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# Learning Analytics to Support Teaching Skills: A Systematic Literature Review

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**ABSTRACT** Learning Analytics is a vast concept and a rapidly growing field in higher education used by professors to measure, collect and analyze digital learning records to improve learning, generate new pedagogies, and make decisions about technology-driven learning. The following article presents a mapping and systematic literature review on Learning Analytics and its link to the teaching skills carried out in university practice. The research process reviewed 7,886 articles during the period from 2016 to 2020. After applying the inclusion and exclusion criteria, 50 articles were analyzed in-depth under the dimensions of (1) purposes of Learning Analytics, (2) teaching competencies, and (3) teaching practice in higher education. This work provides a basis for identifying gaps and research opportunities related to the application of teaching competencies in the field of Learning Analytics and incorporating it into teaching practice in online tutoring.

**INDEX TERMS** Learning analytics, teaching competence, teaching practice, systematic literature review, higher education.

## I. INTRODUCTION

Learning Analytics (LA) is the analysis and visualization of student data in order to improve education [1]. It aims to optimize the teaching-learning process through data analysis in order to improve decision-making and benefit the involved parties. For teachers, the use of LA represents a basis for improving teaching processes in the classroom and for monitoring, analyzing, predicting, and intervening in student performance during the teaching process.

With the increase of technology, the world has changed, and so has education; LA contributes with massive data through technology. When did the concept of LA emerge, and how has it evolved? The most popular definition was presented by the Society for Learning Analytics Research (SOLAR) at the First Learning Analytics and Knowledge Conference in 2011 and stated that LA is the measurement, collection, analysis, and reporting of data about learners and their contexts, in order to understand and optimize learning and the environments in which it occurs [2], [3]. LA involves measuring, collecting, analyzing, and reporting data about

learners and their contexts to understand and optimize learning and the environments in which it occurs [4]. Although [5] says that LA is a broad term that sometimes refers to the prediction of complex models, [6] defines it as a discipline that uses intelligent data, analysis models, and learner-centered data generation. LA is also considered as the art and science of collecting, analyzing, and reporting data about learners in and seeking to improve teaching-learning processes [7] [8].

This article aims to link LA to the Information and Communications Technology (ICT) competencies described by UNESCO and their implementation in teaching practice.

While digital technology is increasingly common in schools and classrooms, finding ways to improve student learning remains a challenge for researchers and practitioners [9]. In order to optimize the learning process and the work of teachers, UNESCO developed the ICT Competency Framework for Teachers (ICT-CFT) as a guiding tool to bring teachers closer to the use of ICT in education. Within the framework of the 2030 Agenda for Sustainable Development, ICT-related targets are mainly found in Goal 4: Quality Education. Version 3 of the ICT-CFT was launched in 2018, including recent changes and technological developments in education. This latest version includes other aspects, such as

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the implementation of artificial intelligence, the Internet of things, and mobile technologies.

Educational institutions are increasingly using LA to identify and act with students at risk of underachievement or disruption [10]. For teachers, the task of integrating the use of LA into education is an opportunity to develop digital skills related to the knowledge society, and to enable their students to use and benefit from them as well. Achieving these social and economic goals is critical for the global education system. Teachers must be equipped to guide the next generation to adopt these goals and achieve them [11].

The ICT-CFT indicates six aspects of teacher professional practice, each consisting of 3 levels, adding up to 18 competencies. If teachers have competencies in using ICT, then they will be able to deliver better quality education. The six aspects are: (1) understanding the role of ICT in education policy, (2) curriculum and assessment, (3) pedagogy, (4) application of digital skills, (5) organization and management, and (6) professional learning by teachers. The first level is knowledge acquisition, the second level is knowledge enhancement, and the third level is knowledge creation. At this point, the question is, how has teaching practice developed by applying LA, and how does it relate to UNESCO's ICT competencies?

Researchers have argued that understanding patterns in the vast amount of data available could be valuable in addressing dropout problems in online learning, in improving student participation and performance, and overall learning experiences that lead to improved student satisfaction [12].

As a newly defined field, LA draws on theories and methodologies from disciplines as diverse as education, psychology, philosophy, sociology, linguistics, learning sciences, statistics, artificial intelligence, and computer science that must dialogue with each other to ensure educational improvement [3], [6], [13].

The research process contemplated a review of 7,886 articles framed between 2016 and 2020, which, after applying the criteria of inclusion and exclusion (Table 1), made an in-depth analysis of 50 articles under the dimensions of (1) purposes of LA, (2) teaching skills and (3) teaching practice in higher education.

The contribution of this work is framed in: (a) identifying the objectives of applying LA in higher education; summarizing the ways of using LA in teaching practice; (c) summarizing the results of studies related to the association of teaching competencies with the use of LA in the university context.

The remainder of the article is organized as follows: section II describes the review method; section III includes the results (mapping and systematic review) and section IV discussion. Finally, section V concludes with the study.

## II. REVIEW METHOD

The systematic literature review was based on the procedure suggested by the method by [14], [15], [62], [63], [64].

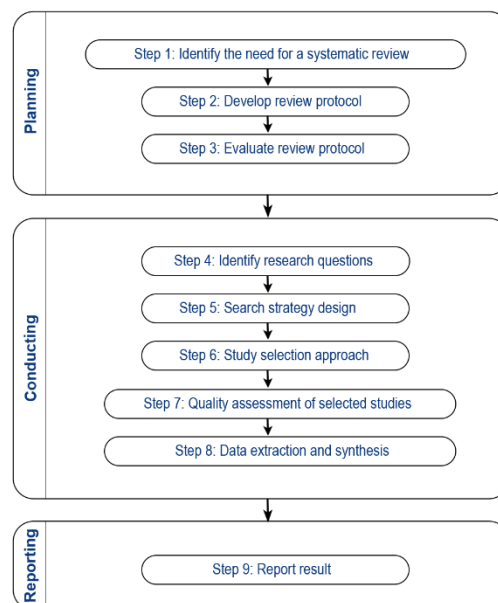


FIGURE 1. Systematic review process.

