

Analíticas de aprendizaje en educación superior: una revisión de la literatura científica de impacto

Learning analytics in higher education: a review of impact scientific literature

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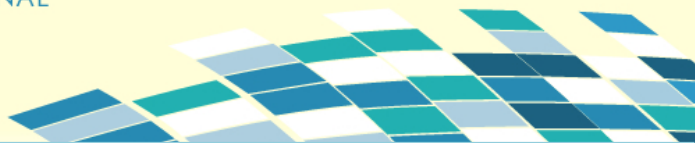
RESUMEN.

Las analíticas de aprendizaje pueden definirse como una serie de técnicas para recopilar, analizar y otorgar datos procesables y generados por parte de los estudiantes con el objetivo de elaborar estrategias adecuadas para mejorar los procesos de aprendizaje, el rendimiento de los alumnos o el de la propia institución. Este tipo de técnicas son especialmente útiles para establecer patrones de acción que guíen y orienten el proceso educativo en educación superior. Bajo estas premisas, la presente investigación tiene por objetivo analizar la producción científica de mayor impacto sobre el empleo de analíticas de aprendizaje en educación superior. Para ello se ha seguido una metodología cuantitativa atendiendo diez variables: año de publicación, publicaciones periódicas, autores, instituciones, países, tipo de documento, formato de publicación, área de publicación, idioma y artículos más citados. Los resultados proyectan una tendencia de investigación que se encuentra totalmente en auge, especialmente por la mayor producción científica ocurrida en los últimos años (2015-2018) destacando países como Australia, Estados Unidos y Reino Unido. Las publicaciones, en su gran mayoría, proceden de conferencias y se encuentran publicadas en inglés. Destacan las áreas de conocimiento de Ciencias Computacionales y Ciencias Sociales.

PALABRAS CLAVE.

Analíticas de aprendizaje, universidad, educación superior, bibliometría, Scopus, productividad científica





ABSTRACT.

Learning analytics can be defined as a series of techniques for collecting, analyzing and granting processable data generated by students. Their objective is to develop appropriate strategies to improve the learning processes, the performance of the students or that of the institution itself. These types of techniques are especially useful to establish patterns of action that guide and guide the educational process in higher education. Under these premises, the present research aims to analyze the scientific production with the greatest impact on the use of learning analytics in higher education. For this purpose, a quantitative methodology has been followed, based on ten variables: year of publication, periodicals, authors, institutions, countries, type of document, publication format, publication area, language and most cited articles. The results project a research trend that is fully on the rise, especially due to the greater scientific production that has occurred in recent years (2015-2018), highlighting countries such as Australia, the United States and the United Kingdom. The publications, in their great majority, come from conferences and are published in English. The knowledge areas of Computational Sciences and Social Sciences stand out.

KEY WORDS.

Learning analytics, university, higher education, bibliometrics, Scopus; scientific production-

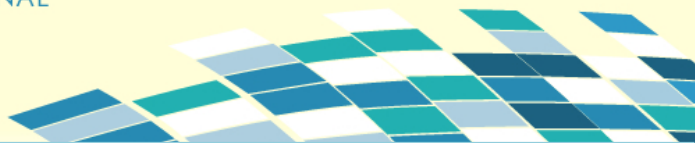
1. Introducción.

Education is one of the main axes of any society. For this reason, it has always been one of the most debated and criticized fields over the years (Moreira, Bates y Mota, 2019). During the last years, it has struggled to conquer a process of reconversion of the roles of the people who inhabit the institutions; bet on organizational structures more flexible, open, participatory, communicative; the introduction of new methodologies and resources to improve learning and the quality of training; among other (Hinojo-Lucena *et al.*, 2018; Alonso-García, Rodríguez-García & Cáceres-Reche, 2018; Montgomery *et al.*, 2019). The objective is not other than to adapt education and the education system to the society of the 21st century.

However, the truth is that education is currently in a period of crisis (Chiape y Rodríguez, 2017). The investigations speak of a disinterest on the part of the students regarding their teaching-learning process (Ulstad, Halvari & Deci, 2018; Klein, Lester, JRangwala & Johri, 2019). Therefore, researchers and experts in this field ask ourselves: what is wrong with our educational system? What can you do about it? What happens inside the classrooms? What information can be used to improve?

