prominence. At the same time, that is not relevant to our study because the related university systems are out of the study's scope. We consider Moodle an information system that must serve any purpose given to it by the universities, teachers, and students.

Laudon and Laudon (2022, p. 46) defined an information system "as a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making and control in an organization. In addition to supporting decision making, coordination, and control, information systems may also help managers and workers analyze problems, visualize complex subjects, and create new products". Moodle meets all requirements of the definition:

– it is software with different modules, functions, and features,
– it collects, stores, and distributes information, however, in an asymmetric way: learning materials from teachers (the main representatives of the manager), and survey responses, using information from students (workers),
– control takes the forms of learning progress, presence, and activities,
– Individual and mass information about using support development actions.

The technology provided by the system helps to organize, manage, and deliver course materials, including creative elements and multimedia tools (Martín-Blas et al., 2009).

The reason for the information system approach to Moodle can be derived from quality assurance. Customer/user satisfaction with the system and attitudes to use intentions are valuable information sources to define goals and expectations, as well as measures of meeting them. The large number of features and the different use levels, even within a given organization, make it difficult to compare the individual evaluations. Although Moodle is free software with a broad and supportive network to assist with the installation and use, serious efforts are required from the universities to use it effectively. Beyond ensuring the IT background, resources are required for maintenance, system administration, content development, and user training. Assuming that the universities take these efforts to improve the success of the learning process, besides accepting that teachers' skills and approaches may lead to various course structures and toolsets used within Moodle, a higher-level model, such as the information system approach to Moodle, can provide helpful information.

Research goals and methods

The study aims to support the successful digitalization of higher education through developing a measurement model. An effective learning management system is not exclusive but an important element of this. Understanding the factors that influence effective use and user satisfaction with Moodle can contribute to organizational actions to maximize the benefits. Since information systems play an integrative role in the process, the study accepts this approach. The goal is to learn students' opinions about the quality of Moodle and its usability. There are three research questions formulated:

– RQ1: What is the students' opinion about the Moodle system?
– RQ2: Can the perceived benefits of the Moodle system be explained using a system quality approach?
– RQ3: Are there differences in the perception of the Moodle system by universities, study level, or study form?

An online survey was developed and distributed among higher education students. Grouping factors included gender, university, study level (bachelor or master), and study form (full-time or part-time). Most questions are statements organized in line with the factors of the information system success model by DeLone and McLean (2003). A 7-point scale assessment was used between 'I do not agree at all' and 'I totally agree'. Additionally, open-ended questions were included to ask respondents about what they like and dislike about Moodle.

Beyond the descriptives about the students' opinions (RQ1), the survey was designed to establish a structural equation model (RQ2) with moderating effects (RQ3).

Data processing and analysis were performed with Microsoft Excel, IBM SPSS version 29, and SmartPLS version 4.1.0.9 software based on the guidance of Sajtos and Mitev (2007), Hair et al. (2022), and Ringle et al. (2024). The path model was designed for PLS-SEM analysis with a reflective measurement model. Bootstrapping analysis was performed using 5,000 subsamples with the bias-corrected and accelerated (BCa) method. The significance level is 0.05 for each analysis in the study.

Research model development

In search of management information system success factors, DeLone and McLean (1992) made a taxonomy review

of former studies. Their recognition that 'as many measures as studies' made an urgent need for a comprehensive framework in the age when personal computers and networks were emerging. The synthesis defined system quality, information quality, use, user satisfaction, individual impact, and organizational impact. A benefit of the model is that path analysis is allowed along with the relations between the factors. A ten-year update of the model was published in 2003 (DeLone & McLean, 2003), taking into account the experience gained from validation and the changing environment. The new model uses net benefits instead of individual and organizational impacts and incorporates service quality. Dealing with 'intention to use' allows the measurement of voluntariness of use if applicable. The flexibility and diversity in use in the field of e-learning are underlined by Sabeh et al. (2021), who identified several additional success factors added to the DeLone and McLean information system success model; some of these are known from acceptance and behavior models (e.g., ease of use, task-technology fit model elements, self-efficacy), others incorporate learning material content quality, social motivations, communality or evaluation of the teachers.

Our research model is based on the second edition of the model (DeLone & McLean, 2003):

– system quality: usability, reliability, and response time,
– information quality: concise, relevant, and accurate outcomes,
– service quality: quality of support,
– use: frequency of use,
– satisfaction: customers' opinions,
– benefits: contribution to success.

