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Adoption of Learning Management Systems in Face-to-Face Learning: A Systematic Literature Review of Variables, Relationships, and Models

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Abstract. The use of learning management systems (LMSs) is an outstanding research topic in technology and education. LMSs are used for fully virtual, blended, and face-to-face learning processes. There are reviews in the field on variables and models that explain LMS adoption. However, no literature reviews have been found that analyze LMSs for face-to-face educational processes. As such, the aim of this paper was to conduct a literature review that identifies the variables involved in LMS adoption and their relationships, especially in those studies where the LMS was used to support face-to-face teaching−learning processes. Another aim was to identify the models used in the literature to understand the phenomenon under study. We analyzed 50 research studies and identified approximately 295 variables and their relationships, as well as 11 models attempting to explain the phenomenon. The variables we found include user perception, quality, user skills, social influence, behavior, access, cost, attitude towards use, and intention to use. Very little research has explored the use of LMSs to support face-to-face teaching and learning processes. We therefore see an opportunity for future research in this area.

Keywords: face-to-face learning; learning management systems; literature review; teaching process

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1. Introduction

Learning management systems (LMSs) are a growing research topic in literature. Şahin and Yurdugül (2022) defined LMSs as specialized software platforms, primarily web-based, that allow students to interact with content, learning resources, tests, assessments, and other students and instructors. There is a growing global trend to use LMSs in academic institutions to enhance the student learning experience (Aldiab et al., 2019). LMSs are, therefore, a means of knowledge acquisition and learning management in any educational process (Nguyen, 2021). The nature of LMSs is to develop virtual learning or e-learning processes. LMSs provide resources to participants via an Internet, intranet, or extranet connection. In other words, e-learning is the ability to access learning tools and resources anytime, anywhere (Ülker & Yılmaz, 2016).

LMSs offer several advantages by leveraging the benefits of e-learning and enabling the permanent availability of course content. LMSs provide the tools to enhance and encourage participation and interaction and the continuous monitoring of progress, grades, updates, and announcements in course subjects (Bradley, 2020). This makes the process flexible, interactive, and delocalized, transforming knowledge creation (Cabero Almenara et al., 2019). The main disadvantage of e-learning is the lack of face-to-face interaction between peers and between students and the instructor(s), which can lead to lack of motivation and poor performance. Therefore, there are mixed learning processes, called blended learning or b-learning. This involves part of the educational process occurring on the LMS platform, with other parts taking the form of face-to-face meetings between peers and between students and the instructor(s) (Ustun et al., 2021). In addition to the use of an LMS for e-learning and b-learning processes, the literature has also reported the use of LMSs to support face-to-face processes, where training is face to face and the LMS is used to support repositories, delivery of activities, and evaluations (Kaewsaiha & Chanchalor, 2021; Montes de Oca et al., 2015).

LMS adoption and use by individuals depend on many factors, including perception, age, experience, gender, knowledge, and culture (Khan & Qudrat-Ullah, 2021) Individual, contextual, and psychological behaviors intervene as moderating factors. However, many of the constructs that explain the process have considerable conceptual ambiguity. In addition, the integration of variables in models is usually problematic, and they often assume linearity in the relationship between factors, which ignores the complexity of technology adoption processes (Al-Nuaimi & Al-Emran, 2021). It is necessary to identify critical elements in the aforementioned technological acceptance. Several literature reviews have been conducted on LMS adoption (Li et al., 2018; Panigrahi et al., 2018; Sabharwal et al., 2018; Ziraba et al., 2020). However, we did not find any literature review that examined the use of LMSs to support face-to-face educational processes, including the variables that determine the adoption and use of this technology, the existing relationships between the different variables, and the models used to understand the phenomenon of LMS adoption and use.

In light of the evolving LMS landscape, in this paper, we aim to conduct a systematic literature review (SLR) to identify the variables involved in LMS adoption and their relationships, with a specific focus on studies where the LMS was utilized to support face-to-face educational processes. The objective is to uncover the existing relationships between different variables and the models employed in understanding the phenomenon of LMS adoption and use.

This research study is vital for informing educational institutions, policymakers, and technology developers, fostering a deeper understanding of the complexities surrounding LMS integration in face-to-face education. The outcomes of the study are poised to contribute valuable insights that can optimize LMS implementation, enhance educational practices, and ultimately improve the overall learning experience for students and instructors.

To realize the aim of this paper, we posted the following research questions (RQs):

1. What are the most representative variables or factors of study within the research on LMS adoption and use?
2. What are the relationships or links between the most representative variables or factors in LMS adoption and use?
3. What are the most representative variables or factors of study within the research on LMS adoption and use to support face-to-face educational processes?
4. What are the models used in research on the topic of LMS adoption and use?

The paper is organized as follows. Section 2 presents the methodology, with the construction of the protocol for the search and collection of information, as well as the questions that guided the analyses carried out in this study. Section 3 presents the results of the bibliometric data and the analyses of the studies reviewed. Finally, Section 4 presents the conclusion.

2. Methodology

The SLR was proposed as the methodology in this study to identify variables as well as relationships and interactions that, according to the academic community, explain the LMS adoption and use process. An SLR is a type of literature review in which particular emphasis is placed on the rigor and reproducibility of the search and analysis of existing information in a field of study (Bai et al., 2019). The SLR is a research method that aims to synthesize scientific evidence in a structured and reproducible way to answer research questions from published studies on a topic, while assessing their quality (Lame, 2019). In this research, we divide the stages of the SLR into three components, namely planning, implementation, and review report, according to the notion of Bai et al. (2019).

2.1 Literature Review Protocol

The review protocol specifies each method within the SLR. The creation of the review protocol is important to make the process transparent and replicable, and to minimize the researcher bias inherent in exhaustive reviews, including a relevant selection of information sources based on appropriate criteria (Mengist

et al., 2020). In this study, we selected Scopus from Elsevier Science as the search database; it contains the most extensive collection of abstracts and citations of peer-reviewed scientific literature (Scopus, 2022), covering a more significant number of academic journals (Chadegani et al., 2013). This selection was constrained by limitations in access to the database.