The main objective is to review the literature to identify, evaluate and interpret existing studies on a research topic.

This procedure is based on three moments that are established in Figure 1: (1) planning, (2) conducting, and (3) reporting the study.

### A. PLANNING REVIEW AND MAPPING

This phase identified the need for a systematic review to identify gaps and opportunities for research related to the application of teaching competencies in Learning Analytics and their incorporation into teaching practice in online tutoring.

A review protocol was planned for the study's validity and to avoid research bias. Three researchers with expertise in the study variables participated in the design of the protocol, which resulted in the development and evaluation of the research protocol after several meetings and discussions.

After planning the review and mapping, we proceeded to: (a) identify the research questions (b) design the search strategies; (c) establish the inclusion and exclusion criteria for the study; (d) evaluate the quality of the selected studies; (e) data extraction and synthesis; and (f) reporting of results.

### B. RESEARCH QUESTIONS

#### 1) MAPPING QUESTION (MQ)

To develop the mapping, we proceeded to establish the following questions:

**MQ1.** How many studies have been published during the years 2016 -2020?

**MQ2.** What is the geographical distribution of publications in LA?

**MQ3.** What have the main benefits of applying LA been?

**MQ4.** In which areas has LA been applied?

**MQ5.** What is the most used language in this type of publication?

## 2) RESEARCH QUESTION (RQ)

To develop the systematic literature review, the following research questions were established from three dimensions: (1) purposes of LA; (2) teaching competence; and (3) teaching practice:

**RQ1.** What are the purposes for which LA has been applied in higher education?

**RQ2.** How are teaching competencies associated with the use of LA in the university context?

**RQ3.** How has LA been applied in teaching practice?

## 3) SCOPE OF THE RESEARCH

To define the scope of the research, the PICOC method proposed by [65] was considered:

**Population/Problem (P):** the target group for the research. In this study: learning analytics.

**Intervention (I):** this element specifies the research aspects or topics of interest to the researchers. In this case, the research gaps and opportunities related to the application of teaching competencies in the field of LA and their incorporation into teaching practice in online tutoring between the years 2016 to 2020.

**Comparison/Control (C):** element of the research to which the intervention is compared. In the case of this work, we did not seek to make comparisons between different LA application settings.

**Outcomes of interest (O):** the effect of the intervention. Proposals for the application of LA in teaching practice and its link with teaching competencies in the university context were sought.

**Context (C):** the research setting or environment. In this sense, the higher education environment was taken into consideration.

## C. SEARCH STRATEGY

At this stage, the concepts of the search were determined: teaching practice, learning analytics and teaching skills, which emerged from a process of review and narrative analysis of the current literature, where an opportunity was found to investigate the application of teaching competencies in the field of LA and its incorporation into teaching practice in the university context.

The period from 2016 to 2020 was chosen due to the fact that in these last 5 years the topic of the use of LA has become more relevant in higher education, transforming educational models and allowing new changes in teaching practice [66].

To establish the databases (DB), the recommendations of [62], [67] were considered, which ensure that WoS and Scopus databases aggregate most of the most relevant scientific content. We also considered including specific databases in the field of study and accessible from the university library; seven databases were selected: WoS, Scopus, SciELO

Citation Index, ScienceDirect, Scielo, IEEE Xplore and Google Scholar.

To carry out the information search process, inclusion and exclusion criteria were established, as shown in Table 1, and the searches were carried out during the year 2020. Scientific articles or book chapters in open access were considered for the study; documents that to be published in journals are thoroughly evaluated by reviewers and editors to verify the validity of the shared knowledge. Open access is one of the criteria that promotes the democratization of knowledge, allowing scientific literature to be available, thus eliminating economic barriers and, in no small extent, reuse permissions [68].

Once the DB were chosen, search equations were developed, including the critical concepts linked by Boolean operators. Each keyword was searched in the two established languages.

Some of the combinations used, based on the keywords, were:

- “Higher education” AND “Literature Review” AND “Learning Analytics”
- “Review” AND “LA” AND “Higher education”
- “Systematic Literature Review” AND “Learning Analytics” AND “Higher education”
- “Review” AND “Teaching practice” AND “Learning Analytics”
- “Review” AND “Learning analytics” AND “Higher education”
- “Revisión de la literatura” AND “Analíticas de aprendizaje” AND “Educación Superior”
- “Práctica docente” AND “Analíticas de aprendizaje” AND “Revisión de la literatura” AND “Educación Superior”

## D. STUDY SELECTION

To answer the different questions posed, six inclusion criteria (IC) and six exclusion criteria (EC) were established as shown in Table 1.

## E. QUALITY ASSESSMENT

Based on the established inclusion criteria, a Google form was developed in order to apply a final filter to the selected documents. This form included several indicators organized into two sections:

- **Section 1. Dissemination aspects:** database where the document is located; type of document; language; author’s name; year of publication; document name; and means of dissemination.
- **Section 2. Theoretical-methodological aspects:** state of the art; background; methodology; instruments (validity and reliability); theory underlying the research; text related to the keywords; study participants, and emerging concepts. Each indicator was evaluated with one of three values: 5 (mentioned and is the central theme), 3 (mentioned, but is not the central theme), and 1 (not mentioned).

TABLE 1. Inclusion and exclusion criteria.

