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Structural Equation Model: an Analysis of Learning Management Systems Acceptance

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Abstract

The continuous growth of ICT in the last decade is transforming the traditional model of teaching and learning based on face-to-face master classes. Today there are virtual online educational platforms that allow students and teachers to interact virtually and use multimedia resources from any mobile device or computer with Internet access. The transition from presence to virtuality can generate resistance to change, this situation must be analyzed to take strategies that allow the effective implementation of virtual educational platforms by teachers and students. The aim of this paper was to identify the aspects that influence the use behavior of learning management systems (LMS), based on data from an online survey sent to 250 students of systems engineering. This research analyzes the impact of five constructs; platform operation, planning and scheduling, teaching program contents, methodology and competencies of teachers, communication and interaction and allocation and use of media resources with use behavior. This paper concludes that the platform operation, planning and scheduling, communication and interaction, the allocation and use of media resources are the constructs that more influence the use behavior of LMS regardless teaching program contents and competencies of teachers.

Keywords: education, SEM, students, LMS, ICT

1. Introduction

LMS are becoming a necessary tool in the teaching and learning process in Universities. The level of student satisfaction is one of the most important factors to be considered (Tjong et al., 2018). In effect, LMS are the tools that allow virtual distance education to be carried out (Soykan & Şimşek, 2017). The rapid implementation of LMS is rapidly transforming the traditional model of teaching and learning. However, there is little research that studies how traditional learning models have been affected, as most research focuses on technical aspects (Coates, James & Baldwin, 2005). It is a reality that LMS are becoming the main tool of interaction between students and teachers in higher education. LMS offer a wide variety of resources and pre-designed activities that move away from being mere content managers, making it easier for teachers to apply different learning methodologies (Cantabella, López, Caballero & Muñoz, 2018).

The aim of this research was to identify the main factors that influence the use behavior of LMS in university students of systems engineering. This paper is structured as follows; first, we present the model and the variables, hypotheses, methodology and the results analysis obtained from the model.

This paper concludes that universities must create strategies to strengthen and improve the operation of LMS platforms they use, train and motivate teachers to communicate through them with students on a permanent basis and train teachers to build multimedia content that encourages autonomous student learning. Further research can include the perceptions of teachers.

2. Learning Management Systems

Thanks to LMS, universities can collect and store information for descriptive and inferential statistical analysis, can make forecasts and business intelligence (BI) (Duin & Tham, 2020). LMS can be very useful tools for universities, since they facilitate the academic follow-up of students. The types of data that are collected through

the use of LMS allow the identification of particular student information (time spent online, forums, activities performed, etc.), which helps teachers create learning strategies for students who are having difficulties (Duin & Tham, 2020). The use of distance learning methodologies in universities has increased in the last decade and the use of LMS has become more frequent. All LMS can be used to improve student academic advising in higher education (Schaumleffel, 2009). The following is a brief description of some LMS:

- *Absorb*: is a LMS engineered to inspire learning and fuel business productivity. It combines forward-thinking technology with customer service. By empowering amazing learning experiences, this LMS engages learners, fuels content retention and elevates training programs (Adsorb, 2020).
- *Schoology*: this LMS allows teachers to organize curriculum, lessons and student assessments. It facilitates collaboration between teachers and the creation of discussion forums (Schoology, 2020).
- *Instructure Canvas*: this LMS is composed of a set of integrated learning products that allow teachers to carry out all the activities involved in the teaching process (Canvas, 2020).
- *Moodle*: this LMS is popularly used as open source systems in many universities around the world. It allows to create and manage virtual learning spaces and to adapt them to the requirements of all (students, teachers and managers). It is based on PHP and MySQL (Soykan & Şimşek, 2017).
- *Blackboard*: this LMS can to assess and work with students of all kinds, in and out of the classroom. It allows to manage the educational process in person, virtually or in person-virtually using collaboration and academic management tools, which can be accessed through mobile devices (Blackboard Learn, 2020).
- *D2L Brightspace*: this LMS helps *K-12* institutes, universities and organizations to deliver face-to-face and semi-face-to-face and virtual courses. It consists of three integrated platforms: environment, repository and learning portfolio. It allows teachers to design interactive courses and evaluate them with multimedia tools (images, videos, audio files, etc.) that enable academic institutes and organizations to management learning resources in databases (Advice, 2020)
- *Edmodo*: this LMS facilitates collaborative learning, content exchange and the use of communication tools and multimedia resources. It allows content storage, which reduces the time spent on handling physical documents (Ingwersen, 2020).
- *Google Classroom*: is the virtual classroom that Google has designed to complete the Google Apps for Education, with the aim of organizing and improving communication between teachers and students (Google, 2020). Table 1 presents the main characteristics of the above mentioned LMS:

