# Learning Analytics in Ecuador: An Initial Analysis based in a Mapping Review

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## ABSTRACT

Learning Analytics allows to describe, diagnose, predict and prescribe learning, especially in Higher Education. Two thousand eight hundred fifty-three papers related to Learning Analytics are stored in the Scopus bibliography database from 2014 until the middle of 2019, evidencing the importance and increasing interest in this line of research. This research discovers specific characteristics of investigations in Learning Analytics and answers the general question: What is the actual state of Learning Analytics research in Ecuador? This research uses a systematic mapping to answer four research questions about indexed production in Learning Analytics by Ecuadorian authors. This study has been done from 2014 until June 2019 (11 semesters). Eighty-six articles about Learning Analytics were found in RRAAE, Scopus, WOS and IEEE. Sixty-eight reports were downloaded, arranged and analysed after removing duplicates, applying inclusion, exclusion and quality criteria. The methodology used is replicable by the researchers interested in establishing a baseline in general and in particular in Learning Analytics.

interaction (HCI) → HCI design and evaluation methods • Information systems → Information systems applications → Data mining

## KEYWORDS

Learning Analytics, Literature Mapping Review; Ecuador.

## 1 Introduction

In Ecuador, almost 235 000 students were enrolled in institutions of higher education or nearly 14% of the population between 18–24 years old. Approximately 80% attend to public universities while the other 20% attended to private universities. The graduation rate at public universities is rarely more than 15% [6]. Table 1 shows the percentage population distributed by school age and by the level of education during 2007-2018 [26].

**Table 1. Percentage of the population by level of education**

| Age Range (years) | Ecuadorian level of instruction | Percentage (%) |
|---|---|---|
| 3 to 5 | Initial | 2.10 |
| 6 to 14 | Basic | 19.47 |
| 15 to 18 | High School | 5.46 |
| 18 + | University | 7.68 |

**Source: Ministry of Higher Education, Science, Technology and Innovation (Senesyt)** [26]

Ecuador has 30 public universities and 37 private universities [29], which provides an excellent opportunity for application of Learning Analytics (LA) in higher education. In Ecuador, there is no equity in education. This problem is significant in low-income sectors, indigenous sectors and rural areas. Despite this inequality, the number of literate people in Ecuador has increased significantly in the last decade [21]. This inequality leads to a low level of schooling, high school repetition and dropout rates, poor quality of education and inadequate educational infrastructure and teaching materials. The efforts made by educators are not enough to face the needs presented [5]; that is why LA is proposed to be used in Ecuador to improve learning. B-learning and e-learning are becoming popular in a country, which it can be the first step towards the use of LA. Most universities offer studies in B-learning mode with the support of information and communication technologies. The modality of distance studies and e-learning is increasingly used as a strategy in postgraduate teaching, giving us the opportunity to obtain student data and its learning context that allows its improvement and personalization [28]. In this job, we use the definition set out in the first International Conference on Learning Analytics and Knowledge (LAK 2011) and assumed by the Society for Learning Analytics Research: "Learning analytics is 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." [1]

The research in Learning Analytics began in Ecuador since 2013 with the publication Expertise estimation based on simple multimodal features, carried out by Xavier Ochoa [16]. He is Assistant Professor of Learning Analytics in the Department of Administration, Leadership, and Technology of the Steinhardt School of Culture, Education, and Human Development of New York University. He previously was Principal Professor at the Escuela Superior Politécnica del Litoral (ESPOL) in Ecuador [32]. Currently, young researchers are proposing new research topics that will improve learning in Ecuador [18]. One of the problems in the development of Research in LA in Ecuador is the lack of information about the current state. A first approach to the solution is made by answering general questions through a Systematic Mapping of Literature. At the moment, no document exists that allows us to have an approach to the authors,

universities, topics and other characteristics of research on Learning Analytics. The main objective of this research is to collect information from the articles that has been made by Ecuadorian authors, and thus characterize the research on Learning Analytics in Ecuador in order to answer the general question: What is the actual state of Learning Analytics research in Ecuador?

