Data Literacy and Confidence for Building Learning Analytics Solutions in Higher Education Institutions. A Review

Idania Lizbeth Rodriguez Moncada[1]

[1] Riga Technical University, Latvia
idaniarodriguez1@gmail.com

Abstract. Learning Analytics as an approach that seek to optimize the student experience at university has a great potential for improving student's learning experience. To ensure that this happens, universities should be driven by the improvement of learning and teaching processes and student engagement, focused on student's needs as part of the institution strategic plan.

Keywords: Data Literacy, Learning Analytics, Student experience.

1   Introduction

This continuously evolving digital world bring so many challenges for Universities to take care of. Universities have to take the lead in building staff capabilities so as to prepare students to work and live in digital society.

As part of digital capabilities that are required nowadays is the ability to read, work, analyze and argue with data which is not only required for educators, so as too for students, not only for interpreting their academical results, also the job market is requiring more data literate people as part of their staff at different roles in the working world.

The main goal of this paper is to review the way higher education institutions are using data with learning analytic methods to assist them in improving instructional process.

2   Perspectives on Data Literacy

21st century came with a brunch of new challenges to higher education institutions, big amounts of data available in educational environments has changed the landscape and turned around the need to understand and use it effectively, bringing to the scenario new challenges and new skills to apply at academic levels and also in student learning activities [1]. Those required transformations are already begun for many higher education institutions which has started taking advantage of the bunch of data generated in the study environment to process, analyze and lead decision making process [2].

"Data literacy is the ability to understand and use data effectively to inform decisions. It is composed of a specific skill set and knowledge base that enable educators to transform data into information and ultimately into actionable knowledge" [3].

The question that may raise is what kind of data might be needed when talking about higher education data? There is a huge amount of data generated within the educational environment. Then, the main concern is: how this data can be used to improve students learning and their overall student experience?

Higher education institutions daily generates vast amounts of data, which are: students records, includes individualized data students active during study periods, modules or courses taken, grading, timetables etc.; People employed in the institution; details about admissions to the institutions and applicants data; Administrative and financial data; research data; some universities also include in their databases, destinations and employment details of their graduated students. This data is generally used for courses planning and overall strategy of the institutions. The importance of the data is evident for influencing strategic decisions within institutions.

The way students interact with the university is becoming mainly digital, logging to the virtual learning environment (VLE) of the institutions leads to a set of data that can be collected (login frequency, page clicks, downloads, login time, topics search in the digital library, etc.). All previous described items are insights which can be used to understand students' behaviors through learning analytics methods for further decision-making process.

3   Learning Analytics

Learning analytics was defined by the first international conference on learning analytics and knowledge: "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." [4]

Why are some higher education institutions interested in implementing learning analytics systems? The main concern is to improve student's experience, according to each institution needs the focus can be in enhancing achievement, providing better feedback to students, improving retention, capturing attendance data, enhancing teaching and learning, etc. Following there are few examples of application cases.

3.1   Improving Retention

Improving retention is an issue of high importance for institutions, how it is possible to make data-driven decisions about student success and retention? Can student's data be an indicator of how likely is him/her to drop out a course? As the focus of this paper is to have an overview of learning analytics and data used for institutions, the following study cases seek to answer previous questions resumed in table 1.

Table 1. Application cases of Learning Analytics related approaches

N.	Institution	Learning Analytics Method	Use of Data
1	Open University	Bayesian classifier, classification and regression tree (CART), k Nearest Neighbors (k-NN), k-NN with VLE data.	Demographic student's data and interactions with the Virtual Learning Environment (VLE) system.
2	Purdue University	Course Signal System	Student alerts for academic issues intervention.
3	Saint Louis University	Retention Center-based early warning system.	Feedback provided by students in two introductory courses.
4	Business School, School of Health, Nursing and Midwifery (HNM), School of Computing. All of them in UK	Prototype mobile web application MyFeedBack	Student's log to MyFeedBack recorded and displayed on the tutor's panel.
5	University of Melbourne	Learning Analytics Dashboards	Student's assessment data (formative and summative), frequency of access to the LMS.
6	University in Saudi Arabia	Analytical application: Quiz My Class Understanding (QMCU)	Results of test knowledge to students based on questions done for lecturer from their lesson's objectives.
7	University of Maryland Baltimore County (UMBC)	Check My Activity (CMA) feedback tool.	Number of times the student logged into the particular Blackboard subject. Discrete interactions within the subject.
8	RMIT University Melbourne	Thermal sensor monitoring traffic.	Student's traffic data, feedback, space utilization data.
9	University in South-Eastern Queensland	Relationship between attendance and academic performance using the Pearson product-movement correlation coefficient.	Records of attendance of a sample of 383 students and records of the marks in each measurement element for each tutorial class associated with the subject and specific academic marks.