Inclusion criteria (IC)	Exclusion criteria (EC)
<ul style="list-style-type: none"> <li>IC1 - Type of document: scientific article, book chapters</li> <li>IC2 - Type of Access: open</li> <li>IC3 - Timing: publication between 2016 - 2020</li> <li>IC4 - Educational level: research focused on higher education</li> <li>IC5 - Language: Spanish and English</li> <li>IC6 - Keywords: learning analytics, teaching practice, higher education.</li> </ul>	<ul style="list-style-type: none"> <li>EC1: Informative articles, bachelor’s thesis, master’s thesis, doctoral thesis, conference proceedings, papers, news, specialized blogs, and book reviews.</li> <li>EC2: No Open Access</li> <li>EC3: Published before 2016</li> <li>EC4: Research focused on industry and other levels: preschool, elementary, secondary, and upper secondary education.</li> <li>EC5: Languages other than Spanish and English</li> <li>EC6: Any reference that does not include the keywords.</li> </ul>

At this stage, it was established which articles would be analyzed in-depth during the systematic literature review. The determining factor was the score obtained by each one, according to the established values. Those that scored equal to or higher than average was selected for an in-depth analysis.

F. DATA EXTRACTION AND SYNTHESIS

At this stage, folders were created for each database in the EdNote manager, in order to store the publications found. Then, the selected databases were searched with the following filters:

- The author(s) details
- The topic area
- Year of publication
- Institution
- Type of document (Revision)
- The type of publication (Open Access)
- Country
- Language

The search and filtering process were performed differently, depending on the characteristics of the academic databases. Figure 2 shows the distribution of the publications found by database.

To show detailed information on the total number of articles considered in the study, the PRISMA flow chart generally applied for reporting systematic reviews was used [69].

To carry out the synthesis of the information, tables and graphs were used for the mapping and in-depth analysis was used for the review based on the dimensions:

- Dimension 1. Purposes of LA
- Dimension 2. Teaching competence
- Dimension 3. Teaching practice

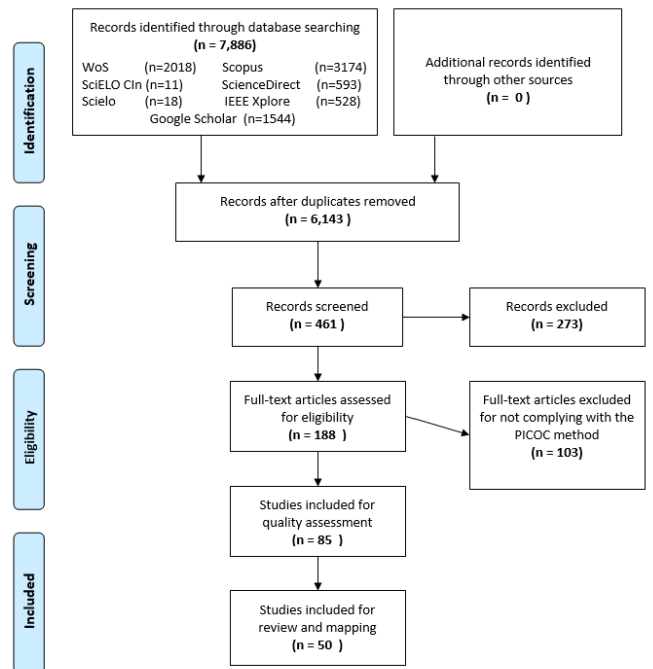


FIGURE 2. PRISMA diagram by [69].

TABLE 2. Distribution of articles by size of the study.

Dimension	Number	Publications
Purposes of LA	24	[Aldowah et al., 2019; Banihashem et al., 2018; Chan et al., 2019; Ciordas-Hertel et al., 2019; Cui et al., 2019; Du et al., 2019; El Alfy et al., 2019; Hui et al., 2019; Knobbout et al., 2018; Larrabee et al., 2019; Lei et al., 2017; Na et al., 2017; Nouri et al., 2019; Parks, 2016; Reche et al., 2020; Rojas-Castro, 2017; Sant, 2016; Santi et al., 2018; Tsai et al., 2017; Wong et al., 2020; Wong et al., 2018; ]
Teaching competence	11	[Avello et al., 2016; Escudero-Nahón et al., 2019; Gedrimiene et al., 2019; Hooda et al., 2020; Ifenthaler et al., 2018; Kim, 2019; Li et al., 2020; Sarker et al., 2019; Sergis et al., 2017; Stewart, 2017]
Teaching practice	15	[Avella et al., 2016; Chiappe et al., 2017; Gašević et al., 2017; Hughes et al., 2018; Jayashanka et al., 2018; Leitner et al., 2017; Liz-Domínguez et al., 2019; Massa et al., 2018; Peña-Ayala, 2018; Peñaloza, 2018; Pishtari et al., 2020; Rajabalee et al., 2019; Teasley, 2019; Valverde-Berrocoso et al., 2020; Viberg et al., 2018]

Table 2 shows the distribution of items according to dimensions.

III. RESULTS

A. MAPPING RESULTS

During the systematic literature review, 50 articles were studied based on the questions established for in-depth analysis.

Some of the articles were placed in two dimensions since they addressed two terms of the three that were researched.

The data in Figure 3 reveals that most of the documents related to the search terms that are available in open access are in order of highest to lowest in the following databases: Scopus, Google Scholar y Web of Science (WoS).

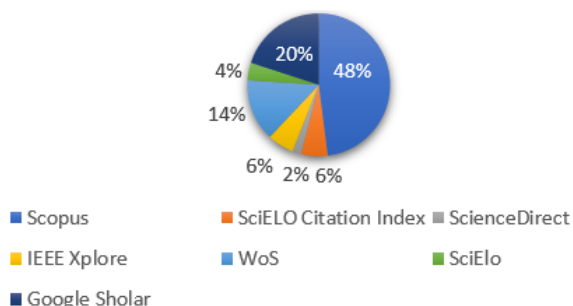


FIGURE 3. Distribution of scientific production according to databases.

The results of the mapping are made based on the questions posed.

**MQ1. How many studies have been published during the years 2016 -2020?**

The number of selected papers per year was counted in order to answer the first mapping question. The results cover 2016 to 2020. The last update of the review was in June 2020. Figure 4 shows the distribution of papers by year. Also, the scientific output related to the fundamental concepts increased from 2017, reaching the highest percentage in 2019.