Although it is true that we deal with difficult questions, from the information and knowledge society, where technology is ubiquitous, there has been talk of an emerging trend for higher education known as "Learning Analytics" (Gedrimiene *et al.*, 2019; Jhonson *et al.*, 2016). Through it, it is easier for institutions to increase their understanding of the needs of their students. In this way, what is intended is that they can use this information to develop strategies that improve and positively influence student learning, thus improving the quality of the process (Yousef, Chatti, Schroeder & Wosnitza, 2014; Wong & Li, 2019) and the





results obtained in it (Antelm, Gil, Cacheiro y Pérez, 2018; Cabedo, Galan & Gomez, 2017; Mingorance, Trujillo, Cáceres & Torres, 2017).

On the one hand, Slade y Prinslo (2013) define learning analytics “as the collection, analysis, use, and appropriate dissemination of student-generated, actionable data with the purpose of creating appropriate cognitive, administrative, and effective support for learners” (p.1512). On the other hand, learning analytics is defined as “the measurement, collection, analysis, and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs” (Long & Siemens, 2014, p. 132).

In this way, through them we obtain the analysis and visualization of a large amount of data (big data) that will allow us to have more information about the situation and make more effective decisions (Huda *et al.*, 2018). Picciano (2012) define big data as “a generic term that assumes that the information or database system(s) used as the main storage facility is capable of storing large quantities of data longitudinally and down to very specific transactions”(p.12). Among them we can highlight: qualifications, attendance to courses, percentage of graduates, access to learning platforms, interventions, messages, etc.

Picciano (2012) said that “Big data concepts and analytics can be applied to a variety of higher education administrative and instructional applications, including recruitment and admissions processing, financial planning, donor tracking, and student performance monitoring” (p.13).

Referring to Macfadyen & Dawson (2012) learning analytics provide higher education with highly valuable information to achieve educational excellence. Learning management systems (LMS) offer a large amount of information and usage patterns whose analysis can influence the improvement of student learning outcomes.

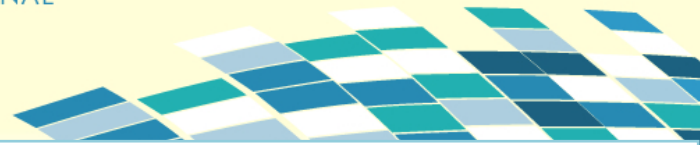
There are other authors who judge it from another perspective. Due to the characteristics of the stored data, there are also those who have their doubts and judge whether this practice is really ethical (Siemens, 2012), because the ownership of this data and the right of privacy of students are questioned (Slade & Prinsloo, 2013). For these reasons, until now, the data is currently restricted for the access of a few. In fact, according to the research of Picciano (2012), only some universities are using this type of techniques.

We can consider, then, that research on learning analytics in higher education is an emerging field that is still poorly researched (Chiappe & Rodríguez, 2017). For this reason, to situate the reader, with the following article is intended to draw a general outline on the research landscape that concerns learning analytics and higher education in the international arena.

2. Methodology.

This research aims to analyze the scientific production with the greatest impact on the use of learning analysis in higher education, following the steps of other similar research (López-Meneses, Vázquez-Cano y Román, 2015; Mengual-Andrés, Vázquez-Cano y López-Meneses, 2017; Rodríguez-García, Cáceres & Alonso, 2018). For this, a systematic review of bibliographic studies has been carried out (Hernández Sampieri, Fernández Collado y Baptista Lucio, 2016) given its suitability to respond to investigations of this type. At the





same time, quality indicators considered essential for studies of systematic reviews have been taken into consideration (Urrutia y Bonafill, 2010). For this purpose, ten variables have been selected:

Table 1: Study variables

Year of publication
Journal or resource
Authors
Institution
Coountry
Resource type
Publication format
Subject area
Language
Most cited papers

To this end, the publications indexed in the Scopus database (Elsevier) have been taken as reference; of collected international prestige. Subsequently, the most suitable keywords that responded to our research objective were selected through ERIC Thesaurus: “learnynng analytic(s)” y “higher education”/ “university”.

The search date began in September 2018 and ended in November 2018; At that time, a second search was carried out to guarantee the inclusion of those results that, due to some casuistry, had not been present in the initial explorations. The equation and field of the search were the following:

Table 2: Search operation

“Learning analytic” OR “Learning analytics” AND “Higher education”
“Learning analytic” OR “Learning analytics” AND “University”

Table 3: Search field.