The results list of articles and other details can be found at https://1drv.ms/u/s!AgztBzyVpXfKiapGgVYM21c6kwKAlQ?e=4CJQd8

## 2 Methods

The purpose of a Systematic Mapping Review of Literature [10] is to answer the research questions posed in a clear and focused way. A Systematic Mapping must be procedural, auditable and replicable, specifically it has been applied to the literature review of scientific articles, but they can be used in other sources of information such as virtual classrooms [20] and titling works [17]. Systematic Mapping conducts a more general study than a Systematic Review and this is reflected in the research questions. A well-formulated research question is one that accurately meets the established objectives and allows you to quickly find valid information [11]. It is important to formulate your research question carefully to avoid missing in relevant studies or collecting a potentially biased result set.

PICOC method is a tool to define clear, precise, focused research questions that generate useful information [27]. There are other methodologies to generate research questions such as based on Learning Analytics [19], PICOS y SPIDER [14]. PICOC method has the next five components: Population (Who?), Intervention (What or How?), Comparison (Compare with what?), Output (What do you want to achieve?) and Context (What circumstances?).

The methodology used was a Systematic Mapping of Literature [11] [23] of scientific articles on Learning Analytics published by Ecuadorian authors. To answer the general question, What is the actual state of Learning Analytics research in Ecuador?, the main research questions were based on Learning Analytics [19] and proposed to answer as follows [10]:

**RQ1 (**DESCRIPTIVE**):** WHAT IS THE ACTUAL STATE OF LA PAPERS IN ECUADOR?

**RQ2 (DIAGNOSTIC):** WHAT IS THE RELATIONSHIP BETWEEN AUTHORS AND THE NUMBER OF PUBLICATIONS PER UNIVERSITY?

**RQ3 (**PROJECTIVE**):** WHAT ARE THE TRENDS OF THE LA PAPERS IN ECUADOR?

**RQ4 (**DESCRIPTIVE**):** WHAT ARE THE CHARACTERISTICS OF PRE AND POSTGRADUATE RESEARCH IN LA IN ECUADOR?

The application of the PICOC method to the four previous questions is shown in Table 2. Note that none of the research questions use an intervention factor to make comparisons.

**Table 2. PICOC method**

|  | RQ1 | RQ2 | RQ3 | RQ4 |
|---|---|---|---|---|
| **P**opulation | Learning Analytics papers in Ecuador | | | LA thesis |
| **I**ntervention | Does not apply | | | |
| **C**omparison | Does not apply | | | |
| **O**utcome | Descriptive Analytics | Diagnostic Analytics | Projective Analytics | Descriptive Analytics |
| **C**ontext | Ecuador (since 2014 until June 2019) | | | |

The Outcome component (see Table 2) and the main research questions, allow to generate 18 subquestions distributed, as shown below:

**1 RQ1 (DESCRIPTIVE):** WHAT IS THE ACTUAL STATE OF LA PAPERS IN ECUADOR?
1.1 What was the first LA paper in Ecuador?
1.2 How many papers are about LA in Ecuador?
1.3 What is the total of Ecuadorian papers about LA by bibliographic database?
1.4 To which Ecuadorian universities do the authors that published on LA belong to?
1.5 Who are the Ecuadorian authors who have published about LA?
1.6 What type of sources of the LA articles are in Ecuador?
1.7 In what subarea are the LA articles?
1.8 What are the funding sponsors of LA Ecuadorian papers?
1.9 What types of publication source of LA Ecuadorian papers are?
**2 RQ2 (DIAGNOSTIC):** WHAT IS THE RELATIONSHIP BETWEEN AUTHORS AND THE NUMBER OF PUBLICATIONS PER UNIVERSITY?
**3 RQ3 (PROJECTIVE):** WHAT ARE THE TRENDS OF THE LA PAPERS IN ECUADOR?
3.1 How many articles will there be about LA in Ecuador?
3.2 How many articles will there be about LA in Scopus and WOS?
**4 RQ4 (DESCRIPTIVE):** WHAT ARE THE CHARACTERISTICS OF PRE AND POSTGRADUATE RESEARCH IN LA IN ECUADOR?
4.1 What was the first LA thesis in Ecuador?
4.2 How many theses are about LA in Ecuador?
4.3 What is the total of Ecuadorian theses about LA by year?
4.4 In which Ecuadorian Universities are the authors that published thesis on LA belong?
4.5 What are the Ecuadorian authors who have published theses about LA??

