The Benefits of Learning Analytics to Higher Education Institutions: A Scoping Review

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Abstract—Learning analytics is a form of data analysis that allows teachers, lecturers, educational experts, and administrators of online learnings to look for students' online traces and information associated with the learning processes. The fundamental goal of learning analytics in online classrooms and computer-supported instruction is to enhance the learning experience and the entire learning process. This review aims at reviewing some of the benefits available through using learning analytics in higher education institutions (HEI) for the students, teaching staff and the management. The search for relevant literature was conducted by searching online databases which include Web of Science, SCOPUS, Science Direct, IEEE, Emerald, Springer, ERIC and Association for Computing Machinery (ACM). The analysis of the literatures obtained from the online databases revealed that learning analytics provide series of benefits to students, teaching staffs and the management of higher education institutions. The benefits include prediction and identification of target courses, curriculum development and improvement, improved students' learning outcomes, improved instructors' performance and monitoring of students' dropout and retention. It is recommended that higher education institutions adopt the use of learning analytics in their online teaching and learning.

Keywords—learning analytics, higher education institutions, learning management systems

1   Introduction

Siemens and Gasevic (2012) defined Learning Analytics (LA) as "the measurement, collection, analysis and reporting of data about learners and their contexts, for the purposes of understanding and optimizing learning and the environments in which it occurs". Learning analytics largely focused on procedures for collecting, analysing, assembling, merging, and processing of educational data from different sources for the purpose of forecasting future educational trends with the aid of appropriate machine learning techniques and algorithms and finally using the outcome of the processed data to make relevant improvement to the process of teaching and learning [2]. Learning analytics is also the use of analytical techniques for analysing educational

data relating to teachers and learners and patterns of learning behaviour, and from these techniques information can be provided for the improvement of learning [3].

Online technology is continuously becoming a significant advantage in higher education institutions in today's competitive environment [4]. The goal of learning analytics is to appraise user's behaviour in the perspective of teaching and learning, additionally to conduct an analysis and also to interpret it for the purpose of gaining new understandings and to offer the educational stakeholders' novel models for bringing about improvement in teaching, learning, organizational effectiveness, and goal driven decision making [5], [6]. A significant fact is the provision of the consequential information to both teachers and students for the purpose of enhancing teaching, improving students' learning behaviours, encouraging the development of relevant skills in the subject area, and to have a better understanding of education and the associated fields. The resources that are available can thereby be efficiently used for providing better supports and care for individuals for developing the relevant potentials in both the teachers and the learners [6].

Higher education institutions are implementing the use of learning analytics to have a better understanding and also support student in their learning process [7] much more than other educational institutions. Analysis of relevant students' data aid improvements in the curriculum and content delivery in higher education institutions [8]. In addition, learning analytics was designed to be of use to higher educational institutions in some strategic areas like resource management, student performance, and financing. Many educational institutions are presently collecting more data than they previously obtained and this has resulted in optimizing competitive outcomes. Therefore, in a range of educational contexts, providing a selection of online technology can assist institutions and lecturers in better responding to students' particular learning patterns, preferences, and requirements [9].

There are many examples of effective use of analytics and frameworks across a wide range of educational institutions [10], [11]. One of the major areas of applying learning analytics is the act of predicting and monitoring academic performance of students which provides timely opportunity to identify areas where students might be having problems and to make provision for immediate correction and interventions in order to prevent poor performance and eventual failure of students [12]. Pardo et al. (2017) posit that learning analytics typically offers feedback aimed at improving the learner in the learning process which may include self-regulation, setting of goals, encouragement, techniques and strategies. This feedback in learning analytics is commonly defined as the need to convey the learning status of a student to various educational stakeholders (instructors, students and school administrators).

Therefore, for the purpose of having a wider understanding of the benefits of using learning analytics in higher education. This review is being guided by a research question which serves as a pivot for the conduct of the review.

1.1 Research question

What are the benefits of learning analytics to higher education institutions?

2 Methodology

For the purpose of achieving the objective of this review, the search for related literatures were limited to articles on learning analytics in higher education institutions. The inclusion criteria are learning analytics in higher education institutions with a focus on prediction and identification of target courses, curriculum development and improvement, improved students' learning outcomes, improved instructors' performance and monitoring of students' dropout and retention in online courses. Articles that have no relationship with benefits of learning analytics in higher education institutions were excluded from the review.