The 'intention to use' is dropped from the model since the use of Moodle is not a choice of the target audience. According to the requirements of PLS-SEM analysis, loops are not allowed in the model (Hair et al., 2022). The original model suggests a bidirectional relation between intention to use/use and satisfaction. The research model selected the path direction from 'Satisfaction' to 'Use'.

Research hypotheses were formulated along the research framework model in Figure 1:

– H1a: Information quality has a positive impact on Moodle use.
– H1b: Information quality has a positive impact on satisfaction with Moodle.
– H2a: System quality has a positive impact on Moodle use.
– H2b: System quality has a positive impact on satisfaction with Moodle.
– H3a: Service quality has a positive impact on Moodle use.
– H3b: Service quality has a positive impact on satisfaction with Moodle.

Table 1

Latent variable constructs and related survey items

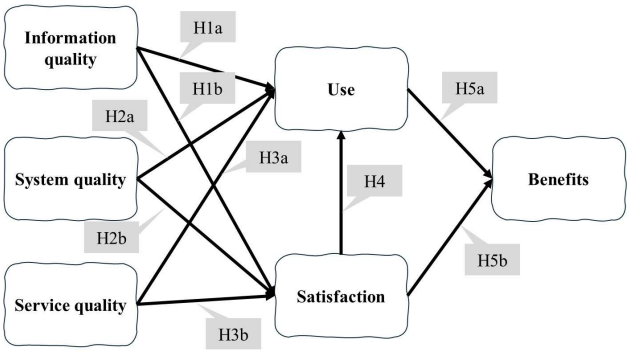
Category (Construct)	Question (Item)	Short name
Information quality	The content and information available in Moodle is up-to-date.	IQ1
	The content and information available in Moodle are useful and easy to understand.	IQ2
	Information from Moodle is in a form that is readily useable.	IQ3
	The content and information available in Moodle can be relied upon.	IQ4
System Quality	Moodle is always available for me to perform learning activities. (dropped)	SQ1
	The response time of Moodle is reasonable.	SQ2
	Moodle has attractive features to appeal to the users.	SQ3
	Moodle provides interactive communication between teacher and students. (dropped)	SQ4
	Moodle is user-friendly.	SQ5
Service Quality	The IT services staff understands the specific needs of students.	SeQ1
	I receive a satisfactory and timely response from the IT services staff. (dropped)	SeQ2
	The IT services staff is available and cooperative when facing an error at Moodle.	SeQ3
	Moodle provides proper online assistance and help.	SeQ4
Use	I log into Moodle frequently.	USE1
	I use many functions and features in Moodle.	USE2
	I spend a lot of time in Moodle during study term period.	USE3
	I spend a lot of time in Moodle during exam period.	USE4
Satisfaction	I am satisfied with the content of the Moodle system.	SAT1
	I enjoy using Moodle in my study.	SAT2
	I am satisfied with surface design of the Moodle.	SAT3
	I am satisfied with the instructions on how to use the Moodle e-learning system.	SAT4
	Overall, I am satisfied with Moodle e-learning system.	SAT5
Benefits	Moodle helps me to save time and efforts.	BEN1
	Moodle helps me to follow the course material better.	BEN2
	Using Moodle improves my learning performance.	BEN3
	Using Moodle is a good choice at the university level.	BEN4

Source: own edition

– H4: Satisfaction with Moodle has a positive impact on use.
– H5a: Use has a positive impact on benefits of Moodle.
– H5b: Satisfaction has a positive impact on benefits of Moodle.

Figure 1

Research model



Source: own edition

The questions (items) by the categories (constructs, latent variables) are presented in Table 1, including the short names used in the remaining parts of the paper.

To improve the model validity, some items were dropped from the PLS-SEM model due to low and insignificant factor loadings and the negative impacts on model fit.

A critical variable in the measurement is system use for two reasons. Due to the multipurpose application and the broad range of features, no single task can be highlighted in the questionnaire. The frequency of visits, the time spent in the system, and the range of functions used are compromise indicators. Additionally, information about use is based on the user's self-assessment. Moving beyond the pilot phase, it is worth noting that data deriving from the system log database if its legal conditions can be assured. Another option is to test the correlation between the self-assessment and the log file information in a subset of samples to validate the methodology.