This research was done from 2014 until June 2019 (11 semesters in total). Here it is considered that a scientific article deals with Learning Analytics and has an Ecuadorian author if it responds to the search string proposed. It was used in several bibliographic search engines and follows search string. It was applied TITLE-ABS-KEY ("learning analytics") AND (LIMIT-TO (AFFILCOUNTRY, "Ecuador")) AND PUBYEAR > 2013.

RRAAE is a free repository of research documents of Ecuadorian Public Universities, its purpose is to facilitate the management, decentralization, organization, preservation and interoperability of open access digital content, generated by the institutions of the academic and scientific community of Ecuador [25]. RRAAE is also the national node that is part of the Federal Network of Institutional Repositories of Scientific Publications of Latin America [22].

Fifty-two scientific articles were found in Scopus [24], 22 in web of science (WOS) [31], 8 in IEEE [9] and 4 in RRAAE. 86 articles in total were found, 18 were repeated (8 IEEE, two RRAAE and 8 WOS articles were also repeated). Inclusion criteria determine the characteristics of the documents to be analyzed, exclusion criteria allow some documents to be removed from the study and the quality criteria do not allow for example gray literature documents [13].The inclusion criteria used were: 1) if it was the result of the search in one of the bibliographic bases used, 2) it was not a repeated scientific article, and 3) it was possible to access the complete document. Articles that did not meet the inclusion criteria, or none of the authors were Ecuadorian, were excluded (exclusion criteria). The quality criterion is guaranteed by the Scimago (JCR) and SJR impact factors maintained by scientific articles of Scopus and WOS, respectively. After applying the inclusion, exclusion, and quality criteria, 14 articles were selected by the web of science (WOS), 52 in Scopus, 0 in IEEE and 2 in RRAAE. The 68 resulting articles were downloaded, organized and read.

The process followed in the systematic mapping of literature is shown in Figure 1.
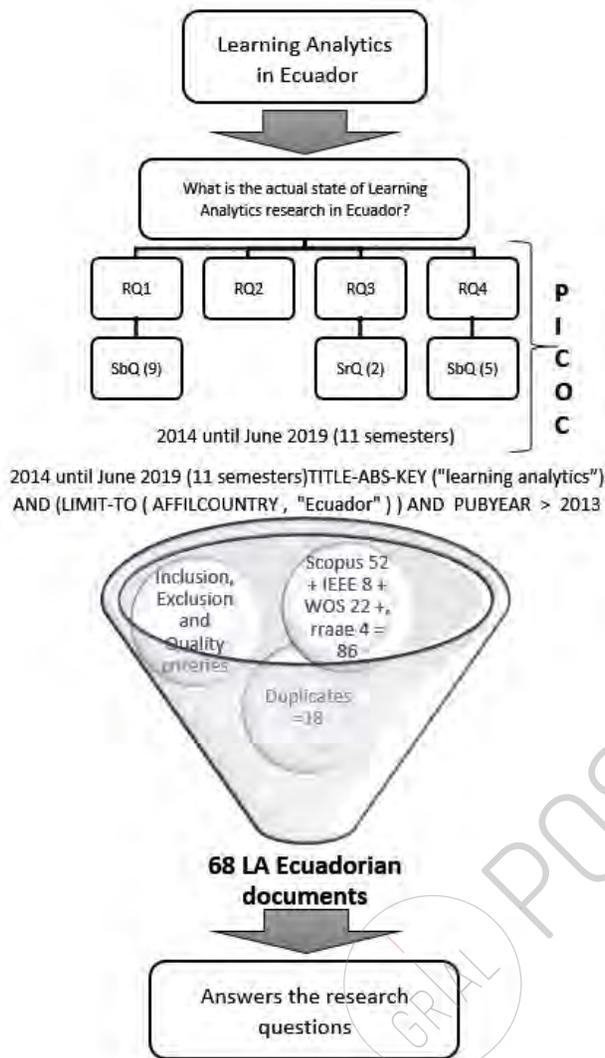
**Figure 1: Mapping Review process**

