

LEARNING ANALYTICS IN POST-SECONDARY BUSINESS EDUCATION: A SCOPING REVIEW OF REVIEWS PROTOCOL

Authors: Tiffany Bayley, Jisu Kim

Abstract

Learning Analytics is a growing discipline as educational institutions aim to exploit data and data analytics for several reasons, especially in higher education. Unfortunately, there is a lack of consensus on how learning analytics should be defined and what subjects fall under the purview of learning analytics. The blurred boundaries of what learning analytics encompasses have given rise to multiple studies and systematic reviews that have been published without any consistent agreement to develop the field in a particular direction. Consequently, we are outlining a protocol for a scoping review to map and summarize existing scoping reviews that have been published regarding learning analytics. More specifically, the scoping review of reviews will focus on learning analytics in business education as a use case when it involves machine learning to inform educational interventions. This scoping review will hopefully be the first step in unifying learning analytics for all stakeholders to further develop it into a field of study where it can benefit everyone relying on learning analytics.

Keywords

- Scoping review of reviews
- Artificial intelligence
- Machine Learning
- Higher Education
- Post-secondary
- Learning Analytics
- Educational Data Mining

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Background

With the increase of technological development in our contemporary time, there has been a paradigm shift for organizations to leverage data for improvements, also being the case in education. Commonly referred to as Learning Analytics (LA), LA is the field that encompasses activities involving educational data and data analytics in the world of education. Regrettably, there is no single definition that can define what exactly LA is, however, the most frequently used definition is given by Siemens (2013) from the 1st International Conference of Learning Analytics and Knowledge (LAK), “*Learning Analytics is the measurement, collection, analysis, and reporting of data about learners and their contexts, for the purposes of understanding and optimizing learning and the environment in which it occurs*” (Siemens 2013). Nevertheless, Guzmán-Valenzuela et al. (2021, p. 2) also proposed an alternative definition of LA being “*a data-driven approach... generated by students... to predict individual learning outcomes*” opting for a more student-focused definition. As can be seen, there are different interpretations placing different emphasis on what LA should be.

The reason why LA has no unified definition to collectively progress the development of the field probably has to do with the inception of LA. According to Siemens (2013), *academic analytics*, the usage of analytics in academia, is rooted in Business Intelligence. Business Intelligence is defined as the practice of using data analytics to improve performance and maximize resource allocation (Siemens 2013). This start of learning analytics which was derived from the perspective of maximizing efficiency for corporations has had a profound influence as educational institutions retained such practices. Essentially, the institution's objective is to recruit and retain successful students (Leitner et al. 2017; Roberts et al. 2016), raising ethical concerns (Roberts et al. 2016). Meanwhile, learners and educators are trying to improve learning opportunities and processes while researchers are answering questions to advance education using Educational Data Mining (EDM) (Leitner et al. 2017).

To provide a bit of context, EDM can be defined as the “*methods of exploring educational data... or applying educational data from data mining techniques to answer important educational questions*” (Romero & Ventura 2020). Like LA, once again there is no universal definition, instead, it is sometimes used interchangeably with LA (Baek & Dolek 2021). At the very least, however, EDM can be said to be an extension of LA (Siemens 2013) being affiliated with the analysis component of LA if one is to temporarily adopt Siemen’s definition of LA.

This in turn raises another important discussion of identifying the stakeholders that are influenced or affected by LA. Leitner et al. (2017) proposes the following four categories:

- Learner
- Educators
- Researchers
- Administrator

These stakeholders have different objectives pertaining to LA. Learners and educators are concerned about personal educational growth and development, researchers are more concerned about questions in education, while administrators are focused on institutional aims.

As a result, there is further discord in this subject regarding the type of data that should be collected and measured (Scalise et al. 2021) as there are different sources of data to assess in education such as those from a Student Information System versus a Learning Management System (Romero & Ventura 2020). Furthermore, after the collection of these data points, various applications and actions can be taken with the analysis. Sometimes these decisions or interventions using these data and analysis are referred to as *actionable insights*, *actionable intelligence*, *actionable knowledge*, etc. (Koh & Tan 2017; Scalise et al. 2021; Van Leeuwen 2018), which further contributes to the lack consistent definitions within the subject of LA.

