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 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:

|                      | 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            | Yes    | No              |
| Course content included | No     | No        | 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         | Yes            | No     | No              |
| Developer API available | Yes    | Yes       | Yes                | Yes    | Yes        | Yes            | Yes    | Yes             |
| LTI Support           | No     | Yes       | Yes                | Yes    | Yes        | No             | No     | No              |
| Web hosting           | No     | Yes       | Yes                | No     | No         | Yes            | 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       |                                                    |
| The contents of the courses allow a practical application               | V2       |                                                    |
| The contents of the courses are relevant                                 | V3       | Teaching program contents (TPC)                    |
| Pedagogical strategies for autonomous learning of the offered courses are carried out | W1       |                                                    |
| 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       | Methodology and competencies of teachers (MCT)     |
| 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 systems (Aldiah, 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](image)

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 competencies 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       | 0.657            | 0.897                  |                |        |       |       |       |
|                                          | U2       | 0.664            | 0.865                  |                |        |       |       |       |
|                                          | U3       | 0.637            | 0.860                  |                |        |       |       |       |
|                                          | U4       | 0.786            |                        |                | 0.778  | 0.654 | 0.023 | 0.012 |
|                                          | U5       |                  |                        |                |        |       |       |       |
|                                          | U6       | 0.668            | 0.987                  |                |        |       |       |       |
|                                          | U7       | 0.673            | 0.843                  |                |        |       |       |       |
| Teaching program contents                | V1       | 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       | 0.659            | 0.856                  |                |        |       |       |       |
|                                          | W2       | 0.718            | 0.865                  |                |        |       |       |       |
|                                          | W3       | 0.695            | 0.865                  |                |        |       |       |       |
|                                          | W4       | 0.707            | 0.832                  |                |        |       |       |       |
|                                          | W5       | 0.797            |                        |                | 0.832  | 0.456 | 0.413 | 0.034 |
|                                          | W6       |                  |                        |                |        |       |       |       |
|                                          | W7       | 0.692            | 0.867                  |                |        |       |       |       |
|                                          | W8       | 0.733            | 0.832                  |                |        |       |       |       |
|                                          | W9       | 0.746            | 0.845                  |                |        |       |       |       |
| Communication and interaction            | X1       | 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                  |                |        |       |       |       |
|                                          | Y1       | 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                  |                |        |       |       |       |


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 |
|---------------------------------------|-----------|-----------------------------|
| 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                      |
| 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 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” ($\beta = 0.51$, $p < .01$), “Methodology and competencies of teachers” 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 competencies 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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