According to previous non-systematic reviews before the construction of the present protocol, for the process, we established the following words as keywords for the construction of an initial search query: adoption, use, acceptation, acceptance, and diffusion. For technology, the following term was determined: learning management system.

Following the above, we obtained the initial version of the search query, in which we explored titles, keywords, and abstracts of the studies: TITLE-ABS-KEY (adoption OR use OR acceptation OR acceptance OR diffusion AND learning management system). In the temporal horizon field, the value "between 2018 – present" was set in the Scopus platform to ensure updated information within the prior five years, including studies from the year of study. We included articles, books, and book chapters in the review. Furthermore, we filtered the information by limiting the search to the areas of interest that were relevant in previous reviews conducted in the field: computer science, social sciences, decision sciences, and business, management, and accounting (de Oliveira et al., 2016). The selection criteria proposed included selecting journals with at least four published studies on the topic of interest and that the research belong to publications in the first 1000 positions of the SCImago Journal & Country Rank (SJR) in one of the areas of interest. We chose the mentioned ranking considering scientific indicators based on the Scopus database (SCImago, n.d.). After the search and filtering, 51 published papers remained, as shown in Table 1, but we performed the SLR with 50 publications because one was duplicated. The journals listed in Table 1 met the selection criteria.

Table 1: SLR publications with quality criteria

Review	Number of publications	Ranking	Area
Education and Information Technologies	16	631	Social sciences
British Journal of Educational Technology	8	192	Social sciences
Interactive Technology and Smart Education	7	87	Computer science
Journal of Theoretical and Applied Information Technology	6	251	Computer science
Interactive Learning Environments	5	528	Social sciences
Journal of Information Technology Education Research	5	84	Computer science
Australasian Journal of Educational Technology	4	461	Social sciences

2.2 Data Extraction

During data extraction, we divided the database into two large groups of information: general data per article and variable specifications. In the part of the database dedicated to general information per publication, we collected the following information: title of the study, main author, secondary authors, year of publication, journal, or publisher to which it belongs, type of document, type of process analyzed, LMS studied, methodological design, population analyzed, models used, and variables found. For the characteristics section of each variable found, we gathered the following information: name of the variable, definition, type of measurement, measurement scale, original item, relationship to other variables, and any pertinent observation.

2.3 Data Analysis

For the data analysis, we used bibliometrics. Bibliometric analysis allowed us to study, quantitatively, the information published on a topic of interest, taking each study as an individual case of analysis without examining its content (van Nunen et al., 2018). Figure 1 shows the number of publications per year yielded by applying the SLR protocol.

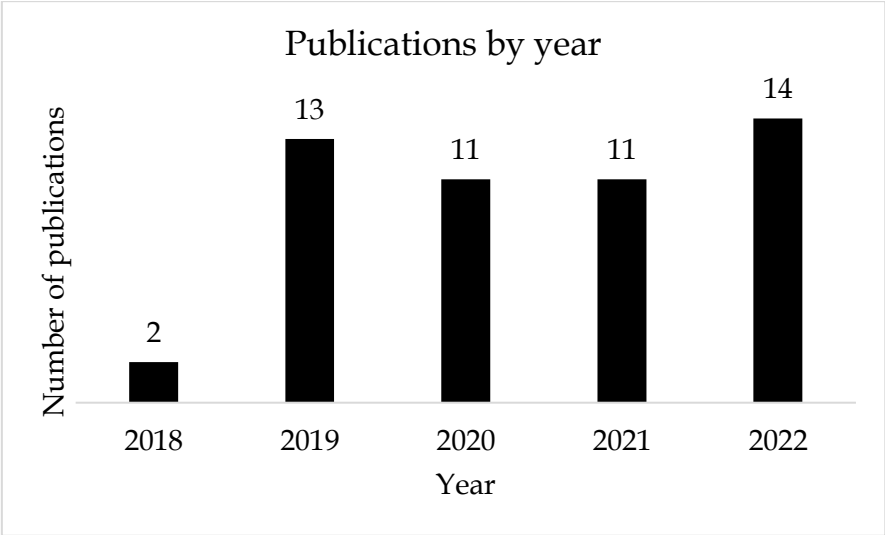

Figure 1: Number of publications per year

On average, about 10 studies were conducted per year from 2018 to 2022. 2022 has the highest number of publications, with 14, whereas the period with the fewest publications on the topic, according to the search criteria, is 2018, with only 2 studies. Altogether, the published papers included in the SLR have 146 different authors, with 8% of these authors involved in 2 publications, and 92% involved in 1 each. Considering the restrictions placed by the review protocol, the above shows many occasional authors or new researchers in the area.

The analysis found that for the selected publications, 85 institutions were involved, including universities, laboratories, and consulting firms. Figure 2 shows the institutions that were involved in at least two different publications. Three institutions were involved in three publications, and twelve in two

publications. Eighty-two percent of the institutions involved have one publication.