Overall, this is merely scratching the surface of the scope of LA. However, the general theme is the disparity between the taxonomy and various interests of the different groups that exist within LA. By conducting a scoping review of reviews with respect to post-secondary business education, our objective is to unify the language of LA to elucidate the current progress made within the field and aid in its future development. We will focus particularly on systematic and scoping reviews that consider machine learning and other predictive tools to inform educational interventions.

Why we are conducting this scoping review

It is evident from the background provided in this protocol that LA is a complex field with multiple dimensions with overlapping attributes when it concerns educational environments, methods of data acquisitions, data analysis, and the stakeholders involved to mention a few of the variables. Consequently, the original intention was to conduct a systematic review/scoping review on the LA research that was done for business schools. However, this was too broad of a topic once we conducted our initial search from our string query, with the results being beyond the tens of thousands. Restricting the search strategy further to only higher education or machine learning or both did not substantially reduce the number of results, especially on the Web of Science Database. Furthermore, upon reading some of the abstracts there appeared to be a disparate understanding between LA and EDM. Thus, this scope is being conducted in hopes of providing a unified overview in the LA field of all the different directions that LA and EDM are headed, summarizing any similarities and differences in each field.

METHODS

Protocol Design

The objective of a systematic review would be to have a standardized level of understanding within a certain field when conducting research (Arksey & O'Malley 2005). However, if there is a wide range of vocabulary to express concepts and characteristics, this may introduce bias into a systematic review. (Arksey & O'Malley 2005). As this is the case for LA, it is more appropriate to conduct a scoping review which summarizes existing evidence in a field while also providing future research priorities. (Levac et al. 2010; Colquhoun et al. 2014). Thus, by using the model proposed by Arksey & O'Malley (2005) for a scoping review protocol, we will be identifying the following in this protocol below.

- 1) Identifying the Research Question

- 2) Identifying relevant Studies
- 3) Study Selection
- 4) Charting the Data
- 5) Collating, Summarizing and Reporting the Result

Stage 1: Identifying the Research Questions

The objective of the scoping review is to understand the current landscape of LA and EDM, and more formally answer the following questions:

1. What are the typical learning environments and characteristics used to study the impact of learning analytics in post-secondary business education?
2. What are the overarching conclusions from systematic and scoping reviews on the state of learning analytics in post-secondary education, with a focus on business education?
3. How can these results be leveraged to successfully incorporate learning analytics in post-secondary pedagogical design in a business school?
4. What role do machine learning and other predictive tools have in developing intervention strategies in post-secondary business education?

Stage 2: Identifying relevant literature

SEARCH STRING

Based on the research questions the eligibility criteria, and the following search string was identified as follows:

("learning analytics" OR "EDM" OR "educational data mining" OR "LA") AND (systematic OR scoping OR literature) AND (review OR reviews) AND (business OR management OR "business school" OR "business schools") AND ("higher edu*" OR "post secondary" OR "post-secondary" OR universit* OR college*) AND ("education" OR "educational" OR "teaching" OR "teach") AND ("Machine learning" OR "Artificial Intelligence" OR predictive OR "predictive model*" OR AI OR ML OR "neural network*" OR Bayes* OR "intelligent tutor*" OR "knowledge tracing")

RELEVANT DATABASES

The nine selected disciplinary databases were to cover all the different elements in our research question that are related to business, education, and technology to fully capture the scope of LA and EDM involving the use case. Furthermore, a handful of multi-disciplinary databases were selected that could potentially cover all disciplinary fields for our scope of research.

Disciplinary database	Multi-disciplinary database
Education Database	Eric (Ovid)
Business Source Complete	Eric (ProQuest)
ABI/Informed	Scopus
IEEE Xplore Digital Library	Web of Science
ACM Digital Library	

An Example of how a scoping review on ERIC (Ovid) was conducted.