Research sample

The research sample consists of 309 responses from Hungarian higher education students from different universities. The representativeness of the sample is not assured; we consider the results a pilot study. The research sample is derived from a broader, multipurpose data collection on technology acceptance and digitalization conducted in 2024. 395 responses were collected, but a data cleaning must have been performed to filter for incorrect completions. Cases where the standard deviation of the responses was low have been excluded, as these may indicate the probability of respondent misconduct. The standard deviation of the responses was checked by latent variable constructs, and the case was excluded if the response showed no dispersion in more than two cases. Sample characteristics are summarized in Table 2. It is worth noting that the university names have been replaced with codes in the study to avoid undesirable comparisons based on a non-representative, convenient sample.

Table 2

Sample characteristics

Grouping factor	Option	Frequency	Percent
Gender	female	194	62.8%
	male	115	37.2%
University	A	130	42.1%
	B	85	27.5%
	C	69	22.3%
	D	25	8.1%
Study level	higher vocational training	30	9.7%
	bachelor	180	58.3%
	master	99	32.0%
Study form	full-time	225	72.8%
	part-time	84	27.2%

Source: own edition

Validation of the research model

The validation of the measurement model followed the guide and threshold values of Hair et al. (2022) for reflective measurement models. The study presents the results of the final model, i.e., after excluding items where the indicator reliability was not met (outer loading < 0.708) and deleting the item improved content validity. The standardized root mean square residual (SRMR) indicators suggest an acceptable model fit for the saturated and the estimated model; the values are 0.078 and 0.080, respectively. Other indices of the saturated model are d_ULS = 0.661, d_G = 0.519, and Chi-square = 936.639. The indices of the estimated model are d_ULS = 0.1,759, d_G = 0.530, and Chi-square = 947.656. (NFI) does not meet the minimum threshold value of 0.90; the results are 0.778 for the saturated and 0.775 for the estimated model. However, model fit measures are broadly available for CB-SEM models; these are not transferrable to PLS-SEM models, the statistical approach is validated differently (Hair et al., 2017), more and more solutions are emerging. High d_ULS and low NFI are cautious, but these are due to the relatively low sample size of this pilot study. That assumption can be verified later by extending the investigations.

Internal consistency indices are summarized in Table 3. Cronbach's alpha values are satisfactory (between 0.7 and 0.90), rho_a values are between 0.60 and 0.90, and AVE values are greater than 0.5 for each construct (Hair et al., 2022).

Table 3

Internal consistency indicators

	Cronbach's alpha	CR (rho_a)	CR (rho_c)	AVE
IQ	0.811	0.815	0.876	0.640
SQ	0.756	0.767	0.859	0.671
SeQ	0.743	0.884	0.839	0.636
SAT	0.875	0.887	0.909	0.667
USE	0.822	0.827	0.883	0.654
BEN	0.876	0.886	0.915	0.729

Source: based on SmartPLS output

No collinearity issues were found; the variance inflation factor (VIF) values ranged from 1.296 (SeQ4) to 2.588 (SAT1), all of which are below the critical value of 5 (Hair et al., 2022). VIF values are presented in the results section (Table 6), along with the descriptive statistics.

Table 4

Results of Fornell-Larcker analysis

	BEN	IQ	SAT	SQ	SeQ	USE
BEN	0.854					
IQ	0.617	0.800				
SAT	0.736	0.722	0.817			
SQ	0.580	0.675	0.687	0.819		
SeQ	0.522	0.585	0.564	0.535	0.798	
USE	0.529	0.352	0.504	0.324	0.363	0.809

Source: based on SmartPLS output

Table 5

Results of HTMT analysis

	BEN	IQ	SAT	SQ	SeQ
IQ	0.727				
SAT	0.818	0.847			
SQ	0.697	0.847	0.832		
SeQ	0.593	0.697	0.625	0.648	
USE	0.618	0.428	0.575	0.408	0.398

Source: based on SmartPLS output

The discriminant validity of the model was tested using the Fornell-Larcker criterion (Fornell & Larcker, 1981). The model is acceptable since the square root of AVE values in the diagonal of Table 4 exceeds the correlations with other constructs for each construct.

Another related test (Table 5) is the heterotrait-monotrait ratio (HTMT). The values are lower than the threshold value of 0.90, which confirms the discriminant validity of the model (Henseler et al., 2015).