Table 1. LMS characteristics

	Absorb	Schoology	Instructure Canvas	Moodle	Blackboard	D2L Brightspace	Edmodo	Google Classroom
Editors' qualifications	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SCORM package import	Yes	No	Yes	Yes	Yes	Yes	No	No
Course content included	No	Yes	Yes	No	No	No	Yes	No
Google Apps Integration	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SSO - Single Sign On	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E-commerce	Yes	No	Yes	No	No	No	Yes	No
Developer API available	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LTI Support	No	Yes	Yes	Yes	Yes	Yes	No	No
Web hosting	No	Yes	Yes	No	No	No	Yes	Yes

Source: authors elaboration

3. Methodology

Data from 250 students of systems engineering were used. This academic program has a model of virtual learning, in which the use of interactive resources available in the virtual classrooms is of great importance. The answers were obtained through a google form. The constructs were developed based on scientific publications. The items that compose the constructs were formulated based on the use behavior of LMS. A Likert scale from 1 to 5 was used. Table 2 presents the items associated with each construct:

Table 2. Constructs and Variables

Question	Variable	Construct
The platform has resources, multimedia, didactic tools, etc.	U1	Platform operation, planning and scheduling (POPS)
The administrative management of the platform is efficient.	U2	
The documentation and bibliography of the platform's courses are available and updated	U3	
The time required for the development of the evaluation activities is assigned	U4	
There is an established timetable for addressing the study	U5	
The structure of the courses is appropriate	U6	
The course materials are adapted to the conditions of the platform	U7	
Course contents are updated	V1	Teaching program contents (TPC)
The contents of the courses allow a practical application	V2	
The contents of the courses are relevant	V3	
Pedagogical strategies for autonomous learning of the offered courses are carried out	W1	Methodology and competencies of teachers (MCT)
Feedback to learning assessment processes is timely	W2	
Teachers comply with schedules for virtual or face-to-face meetings	W3	
The organization of the forums is appropriate	W4	
The answers to the questions and concerns of the courses are given in a time frame (maximum 48 hours)	W5	
Teachers demonstrate skills in developing collaborative learning	W6	
Teachers demonstrate teaching skills	W7	
The exemplification of the course contents are in accordance with the virtual environment and the contents	W8	
Teachers present options for the use of resources	W9	
Students are invited to share ideas and knowledge through the	X1	Communication and interaction (CI)
Students are encouraged to communicate with teachers through the platform	X2	
There is dynamization of the communication environments on the platform	X3	
There is a good level of communication with colleagues through the platform	X4	
The platform's course materials are digitized and/or virtualized	Y1	Allocation and use of media resources (AUMR)
The platform interface is easy to use	Y2	
Synchronous and asynchronous communication processes on the platform are effective	Y3	
Database management programs are effective	Y4	
Multimedia bibliographic materials from the courses and the virtual library are incorporated	Y5	
The platform's navigation system guides its use	Y6	
There are self-assessment activities for course learning	Y7	
Platform response times are adequate	Y8	
I use the LMS to view educational content	Z1	Use Behavior (UB)
I use LMS as a tool to develop task	Z2	
I recommend my teachers to use LMS	Z3	
I recommend other students in my class to use LMS	Z4	

Source: authors elaboration

There is a strong global trend toward utilizing LMS in academic institutions as a part of their educational management system to improve the teaching and learning experience in higher education system (Aldiab, Chowdhury, Kootsookos, Alam & Allhibi, 2019). Multimedia resources encourage student learning, which is why LMS that incorporate interactivity in the development of content and activities are more widely used than those that do not. Similarly, the teaching methodology and the pedagogical and dictational skills of the teachers should be incorporated into the activities developed through the LMS, to encourage their use by the students (Heo & Toomey, 2020). Similarly, the operation, planning and scheduling of LMS play an important role in the use of LMS, so care should be taken with these activities and a person should be assigned to carry them out. The communication and interaction of the teachers who use LMS for the development of their courses directly influence the use of them by the students. If the teachers do not carry out a continuous accompaniment to the students nor give feedback on the results of the activities they carry out, the LMS can have little effectiveness in the learning process (Chow, Tse & Armatas, 2018).