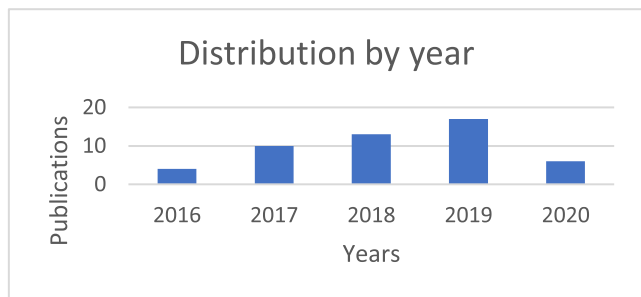


FIGURE 4. Distribution of scientific production 2016-2020.

**MQ2. What is the geographical distribution of publications in LA?** Based on the inclusion criteria, the data showed that the most significant scientific production of LA literature review concepts was in the United Kingdom, China, and the United States.

**MQ3. What have been the main benefits of applying LA?** The main areas that have benefited from the application of LA are summarized in Figure 6.

Based on [16] conception that LA consists in the collection, measurement and analysis of large volumes of data generated by learners in their learning contexts, and that its purpose is to predict potential educational problems that could arise, anticipate effective solutions and thus improve academic

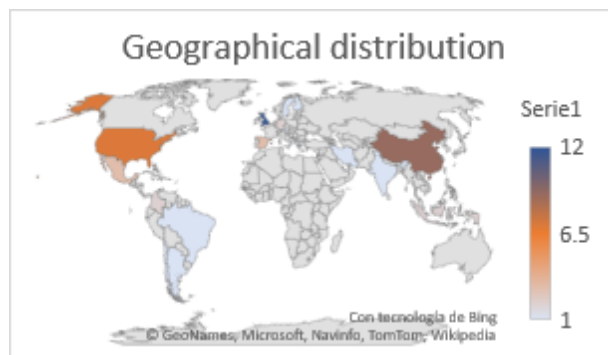


FIGURE 5. Geographical distribution of publications on LA.

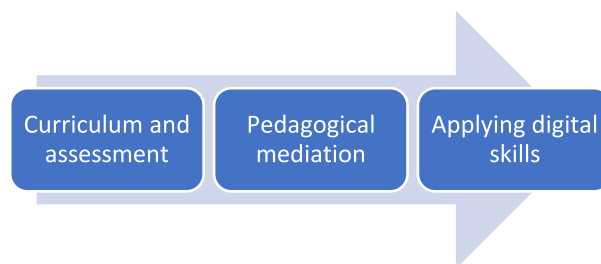


FIGURE 6. Key benefits of applying LA.

achievement, benefits were identified from applying LA to develop the (a) curriculum and assessment, (b) pedagogical mediation and (c) application of digital competencies.

The results show that the use of LA as part of the curriculum review can provide information that cannot be systematized with traditional curriculum review methods. Also, it can provide useful and practical information. However, the challenge is to develop analytical tools that can help teachers conduct LA independently [17].

On the other hand, existing LA models and frameworks are valuable for identifying elements and processes of LA [18]. Incorporating technology into the teaching-learning process can be an effective way to direct students and educators to achieve better learning and educational outcomes [9].

In terms of applying digital competencies, LA should be a paradigm for valuable knowledge findings and facilitate the understanding of interested parties of the learning process and its implications [19]. The decrease in cost of access to technologies and Internet connection has overcome some of the barriers in the adoption of ICT by all educational actors. It has opened new possibilities and interests. Hence, teachers and students must develop skills to respond to the demands of the knowledge society and be able to process and critically apply relevant and pertinent information in solving problems creatively and innovatively [56].

**MQ4. In which areas has LA been applied?** Most of the papers focus on the benefits and application of LA in higher education; the others focus on predictions, interventions, analysis and use of these data in learning for success in higher education; there were also articles identified with





FIGURE 7. Areas of application of LA.

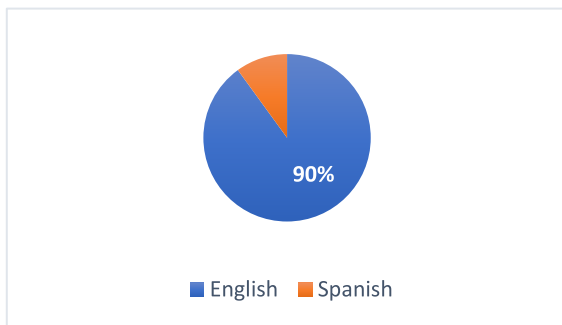


FIGURE 8. Prevailing language.

topics such as Teaching and Learning and others related to the established dimensions.

The most recurrent topics were the benefits, challenges, models, and application of LA in higher education. Other relevant topics were the effectiveness of LA interventions in higher education and analytical models predicting student success.

**MQ5. What is the most used language in this type of publication?** Out of the articles resulting from the systematic literature mapping, 45 were published in English and 5 in Spanish, as shown in Figure 8.

## B. RESULTS OF THE SYSTEMATIC LITERATURE REVIEW

As part of the review, the research questions (RQ) posed in the research protocol were answered and are presented through three dimensions that frame the answers that can deduce the state of the research field and thus generate a summary of the current situation.

In each dimension, the RQs are answered and supported by summary tables, followed by a discussion of the results.