Database	Search field
Scopus	Article title, Abstract, Keywords

Finally, in order to publicize the most relevant results that provide an accurate view of the greatest impact on scientific production on learning analytics in education, the following inclusion criteria were established (Table 4).



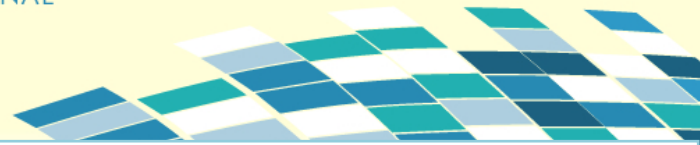


Table 4: Inclusion criteria.

Variable	Criteria
<i>Year of publication</i>	All investigations are considered
<i>Journal or resource</i>	Five or more references about the topic
<i>Authors</i>	Six or more references about the topic
<i>Institution</i>	Six or more references about the topic
<i>Coountry</i>	Six or more references about the topic
<i>Resource type</i>	All investigations are considered
<i>Publication format</i>	All investigations are considered
<i>Subject area</i>	All investigations are considered
<i>Language</i>	All investigations are considered
<i>Most cited papers</i>	Ten most cited papers

3. Results.

The search resulted in the extraction of 821 results, through the two combined searches (Table 5):

Table 5: Results.

Combination	Scopus
"Learning analytic" OR "Learning analytics" AND "Higher education"	332
"Learning analytic" OR "Learning analytics" AND "University"	489

In the following graph we can see the percentage of each of the combined searches with respect to the total of the analyzed references.

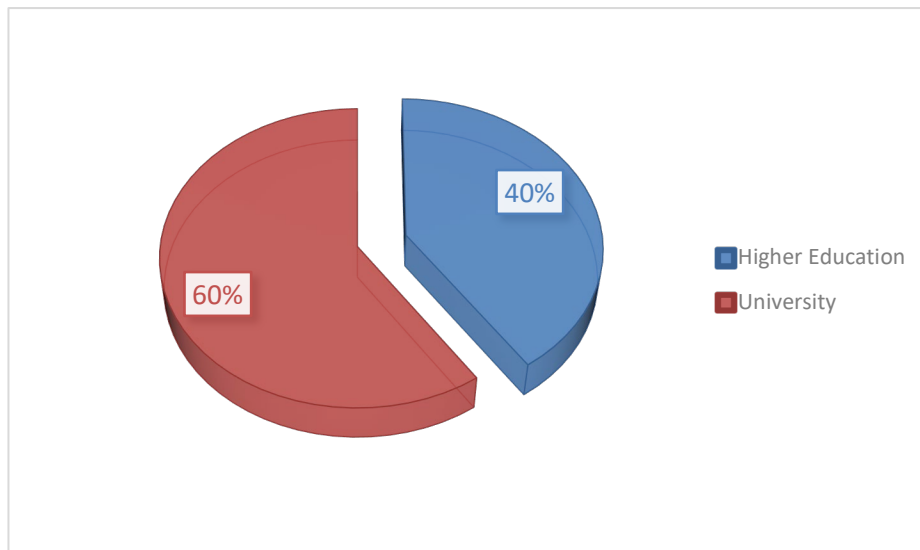
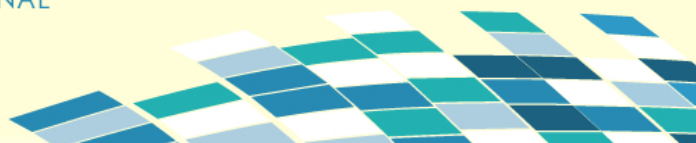


Figure 1. Percentage of references based on the search equation used.



On the other hand, the indexation of the first research on learning analytics in the field of higher education occurred in 2010. However, the highest scientific production begins to occur from 2012, as we can see in the following graphic:



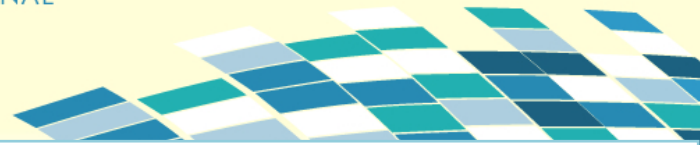
Figure 2. Evolution of research on learning analytics in Higher Education.