In Open University case, data is used to know how students are interacting with their courses which can be a good indicator of student's engagement with learning activities week by week. The model predicts students at risk, for giving properly intervention and reduce dropping out risk [5].

Purdue University created a signal system, which extract data and provides a dashboard for students and faculty to track student progress. According to the researchers this system helps to increase retention, by promoting integration into the institution. The system allows to faculty members personalize attention to students by emailing depending on their performance track, students are also encouraged to visit help resources in the campus [6].

In a Saint Louis University report, the aim is to improve student's performance and retention by collecting and analyzing data from a functionality in their LMS called "Retention Center" which main task was to track student's participation and performance in individual courses [7].

3.2 Providing Feedback During Study Progress

Learning Analytics have been also used to understand each individual student progress, feedback for students is important during the study process (not just at the end of period or examination) this enable students to assess their progress and get direction in how to improve. Table 1 in cases 4 to 6 last rows show some cases of application of this approach.

Business school, School of Health, Nursing and Midwifery (HNM) and School of Computing, in UK, implemented a prototype mobile web application MyFeedBack with aim to investigate if students collect their feedback and how frequently they do. The investigation consisted in three studies, the first and third were summative assessment, while the second one was formative where no marks were included. As general results, researchers found that more than 50% of students accessed their feedback within the three studies, however in the one without any mark included the engagement with feedback was lower [8]. Even though analytics dashboards help students to track their study's engagement, they still depend on potential pedagogical strategies implemented by lecturer to progress in their assessments.

To investigate the influence that feedback has on student's self-regulated learning, Centre for the Study of Higher Education of University of Melbourne did a mixed study into student's interpretation of feedback delivered through learning analytics dashboards and what actions do they take in response. As result, researchers found that majority of students were able to interpret the data presented which and an impact on student's motivation across the subjects [9].

In paper number 6 there is a study of a university in Saudi Arabia, which consisted in the application of an analytical application called Quiz My Class Understanding (QMCU) to investigate the combination between Learning Analytics (LA) an Formative Assessment (FA) to give students immediate feedback, the application created is a mobile web application (available in mobiles and regular computers). The application is in form of a quiz model with questions covering learning objectives of selected subjects, the feedback provided is individual performance, performance compared

with their peers and the class performance as a whole [10]. According to previous researches, giving student's access to their own analytics encourage and help them for self-reflection on their performance and the factors that affect that driving in some cases to become more engaged with their academical activities.

3.3   Monitoring Attendance Data

Some higher institutions are interested in how analytics can capture up to date attendance data and how it impacts student's outcomes.

The University of Maryland Baltimore County developed a tool called Check My Activity (CMA) that let students compare their own activity with the average activity of his or her course peers. The aim of the application is to measure attendance on the LMS through students' activities correlations with their final grades [11].

The next case is in RMIT University Melbourne where a thermal sensor data is used to monitor traffic into classrooms which is associated with lecture timetable. Thermal sensors when connected to timetable system, they are able to provide attendance data at a class level, as the sensor only detect the body heat of anyone passing by, the data collected is not at an individual level, the sensor estimate room occupancy every 30 minutes. The study was linked with a survey feedback filled by students at the end of each semester. As conclusion was found small correlation between overall student satisfaction and average attendance. This study is important in the sense of searching for student's assistance patterns, but there is not strong relationship between it and student's satisfaction, there is also to consider that more research needs to be done for investigating the class type, room size, grouping, etc. to formalize dependency with student's satisfaction [12].

At a university in South-Eastern Queensland was realized a study from two introductory psychology subjects during three cohorts, taking as input data the records of attendance and the records of marks for measurement element in each tutorial classes associated with the subjects, the main aim: To investigate attendance in the class tutorials relation with successful performance in the assessments. As result in this case there is a positive correlation between attendance and assessment. However, this correlation in the last cohort didn't show same results, according to researchers this could be because a change made in the assessment [13, 14].

4   Data Implications

Learning analytics by definition is directly connected and depends on educational data due to it aims to provide actionable insights to educators and learners in the whole learning process, however accurate interpretation of those outputs is an important component of data literacy. To this end, data literacy is a skill required not only by learning analytics practitioners, but also by intended end users.

In previous table there are collected the types of data used by institutions and a brief review of the analysis applied to it. As seem dashboards and app tools are the most used strategy which is useful for data visualization results to non-data experts.

Modes of visualization is another important approach to address due to the different audiences that the data results need to be presented.

5   Conclusions

Higher education institutions have embraced the adoption of data mining, learning analytics, big data, data visualizations and related data-driven approaches for their analysis and decision-making process. However, there is still to be embraced new approaches to address a data literacy discussion among lecturers to understand how the data analyzed, how can those interpretations be used to properly and timely improve in teaching and formative assessment.

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