### 1) DIMENSION 1: PURPOSES OF LA

Regarding **RQ1. What are the purposes for which LA has been applied in higher education?** it is important to mention that in order to answer this question the following purposes were considered, which were identified in the review:

1. Monitoring and analysis
2. Prediction and intervention
3. Tutoring and mentoring

4. Evaluation and feedback
5. Adaptation
6. Personalization and recommendation
7. Reflection

The selected articles were found to be related to the purpose of LA and higher education and refer to the concept of LA as a set of techniques for collecting, analyzing and delivering actionable, student-generated data to develop appropriate strategies for improving learning processes, student performance or the institution itself [21]. LA can also be defined as the measurement, collection, analysis, and reporting of data about students and their learning contexts to understand and optimize learning and the environments in which it occurs. [22]. Also, LA is the analysis of student data to improve education, as it focuses on the study of student behavior regarding the educational content provided. It focuses on analyzing data in order to improve assessment, predicting student learning outcomes, supporting teachers in teaching with the use of LA tools, and improving educational quality. LA presents unprecedented opportunities to properly evaluate new teaching strategies that incorporate digital technology, such as the inverted classroom. [16].

In terms of LA objectives [23] include *reflection* and *prediction*. *Reflection* serves as self-assessment, and *prediction* facilitates decision making for learning paths to predict and improve learning. The stakeholders are the clients of the data (teachers) and the subjects of the data (students). With the use of LA, it is possible to use the behavioral footprints of learners to create better learning environments and strategies for students. For example, virtual classrooms in systems such as Moodle or Blackboard, and the digital repositories associated with them, store large amounts of data by recording traces of interaction between students and teachers, and even among the students themselves.

LA has become one of the fields of educational technology and has generated interest in educational researchers and practitioners according to [24] among the application purposes of LA is analysis, evaluation, feedback, and recommendation. Analysis on teaching methods, learning performance, and understanding of social, cognitive, and behavioral problems, assessment of learning and effectiveness for virtual learning environments is one of the uses of LA for educational administrators. Regarding feedback and recommendation [25] mentions that the use of LA gives answers to learning needs to improve students' performance and for educators, it supports the understanding of the learning process.

The use of learning management systems in education has increased in recent years allowing, according to [26], a better *monitoring* of students; who have begun to use their cell phones more, and access to online content has become part of their lives, which generates a considerable amount of data that with the use of LA tools becomes really useful for *tutoring* and *mentoring*.

Another objective of applying LA in higher education has been to make timely interventions based on students'

**TABLE 3. Levels and objectives of LA by [2].**

Type of analysis	Level and objective of analysis	Beneficiary
Learning Analytics	<b>Course level:</b> social networking, conceptual development, discourse analysis, "smart curriculum".	Students, institution
	<b>Departmental:</b> predictive modeling, success/failure patterns.	Students, institution

e-learning usage behaviors, identifying the number of logins, time spent on e-learning platforms, and other resources that have been studied and identified as positively associated with academic performance outcomes [27].

Student data are relevant, and factors such as time, number of clicks, comments in publications and time spent on a given platform are analyzed, as are multimodal data such as log files, gaze behavior, perspiration, facial expressions of emotions, heart rate and electrothermal activity, since these data can be relevant to understand cognitive, affective and motivational processes in students; therefore, LA is used with the purpose of better understanding learning processes to *adapt* and *personalize* teaching through data collection, measurement, analysis and presentation [28].

Phil Long and George Siemens present a table to differentiate the objectives of LA:

### C. DIMENSION 2: TEACHING COMPETENCIES

**RQ2 How are teaching competencies associated with the use of LA in the university context?** entails recognizing that with the use of new technologies, teachers are assuming new roles, and as a result, new pedagogies and methods are being adopted for teacher training. Teaching skills of the future will include the ability to devise innovative ways of using technology to improve the learning environment and foster the acquisition, deepening, and creating knowledge. Professional learning of teachers will be a central component of this educational improvement.

The ICT-CFT advocates the concept of professional development of teachers as a lifelong learning process. To this end, the learning and application of teachers' digital competencies are acknowledged as an integral part of their capacity development, from their initial training to their continuing education throughout their careers [11].

LA promises to support the success of the study in higher education. Therefore, they are increasingly adopted in higher education institutions [30]. Information and communication technologies are increasingly mediating learning and teaching practices and the way educational institutions manage their administrative work [31]. Teachers are responsible for preparing themselves to deliver the best courses they can teach. Technology is continuously evolving, and many tools can be used in educational work. Competencies also refer to

the capacity or ability to perform a given task; in this sense, it is expected that teachers can appropriate knowledge and use the tools provided by technology for their professional practice. The 18 competencies developed by UNESCO are essential, since they provide a framework for each teacher to develop and apply them in their classroom, whether in a face-to-face setting or the virtual classroom, if online. Educational institutions are increasingly using LA to identify and act with students at risk of underachievement or disruption and to assist them. With the development of LA, intervention delivery has relied on data-based approaches to identify student problems and provide a personalized, timely assistance [10], [32], [57], [60]. Higher education in the 21st century must continue to promote discovery in the field through the utility of LA as a key element in supporting an education appropriate for the world in which we live and engage with it from the perspective of different educational actors, such as teachers, students, principals, and families [20], [33], [61].

Recent research on technology-enhanced learning environments has indicated the need to redefine the role of teachers as designers. How can we empower teachers to become more involved in designing innovative technology-enhanced learning activities for deep student learning? [34]. The problem is that the rapid acceptance of LA diverts educators' attention from identifying the requirements and implications of its use in higher education [20]. The potential capabilities and benefits that LA can provide are not fully utilized. Current research suggests that LA has more to offer for the continuous improvement of higher education institutions [35]. There is a need for educational institutions to provide teachers with ongoing training and the means to receive continuing education in the use of ICT.

Teacher research is identified as a critical global need to drive the continuous improvement of teaching and learning conditions for students. However, specific barriers (mainly related to teachers' data literacy skills) may delay their involvement in research to improve their teaching practice [36], [58], [61]. Teachers, school administrators and others need support and training in ethics, technology, and logical data handling procedures. All parties must understand how data are generated and used to make predictions [37]. It is essential to provide teachers with updated material so that they can have different resources to work and learn how to use the LA operation, teach their students in innovative ways, and evaluate them most appropriately.