The search for relevant literatures was focused on articles published between 2010 and 2020. Online databases were searched through Web of Science, SCOPUS, Science Direct, IEEE, Emerald, Springer, ERIC and Association for Computing Machinery (ACM). All the articles reviewed were written in English. The keywords searched were, learning analytics, higher education institutions, prediction, curriculum development, students' learning outcomes and students' dropout and retention.

3 Findings and discussion

Table 1 shows the analysis of all the articles obtained from all the databases and the number of articles selected for review from the entire articles from the databases. The whole literature search produced a total of 72 research articles, and after the application of the inclusion and exclusion criteria, a total of 25 research articles that were found to have direct relationship with benefits of learning analytics to higher education institutions and also aided the answering of the research question were included in the review.

Table 1. Analysis of articles obtained from all the online databases

Online Database	Total number of articles obtained from databases	Total number of articles selected for review
Web of Science	15	6
SCOPUS	11	8
Science Direct	13	4
IEEE	8	3
Emerald	8	1
ERIC	6	1
Springer	6	1
ACM	5	1
Total	72	25

Table 2 shows the summary of the articles on benefits of learning analytics in higher education institutions.

Table 2. Summary of Studies on Benefits of Learning Analytics to Higher Education Institutions.

	Author(s)	Research Objective	Population	Benefits Derivable through Learning Analytics
1	Althubaiti & Alkhazim (2014)	To estimate the output of medical colleges and to predict number of graduate students using learning analytics.	Higher Education Institution	Prediction and identification of target courses.
2	Dietz-Uhler & Hurn (2013)	To use learning analytics for improving and monitoring students' performances.	Higher Education Institution	Prediction and identification of target courses.
3	Agudo-Peregrina et al., (2014)	To find out the relationship between types of online interactions and related academic performances in online courses.	Higher Education Institution	Improved students' learning outcomes.
4	Agustianto et al. (2016)	To employ Adaptive Learning (AL) for focusing on students' personality through recommendation-based learning and inquiry-based learning form of learning path (LP) for assisting teachers in constructing a learning process for students.	Higher Education Institution	Improved students' learning outcomes.
5	Chalaris et al. (2015)	The application of data mining techniques by administrators of higher education institutions for solving the problem of delay in completion of studies by students.	Higher Education Institution	Improved students' learning outcomes.
6	Arnold & Pistilli (2012)	Analysis of Course Signals in assisting teachers to provide real-time feedback to students.	Higher Education Institution	Improved students' learning outcomes.
7	Jo et al. (2017)	To explore the influence of asynchronous online discussion (AOD) and how it influences students' academic outcomes.	Higher Education Institution	Improved students' learning outcomes.
8	Pardo et al. (2016)	To develop a model for using analytics methods for improving the quality of students' learning experiences.	Higher Education Institution	Improved students' learning outcomes.
9	Iam-On & Boongoen (2017)	Using data driven methodology to detect students at-risk.	Higher Education Institution	Monitoring of students' dropout and retention.
10	Cambruzzi et al. (2015)	Development of a learning analytics system to address dropout challenges in distance education courses.	Higher Education Institution	Monitoring of students' dropout and retention.
11	Pradeep et al. (2015)	Usage of data to analyse factors affecting students' academic performances that facilitate the prediction of their failure and dropout.	Higher Education Institution	Monitoring of students' dropout and retention.
12	Bayer et al. (2012)	Employing data derived from students' social behaviour for predicting students' failures and drop-outs.	Higher Education Institution	Monitoring of students' dropout and retention.
13	Coussement et al. (2020)	Determining the impact of logit leaf model on students' dropout and retention	Higher Education Institution	Monitoring of students' dropout and retention.
14	Vasic et al. (2015)	Using data sets from Learning management systems (LMS) to provide feedback to individual students and having a deeper analysis of students' results.	Higher Education Institution	Prediction and identification of target courses.
15	Armayor & Leonard (2010)	To describe curricular mapping strategies used in analysing and interpreting curricular mapping data that can facilitate curricular development.	Higher Education Institution	Curriculum development and improvement.