The program contents must be well structured; teachers must plan and schedule the thematic units in an orderly and sequential manner to facilitate the work of the working group in charge of the operation, planning and scheduling of the LMS. The competencies and teaching methodology of teachers are what define the types of learning resources they will use in LMS, which can be multimedia, plain text, and other resources (Ravanelli & Serina, 2014). In addition, the platform operation, planning and scheduling may directly influence the allocation and use of media resources, since LMS may have certain technical and structural characteristics that enable or prevent the use of certain types of multimedia resources. Figure 1 presents the graph of the model and hypothesis:

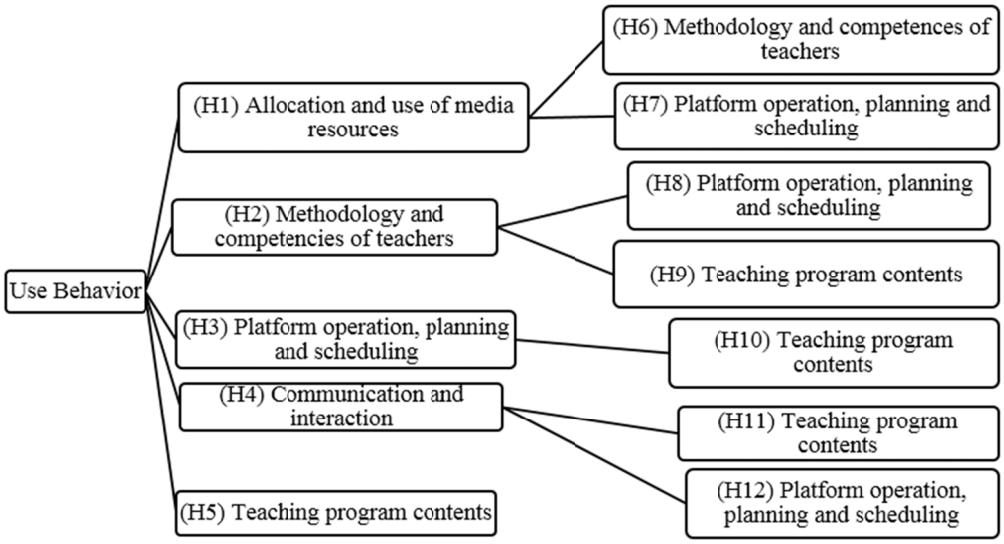

Figure 1. Hypothesis model

Source: author elaboration

- *H1: Use behavior of LMS is determined by allocation and use of media resources, (H2) by the methodology and competencies of teachers, (H3) by the platform operation, planning and scheduling (H4) by communication and interaction, (H5) by teaching program contents.*
- *H6: Platform operation, planning and scheduling is determined by teaching program contents*
- *H7: Allocation and use of media resources is determined by the methodology and competences of teachers and (H8) by the platform operation, planning and scheduling.*
- *H9: Methodology and competencies of teachers is determined by platform operation, planning and scheduling and (H10) by teaching program contents.*
- *H11: Communication and interaction is determined by teaching program contents and (H12) by platform operation, planning and scheduling.*

Table 3 presents the relationship of the predictor variables:

Table 3. Predictor variables

Model <- ' # regressions
UB ~ POPS, UB ~ TPC, UB ~ MCT, UB ~ CI, UB ~ AUMR, POPS ~ TPC, AUMR ~ MCT,
AUMR ~ POPS, MCT ~ POPS, MCT ~ TPC, CI ~ TPC, CI ~ POPS
latent variable definitions
POPS=~ U1 + U2 + U3 + U4 + U5 + U6 + U7
TPC=~ V1 + V2 + V3
MCT=~ W1 + W2 + W3 + W4 + W5 + W6 + W7 + W8 + W9
CI=~ X1 + X2 + X3 + X4
AUMR=~ Y1 + Y2 + Y3 + Y4 + Y5 + Y6 + Y7 + Y8
UB=~ Z1 + Z2 + Z3 + Z4

Source: authors elaboration

Table 4 presents the internal reliability (IR), convergent validity (CV), and discriminant validity (DV) of the constructs.