The resources used were: statistical programming environment R-version 3.5.2, user interface RStudio-version 1.2.1335, bibliographic manager Zotero-version 5.069 and the Bibliographic Data Bases Scopus, web of science (WOS), IEEE and RRAAE. Other bibliographic databases were not used because they did not allow a search composed by nationality or Affiliation.

## 3   Results and discussion

It will answer the research questions, with its help of sub-questions.

**• RQ1 (DESCRIPTIVE): WHAT IS THE ACTUAL STATE OF LA PAPERS IN ECUADOR?** Next, nine subquestions are answered:

**RsQ1.1: What was the first LA paper in Ecuador?** Authors are Ochoa, X., K. Chiluiza, G. Méndez, G. Luzardo, B. Guamán, y J. Castells. The title of conference paper is Expertise Estimation Based on Simple Multimodal Features. The Congress and year are ICMI 2013. The paper is about Multimodal Learning Analytics and shows a set of multimodal resources provided to the participants of the Second International Workshop on Multimodal Learning Analytics [16].

RsQ1.2: How many papers are about LA in Ecuador?
52 SCOPUS + 22 WOS + 8 IEEE + 4 RRAAE = 86

Eighty-six scientific articles on learning analytics in Ecuador, eight in IEEE, but all repeated. After removing the repeated papers and applying the inclusion, exclusion and quality criteria, the final number of papers was:

52 SCOPUS + 14 WOS + 2 RRAAE = 68

Finally, sixty-eight scientific articles on learning analytics in Ecuador were found.

**RsQ1.3: What is the total of Ecuadorian papers about LA by bibliographic database?** Table 3 shows the results of the research question 3:

**Table 3. Papers about LA by bibliographic database**

| YEAR | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | June 2019 |
|---|---|---|---|---|---|---|---|
| SCOPUS | 1 | 3 | 9 | 10 | 8 | 13 | 8 |
| WOS | | | 7 | 5 | 2 | | |
| IEEE | | | | | | | |
| RRAAE | | | | 1 | | 1 | |

52 of 68 documents belong to Scopus (76.4%), 14 of 68 documents belong to WOS (20.6%) and 2 to RRAAE (3%). All IEEE document was included in Scopus. Due to the high percentage of scientific articles in Scopus (more than 76%, maybe because Scopus is more popular), in order to answer the following research questions, the 52 articles published in Scopus will be taken as references.

**RsQ1.4: To** which **Ecuadorian universities do the authors that published on LA belong to?** Figure 2 shows the leading Universities of Ecuadorian authors that write about Learning Analytics.
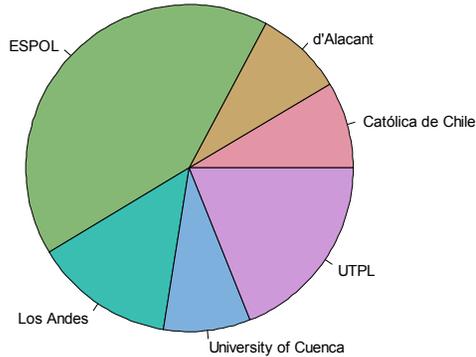
**Figure 2: First six universities (three in Ecuador)**

In Figure 2, it can be seen that 41.4% of Ecuadorian publications are in Escuela Superior Politécnica del Litoral (ESPOL) [7], followed by 19% in Universidad Técnica Particular de Loja (UTPL) [30] and 8.6% by the Universidad de Cuenca [8], 69% of publications have Ecuadorian first author, 31% of the publications are made by Ecuadorians who are not the principal authors. The Universities of the primary authors are distributed in the University of the Andes of Venezuela, the Catholic University of Chile and the University d'Alicant in Spain.