Continuing with the results, within the periodic publications variable we find 21 titles that agglutinate 330 investigations (40.2%) of the 821 analyzed; being all these who have published more on the subject.

Table 6: Periodic publications.

Periodic publications	Combination		Total
	L.A. + Higher Education	L.A. + University	
ACM International Conference Proceeding Series	48	59	107
Behaviour And Information Technology	5	-	5
Big Data And Learning Analytics In Higher Education Current Theory And Practice	7	-	7
Ceur Workshop Proceedings	7	30	37
Communications In Computer And Information Science	8	-	8
Computers In Human Behavior	6	11	17
Data In Brief	-	6	6
Educational Technology Research And Development	5	8	10
IEEE Global Engineering Education Conference Educon	-	9	9
IFIP Advances In Information And Communication Technology	-	7	7
International Journal Of Emerging Technologies In Learning	-	7	7
International Review Of Research In Open And Distance Learning	5	-	5
Internet And Higher Education	-	6	6
Journal Of Asynchronous Learning Network	5	-	5
Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In Bioinformatics	27	24	51
Open Learning	-	8	8
Proceedings Frontiers In Education Conference Fie	-	9	9





Periodic publications	Combination		Total
	L.A. + Higher Education	L.A. + University	
Proceedings Of The European Conference On E Learning Ecel	-	6	6
Smart Innovation Systems And Technologies	-	5	5
Technology Knowledge And Learning	8	7	15
Total	131	199	330

Regarding the variable that analyzes the authors with the highest scientific production on this research focus, in the following table we present those that have indexed 6 or more works in the database analyzed.

Tabla 7. Authors with more scientific production.

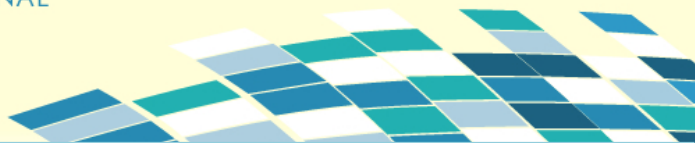
Author	Combination		Total
	L.A. + Higher Education	L.A. + University	
Dawson, S.	12	10	22
Ebner, M.	-	6	6
Gašević, D.	8	-	8
Guenaga, M.	-	7	7
Ifenthaler, D.	8	7	15
Kailanto, M.	-	6	6
Lonn, S.	7	-	7
Pardo, A.	-	7	7
Prinsloo, P.	8	-	8
Rienties, B.	-	13	13
Shimada, A.	-	6	6
Slade, S.	7	-	7
Teasley, S.D.	6	-	6

The following table presents the results of the institutions that have the highest concentration of scientific production on the topic studied.

Table 8. Institutions.

Institution	Combination		Total
	L.A. + Higher Education	L.A. + University	
Central Queensland University	-	6	6
Covenant University	-	7	7
Curtin University	12	12	24
Ewha Womans University	-	6	6
Griffith University	6	-	6
Kyushu University	-	9	9
Macquarie University	9	6	15
Open University	19	28	47
Tampere University of Technology	-	7	7
Technische Universitat Graz	-	6	6
The University of Sydney	6	12	18
Universidad Carlos III de Madrid	-	6	6





Institution	Combination		
	L.A. + Higher Education	L.A. + University	Total
Universidad de Deusto	-	7	7
Universidad de Leon	-	6	6
Universidad de Vigo	-	6	6
Universitat Mannheim	8	10	18
Universitat Oberta de Catalunya	-	7	7
University of Edinburgh	11	-	11
University of Melbourne	7	6	13
University of Michigan, Ann Arbor	10	13	23
University of South Africa	10	-	10
University of South Australia	12	13	25
University of Southampton	-	6	6
University of Southern Queensland	-	7	7
University of Wollongong	-	7	7

Considering the country variable, in Table 9 we present those regions that have produced the highest scientific production on learning analytics in higher education.

Table 9. Country.