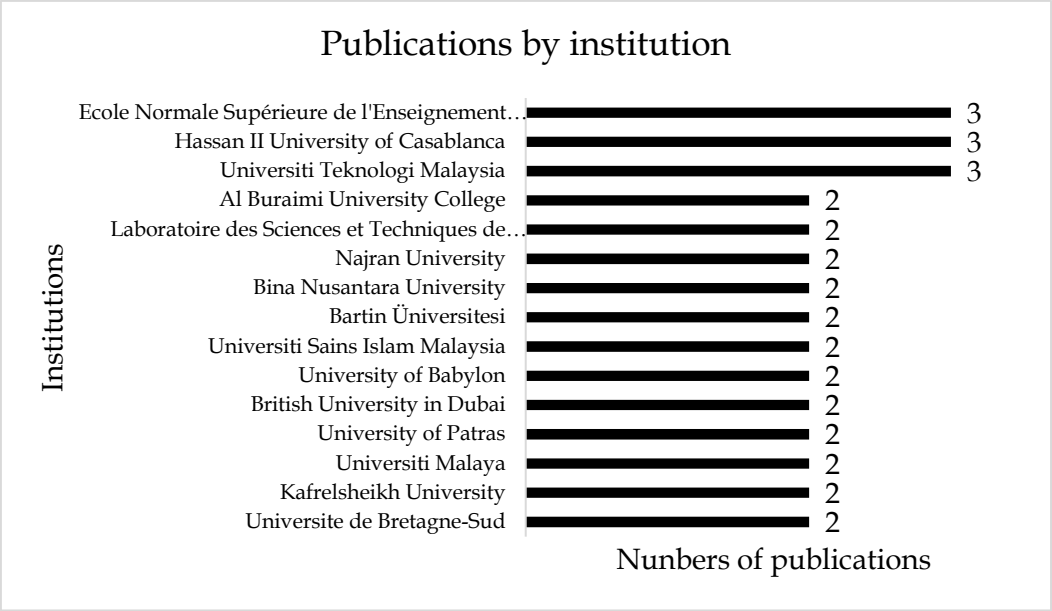

Figure 2: Number of publications per institution

Figure 3 shows the countries that were involved in at least three of the SLR publications. Malaysia and Saudi Arabia were involved in the highest number of publications, with six each. The SLR showed that 51 different countries were involved in the reviewed publications, according to the review protocol. Seventeen percent of the countries were involved in two publications, and about thirty percent in one each.

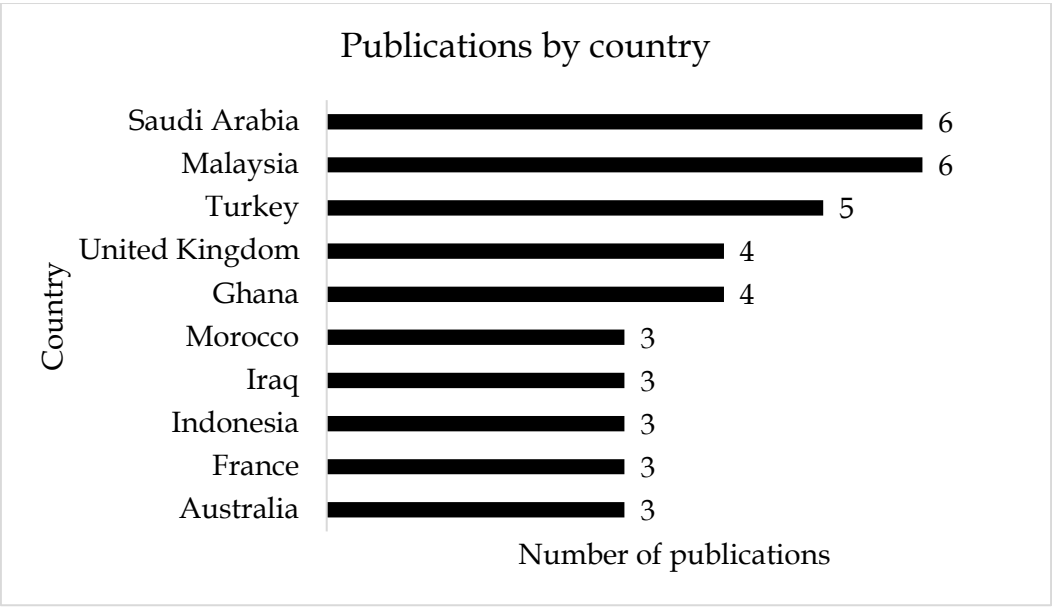

Figure 3: Number of publications per country

The 50 publications included in this SLR have been cited 612 in total. This is a significant number, especially considering the time limitations of the search protocol and the timeliness criteria of the studies. Table 2 shows the five publications with the highest number of citations. *Extension of technology acceptance model by using system usability scale to assess behavioral intention to use e-learning* by Revythi and Tselios (2019) is the publication that is part of the SLR which has the highest impact.

Table 2: Most cited publications

Authors and year	Title	Number of citations
Revythi and Tselios (2019)	Extension of technology acceptance model by using system usability scale to assess behavioral intention to use e-learning	70
Eraslan Yalcin and Kutlu (2019)	Examination of students' acceptance of and intention to use learning management systems using extended TAM	57
Garone et al. (2019)	Clustering university teaching staff through UTAUT: Implications for the acceptance of a new learning management system	41
Ashrafi et al. (2022)	Exploring factors influencing students' continuance intention to use the learning management system (LMS): A multi-perspective framework	40
Khechine et al. (2020)	The adoption of a social learning system: Intrinsic value in the UTAUT model	35

Figure 4 shows the authors in the SLR publications with the most citations. Tselios, N., Revythi, A., Kutlu, B., and Eraslan Yalcin, M. are the authors with the highest impact on the publications resulting from the search protocol.

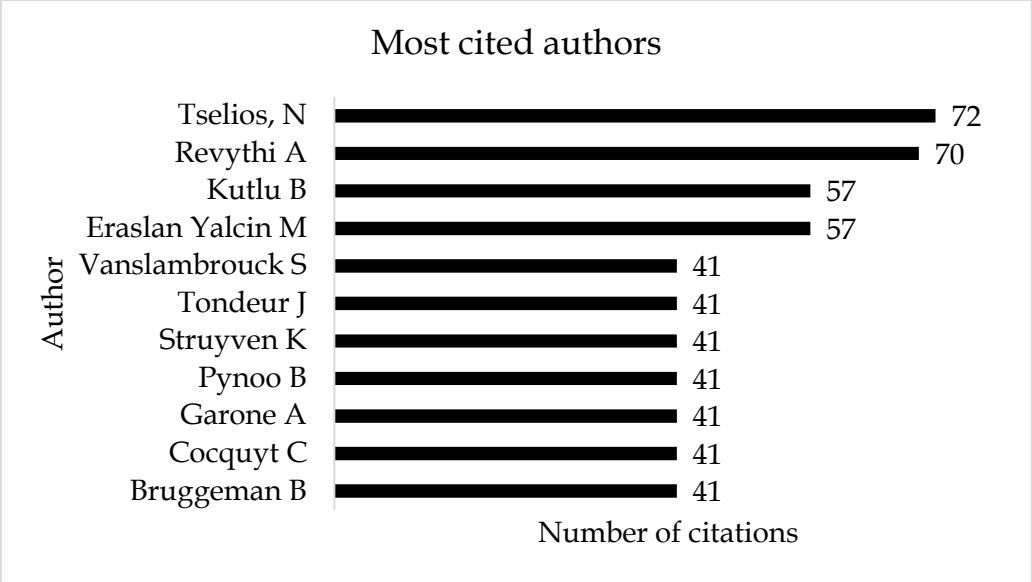

Figure 4: Number of citations per author

3. Analysis and Results

This section presents the results of the SLR in alignment with the questions formulated in Section 1. Various aspects pertaining to the variables involved in the process of adopting and utilizing LMSs are outlined. We also specify those variables that are directly implied on LMS adoption for face-to-face education support environments.