	Author(s)	Research Objective	Population	Benefits Derivable through Learning Analytics
16	Kaya (2019)	To highlight the use of Artificial Neural Network (ANN) for providing support for curriculum development process at program level.	Higher Education Institution	Curriculum development and improvement.
17	Martin & Nock (2018)	To assist teachers in integrating content by developing a web of study method to chemistry curriculum rather than the traditional linear course of study.	Higher Education Institution	Curriculum development and improvement.
18	Gallimore et al. (2016)	To develop and also implement a stepwise method to assess the achievements in course objectives in pharmacy practice in order to facilitate redesigning of sequential skills-based courses.	Higher Education Institution	Curriculum development and improvement.
19	Joshi et al. (2017)	To test the significant relationship between selected variables in online learning environment and students' performance.	Higher Education Institution	Improved students' learning outcomes.
20	Pardo et al. (2017)	To use learning analytics for conducting actionable remediation for bringing about improved university students' academic performance.	Higher Education Institution	Improved students' learning outcomes.
21	Mardikyan & Badur (2011)	Investigates the factors associated with the assessment of instructors' teaching performance using two data techniques.	Higher Education Institution	Improved instructors' performance.
22	Hamza Osman (2016)	Presentation of a framework for assessment and prediction of teachers' performance in academic institutes.	Higher Education Institution	Improved instructors' performance.
23	Ndukwe & Daniel (2020)	The design of a conceptual model to provide a platform for teachers in using data for reflecting on teaching outcomes.	Higher Education Institution	Improved instructors' performance.
24	Prieto et al. (2018)	Explores the using of sensors and learning techniques by teachers to automatically obtain graphs on a dataset of classroom sessions.	Higher Education Institution	Improved instructors' performance.
25	Vijayalakshmi et al. (2020)	Predicting the performance of teachers and exploring the factors influencing students' accomplishments.	Higher Education Institution	Improved instructors' performance.

Based on the number of articles selected for this review, it can be inferred that higher education institutions can gain series of benefits from using learning analytics which include prediction and identification of target courses, curriculum development and improvement, improved students' learning outcomes, improved instructors' performance and monitoring of students' dropout and retention.

Based on the results from Figure 1, a large number of the studies reviewed showed that learning analytics can assist higher education institutions in improving students' learning outcomes.
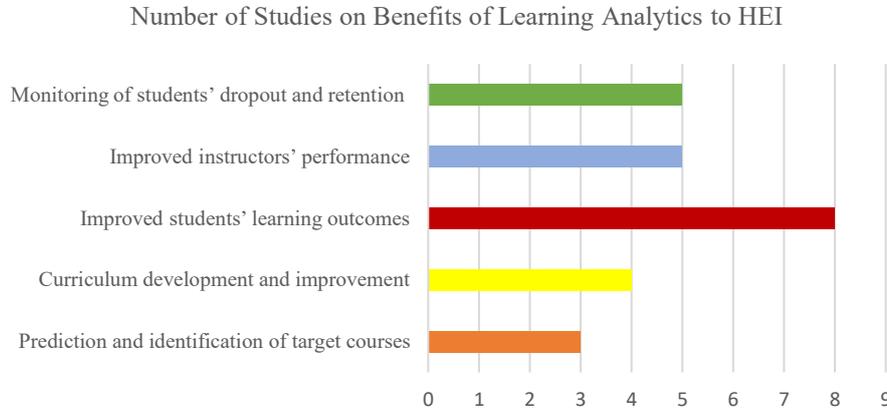
Number of Studies on Benefits of Learning Analytics to HEI

Fig. 1. Number of Studies on Benefits of Learning Analytics to Higher Education Institutions

One of the most important advantage of learning analytics is that it allows schools and instructors to identify student learning outcomes and how to bring about improvement in student's performance during the educational process. The use of data from learning analytics, according to researchers, contributed to positive learning outcomes. Learners interactions with technological tools such as e-learning and mobile learning can assist educators to have a better understand of the student's learning experience through learning analytics [39].

The use of learning analytics in the learning process also highlights student's learning behaviours, the effect on adaptive learning, and learners' endurance. The utilisation of student data also reveals ways to improve student learning and their performance in academic courses by studying the implications on their learning outcomes [40]. Hence, learning analytics enables teachers to assess different types of knowledge and adapt educational content as needed.

A typical example is Course Signals, a learning analytics application, which was designed to assist instructors to use learner analytics to deliver real-time feedback to their students. Course Signals does not rely solely on grades to forecast student achievement, it also uses demographic variables, prior academic experience, and students' effort as evaluated by their engagement with the learning management system. The result is sent to students in the form of a personalised email to each student, as well as a specific colour on a stoplight to indicate how each student is performing [19].

In the area of prediction and identification of target courses, learning analytics makes use of appropriate statistical techniques and models in the projection of graduation rates in schools, and by doing that, differences between actual and projected rates can be useful for the university in achieving general and specific educational goals. This type of data will provide a solid foundation for establishing target courses, developing new programmes, making beneficial academic decisions, and bringing about a number of changes to higher education institutions [41].