Country	Combination		
	L.A. + Higher Education	L.A. + University	Total
Australia	70	87	157
Austria	-	6	6
Canada	10	12	22
China	-	20	20
Colombia	7	7	14
Czech Republic	-	6	6
Ecuador	6	-	6
Finland	-	12	12
France	-	6	6
Germany	16	29	45
Greece	-	10	10
Hong Kong	7	9	16
Ireland	-	6	6
Italy	-	11	11
Japan	7	17	24
Netherlands	10	12	22
Nigeria	-	7	7
Portugal	7	-	7
Saudi Arabia	6	-	6
South Africa	15	8	23
South Korea	-	7	7
Spain	28	64	92
Taiwan	-	7	7
United Arab Emirates	7	-	7
United Kingdom	57	67	124
United States	67	75	142



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Regarding the type of document, in the following table they are presented classified according to the combination used and the type of document analyzed: article, conference paper, review in congress, article in press, among others.

Table 10. Document type.

Document type	Combinación		Total
	L.A. + Higher Education	L.A. + University	
Conference Paper	157	248	405
Article	110	180	290
Book Chapter	24	27	51
Conference Review	23	20	43
Article in Press	8	9	17
Review	5	3	8
Book	4	3	7
Editorial	2	-	2
Erratum	1	-	1

In line with the previous result, the following table presents the results based on the source type of the researches analyzed.

Table 1: Source type.

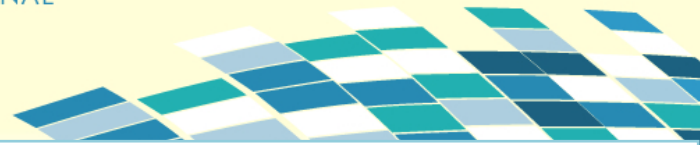
Source type	Combinación		Total
	L.A. + Higher Education	L.A. + University	
Conference Proceedings	136	228	364
Journals	127	192	319
Book Series	47	49	96
Books	24	20	44
Trade Publications	-	2	2

Table 12 shows the different publication areas where research on higher education learning analytics has been researched.

Table 2: Subject área.

Subject area	Combinación		Total
	L.A. + Higher Education	L.A. + University	
Agricultural and Biological Sciences	-	1	1
Arts and Humanities	13	18	31
Biochemistry, Genetics and Molecular Biology	1	2	3
Business, Management and Accounting	15	11	26
Chemical Engineering	-	2	2
Chemistry	-	3	3
Computer Science	237	339	576
Decision Sciences	18	31	49
Denistry	1	1	2
Economics, Econometrics and Finance	5	3	8
Energy	-	1	1
Engineering	40	80	120
Environmental Science	1	1	2
Health Professions	1	1	2





Subject area	Combinación		
	L.A. + Higher Education	L.A. + University	Total
Inmunology and Microbiology	1	-	1
Materials Science	1	3	4
Mathematics	50	50	100
Medicine	5	4	9
Multidisciplinary	-	7	7
Neuroscience	-	1	1
Nursing	-	1	1
Physics and Astronomy	2	2	4
Psychology	15	17	32
Social Sciences	179	259	438

Regarding the language of publication, a scientific production stands out that, predominantly, is written in English (98.29%), as we can see below:

Table 3: Language.

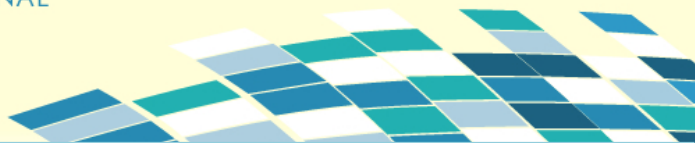
Language	Combinación		
	L.A. + Higher Education	L.A. + University	Total
Chinese	1	-	2
English	329	478	807
German	1	1	2
Portuguese	2	2	4
Spanish	3	9	12
Turkish	-	1	1

Finally, we present the ten most cited articles and greatest impact generated by the scientific community distinction between search equations used.

Table 4. Most cited papers –L.A. AND Higher Education.