Table 4. IR - CV - DV

Construct	Variable	Cronbach's alpha	Item total correlation	Factor loading	CR	AVE	MSV	ASV
Platform operation, planning and scheduling	U1	0.786	0.657	0.897	0.778	0.654	0.023	0.012
	U2		0.664	0.865				
	U3		0.637	0.860				
	U4		0.623	0.857				
	U5		0.657	0.903				
	U6		0.668	0.987				
	U7		0.673	0.843				
Teaching program contents	V1	0.855	0.794	0.823	0.934	0.546	0.542	0.124
	V2		0.785	0.825				
	V3		0.752	0.834				
Methodology and competencies of teachers	W1	0.797	0.659	0.856	0.832	0.456	0.413	0.034
	W2		0.718	0.865				
	W3		0.695	0.865				
	W4		0.707	0.832				
	W5		0.684	0.831				
	W6		0.723	0.854				
	W7		0.692	0.867				
	W8		0.733	0.832				
	W9		0.746	0.845				
Communication and interaction	X1	0.864	0.657	0.854	0.732	0.687	0.218	0.451
	X2		0.678	0.556				
	X3		0.785	0.876				
	X4		0.626	0.834				
Allocation and	Y1	0.743	0.794	0.856	0.934	0.587	0.345	0.543
	Y2		0.758	0.898				
	Y3		0.766	0.876				
	Y4		0.698	0.887				

use of means and resources	Y5		0.679	0.843				
	Y6		0.684	0.864				
	Y7		0.705	0.846				
	Y8		0.694	0.776				
Use behavior	Z1	0.823	0.894	0.756	0.834	0.687	0.445	0.643
	Z2		0.798	0.798				
	Z3		0.753	0.776				
	Z4		0.798	0.801				

Source: author elaboration

4. Results and Discussion

Table 5 presents the results of the fit indexes measures. The normed fit index NFI = 0.901, which measures the difference between the $\chi 2$ of the null model and the estimated model, is not below of the minimum required (0.90) (Hu & Jen, 2005). Similarly, the TLI = 0.980 and CFI=1.000 are above the lower acceptance limit (0.90) (Bentler, 1990). Additionally, the PNFI = 0.696 and the PCFI = 0.754 indicates a good fit of the model, both are greater than 0.50 (Mulaik et al., 1989). The majority of fit indexes are good, in effect the proposed structural model is adequate to explain the relationships between variables and to test the associated hypotheses.

Table 5. Fit indexes

Measures		Value	Recommended cut – off Values
Absolute	Minimum fit function chi-square ($\chi 2$)	1053.485	The lower the better
	Degrees of freedom (d.f.)	57	
	P-value	0.000	>0.050
	$\chi 2$/d.f.	4.115	<5.000
	Goodness-of-fit index (GFI)	0.812	>0.800
	Standardized root mean square residual (SRMR)	0.071	<0.080
	Root mean square error of approximation (RMSEA)	0.059	<0.080
Incremental	Adjusted goodness-of-fit index (AGFI)	0.817	>0.800
	Tucker-Lewis index (TLI) or (NNFI)	0.980	>0.900
	Normed fit index (NFI)	0.901	>0.900
	Comparative fit index (CFI)	1.000	>0.900
Parsimonious	Parsimonious goodness of fit index (PGFI)	0.654	>0.500
	Parsimonious normed fit index (PNFI)	0.696	>0.500
	Parsimonious comparative fit index (PCFI)	0.754	>0.500

Source: author elaboration

All the values of the regression weights between constructs are positive and significant ($\alpha = 0.05$). In effect, "Platform operation, planning and scheduling" has a positive and significant impact on "Use behavior" ($\beta = 0.68$, $p < .01$), "Teaching program contents" positively influences "Use behavior" ($\beta = 0.51$, $p < .01$), "Methodology and competencies of teachers" positively influences "Use behavior" ($\beta = 0.51$, $p < .01$), "Communication and interaction" positively influences "Use behavior" ($\beta = 0.55$, $p < .01$) and "Allocation and use of media resources" positively influences "Use behavior" ($\beta = 0.53$, $p < .01$).