In the same way, the existing relationships between the different variables and the most used models in the explanation of the process of interest are pointed out. It is worth mentioning that a general analysis of the findings found in the SLR is made, according to the characteristics found in each of the publications included in the review. This general analysis includes type of process, population type, and LMS used, among other aspects, as shown in the following discussion.

3.1 General Analysis

Two of the fifty publications in this SLR were SLRs. Despite the nature of these studies, they were considered in the present review because it was evident that these two studies contain variables and relationships relevant to the object of study of this research.

Table 3 shows the type of educational process for which the LMS was used. In 60% of the cases, the LMS was used in an entirely virtual process (e-learning), which is a natural occurrence, since this is the primary use of LMSs (Al Rawashdeh et al., 2021). Ten percent of the SLR studies analyzed adopted a blended process (b-learning), which combines virtual with face-to-face learning. Four percent of the works studied the intention to use LMSs in remote teaching and learning processes, both motivated by the consequences of the Covid-19 pandemic (Al-Nuaimi et al., 2022; Hussein et al., 2021). Another 4% of the studies focused on adopting LMSs to support face-to-face learning, evidencing the little research in this area. Furthermore, 22% of the analyzed works did not specify the type of process, from which 4% were classified in the category of face-to-face learning support due to the descriptions given in the research.

Table 3: Type of educational process

Process	Frequency	Percentage
E-learning	30	60%
B-learning	5	10%
Distance learning (remote)	2	4%
Support for face-to-face attendance	2	4%
Possible support for face-to-face attendance	2	4%
Not mentioned	9	18%

Table 4 shows the LMSs used in the studies that were part of the SLR.

Table 4: LMSs used

LMS	Frequency	Percentage
Moodle	19	32%
Blackboard	7	12%
Google Classroom	7	12%
Canvas LMS	2	3%
eClass	2	3%
Edmodo	2	3%
Microsoft Teams	1	2%
Padlet	1	2%
Not mentioned / Does not apply	19	32%

It is important to note that some studies analyzed more than one LMS, so the total sum of LMSs used is greater than the number of publications analyzed. A large percentage of the studies (32%) did not specify the LMS used by the population under study. This may be because the studies focused on analyzing adoption as a process and the variables involved, based on previously proposed models, leaving aside the LMS. Moodle was the most studied LMS, with 32%, which was quite expected, since this platform is one of the most used knowledge management tools (Simanullang & Rajagukguk, 2020). Blackboard and Google Classroom follow Moodle as the most analyzed LMS, with 12% each.

Table 5 shows the main methodological designs used in the publications reviewed. Some studies used more than one methodology; however, the analysis indicated the survey as the main methodological design. For example, when a study used a survey as the primary methodology complemented by secondary information in the methodological design, we counted survey as the main methodological method.

Table 5: Methodological design used

Methodological design	Frequency	Percentage
Survey	40	80%
Secondary information	6	12%
Design of experiments	2	4%
Case studies	1	2%
Interviews	1	2%

The results show that the most used methodological design was the survey method, a methodology used in 80% of the research. The purpose of this type of methodology is to collect information through structured questionnaires. The questionnaires are applied to a population or population sample, representative or not, according to the results to be obtained, to the hypotheses and research questions. The survey thus allows the researchers to capture perceptions,

opinions, qualitative or quantitative data about the process, as well as the results to be obtained (Yin, 2017).

Secondary information was the second most used methodological design. As mentioned, there are two SLRs among the works on which we based this review. Although SLR can be considered another methodological design by itself, it was considered as "secondary information" because in this type of methodological design, information developed in previously published studies is used (Al-Nuaimi & Al-Emran, 2021; Granić, 2022). In addition, information corresponding to user access to LMS platforms is also used (Wells et al., 2021) and allows new models to be proposed, relating variables developed in previous studies (Alduraywish et al., 2022; Louhab et al., 2020).

The third most used methodological design was the experimental design. In this methodology, the study population is divided to compare the differences in user behavior and whether technological tools or LMSs were used (Elfeky & Elbyaly, 2021b, 2021a).

Table 6 shows the populations analyzed in the reviewed studies.

Table 6: Population analyzed

Analyzed population	Frequency	Percentage
Students	40	68%
Teachers	14	24%
Administrative staff	4	7%
Not mentioned	1	2%

Because some publications analyzed more than one population, the total frequency is greater than the number of studies that were part of the SLR. The results in Table 6 show that most of the studies analyzed in the SLR (68%) addressed adoption issues from the students' point of view, such as how students perceive and start using an LMS, the variables involved in the process, and their relationships. Much of the research on LMS adoption pays particular attention to student use; however, there are efforts to understand the phenomenon from the point of view of other actors, especially teachers (Hussein et al., 2021; Stockless, 2018). In the case of the current SLR, studies addressing adoption by this population correspond to 24%.

3.2 Most Representative Study Variables and Their Relationships

This section aims to answer RQ1 and RQ2 of the formulation of the review problem. As such, the most representative variables and the existing relationships between these variables will be shown. We took the number of occurrences of each variable as a criterion of importance within the process of adoption and use of LMS due to the large number of factors found in the SLR, 295 in total. Considering repetitions of variables, for the same reason, we divided the variables into different categories. These categories are user perception variables; quality variables; user ability-, skills-, or personality trait-related variables; social

influence variables; behavior variables; technical and access conditions variables; attitude towards use variables; intention to use variables; and cost variables.