The projections can also include predicting students' performances, suggesting relevant learning resources to students', detection of undesirable learning behaviours, and detecting affective states. All these increases reflections and awareness on the part of the students. Learning analytics will also free teaching staff from having to rely only on their intuition and insight to identify challenging students. It also assists on when to propose relevant learning resources, and inspire students to reflect on their learning [15].

Vasic et al. (2015) also reported that system logs from Moodle LMS were used for prediction of students' learning outcome. On the basis of a training set, the procedure of predicting students' knowledge was carried out. The predictive model was put to the test on 64 students that enrolled in IT programs, and the findings revealed that the prediction was extremely accurate.

For curriculum development and improvement, learning analytics can also be used to offer additional solutions on educational issues that are related to curriculum design, primarily at the course level, with the goal of improving learning and teaching processes and providing assistance for curriculum development at the programme level. Obtaining the dependencies between courses within a programme is critical for putting them systematically and ensuring curriculum success [29].

Through the development of a web study approach to subject curricula, using learning analytics in the curriculum process also helps teachers to better integrate content and respond to expressed frustration regarding extensive lists of standards often presented as collections of isolated topics in prescribed courses of study [30].

Learning analytics also enables teaching staff to make relevant changes and necessary adjustments that will bring about improvement in the curriculum development in the educational system as a whole. These can be achieved through the use of data-driven curricular mapping. Educators can also use learning analytics to identify deficiencies in students' learning process and comprehension in order to assess the curriculum for possible changes [39].

In order to achieve improved instructor performance, learning analytics also provide a framework to predict the performance quality level of teachers in order to improve the students' learning outcomes. Performance evaluation system assists in achieving educational aims of universities. The aim is to assist the growth and development of teaching staff by analysing, monitoring, and employing relevant information available within a model to enhance their progress and efficiency [35].

Learning analytics also improves teachers' diagnostic pedagogical abilities in using data and evidence to improve teaching quality, as well as finding the best strategies to improve teaching performance. Learning analytics equally provides a platform for teachers to reflect on teaching outcomes through the use of data which may be utilised to engage colleagues in meaningful discussions to enhance teaching quality. To bring about improvement in teaching challenges, teachers must also strengthen their data literacy and data inquiry skills. Therefore, providing teachers with access to analytics in relation to their teaching practice and learning outcomes can bring about improvement in the quality of their teaching practices [36].

Learning analytics also promote effective monitoring of students' dropout and retention. It should be known that despite the numerous benefits of online courses, such

as continuous access, high flexibility, rich content, and low cost, online learning continues to suffer from significant dropout rates, which impede pedagogical and economic goals. Other studies have also reported that online classes have experienced a large increase in dropouts and low attendance [42]. However, the use of students' dropout detection tools would allow educational institutions to identify students who are at risk of dropping out and highlight variables that may be addressed to help students complete their education [26].

Learning Analytics systems have been developed to address the issue of dropout in some universities' online distance education courses. In such LA systems, there are varieties of supplementary tools that allow for data visualisation, dropout predictions, instructional action support, and textual analysis, among other things. The systems have shown that they can forecast dropouts with an average of 87 percent accuracy. In a study by Cambruzzi et al (2015), a dropout rate reduction of about 11 percent was reported when a set of pedagogical measures targeting students with higher dropout risks was adopted.

4 Conclusion

This review has further demonstrated the advantages derivable from implementing learning analytics in higher education institutions, particularly in the area of online teaching and learning which is gaining momentum in all institutions globally. The literatures reviewed have shown that prediction and identification of target courses, curriculum development and improvement, improved students' learning outcomes, improved teachers' performance, and monitoring of students' dropout and retention are major areas where learning analytics can positively impact online teaching and learning in higher education institution.

5 Suggestions for further studies

Since students are the major recipients of learning analytics tools, it is therefore recommended that a research on students' perception of learning analytics should be conducted. This will go a long way in revealing how students feels about learning analytics.

The use of learning analytics also requires that lecturers should possess some competence in interpreting data from learning analytics dashboards, research relating to lecturers' competence in terms of data literacy will therefore be of great importance for effective provision of feedback to students.

The large datasets obtained through learning analytics can assist higher education institutions in having access to information that can guide in making educational plans that can foster improved teaching and learning in schools. Research in terms of how higher education institutions can better make use of such information obtained through students' data would be of great value.

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