Further considerations are needed to establish communication channels between interested parties and adopt pedagogically based approaches to LA [38]. This training process goes beyond pure knowledge, and its purpose is to be applied on a day-to-day basis and that both teachers and students benefit from it. For LA to find interest and usability among educators, a change from professional use to practical application is needed [39]. In-service training will help teachers develop practical skills in applying IT-based pedagogy and implementing innovative tools for classroom management, curriculum implementation, student assessment, and

learning improvement. Within this context, we can mention the inverted classroom, educational games, the use of data mining, the use of dashboards, and the implementation of learning metrics. The purpose of the inverted classroom is for the student to optimize the time spent in the classroom, studying previously at home and coming to the classroom to solve doubts with the teacher or put into practice what has been learned. This process can be designed on digital platforms that allow students to easily access the necessary information and design their own virtual learning environment. The Open Learner Models (OLM) and LA Dashboards (LAD) include intelligent tutoring systems, LA, and regulated learning self-assessment. The use of these tools provides students with up-to-date information on their learning status in an interactive way, which is beneficial to the educational process and can help teachers keep track of their students. The explosive growth in the number of digital tools used in everyday learning activities generates data on an unprecedented scale, providing exciting challenges across academic communities [40]. LA tools can be used for tracking purposes. However, data from these tools alone will not provide benefits for improving learning designs. Therefore, it is essential to create synergy between LA and learning design, where performance, engagement, interactions, and student satisfaction can be improved [41], [59].

The results show that the use of LA as part of the curriculum review can provide information that is not possible with traditional curriculum review methods and can provide useful and practical information [17]. The growth of LA is guided by the need to use the knowledge gained from data analysis in making interventions to improve learning [29]. Different forms of assessment are used with students, and teachers are exposed to innovative assessment tools such as educational games.

Through the collection and analysis of relevant data regarding students to assess, predict and optimize teaching and learning (Pedagogy), LA provides reliable technical support for the implementation of individualized teaching [42]. Recent technological developments have enabled LA researchers to capture the fingerprints of student learning activities in virtual learning environments. It is claimed that this rich and detailed information about actual student behavior provides educators with potentially valuable information about how students react to different learning designs and how students “at-risk” might be supported in completing their studies [43].

The LA also provides practitioners and researchers with information on educational data that are useful in supporting decisions in teaching and learning management [44]. Teachers and students should develop skills (Application of digital competences) to respond to the demands of the knowledge society and be able to process and critically apply relevant and pertinent information for problem-solving, in creative and innovative ways [56].

**TABLE 4. UNESCO ICT-CFT elements linked to LA (Self-Adaptation).**

Areas	Definition
Curriculum and assessment	This aspect explores how ICTs can promote specific objectives defined in the curriculum and how they can assist in assessment. At knowledge acquisition level, this aspect shows the advantages that ICTs can offer for teaching the curriculum and for assessment; then, it promotes the application of these tools at the deepening knowledge level and finally, at the stage of knowledge creation, it encourages teachers to reinterpret the curriculum to function effectively in a knowledge society and to devise authentic assessment strategies to monitor progress.
Pedagogy	This aspect encourages teachers to acquire ICT skills in order to improve teaching and learning methods. At knowledge acquisition level, ICTs are integrated into traditional teaching methods. At this level, teaching methods are often didactic, while at subsequent levels, teachers are encouraged to adopt alternate, learner-centered pedagogies; ideally, problem-based and project-based methodologies that integrate collaboration and cooperation.
Digital skills applications	This aspect has a substantial dimension at the knowledge acquisition level because necessary ICT skills are a prerequisite for integrating technology into teachers' work. The digital tools identified at this level are common and well-known, such as word processing and presentation software, email applications, and social networking. However, the other levels are less specific about the tools to be used, letting the learning community determine which tools are best suited to the tasks at hand.

#### D. DIMENSION 3: TEACHING PRACTICE

##### RQ2. How has LA been applied in teaching practice?

Sarker, Stewart and Sergi agree that incorporating technology into the teaching-learning process can empower teachers to improve their teaching practice through LA methods and tools. It can also be an effective way to develop new learning in educators and improve their outcomes. However, teachers, students, and administrators should obtain the best possible information to improve learning within educational institutions. [9], [39], [36]. The widespread integration of digital technology in higher education influences teaching and learning practices and provides access to data, mainly available in online learning environments, that can be used to enhance student learning [45]. Teachers' educational practice is a dynamic, reflective activity that involves developments in teacher-student interaction. It is not limited to the teaching concept, i.e., the educational processes that take place within the classroom. However, it includes pedagogical intervention that occurs before and after the classroom's interactive processes [46].

Teaching practice is the social activity that the teacher carries out when teaching a class. In this exercise, teachers



are influenced by their academic training, preparation, and the context in which they work. In teaching practice, solutions must be developed in order to improve teachers' work, pedagogical functions, the handling of competencies, and evaluation models. In practice, teachers become communicators. They share their knowledge of a specific subject with their students so that they may also be trained; the message is the knowledge that they must teach creatively and effectively so that students may absorb this knowledge and make it their own. The teacher can implement different activities to improve his classes and evaluate the students on the contents taught. Teaching practice includes planning the activities and tasks developed during the process of teaching and learning within the classroom. Recent developments in LA have attracted much attention from researchers and practitioners, as well as from various stakeholders, exploring the potential of LA to improve learning and teaching practices [47].

LA is an emerging field focused on the study of student behaviors regarding the educational content presented to them. The key in these technologies is to seek standardization of the data obtained, being this task particularly tricky since the collection generates diverse ranges of data. [48]. Educational data mining and LA can be used for better decision making related to course design, teaching tools, and pedagogical approaches to involve students more and to support those at risk of failure. Educational institutions are increasingly using LA to identify and act with students at risk of underachievement or disruption [10]. For example, data can provide information about why students do not graduate, why a student drops out of a course, and why they have difficulty completing a task. In the area of learning assessment, non-conventional assessment methods such as serious games, or so-called educational games, can be used. The use of educational games can be helpful and motivating; however, first, it must be resolved that teachers can adapt the game to the needs of their students and access data to verify whether the objectives of teaching have been met; this helps develop skills such as awareness-raising, attitude change, learning or teaching. The goal is to improve the learning process in students through data collection and implementation of LA. The educational game has been implemented in education effectively; schools up to higher education institutions are making use of these tools. There are already several studies on the use of play-based learning in education and its relationship to learning and knowledge retention.