Results

Descriptive statistics of the measurement model

The mean values of the items in the survey show above medium values, but the standard deviation is high, which suggests a diversity of perception (Table 6). The lowest values belong to 'Service quality' and 'Use'. The students are less satisfied with staff support (SeQ1 and SeQ3) than online assistance and help (SeQ4). However, the mean value (M=4.680) in the case of USE2 item about using many functions and features of Moodle is not an extreme outlier; it is apparently lower than other values within 'Use'.

Path coefficients and determination

The explanatory power (R^2) of the structural model is considered moderate (Hair et al., 2022), the constructs can explain 57.6% of the variation of 'Benefits', 60.8% of 'Satisfaction'. According to 'Use', the R^2 = 26.8% value is low. Since the use of the system is not a choice of the

Table 6

Descriptive statistics and VIF values

	Mean	Median	Standard deviation	Excess kurtosis	Skewness	VIF
IQ1	5.217	5	1.169	0.254	-0.649	1.550
IQ2	5.689	6	1.002	0.269	-0.684	2.038
IQ3	5.560	6	1.049	1.210	-0.869	2.165
IQ4	5.612	6	1.026	2.202	-1.044	1.481
SQ2	5.424	6	1.246	0.831	-0.855	1.501
SQ3	5.304	5	1.259	1.062	-0.913	1.459
SQ5	5.528	6	1.119	0.362	-0.689	1.697
SeQ1	4.269	4	1.092	0.574	0.005	1.674
SeQ3	4.553	4	1.135	0.561	0.367	1.736
SeQ4	5.049	5	1.118	0.633	-0.459	1.296
USE1	5.631	6	1.396	1.031	-1.137	2.194
USE2	4.680	5	1.409	-0.116	-0.492	1.610
USE3	5.563	6	1.312	0.888	-1.002	2.232
USE4	5.537	6	1.325	0.497	-0.831	1.441
SAT1	5.453	6	1.077	1.554	-0.932	2.588
SAT2	5.592	6	1.197	1.117	-0.936	1.965
SAT3	5.427	6	1.362	1.015	-0.992	1.768
SAT4	5.120	5	1.224	0.389	-0.688	1.883
SAT5	5.712	6	1.051	1.217	-0.932	2.178
BEN1	5.366	5	1.292	0.188	-0.688	2.350
BEN2	5.728	6	1.105	2.238	-1.182	2.008
BEN3	5.388	5	1.256	1.178	-0.863	2.184
BEN4	5.806	6	1.089	2.606	-1.240	2.431