# ▲	Searches	Results
1	("learning analytics" or "LA" or "educational data mining" or "EDM").mp. [mp=abstract, title, heading word, identifiers]	7862
2	limit 1 to peer reviewed	3686
3	("business" or "business school" or "management").mp. [mp=abstract, title, heading word, identifiers]	167887
4	limit 3 to peer reviewed	76146
5	("education" or "educational" or "teaching" or "teach").mp. [mp=abstract, title, heading word, identifiers]	1409266
6	limit 5 to peer reviewed	762279
7	("post-secondary" or "university" or "college" or "post secondary").mp. [mp=abstract, title, heading word, identifiers]	432945
8	limit 7 to peer reviewed	239842
9	2 and 4 and 6 and 8	131
10	("Machine learning" or "Artificial Intelligence" or predictive or "predictive model" or AI or ML or "neural network" or Bayes* or "intelligent tutor" or "knowledge tracing").mp. [mp=abstract, title, heading word, identifiers]	26731
11	limit 10 to peer reviewed	17387
12	9 and 11	25
13	("higher ed" or "post secondary" or "post-secondary" or universit* or college*).mp. [mp=abstract, title, heading word, identifiers]	585571
14	limit 13 to peer reviewed	329276
15	(systematic or scoping or literature).mp. [mp=abstract, title, heading word, identifiers]	161585
16	limit 15 to peer reviewed	93043
17	(review or reviews).mp. [mp=abstract, title, heading word, identifiers]	148154
18	limit 17 to peer reviewed	74410
19	3 and 13 and 16 and 18	1009
20	5 and 19	941
21	11 and 20	15
22	limit 21 to peer reviewed	15
23	2 and 4 and 6 and 11 and 14 and 16 and 18	3
24	((("learning analytics" or "EDM" or "educational data mining" or "LA") and (systematic or scoping or literature) and (review or reviews) and (business or management or "business school" or "business schools") and ("higher ed" or "post secondary" or "post-secondary" or universit* or college) and ("education" or "educational" or "teaching" or "teach") and ("Machine learning" or "Artificial Intelligence" or predictive or "predictive model" or AI or ML or "neural network" or Bayes* or "intelligent tutor" or "knowledge tracing"))).mp. [mp=abstract, title, heading word, identifiers]	6
25	limit 24 to peer reviewed	3

Stage 3: Study selection

After the initial search, the Title and Abstracting Screening and the Full Text Screening will follow the criteria listed out below on Covidence.

- **Exclusion criteria**
 - Written in a language other than English
 - Focus exclusively on K-12 (or non-post-secondary) education
 - Focus on non-business-related topics
- **Inclusion criteria**
 - Peer-reviewed article, abstract, and/or conference proceedings
 - Must be a systematic/scoping/literature review
 - Business Education
 - Higher education
- Other criteria to potentially sort by
 - Machine learning
 - Artificial intelligence
 - Flipped classroom
 - Interventions

Stage 4: Charting the data/literature

The scoping review will chart the following data and literature from existing scoping reviews.

- 1) The different definitions of LA and EDM used in business schools of higher education institutions.
- 2) The different types of data that are being collected and measured.
- 3) The different methods of how educational datasets are being collected and measured.
- 4) The type of analysis that is being conducted in business school using the educational data that is collected.
- 5) The reporting or application that is implemented based on the analysis that has been conducted.

Stage 5: Collating, summarizing and reporting the result

A summary will be presented based on the most prevalent definitions and methodologies identified in the charting stage of the scoping review.

Next Steps and Discussion

This scoping review is being conducted to identify potential areas of consensus in the field of LA and to develop a common learning analytics taxonomy. It is hoped that future stakeholders of LA will benefit from a more relevant classification scheme that better identifies the appropriate aspects of LA to implement when working towards a desired teaching and learning outcome. Furthermore, a more formal taxonomy will allow LA researchers to position their contributions to the field with less ambiguity, leading to less duplication of effort and more efficient expansion of valuable research and knowledge in LA.

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