**RsQ1.5: Who are the Ecuadorian authors who have published about LA?** Figure 3 shows the principal Ecuadorian authors who write about Learning Analytics.
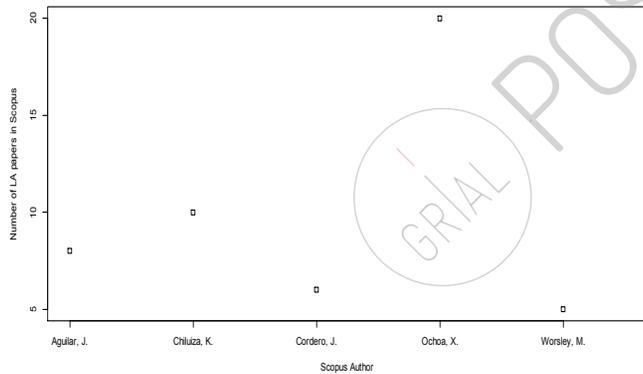


**Figure 3: Five Ecuadorian authors according to Scopus**

**RsQ1.6: What type of sources of the LA articles are in Ecuador?** The sources of the scientific articles in Learning Analytics are shown in number and percentages below: Conference Paper 55 (80.8%), Article 8 (11.7%), Editorial 2 (2.9%), Review 2 (2.9%), Undefined 1 (1.4%).

**RsQ1.7: In what subarea are the LA articles?** The subareas of the scientific articles in Learning Analytics are shown in number and percentages below: Psychology 2 (2.9%), Decision Sciences 3 (4.4%), Arts and Humanities 2 (2.9%), Mathematics 4 (5.8%), Engineering 11 (16.1%), Computer Science 46 (67.6%).

**RsQ1.8: What are the funding sponsors of LA Ecuadorian papers?** The main funding sponsor are shown in absolute frecuency below: Secretaría de Educación Superior, Ciencia, Tecnología e Innovación 4, Fondo Nacional de Desarrollo Científico y Tecnológico 2, Agencia Nacional de Investigación e Innovación 1, Comisión Nacional de Investigación Científica y Tecnológica 1, European Commission 1, European Geosciences Union 1, Fondo Nacional de Desarrollo Científico, Tecnológico y de Innovación Tecnológica 1, Fonds Wetenschappelijk Onderzoek 1, Ministry of Science, Innovation and Universities 1.

**RsQ1.9: What types of publication source of LA Ecuadorian papers are?** In Figure 4, the main sources of publication of papers on Learning Analytics in Ecuador are shown. Because the importance is shown in the results in Scopus and WOS.
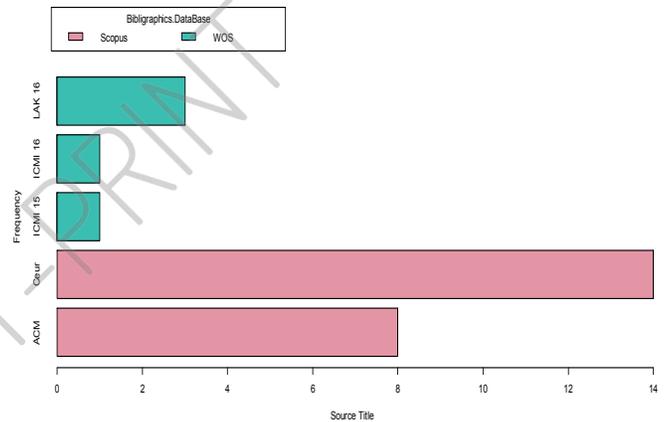


**Figure 4: Types of publication**

In Scopus, the most frequent publication source is Ceur (14), followed by ACM (8). In WOS, the most frequent publication source is LAK2016 (3), followed by ICM15 and ICM16 with one publication. The two RRAAE publications are not shown in Figure 4 because they are theses and have no publication source.