3.2.1 User perception variables

Table 7 shows the user perception variables found in the SLR. Due to the number of variables in this category (105), the results show the factors with the highest frequency.

Table 7: User perception variables

Variable	Frequency
Perceived usefulness (performance expectancy, relative advantage)	32
Perceived ease of use (effort expectancy, cognitive load, learning value)	31
Facilitating conditions (perceived external control)	14
Satisfaction (user satisfaction, system satisfaction, learning satisfaction)	10
Hedonic motivation (perceived enjoyment, perceived playfulness, intrinsic value)	6
Technological complexity (complexity)	3

The variable with the highest frequency is perceived usefulness, which refers to how users perceive that a system will help them perform their work more efficiently (Al-Nuaimi et al., 2022). From the point of view of LMSs, perceived usefulness measures the extent to which a person believes that using an LMS can improve their performance in their various activities (Hussein et al., 2022). As can be seen in Table 7, the variable was grouped with performance expectancy and relative advantage because they are very similar constructs but in different technology adoption models (Al-Nuaimi & Al-Emran, 2021).

Perceived usefulness positively affects the attitude users take towards LMS use (Safsouf et al., 2020); likewise, the higher the perceived usefulness, the higher the intention to use (Kaewsaiha & Chanchalor, 2021). User satisfaction is also affected by perceived usefulness (Hussein et al., 2021); as a sense of community, perceived usefulness exerts an influence on LMS acceptance (Ustun et al., 2021), current use (Abdallah et al., 2019), and continued use (Hussein et al., 2022). Performance expectancy has equal relationships with the variables attitude towards use (Buabeng-Andoh & Baah, 2020), intention to use (Wut & Lee, 2021), and use of an LMS (Mohammadi et al., 2021). Meanwhile, relative advantage positively affects perceived usefulness, perceived ease of use, and current use of the LMS (Stefanus & Mauritsius, 2019).

The variable with the second highest frequency of occurrence is perceived ease of use, defined as the degree to which a person believes that using a system will not require much effort (Kaewsaiha & Chanchalor, 2021). From the point of view of the LMS, the user perceives that the LMS is easy to use and does not represent extra work (Hussein et al., 2021). This variable was grouped with effort

expectancy, cognitive load, and learning value, since these constructs capture the exact conceptual nature in different models (Al-Nuaimi & Al-Emran, 2021).

Perceived ease of use positively impacts perceived usefulness (Elfeky & Elbyaly, 2021b). Similarly, the higher the user's perceived ease of use, the better their attitude towards the LMS (Revythi & Tselios, 2019), and thus their intention to use (Eraslan Yalcin & Kutlu, 2019), their current use (Abdallah et al., 2019), and their continued use. Perceived ease of use also interferes with user satisfaction (Hussein et al., 2022) and their sense of community (Ustun et al., 2021). Effort expectancy has equal relations with attitude towards LMS use and intention to use. However, it links performance expectancy (Buabeng-Andoh & Baah, 2020) and social influence (Bervell et al., 2022).

The third factor in the user perception category is facilitating conditions, which indicates the degree to which a person perceives that the technological and organizational infrastructure exists to allow the correct functioning of the technology of interest, in this case, the LMS (Alotumi, 2022). Facilitating conditions positively influence perceived ease of use (Unal & Uzun, 2021). Technological and organizational infrastructure around the LMS facilitates behavior (Alotumi, 2022), understood as the tendency to continue using the LMS. Facilitating conditions also affect hedonic motivation, defined as the degree to which the user perceives using the LMS as pleasurable. Facilitating conditions are directly related to social influence (Bervell et al., 2022), intention to use (Micchelucci Malanga et al., 2022), current use (Alshehri et al., 2020), and continued use of the LMS (Kuadey et al., 2023).

Satisfaction is the variable with the fourth highest number of occurrences in the context of user perception. It constitutes the degree to which a user perceives that using the LMS will provide a positive learning experience and meet their expectations (Hussein et al., 2022). We grouped this construct with user satisfaction, system satisfaction, and learning satisfaction. Satisfaction affects the intention to use and reuse an LMS (Stefanus & Mauritsius, 2019). The higher the satisfaction, the higher the net benefit. The latter is the total value of implementing technologies, including LMSs, in educational settings (Al-Azawei, 2019).

Hedonic motivation comprises the fifth variable in terms of user perception and is grouped with the following constructs: perceived enjoyment, perceived playfulness, and intrinsic value. Hedonic motivation refers to the user's perception of enjoying using a specific technology. This variable positively influences behavior, that is, the continued use of an LMS (Alotumi, 2022). In the same way, hedonic motivation interferes with intention to use (Bervell et al., 2022). Perceived enjoyment and perceived playfulness affect perceived usefulness (Granić, 2022) and perceived ease of use; likewise, continued intention to use is affected when there are perceived enjoyment and intrinsic value (Khechine et al., 2020; Kuadey et al., 2023).

The sixth variable in terms of user perception corresponds to technological complexity, defined as the degree to which a user perceives technology as difficult

to use (Unal & Uzun, 2021). The higher the technological complexity, the lower the perceived ease of use (Granić, 2022).

3.2.2 Quality variables

Table 8 shows the quality variables identified in the SLR. Due to the number of variables found for this classification, 20 in total, the factors with the highest frequency of study are shown in the results.

Table 8: Quality perception variables

Variable	Frequency
Information quality	10
System quality	9
Service quality	3
Content quality	3
User interface design	3
LMS quality	2

The variable with the highest number of occurrences is information quality. Hussein et al. (2022) stated that information quality is related to the accuracy and adequacy of the information obtained from the LMS. Information quality is an output generated by an information system, the LMS in this case, which includes categories such as being timely, having sufficient scope, relevance, efficiency, timeliness, completeness, and accuracy of information (Abdallah et al., 2019). Information quality positively affects perceived ease of use (Al-Nuaimi et al., 2022), perceived usefulness (Hussein et al., 2022), intention to use (Wut & Lee, 2021), current LMS usage (Abdallah et al., 2019), and user satisfaction (Wirawan et al., 2018).