Assessment and feedback are vital in a teaching and learning process, so it must be allowed, as well as mechanisms for educators to measure learning. As stated by Avella and Aldowah, various LA methods that include visual data analysis techniques, social network analysis, semantic and educational data mining that includes prediction, clustering, relationship mining, a discovery with models, and data separation for human judgment for analyzing data can be useful in developing a student-centered strategy and provide the necessary tools that institutions can use for continuous improvement [20], [49].

LA is considered the third wave in educational technology and is a promising new field of study [50]. Education must adapt to the 21st century and the use of technology to optimize learning. LA applied to higher education has enabled the detection of students at risk and the prediction of each student's learning needs in the same way that teachers must adapt to change. The use of planning systems and software in data analysis speeds up decision-making and favors the process of continuous improvement in education. A student's online activities generate an enormous amount of data that is wasted if it is not used and analyzed. Depending on the nature of the data being analyzed and the objective that the analysis task must fulfill, several sub-disciplines can be defined in data analysis. Examples of these are text analysis, audio analysis, video analysis, and social network analysis [51]. Another aspect worth mentioning, related to its link with other related fields, is that the instrumental dimension of LA is oriented towards the conversion of massive data from its original state (i.e., unstructured, complex, etc.) into useful information. Big Data refers to data that is fundamentally too large and complex and moves too fast for the processing capacity of conventional database systems. The value of large data is the ability to identify useful information and convert it into useful data by identifying patterns and pattern deviations [52]. Under this premise, LA draws on analytical tools from various fields, such as EDM, machine learning, or classical statistical analysis. [29].

The use of LA has excellent advantages in predicting student learning outcomes. By using LA, it is possible to find information to improve teaching and learning methods, as well as to facilitate decision making. LA can dramatically impact existing models of education and generate new ideas about what works and what does not work in teaching and learning. Furthermore, despite its importance and educational potential, LA's current implementation should no longer be limited to highly technical profiles. However, it should be open to the academic community and the general population [33]. The results are potentially transformative for all levels of the current education system [5]. The purpose of LA is to tailor educational opportunities to the individual student's need and capacity through actions such as acting with at-risk students or providing feedback and instructional content [20]. Many higher education institutions are investigating the possibility of developing predictive models of student success that use different available data sources to identify students who may be at risk of failing a course or program [53]. The intervention has long been practiced in higher education to assist at-risk or underachieving students. With the development of the intervention, the intervention's delivery has been based on data-based approaches to identify students' problems and provide timely, personalized assistance [54]. LA applied to higher education has made it possible to detect students at risk and predict the learning needs of each student.

The application of LA intervention, its purpose, effects, and examples are also discussed in this document. The results show that most LA interventions have an impact on student

**TABLE 5. Benefits of using LA in teaching practice.**

Areas	Benefits of using LA in teaching practice
Planning and Design of learning	<ul style="list-style-type: none"> <li>Identify which learning activities are being practical with students.</li> <li>Analyze the most effective methods for evaluating the learning being used</li> <li>Identify information to improve teaching and learning methods.</li> <li>The improvement in the determination of competencies and the mapping of the Curriculum.</li> </ul>
Learning management	<ul style="list-style-type: none"> <li>Making decisions related to redesigning learning experiences.</li> <li>Identify pedagogical approaches that are being effective in teaching practice.</li> <li>Predicting student dropouts and making timely decisions</li> <li>Identify students who are having difficulty with homework submission.</li> <li>Predicting the learning needs of students in a learning environment</li> <li>Measure more accurately what is happening in the Learning Management Systems (LMS).</li> </ul>
Tutoring and pedagogical mediation	<ul style="list-style-type: none"> <li>Identify students who present a certain degree of motivation and participation in the courses.</li> <li>Identify students who need personalized feedback and tutoring to advance learning management further.</li> <li>Accelerate decision making to encourage continuous learning improvement</li> <li>Conduct pedagogical interventions with students based on student interaction data.</li> </ul>

learning success [47]. Interventions have led to outcomes such as improved study performance, retention, and course registration, as well as productivity and effectiveness in learning and teaching [55]. LA uses several methods, including visual data analysis techniques, social network analysis, semantic and educational data mining, including prediction, clustering, relationship mining, model discovery, and data separation for human judgment to analyze data [20].

Table 5 shows the benefits identified using LA in teaching practice, divided into three areas in which teachers develop: (1) Learning planning and design, (2) Learning management, and (3) Tutoring and pedagogical mediation. In conclusion, the use of LA in higher education has significant benefits; however, there are also considerable challenges such as technical aspects, lack of technology and trained personnel, resistance to change, and addressing issues such as ethical use of data.

#### IV. DISCUSSION

From the findings found, it is established that LA is framed in the measurement, collection, analysis, and presentation of data about students and the contexts in which they interact, in order to understand their situation about the learning process, optimize learning and understand educational

environments from digital platforms, social networks, and web-based devices, in order to improve education. In this sense, the actions that teachers should perform for learning management are key, without losing sight of (1) the purposes for applying LA, (2) the adoption of new digital competencies associated with LA, and (3) the benefits of applying LA in teaching practice.

The analyzed works show that the purposes for which LA has been used in higher education are: (a) Monitoring and analysis, (b) Prediction and intervention, (c) Tutoring and mentoring, (d) Evaluation and feedback, (e) Adaptation, (f) Reflection and (g) Personalization and recommendation [23]–[28]. In the works analyzed, it is evident that prediction and monitoring as LA purposes have been used more frequently in learning performance topics [23], [27]. On the other hand, adaptation and personalization of learning are being developed but have not gained the first two momenta [28].