Reference	N
Slade, S., & Prinsloo, P. (2013). Learning analytics: Ethical issues and dilemmas. <i>American Behavioral Scientist</i> , 57(10), 1510-1529.	140
Picciano, A. G. (2012). The evolution of big data and learning analytics in American higher education. <i>Journal of Asynchronous Learning Networks</i> , 16(3), 9-20.	103
Macfadyen, L. P., & Dawson, S. (2012). Numbers are not enough. Why e-learning analytics failed to inform an institutional strategic plan. <i>Journal of Educational Technology & Society</i> , 15(3), 149-163.	96
Dietz-Uhler, B., & Hurn, J. E. (2013). Using learning analytics to predict (and improve) student success: A faculty perspective. <i>Journal of Interactive Online Learning</i> , 12(1), 17-26.	78
Yousef, A. M. F., Chatti, M. A., Schroeder, U., & Wosnitza, M. (2014, July). What drives a successful MOOC? An empirical examination of criteria to assure design quality of MOOCs. In <i>Advanced Learning Technologies (ICALT), 2014 IEEE 14th International Conference on</i> (pp. 44-48). IEEE.	62





Reference	N
Ifenthaler, D., & Widanapathirana, C. (2014). Development and validation of a learning analytics framework: Two case studies using support vector machines. <i>Technology, Knowledge and Learning</i> , 19(1-2), 221-240.	42
Barber, R., & Sharkey, M. (2012, April). Course correction: Using analytics to predict course success. In <i>Proceedings of the 2nd international conference on learning analytics and knowledge</i> (pp. 259-262). ACM.	39
Pursel, B. K., Zhang, L., Jablokow, K. W., Choi, G. W., & Velegol, D. (2016). Understanding MOOC students: motivations and behaviours indicative of MOOC completion. <i>Journal of Computer Assisted Learning</i> , 32(3), 202-217.	31
Mattingly, K. D., Rice, M. C., & Berge, Z. L. (2012). Learning analytics as a tool for closing the assessment loop in higher education. <i>Knowledge Management & E-Learning</i> , 4(3), 236.	30
Drachslar, H., & Greller, W. (2012, April). The pulse of learning analytics understandings and expectations from the stakeholders. In <i>Proceedings of the 2nd international conference on learning analytics and knowledge</i> (pp. 120-129). ACM.	30

Table 5. Most cited papers – L.A. AND UNIVERSITY.

Reference	N
Macfadyen, L. P., & Dawson, S. (2012). Numbers are not enough. Why e-learning analytics failed to inform an institutional strategic plan. <i>Journal of Educational Technology & Society</i> , 15(3), 149-163.	96
Gasevic, D., Kovanovic, V., Joksimovic, S., & Siemens, G. (2014). Where is research on massive open online courses headed? A data analysis of the MOOC Research Initiative. <i>The International Review of Research in Open and Distributed Learning</i> , 15(5).	86
Ferguson, R., & Shum, S. B. (2012, April). Social learning analytics: five approaches. In <i>Proceedings of the 2nd international conference on learning analytics and knowledge</i> (pp. 23-33). ACM.	73
Baker, R. S., & Inventado, P. S. (2014). Educational data mining and learning analytics. In <i>Learning analytics</i> (pp. 61-75). Springer, New York, NY.	72
Coffrin, C., Corrin, L., de Barba, P., & Kennedy, G. (2014, March). Visualizing patterns of student engagement and performance in MOOCs. In <i>Proceedings of the fourth international conference on learning analytics and knowledge</i> (pp. 83-92). ACM.	70
Wolff, A., Zdrahal, Z., Nikolov, A., & Pantucek, M. (2013, April). Improving retention: predicting at-risk students by analysing clicking behaviour in a virtual learning environment. In <i>Proceedings of the third international conference on learning analytics and knowledge</i> (pp. 145-149). ACM.	52
Watson, C., Li, F. W., & Godwin, J. L. (2013, July). Predicting performance in an introductory programming course by logging and analyzing student programming behavior. In <i>2013 IEEE 13th International Conference on Advanced Learning Technologies (ICALT)</i> (pp. 319-323). IEEE.	47
Gašević, D., Zouaq, A., & Janzen, R. (2013). "Choose your classmates, your GPA is at stake!" The association of cross-class social ties and academic performance. <i>American Behavioral Scientist</i> , 57(10), 1460-1479.	44
Ferguson, R., & Clow, D. (2015, March). Examining engagement: analysing learner subpopulations in massive open online courses (MOOCs). In <i>Proceedings of the Fifth International Conference on Learning Analytics And Knowledge</i> (pp. 51-58). ACM.	40
Barber, R., & Sharkey, M. (2012, April). Course correction: Using analytics to predict course success. In <i>Proceedings of the 2nd international conference on learning analytics and knowledge</i> (pp. 259-262). ACM.	39



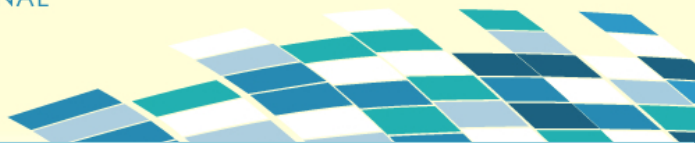
4. Discussion y Conclusions.