System quality is the second most studied variable in the quality category. It is related to the technical factors of LMSs, such as stability, reliability, interface design, and efficiency (Hussein et al., 2022). Al-Nuaimi et al. (2022) defined the system quality of an LMS as the efficiency of LMS performance in terms of key indicators such as reliability, functionality, usability, ease of use, navigability, and accessibility as perceived by end users, teachers, and students. System quality also implies interactivity, responsiveness, and absence of errors. The latter positively affects perceived usefulness (Hussein et al., 2022), perceived ease of use (Granić, 2022), intention to use (Yakubu et al., 2020), current use (Abdallah et al., 2019), and user satisfaction (Safsouf et al., 2020).

The third variable in quality factors is service quality. This factor focuses mainly on the quality of technical support during the use of the LMS (Hussein et al., 2022). It indicates the overall support of the information system provided by the service provider, including helpdesk services, hotlines, online support services, and other type of services (Abdallah et al., 2019). Service quality directly correlates with perceived ease of use (Al-Nuaimi et al., 2022).

Content quality is the fourth variable in the quality category. In this regard, the LMS must contain stable, accurate, and high-quality information sources. The

information presented must be reliable and error-free to perceive high quality in the contents. Accessing high-quality LMS information would be a leverage point for users and students to be convinced that the current platform can respond to the educational needs they are following and, therefore, increase the perceived usefulness of the LMS (Ashrafi et al., 2022).

The fifth variable, user interface design, is related to menu design, including control bars, screen layouts, and icons (Eraslan Yalcin & Kutlu, 2019). Users perceive the design as relevant, interfering with perceived ease of use and perceived usefulness (Yakubu et al., 2020).

The sixth study variable in this category corresponds to the quality of the LMS. Mohammadi et al. (2021) defined this variable in terms of usability, that is, the level of complexity or ease of use of the LMS for the user, and in terms of functionality, that is, how well the LMS works during use. The quality of the LMS affects the use of the LMS.

3.2.3 User ability, skills, or personality traits variables

Table 9 shows the variables related to the LMS users' capacity, ability, and personality. Due to the number of variables identified for this category, we show the concepts with the highest frequency of occurrence in the results.

Table 9: Capacity-skills-related variables

Variable	Frequency
Computer self-efficacy	10
Personal innovativeness	5
ICT competency	5
Computer anxiety	3
Level of education	2

Computer self-efficacy is the variable with the highest number of occurrences in this category, defined as individuals' beliefs regarding their control over their ability to use a system (Safsouf et al., 2020). The concept refers to the individual's perception of their ability to use a computer system, in this case, an LMS (Unal & Uzun, 2021) Computer self-efficacy positively affects perceived usefulness (Stefanus & Mauritsius, 2019), perceived ease of use (Eraslan Yalcin & Kutlu, 2019), intention to use (Revythi & Tselios, 2019), and intention for continued use (Al-Adwan et al., 2022).

The second variable identified in the category is personal innovativeness. It refers to the willingness of individuals to experiment with new technologies (Hussein et al., 2022). In the context of the LMS, it relates to an individual's attitude that reflects their willingness and ability to try a technology enthusiastically and sometimes independently (Abdallah et al., 2019). Innovative personality has positive effects on perceived ease of use (Stefanus & Mauritsius, 2019), perceived usefulness (Abdallah et al., 2019), intention to use (Zwain, 2019), and current use (Pinho et al., 2021).

ICT competency is the variable with the third highest ranking in this category. It represents the degree of knowledge and experience using computers and the Internet. It describes the level of knowledge and experience in using any LMS (Mohammadi et al., 2021). Competencies and skills in technologies increase perceived usability (Vlachogianni & Tselios, 2021), LMS usage (Mohammadi et al., 2021), and user satisfaction (Al-Azawei, 2019).

The fourth variable is computer anxiety, defined as the degree of fear when a person is faced with the possibility of using a computer (Safsouf et al., 2020). Anxiety decreases perceived usefulness and ease of use (Hussein et al., 2022).

Level of education is the fifth variable in the category of abilities, skills, or personality traits. The publications reviewed did not define this variable; however, it positively affects perceived usability (Vlachogianni & Tselios, 2021) and the intention to use an LMS (Revythi & Tselios, 2019).

3.2.4 Social influence variables

Social influence was grouped with subjective norm, social norm, and image. These constructs correspond to very similar concepts (Al-Nuaimi & Al-Emran, 2021) and to the only factor with a considerable number of occurrences (25 occurrences). Social influence is the level at which a person believes that people who are essential around them think that they should use the new system (Alotumi, 2022). In this case, the new system is an LMS. Social influence has a positive effect on perceived ease of use (Revythi & Tselios, 2019), perceived usefulness (Unal & Uzun, 2021), attitude towards use (Buabeng-Andoh & Baah, 2020), intention for continued use (Bervell et al., 2022), and current use. Sense of community (Ustun et al., 2021) and social interactions (Safsouf et al., 2020) also appear in this category, with one appearance in the studies for each variable.

3.2.5 Behavior variables

Behavior is defined as the extent to which individuals tend to perform actions automatically due to learning, thus equating behavior with routine and life experience (Micchelucci Malanga et al., 2022). In the context of the LMS, behavior refers to the indirect adoption of technology because it is central to users' daily lives (Micchelucci Malanga et al., 2022). Behavior has a positive influence on performance expectancy (Alotumi, 2022), effort expectancy, social influence, hedonic motivation (Bervell et al., 2022), intention to use (Micchelucci Malanga et al., 2022), and current use (Zwain, 2019). Other variables referring to behavior appeared in the search, but with somewhat limited study frequency, as shown in Table 10.

Table 10: Behavior variables

Variable	Frequency
Behavior	4
Learning tradition	1
Faculty resistance	1
E-learning frequency	1

3.2.6 Technical and access conditions variables

Table 11 shows the variables belonging to technical- and access-related aspects as identified in the SLR.