**• RQ2 (DIAGNOSTIC): WHAT IS THE RELATIONSHIP BETWEEN AUTHORS AND THE NUMBER OF PUBLICATIONS PER UNIVERSITY?** Universities are very sensitive to internal research groups. If a group changes its scientific production, the University will also. If one of the members of the research group changes its scientific production, so will the research group and the University. Scientific production can be severely affected if the principal investigator becomes absent. In Escuela Superior Politécnica del Litoral (ESPOL), the researcher Xavier Ochoa had change of university to another one. However, Xavier Ochoa is one of the most published researchers on Learning Analytics in Ecuador. The absence of Xavier Ochoa will significantly decrease the publications in Learning Analytics in Ecuador.

• RQ3 (PROJECTIVE): WHAT ARE THE TRENDS OF PAPERS IN ECUADOR? Two subquestions are answered below:

**RsQ3.1: How many articles will there be about LA in Ecuador?** Figure 5 shows the trend of publications in Learning Analytics in Ecuador. It shows a tendency to grow by the next years. The trend line shows a relatively low coefficient of variation (48.47%).
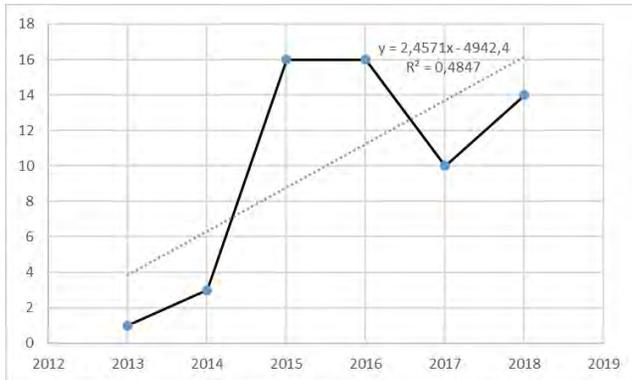


**Figure 5: Trend in the number of LA papers in Ecuador**

In the years 2015 and 2016, local maximums are found because in 2015 the LAK15 was held and in 2016 the Second International Conference, CITI 2016 in Guayaquil-Ecuador was held. Through the trend line (fairly appropriate) it can be determined that in 2019 approximately there will be 18 new publications on Learning Analytics in Ecuador. That is by the second semester of 2019, it should be at least ten new publications.

**RsQ3.2: How many articles will there be about LA in Scopus and WOS?** Figure 6 shows the relationship between the publications in WOS and Scopus over time. Publications in WOS tend to decrease (0, 0, 7, 5, 2, 0), while publications in Scopus tend to grow (1, 3, 9, 10, 8, 13) over time (2013, 2014, 2015, 2016, 2017, 2018).



**Figure 6: Bubble chart between publications in WOS and Scopus in time**

The growth model for publications in Scopus is inappropriate, with a coefficient of variation of 0%.

• **RQ4 (DESCRIPTIVE): WHAT ARE THE CHARACTERISTICS OF PRE AND POSTGRADUATE RESEARCH IN LA IN ECUADOR?** Five subquestions are answered below:

**RsQ4.1: What was the first LA thesis in Ecuador?** The first Learning Analytics document it was found on the thesis: ONTOLOGY FOR MODELLING AND UNDERSTANDING EDUCATIONAL DATA AND CONCEPTS-AN APPLICATION TO LEARNING ANALYTICS FOR SECONDARY PROJECT [4]. The Author was Cueva Rueda, Rodrigo Alejandro and his advisor was Sancho Sansó, María Ribera. However, the first thesis in an Ecuadorian University was: ESTUDIO COMPARATIVO DEL ANÁLISIS ESTADÍSTICO IMPLICATIVO Y EL LEARNING ANALYTICS EN RELACIÓN AL USO DE LAS TÉCNICAS DE EXPLORACIÓN DE DATOS EDUCATIVOS [15], whose author was Naranjo Serrano, Mauricio Medardo and his advisor was Pazmiño Maji, Rubén Antonio.