The ICT Competency Framework for Teachers proposed by UNESCO presents a series of aspects and competencies necessary to develop teaching practice. Considering these competencies, it was found that (a) the curriculum and assessment, (b) pedagogy, and (c) digital skills applications are associated with the use of LA in the university context. This means that, through LA-based digital tools and resources, the professor can analyze the curricular standards and determine the possible pedagogical use to meet these standards [17]. In terms of pedagogy and the selection of appropriate pedagogical solutions to enhance the learning of disciplinary content, the LA is a tool for the design of learning from educational data [11]. On the other hand, to implement LA in learning management processes, teachers must possess digital competencies to monitor, intervene, tutor, evaluate and recommend using digital tools based on LA [31], [39], [40], [56].

In teaching practice, the application of LA has been developed in different ways. However, the findings show the benefits of using LA in teaching practice impact planning, learning design, learning management, virtual tutoring, and pedagogical medication.

This work aimed to relate LA to the competencies in Information and Communication Technologies (ICT) described by UNESCO and their application in teaching practice within the university context. As in any research process, different validity threats and certain limitations can be detected in these studies. In the case of mappings and systematic reviews of the literature [62], it points out that “certain non-controllable limitations may influence them.” One of the main threats is the authors’ bias concerning some aspects of the research.

To mitigate this bias, the PICOC method was used to establish the research scope. A quality assessment instrument was developed that included two aspects: (1) dissemination aspects and (2) theoretical-methodological aspects.

Regarding the presentation of the results, the levels of teaching competencies carried out when applying AL in university contexts were not established; however, the

components proposed by the ICT Competency Framework for Teachers proposed by UNESCO, whose objective is to provide materials for teachers, experts, and education professionals, were established.

## V. CONCLUSION

This paper presents a systematic review and mapping to identify and analyze the application of teaching competencies in the field of learning analytics and their incorporation into teaching practice in the university context.

In order to analyze the texts, a protocol and a review strategy were designed, based on the work of other authors, through which the information is systematized and structured.

During the review and mapping process of the articles, 7,886 articles from different databases were originally found. This number was reduced to 50 articles, using different criteria, review strategies and quality assessments. In this way, the papers that were considered most relevant for this research were obtained.

This article focused on the application of LA in higher education. Through a review of recent literature (2016-2020), we analyzed how the use of LA is linked to the curricular goals of training and the teaching skills needed in an ever-changing world, where technology is increasingly entering the field of education. This is an innovative approach, which is presented as the new meeting point for the implementation of competencies in teaching practice. Several articles describe a systematic literature review, some providing a comprehensive view of the benefits of applying LA and others delving into specific aspects that also require attention. Some studies focus on LA tools that teachers can use to improve; the term learning design and the application of LA for curriculum review are referred to.

This paper presents a systematic literature review focused on three dimensions: (1) Purposes of LA, (2) Teaching competencies, and (3) Teaching practice.

Dimension 1: The purposes of LA identified through the information contained in the articles reviewed include monitoring and analysis, prediction and intervention, tutoring and mentoring, evaluation and feedback, adaptation, personalization, and recommendation, as well as reflection, concerning both the administrative area of the institutions as well as the teaching and learning process that takes place within the classroom. The information also indicates that, although there are diverse uses for the data and, in particular for the improvement of processes, monitoring of teacher and student performance, decision making, improvement of the quality of processes, the data generated can be partially used or even wasted.

Dimension 2. Teaching skills are related to new pedagogies, digital skills, attention to students' needs, new didactic strategies for deep learning, computer literacy of teachers for teaching practice and data management, adequate evaluation, application of digital tools, and fingerprint identification in activities outside the LMS. Teaching skills become a crucial element in the use of technology in the classroom and the

data generated by the LA. The use of information depends on its identification, interpretation, analysis, and use for decision making with the intention of improvement.

Dimension 3. Teaching practice is the silver bridge between the use of technologies, methods and digital tools through a vigorous, but reflexive activity of the teacher and the student, appropriate curricular adaptation to technologies, the intervention of students according to their performance or continuity in the process, application of didactic alternatives developed for technologies, such as serious games, verification and evaluation of the process of teaching and learning through technology, the discovery of emerging models, continuous improvement of processes, and the conformation of predictive models to detect risks of diverse types in students.

Taking the systematic literature review as reference point, which presents original data that can support future studies on the implementation of LA, it is possible to identify various opportunities. In the first dimension, the implementation of LA in institutional plans is relevant, motivating the digitalization of processes and optimizing the existing ones. In the second dimension, an ambitious and extensive scenario can be seen. However, it is possible in terms of the development of teaching skills and the use of data generated by LA, which, although it cannot be considered uniquely due to current needs, it does offer a wide field of intervention.

Regarding the third dimension, which is considered a relevant field of interest, and the growing advance of technologies applied to education, an opportunity is identified for the systematization of teaching practice that proposes an option for the structuring of the virtual educational process, based on the Framework of Competences for ICT Teachers, developed by UNESCO. This may be a first step towards establishing LA as a source of information on the educational process. The implementation of a system with a primary role of the LA could represent a way to develop teaching and learning with greater relevance and quality, in terms of the use of technologies and all its resources, considering both the LMS or educational platforms, as well as external tools profusely developed in recent years. In order to carry out this objective, we propose the design, validation, and systematization of a prototype that allows the effective and pertinent development of the teaching-learning process, with the quality and depth required by higher education, considering that the implementation of LA is an innovative aspect that is transforming higher education by facilitating the interaction between the different parties involved, teachers, students, administrators, and researchers. The challenge is to adapt education to the information age, reinvent how it is taught, and optimize the available resources that technology provides, such as learning analytics.

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