Table 11: Technical and access variables

Variable	Frequency
System accessibility	3
Availability of resources	1
Access to electricity	1
Access to Internet	1
Affordances	1
Observability	1
Compatibility	1
Trialability	1

System accessibility is the technical and access variable with the highest number of appearances in the SLR publications. The degree to which students access an LMS is understood as accessibility (Stefanus & Mauritsius, 2019). Accessibility to the system positively influences attitude towards use, intention to use, perceived usefulness, and perceived ease of use (Revythi & Tselios, 2019).

3.2.7 Attitude towards use variables

Attitude towards use relates to whether individuals perceive a positive or negative feeling related to using a system. In this case, the system is the LMS, so attitude towards LMS is defined as the user's impression of engaging in learning activities by using the LMS (Safsouf et al., 2020). Attitude towards use positively influences intention to use (Elfeky & Elbyaly, 2021b). Attitude strength, defined as the degree to which attitude manifests itself through temporal persistence, resistance to persuasion, and predictability of behavior, positively affects performance expectancy, effort expectancy, and social influence (Nistor et al., 2019).

3.2.8 Intention to use variables

Behavioral intention to use any proposed system consists of adoption and intention for continuous use (Kaewsaiha & Chanchalor, 2021). For Eraslan Yalcin and Kutlu (2019), intention to use measures the likelihood that a person will employ the application, in this case, an LMS. Table 12 shows the usage variables corresponding to response variables in the models used to analyze LMS adoption and usage. Intention to use positively affects current use (Wut & Lee, 2021), satisfaction, and learning achievement (Stefanus & Mauritsius, 2019). Continued intention to reuse is the extent to which an individual is inclined to continue using a particular LMS for learning activities (Hussein et al., 2022). This variable positively influences current use (Alshehri et al., 2020) and continued use (Kuadey et al., 2023).

Table 12: Intention to use variables

Variable	Frequency
Behavioral intention to use	22
Continued intention to reuse	7

3.2.9 Cost variables

Among the cost variables, we identified the cost of the Internet, defined as the amount of money paid to access the Internet; and the cost of hardware, described as the expenses associated with the hardware devices used for learning. These variables are limiting factors in the use of the LMS (Mohammadi et al., 2021).

3.3 Most Representative Variables on LMS Adoption and Use to Support Face-to-Face Educational Processes

This section aims to answer RQ3 of the SLR by identifying the most representative study variables and their associations in the use of LMSs to support face-to-face learning. Only two of all the publications analyzed in this study addressed the issue of adoption and use of LMSs to support face-to-face learning. The first study, by Wells et al. (2021), focuses on understanding the behavior of university students, analyzing their access to the LMS, and the use of the different resources offered by the LMS. We did not find any factors related to adoption and use.

The other work on face-to-face learning supported by LMSs is that by Unal and Uzun (2021). These authors determined factors influencing the intention to use Edmodo, analyzing 218 university students using partial least squares structural equations. We identified the following variables (Unal & Uzun, 2021):

- *Perceived usefulness*, understood as the degree to which a person believes that using a particular system would improve their job performance, positively affects behavioral intention to use and attitude towards use.
- *Perceived ease of use* is the degree to which a person believes that using a particular system would be free of physical and mental effort. It positively influences attitude towards use and perceived usefulness.
- *Subjective norm*, the individual's perception that most important people think they should (or should not) perform a particular behavior, positively influences perceived usefulness.
- *Output quality*, the degree to which the individual perceives how well the system performs tasks, positively affects perceived usefulness.
- *Perceived external control*, defined as the degree to which an individual believes that organizational and technical resources exist to support system use, positively affects perceived ease of use.
- *Perceived enjoyment*, which is the extent to which the activity of using a particular system is perceived as enjoyable, independent of any performance consequences resulting from the use of the system, positively influences perceived usefulness.
- *Technological complexity*, conceptualized as the degree to which a system is considered difficult to use, negatively affects perceived ease of use.
- *Computer self-efficacy* is the individual's belief that their ability to use a computer system has a positive effect on perceived ease of use.

- *Attitude towards use* (attitude towards using), specified as the individual's positive or negative feelings about performing the behavior, positively influences the intention to use an LMS.

3.4 Used Models to Explain LMS Use and Adoption

This section attempts to provide an answer to RQ4 of this SLR. Table 13 shows the models used in the studies analyzed. Derivations of the original models are not considered, as in the case of the technology acceptance model (TAM) and the unified theory of acceptance and use of technology (UTAUT), which have some derivations, TAM2 and TAM3 in the case of the TAM and UTAUT2 for the UTAUT model. The joint use of two or more models in the same study was also not considered. In these cases, only the main model, as identified by the authors, was considered.

Table 13: Models for explaining LMS use and adoption

Variable	Frequency
TAM	21
UTAUT	18
DeLone & McLean model	9
Expectation confirmation model	3
Interpretive structural modelling (ISM)	1
Innovation diffusion theory	1
Service quality evaluation model	1
Transformative learning theory	1
Cognitive load theory	1
Service quality evaluation model	1
Theory of planned behavior (TPB)	1

Three models were widely used to explain the LMS adoption and use process. The most widely used model is the TAM, introduced by Davis in 1986 in a doctoral dissertation at the Massachusetts Institute of Technology (MIT). Since then, it has been one of the most widely used and cited models to explain individuals' intention to accept new technology, including an LMS (Kaewsaiha & Chanchalor, 2021).

The TAM is a model on technology adoption by individuals based on the theory of reasoned action (TRA), which predicts the user's intention to accept a technology. According to the TAM, two crucial factors determine a consumer's intention to accept a new technology: perceived ease of use and usefulness, which become the antecedents for technological adoption (Davis, 1986). The TAM is illustrated in Figure 5.