**RsQ4.2: How many theses are about LA in Ecuador?** In the network of open access repositories of Ecuador (RRAAE), two Master Theses [15] [3] were found. Also, two papers were found [2][12] and zero pre-graduate theses.

**RsQ4.3: What is the total of Ecuadorian theses about LA by year?** In the network of open access repositories of Ecuador (RRAAE), we found one Master Thesis in 2016 [3] and one Master Thesis [15] in 2018 [15]. Table 4 shows the results of the research question RsQ4.3:

**Table 4. Ecuadorian Scientifics documents about LA by year**

| YEAR | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | June 2019 |
|---|---|---|---|---|---|---|---|
| Pre-graduate Thesis | | | | | | | |
| Master thesis | | | | 1 | | 1 | |
| Total | | | | 1 | | 1 | |

**RsQ4.4: In which Ecuadorian Universities are the authors that published thesis on LA belong?** One thesis (2018): Pontificia Universidad Católica del Ecuador [15] and one thesis (2016): Universidad Politécnica de Cataluña [3] (but, no is a Ecuadorian University).

**RsQ4.5: What are the Ecuadorian authors who have published theses about LA?** One thesis (2016): Casanovas Muñoz, Jordi [3] and one thesis (2018): Naranjo Serrano Mauricio Medardo [15]

## 4  Conclusions

The history of research in LA in Ecuador began in 2013 with Xavier Ochoa and a publication on multimodal resources held at the ICMI congress. After 2013 Ecuador has continuously publishing and growing. 2018 was the highest year in publications (13), but by 2019, it will surely be better because there are already eight publications in the first semester. Until last year (2018) Xavier Ochoa was a research professor at Escuela Superior Politécnica del Litoral (41.4%), his research led the university to place as the first in Ecuador, followed by the Universidad Técnica Particular de Loja (19%) and the Universidad de Cuenca (8,6%). The three universities together have produced 69% of the scientific work in Learning Analytics. Most papers were published in conferences, notably Computer Science 42 (64.6%) in Ceur and Engineering 10 (15.4%). The primary funding sponsors are Secretaría de Educación Superior, Ciencia, Tecnología e Innovación and Fondo Nacional de Desarrollo Científico y Tecnológico. The absence of Xavier Ochoa will significantly decrease the publications in Learning Analytics in Escuela Superior Politécnica del Litoral (ESPOL) and Ecuador. Using data from the last five years, it has been projected that ten new publications related to Learning Analytics will be produced by the second semester of 2019. Publications in WOS tend to decrease, while publications in Scopus tend to grow. Although the publications in Scopus tend to grow, the linear model is inappropriate to predict. To answer the research question number 4, the RRAAE network has been used in its entirety. Concerning undergraduate research, no research work was found in Learning Analytics. Regarding the postgraduate research on Learning Analytics, two publications and two Master's theses have been found. Only one of the theses have been carried out in an Ecuadorian University (Pontificia Universidad Católica del Ecuador). The thesis titled "Comparative study of the statistical implicative analysis and the Learning Analytics in relation to the use of the techniques of exploration of educational data" was done in 2018 by Mauricio Naranjo Serrano and directed by Rubén Pazmiño Maji. The thesis work indicated is not related to any of the results presented in questions 1, 2 and 3. The research in the research groups is quite good, but in some cases, it depends only on the leading researcher. Undergraduate research in LA is null. Postgraduate research in LA is very little. The antecedent facts lead us to conclude that there is no integrated research system in Learning Analytics that considers research groups, pre-degree research and postgraduate.

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