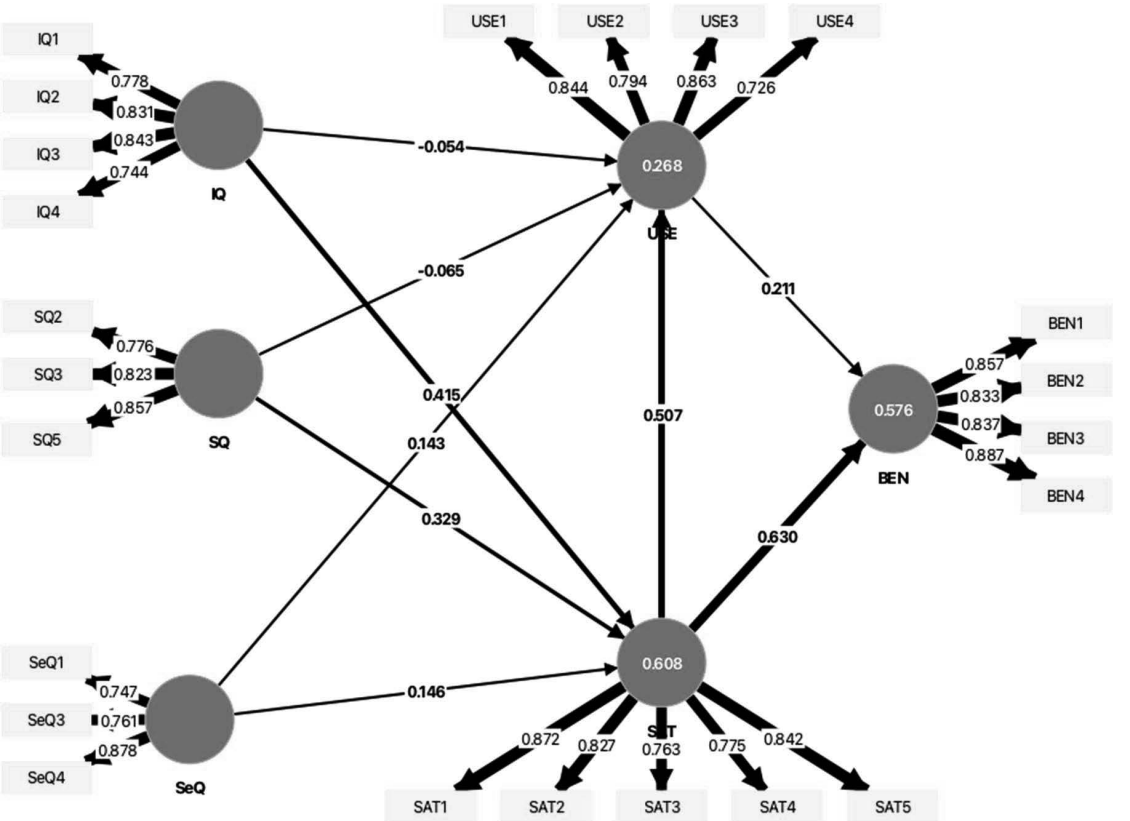
Source: based on SmartPLS output

students, a low value was expected. The results are summarized in Figure 2, including the loadings of the constructs, path coefficients, and R^2 values.

the same time, 'Service quality' positively impacts 'Use'. The most important driver for 'Satisfaction' is 'Information quality' (ß=0.415).

Figure 2

Research model with results



Source: SmartPLS output

Table 7

Path Coefficients and decision on the hypotheses

	Original sample ß	Sample mean ß	Standard deviation	t	p	Related hypothesis evaluation
IQ -> USE	-0.054	-0.053	0.081	0.668	0.504	H1a rejected
IQ -> SAT	0.415	0.416	0.049	8.414	0.000	H1b supported
SQ -> USE	-0.065	-0.065	0.078	0.831	0.406	H2a rejected
SQ -> SAT	0.329	0.325	0.064	5.157	0.000	H2b supported
SeQ -> USE	0.143	0.144	0.060	2.363	0.018	H3a supported
SeQ -> SAT	0.146	0.151	0.052	2.802	0.005	H3b supported
SAT -> USE	0.507	0.507	0.081	6.265	0.000	H4 supported
SAT -> BEN	0.630	0.630	0.035	18.124	0.000	H5b supported
USE -> BEN	0.211	0.212	0.044	4.754	0.000	H5a supported

Source: based on SmartPLS output

The hypotheses of the study are related to the path coefficients of the PLS-SEM model. The bootstrapping analysis results are presented in Table 7. The result revealed exogenous constructs of the DeLone and McLean Model of Information Systems Success as 'Information quality', 'System quality', and 'Service quality' have a significant positive impact on 'Satisfaction', while 'Information quality' and 'System quality' do not have an impact on 'Use'. At

Satisfaction is the most important driver for 'Use' (ß=0.507) and 'Benefits' (ß=0.630). 'Benefits' are retrieved to a lower extent from 'Use' (ß=0.211). The path coefficient value of 0.507 between 'Satisfaction' and 'Use' is significant and among the higher ones in the model. We made a model run with an inverse link to test the relations. In that model, the path coefficient from 'Use' to 'Satisfaction' was 0.380 (t=5.767, p=0.000). That confirms that 'Satisfaction' impacts 'Use' more than the other way.

The total effects (Table 8) are significant, except for the case between 'System Quality' and 'Use', and most of the indirect effects (Table 9) are also significant.

Moderating effects

The distributions of responses to survey questions are typically right-skewed, which suggests high confidence and satisfaction with Moodle. However, due to the high standard deviation values, the question logically arises whether the students' opinions show patterns. The study employed moderation analysis in SmartPLS software, using institution, gender, study level, and study form as grouping factors.