On the other hand, "platform operation, planning and scheduling" do not have a positive and significant impact on "teaching program contents" ($\beta = 0.28$, $p < .01$). "Methodology and competencies of teachers" do not have a positive and significant impact on "platform operation, planning and scheduling" ($\beta = 0.39$, $p < .01$) neither on "teaching program contents" ($\beta = 0.40$, $p < .01$). "Communication and interaction" do not have a positive and significant impact on "teaching program contents" ($\beta = 0.21$, $p < .01$) neither on "platform operation, planning and scheduling" ($\beta = 0.21$, $p < .01$). Table 6 presents the results:

Table 6. Hypothesis and structural model path coefficients

Hypothesis	Construct			Estimate	S.E	C.R	P
H1	Platform operation, planning and scheduling	→	Use behavior	0.683	0.033	20.455	0.000
H2	Teaching program contents	→	Use behavior	0.512	0.040	3.214	0.000
H3	Methodology and competencies of teachers	→	Use behavior	0.516	0.060	6.885	0.000
H4	Communication and interaction	→	Use behavior	0.553	0.055	6.422	0.000
H5	Allocation and use of media resources	→	Use behavior	0.533	0.058	7.347	0.000
H6	Platform operation, planning and scheduling	→	Teaching program contents	0.281	0.048	12.604	0.000
H7	Allocation and use of media resources	→	Methodology and competences of teachers	0.534	0.047	11.395	0.000
H8	Allocation and use of media resources	→	Platform operation, planning and scheduling	0.554	0.047	11.714	0.000
H9	Methodology and competencies of teachers	→	Platform operation, planning and scheduling	0.395	0.064	6.290	0.000
H10	Methodology and competencies of teachers	→	Teaching program contents	0.401	0.064	6.290	0.000
H11	Communication and interaction	→	Teaching program contents	0.210	0.037	5.729	0.000
H12	Communication and interaction	→	Platform operation, planning and scheduling	0.210	0.037	5.729	0.000

Source: author elaboration

The links are active within the internal factors of the model. The use behavior of LMS: (H1) is determined by allocation and use of media resources, (H3) by the platform operation, planning and scheduling, (H4) by communication and interaction and (H5) by teaching program contents as they have been studied in (Wichadee, 2014), this research offers proof that the relationships have additional validity within the LMS and its academic use in higher education. (H7) allocation and use of media resources is determined by the methodology and competences of teachers and (H8) by the platform operation, planning and scheduling as they have been studied in (Lim & Chai, 2008). The hypotheses; (H6) platform operation, planning and scheduling is determined by teaching program contents, (H9) methodology and competencies of teachers is determined by platform operation, planning and scheduling, (H10) by teaching program contents and (H11) communication and interaction is determined by teaching program contents and (H12) by platform operation, planning and scheduling were rejected (estimate < 0.5).

5. Conclusions

This research describes the main factors influencing the use behavior (UB) of LMS in higher education and the effects between them. We consider the following five factors: platform operation, planning and scheduling (POPS), teaching program contents (TPC), methodology and competencies of teachers (MCT), communication and

interaction (CI) and allocation and use of media resources. We studied the model through SEM, using data from an online survey of 250 students of system engineering.

The results of the model show that the platform operation, planning and scheduling, communication and interaction, and the allocation and use of media resources have a direct impact on use behavior of LMS regardless of teaching program contents, methodology and competencies of teachers. Universities must create strategies to strengthen and improve the operation of LMS platforms they use, train and motivate teachers to communicate through them with students on a permanent basis and train teachers to build multimedia content that encourages autonomous student learning. Further research can include the perceptions of teachers.

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