The objective of this article was to analyze the scientific production with the greatest impact on learning analytics in the field of higher education. Its main contribution is determined by the outline of the panorama of research on this practice at an international level. At this time, it should be noted that no similar studies have been conducted on this subject, but the one presented here follows the line of other studies of a similar nature, such as those carried out by López-Meneses, Vázquez-Cano & Román, 2015; Mengual-Andrés, Vázquez-Cano & López-Meneses, 2017; or Rodríguez-García, Cáceres, & Alonso, 2018.

In this way, once the investigation is carried out, we proceed to capture the main conclusions we have reached:

- Research begins to be indexed in the database from the year 2010. From that moment, we can observe a phase of progressive growth whose maximum exponent is concentrated between the years 2015-2018. These results confirm the hypothesis that the learning analytics are an emerging trend in the field of higher education (Johnson *et al.*, 2016; Slade y Prinsloo, 2013).
- Within the periodical publications, we highlight The ACM International Conference, for concentrating 13% of the scientific production analyzed.
- We found an increasing scientific production of Shane Dawson (Director of the Teaching Innovation Unit and Professor of Learning Analytics at the University of South Australia) and Dirk Ifenthaler (Deakin University Melbourne, Australia).
- Taking into account the variable that relates the quantity of publications with the signatory institutions, a greater scientific production of the Open University, Milton Keynes (United Kingdom), the University of South Australia (Australia), Curtin University (Australia) and the University of Michigan, Ann Arbor stands out.
- Australia is the country, in general, with the highest scientific production (19.12%), followed by the United States (17,3%) and United Kingdom (15,1%).
- The vast majority of the publications analyzed are conference paper (49.33%). In second place are the articles (35, 32%). In an intermediate position are the book chapter (6.21%) and conference review (5.23%).
- Logically, in line with the previous result, most of the research is published in conference proceedings (44.34%) and journals (38.86%). To a lesser extent we find book series (11.69%), books (5.35%) and Trade Publications (0.24%).
- Regarding to the subject area, most of the investigations are indexed in computer science (70.16%). Second, the Social Sciences area occupies a relevant position, bringing together 53.34% of the research found.
- Predominantly, in its vast majority, a research published in English (98.3%).
- Due to the importance of their work in the area under investigation, it is worth mentioning those carried out by Baker & Inventado (2014), Coffrin, Corrin, by Barba & Kennedy (2014), Dietz-Uhler & Hurn (2013), Ferguson & Shum (2012) Gasevic, Kovanovic, Joksimovic & Siemens (2014), Macfadyen & Dawson (2012) Picciano (2012), Slade and Prinslo (2013), Yousef et al. (2014).





In short, we see a research landscape that has grown exponentially in recent years. Although the largest research focus is in Australia, large numbers of researchers from countries in different parts of the world are showing a growing interest in learning analytics in the field of higher education. So, we bet that, very possibly, in the coming years this practice will have achieved a greater educational setting and will be used for the improvement of the teaching-learning processes, the results of the students, the teachers and, ultimately, the quality of education and of the institution itself (Gedrimiene et al., 2019).

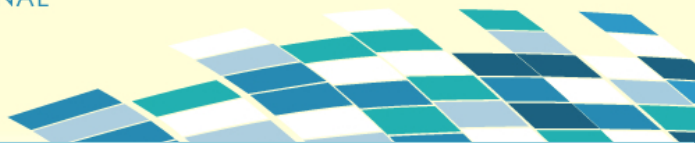
Financing

Ministry of Education, Culture and Sport through the Aid of the University Teaching Staff Training Program (F.P.U). Reference FPU14/04626.

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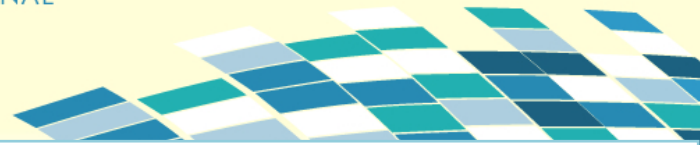
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