Table 8

Total effects

	Original sample	Sample mean	Standard deviation	t	p
IQ -> BEN	0.294	0.295	0.043	6.837	0.000
IQ -> SAT	0.415	0.416	0.049	8.414	0.000
IQ -> USE	0.156	0.158	0.077	2.028	0.043
SAT -> BEN	0.737	0.737	0.031	23.939	0.000
SAT -> USE	0.507	0.507	0.081	6.265	0.000
SQ -> BEN	0.229	0.227	0.049	4.644	0.000
SQ -> SAT	0.329	0.325	0.064	5.157	0.000
SQ -> USE	0.102	0.100	0.077	1.323	0.186
SeQ -> BEN	0.138	0.141	0.039	3.573	0.000
SeQ -> SAT	0.146	0.151	0.052	2.802	0.005
SeQ -> USE	0.217	0.220	0.062	3.494	0.000
USE -> BEN	0.211	0.212	0.044	4.754	0.000

Source: based on SmartPLS output

Table 9

Indirect effects

	Original sample	Sample mean	Standard deviation	t	p
SQ -> SAT -> BEN	0.207	0.205	0.040	5.173	0.000
SeQ -> SAT -> BEN	0.092	0.095	0.034	2.706	0.007
IQ -> SAT -> USE	0.211	0.210	0.040	5.253	0.000
SQ -> SAT -> USE	0.167	0.165	0.044	3.819	0.000
SeQ -> SAT -> USE	0.074	0.076	0.029	2.536	0.011
IQ -> SAT -> USE -> BEN	0.044	0.044	0.012	3.699	0.000
SQ -> SAT -> USE -> BEN	0.035	0.035	0.012	2.853	0.004
SeQ -> SAT -> USE -> BEN	0.016	0.016	0.006	2.408	0.016
IQ -> USE -> BEN	-0.011	-0.011	0.018	0.649	0.517
SAT -> USE -> BEN	0.107	0.107	0.027	3.994	0.000
SQ -> USE -> BEN	-0.014	-0.013	0.017	0.823	0.411
IQ -> SAT -> BEN	0.261	0.262	0.036	7.321	0.000
SeQ -> USE -> BEN	0.030	0.030	0.014	2.113	0.035

Source: based on SmartPLS output

The direct, indirect, and total effects between the constructs (Tables 7-9) emphasize the primary role of information quality, and also the important role of system quality in the model on satisfaction. The direct effects between the factors and use are not significant. Indirect effects confirm that information and system quality affect Moodle use through the user's satisfaction. The impact of service quality on the results is statistically significant but only of secondary importance. Based on the total effects, benefits are significantly affected by all constructs of the model, allowing the conclusion that the model is comprehensive and applicable to Moodle evaluation. The non-voluntary use of Moodle by students is mirrored in the not significant total effects between 'System quality' and 'Use' (ß=0.102, t=1.323, p=0.186), and the related indirect effects between 'Information quality' to 'Benefits' through 'Use' (ß=-0,011, t=0.649, p=0.517) and 'System quality' to 'Benefits' through 'Use' (ß=-0,014, t=0.823, p=0.411).

The research model was supplemented with moderating factors for all significant paths. Table 10 highlights the significant findings. The bootstrapping options used 5000 samples and the bias-corrected and accelerated (BCa) method. No significant moderating effects were found by gender or the full-time or part-time nature of the studies. Study level moderates the path between 'Use' and 'Benefits'; the positive coefficient (ß=0.129) suggests that satisfied master-level students can take better advantage of the system. University differences were caught in the impact of 'System quality' and 'Service quality' on 'Use'. These paths are not significant, but the results have

a remarkable message on the role of institutional differences.

According to RQ1, the survey shows that the students like the Moodle system. They found it easy-to-use, up-to-date, and helpful in following the course materials. The main finding of our study is that satisfaction plays a key role in achieving the benefits of the Moodle system. Through this, the total effect is 0.737, which is considered high. The indirect effect of the 'Satisfaction', 'Use', and 'Benefits' path is 0.107. Exogenous constructs explain 60.8% of the standard deviation in satisfaction. That means the individual and organizational benefits can be achieved through investments in improving satisfaction. 'Satisfaction' is primarily achieved through 'Information quality' (ß=0.415, t=8.414, p=0.000), followed by 'System quality' (ß=0.329, t=5.157, p=0.000). The low path coefficients from 'Information quality' to 'Use' (ß=-0.054, t=0.668, p=0.500) and from 'System quality' to 'Use' (ß=-0.065, t=0.831, p=0.406), while the paths to 'Satisfaction' are more significant, warn policymakers that increase in use is not directly available, the measures must incorporate the user satisfaction. Furthermore, related measurements must be designed accordingly, which clearly indicates the need for quality management experts. They can survey the factors contributing to satisfaction and help define whether information, system, or service development is required for success.