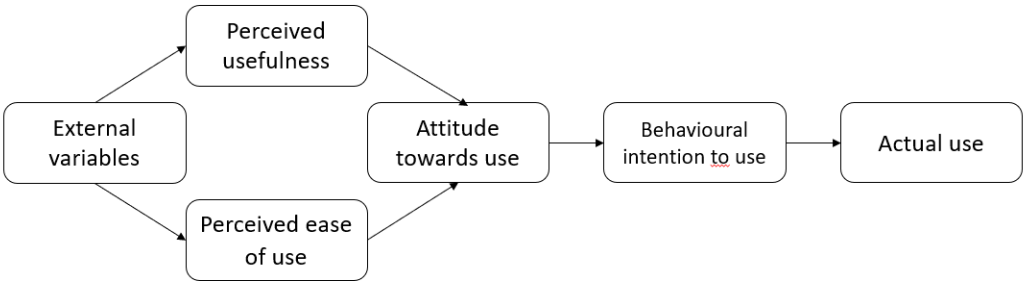

Figure 5: The TAM model (Davis, 1986)

The second most widely used model is UTAUT, proposed by Venkatesh et al. (2003). UTAUT attempted to consolidate existing research and models on technology adoption at the time by comparing and integrating about eight pre-existing models. According to UTAUT, technological adoption has four dimensions: performance expectancy, effort expectancy, facilitating conditions, and social influence, as shown in Figure 6. In addition to the mentioned dimensions, we included four moderating variables: gender, age, experience, and willingness to use.

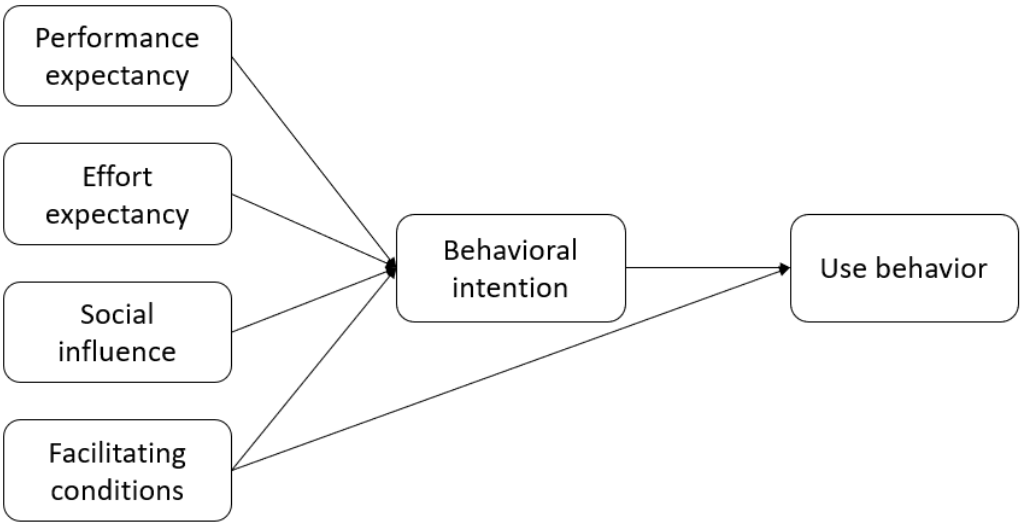

Figure 6: The UTAUT model Venkatesh et al. (2003)

The third most widely used model is that of DeLone and McLean (1992), known as the information systems success (ISS) model or D&M ISS model. This proposal seeks to elucidate the success of information systems based on quality constructs. This use and user satisfaction of this model depend on the system and information quality.

System quality refers to the characteristics of the information system in terms of usability aspects and performance characteristics. Several indicators measure the quality of information systems, such as access, convenience, customization, data accuracy, data updating, ease of learning, ease of use, efficiency, and flexibility, among other indicators (DeLone & McLean, 2003).

Information quality relates to the characteristics of the information system in which the output information generated by the system is helpful to the users of the application. The quality of information can be measured by several indicators, such as accuracy, adequacy, availability, completeness, conciseness, consistency, format, and precision (DeLone & McLean, 2003). The proposed model is illustrated in Figure 7.

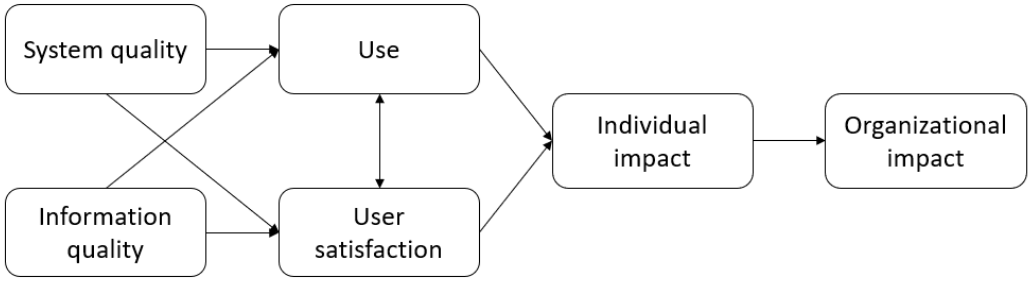

Figure 7: The D&M ISS model

4. Conclusion

The primary purpose of this paper was to review the variables and the relationships between them in the LMS adoption process where an LMS is primarily used to support face-to-face educational processes. From the bibliometric results presented, we observed a high proportion of occasional authors and many citations of the publications, despite the time limits of the search protocol. According to the analyzed studies, the most studied process corresponds to e-learning. In contrast, the least studied in the literature is LMSs as support for face-to-face educational processes, showing an opportunity for research in the area. The research analyzed many LMSs, but Moodle stood out among those studied. Regarding the population under study, students had the highest rate of participation in the works analyzed in the review, far above those by teachers and other actors.

It is important to mention that the use of the LMS to support face-to-face learning is primarily motivated by the teachers' use of these systems. The large number of variables and their relationships denote that the process of adoption and use of LMSs is complex by nature, which gives rise to studies with methodologies that incorporate the complexity and non-linearity of the phenomenon (Al-Nuaimi et al., 2022).

We found 265 factors that determine the use of LMSs, with multiple relationships among them. We classified the variables into user perception, quality, user skills, social influence, behavior, access, cost, attitude towards use, and intention to use variables. Concerning the use of the LMS to support face-to-face education, we found that perceived usefulness, perceived ease of use, subjective norm, output quality, perceived enjoyment, technological complexity, and computer self-efficacy are important variables for adoption. Furthermore, we identified a total of 11 different models used by the publications under review. Their variations and combinations show diverse views on the phenomenon. The TAM, UTAUT, and D&M ISS models were the most used models.

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