'Service quality' significantly and positively impacts both 'Use' (ß=0.143, t=2.363, p=0.018) and 'Satisfaction' (ß=0.146, t=2.802, p=0.005), but the path coefficients are lower than the other constructs. That suggests that service quality must be considered a hygiene factor, i.e., required for effective operation, but it is a kind of default assumption. Indeed, in the case of regular operation, the service can remain in the background. The results reveal that the universities have dual responsibility for information quality and system quality. Information quality depends on the teachers and instructors, while system quality depends on managerial decisions regarding which features will be developed and utilized. These responsibilities should not be mixed or joined.

The DeLone and McLean Model of Information Systems Success (DeLone & McLean, 2003) is an appropriate selection for the analysis. The convergent and discriminant validity analysis confirms that Moodle can be analyzed as an information system (RQ2). Since universities run different software within their information systems, the implication of the study is to extend the scope of investigations to those. That requires mapping

Table 10

Summary of significant moderating effects

		Original sample ß	Sample mean ß	Standard deviation	t	p
Study level	USE -> BEN	0.129	0.125	0.049	2.630	0.009
Study level	SAT -> BEN	-0.134	-0.134	0.049	2.739	0.006
University	SQ -> USE	0.183	0.189	0.074	2.466	0.014
University	SeQ -> USE	-0.158	-0.158	0.051	3.115	0.002

Source: based on SmartPLS output

Discussion and conclusion

It is not a new finding, but it has become a universal truth that investment in information technology contributes to value creation (Nemeslaki & Aranyossy, 2005). Since Moodle is a remarkable platform for the digitalization of higher education, careful management and development of the system are essential. Gamage et al. (2022) noted strong evidence that Moodle increases student engagement, performance, and satisfaction. Taking the views of students as the main beneficiaries into account is worthwhile.

The explanatory power of the model is rated as moderate, according to Hair et al. (2022), as it does not exceed 75%, but this level is acceptable. Among studies that use a technology acceptance approach with the TAM model (Davis, 1989) or its extensions (Venkatesh & Davis, 2000; Venkatesh & Bala, 2008), Saqr et al. (2024) or Sánczez and Hueros (2010) found that perceived usefulness and ease of use influence satisfaction and students' attitudes toward e-learning. Saqr et al. (2024) found that there is no impact on their intention to use it, and Sánczez and Hueros (2010) found a low $R^2 = 0.41$ explanation on system usage. These two papers show similar conclusions before and after the COVID-19 lockdowns.

Nasution (2024) highlighted the positive impact of prior experience on perceived ease of use. In their review paper, Mustafa and Ali (2023) confirmed the usability of such models and the positive impact chains from the influencing factors and the results. At the same time, the authors present the limitations of such studies, including the lack of generalizability and the missing measurement of actual use. Most studies in the field have found low explanatory power regarding use, regardless of the system used by the university. The intention to use Moodle is not in question, as students cannot choose whether they want to use it. The experience with behavioral and technology acceptance models has appeared in our information system approach as well. The high consistency of the results by framework models and the locality of the research confirm the usability of different models, including the information system success approach.

Since students and teachers have different motivations and expectations derived from their different tasks according to using the same system, a common assessment model can be found in the DeLone and McLean IS Success Model.

the stakeholders and the system in use, as well as the refinement of the questions in the survey. As a result, a comprehensive instrument can be established to support management decisions.

According to RQ3, the study found that there are few moderating effects in the judgments on the Moodle system, and it is generally accepted. The differences by study level suggest the need for user training and education. More experience in system use saves time and effort for the students; the confident use contributes to successful utilization. The differences in system quality and service quality among universities may be based on the varying maturity of institutions, which highlights the importance of knowledge sharing and adopting best practices.

Limitations

The study has some limitations. First, the data collection was not representative of the population. Although more universities were included, and the results do not show many differences by that grouping factor, a broader data collection is needed for policy-making. The study is considered a pilot study and aims to develop a measuring tool. A comprehensive survey among universities enables general conclusions and informed system development actions. The results will hopefully raise interest in the topic among universities, and a representative sample can be obtained through their collaboration. Second, the analysis is based on the self-assessment of the students as users of the Moodle system. Alternative measurement methods of use may improve the explanatory power of the model. Third, the study was not longitudinal. Due to the fast technological development, repeated data collection could justify the timeliness of the results. Fourth, the database was filtered for incorrect completions, but the bias of self-managed, voluntary online data collection cannot exclude all errors.

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