



Learning Analytics, the Latest Data Mining Technique in Higher Education -Case Study

Fawzia Awad Elhassan Ali

PhD Program, Computer Science Dept. Sudan University of Science and Technology Khartoum, Sudan

***Corresponding Author:** Fawzia Awad Elhassan Ali, PhD Program, Computer Science Dept. Sudan University of Science and Technology Khartoum, Sudan

Abstract: Evolution in managing information systems and the big datasets that increasing every minute, generates the vital demand competition to explore the maximum benefits of the 'big data' creating in higher education institutes. Business intelligence (BI) and learning analytics (LA) are nowadays draw attention in business and society and being one of the most competitive advantages themes and profitable areas of interest in industry and organizations, including higher education institutions. Business intelligence Predictive analytics systems, using BI tools have established substantial effect on tactical transformation, decision support and informing trends' predicting. Learning analytics is working to deploy the worth of business intelligence in the academic context arena of education and training as it influences students' success, retention and explore enhancement to improve satisfaction. These concepts extent the process from envisioning the problem to applying learning analytics techniques to a particular situation, achieving insight to help deploy the results to improve decision-making.

This paper is based on a real dataset in a case study grounded in "Computer Science and Information Technology" college in Sudan university of science and technology (SUST), and focuses on investigating the potential of applying Business Intelligence approaches toward an expressive analysis of the organization's and student's experience, by making use of "business intelligence enhanced learning analytics framework", showing challenges and opportunities. It provides valuable insights into build a profound knowledge about students' experience, so as to assess the situation in teaching- learning process, by identifying weaknesses to be considered through practical institutional responses and, prepares for smart informative supervision.

The findings explored that, how technology captured data of students' performance for prediction, to identify at risk students, for the purpose of consulting and withholding them before being drop out, investigate the states and provinces that have very small number of students, the effect of number of students per college/department on average GPA, the individual student details are showed, such as his personal profile and his results in his complete educational life and the completion rate for graduated students is calculated. Moreover, how that constructions can take the form of statistical outlines, models, KPIs, insightful and interactive dashboards and relationships, offering a grand challenge for technology enhance learning (TEL).

Keywords: Business intelligence; learning analytics; case study, higher education institutes ;educational management

1. INTRODUCTION

Higher Education recently has a strong demand for, and perfect strategic transformation, as the data come to be more available, toward using innovative technologies in complex decision making, students' retention and quality control environment, improving learning process, teaching strategies and quality control mechanisms [1], [2], [3].

The establishment of higher education institutions for large data is increasingly important in preparation their foundation for advanced analysis, which is now urgently needed, as well as the need to transform organizational and student data into useful knowledge[4], [5], [6], [7].

Big data has become one of the most important issues in data analysis. They refer to ocean amount of data that are either too large or too unstructured, flowing from various heterogeneous sources and different in shape, genre and independent relationships, and so need sophisticated techniques to take advantage of and analyze them [8], [9]. The numbers show that thousands of hours of data, videos and

lots of pictures have been uploaded via YouTube and Facebook and various social networking sites every minute over the past few years [10], [11]. According to IBM, it has been creating 90 percent of all the data in the last two years only [12], In information attributed to the International Data Centre, only 22% of the information in the digital universe is useful information if selected, less than five percent of them have been analyzed for deceased knowledge of their own [13]. These developments have enhanced the capacity for continuity in increasing the use of data sets flowing from many sources. Furthermore, the organization and disaggregation of data in regulatory environments, often about 80 % of these data is not structured [12], which refers to the challenge process of controlling and analyzing these datasets. Because of the amazing possibilities provided by business intelligence (BI) leading technology offerings to meet the urgent need to streamline datasets from everywhere, synthesized and how they are presented in a clear visualization evident to support informed decisions based on expertise, and planning Strategist [14], had already proved the importance of their impact on the business. Implementing of learning Analytics help a qualitative leap in the value of the business intelligence in the context of the Academy in order to achieve the educational goals of the student success, retention and satisfaction that backing benefit to the entire education and society.

Despite the vast amount of data available at higher education institutes, decision makers rarely rely on them [5], as the ability to absorb data or its ability to synthesize and merge data from all sectors or angles to form "One copy of the truth" or a repository window to be Basically like the educational data repository, it does not exist in most higher institutions [2]. Therefore, there are no future resource requirements [5].In the educational context we find that the retrieval of information and the scope of the analysis is "still in its infancy", and many higher education institutes are still in the process of collecting or monitoring data [15].

This limitation is an inevitable consequence of the barriers like "cover-up of costs, data constraints, different cultures and experiences, and the potential for extensive communication [15], institutions must overcome those barriers and constraints and give top priority to analytic [15]

For information attributed to [2], many of the standard legal levels in terms of "student success rates, graduation rates, registration targets, retention etc." remain low. Therefore, there are great requirements to explore the exciting abilities of BI&LA.

Because of the above-explained situation in the education domain with reference to reality, obstacles, trends and opportunities, there is a worldwide need to focus on this area of research.

In this case study, predictive analytics using BI solution, employed to a real dataset of computer science and information technology college students' in Sudan university of science and technology (SUST).

This paper is structured as follows: Section 2 defines the contextual for this study, primarily focused on the joint between business intelligence technologies and learning analytics, and educational management section 3presents the methodology part, section 4 illustrate findings and discussion where BI tools are used to visualize students' experience, and finally section 5 shows the summary and the future direction of the research.

2. BACKGROUND

Business intelligence is a combination of concepts, technologies, methods, tools and practices, developed towards compiling, archiving, organizing, managing, analyzing and displaying business knowledge relevant to past, present and required performance of the Organization, towards enabling decision support processes and the development and achievement of actionable, operational and strategic objectives, this of course done by integrating intelligent analysis, statistics and advanced visualization technologies that enables smart use of data that-driven resolutions.

There's a lot of overlapping concepts with relevant impact on BI&LA like Data ware house, data marts, Artificial intelligence (AI), online analytical processing (OLAP), online analytical mining (OLAM), extract transform load (ETL), metadata, data mining, process mining, complex event processing, analytics, business performance management, and query and reporting system. BI tools allow accessing structured and unstructured data from heterogeneous sources of information and knowledge considered high value, very accurate, easy to understand and accessible to proceed with increased performance and capacity of the Organization and its impact and effectiveness, as well as to improve forecasting and

strategic planning value [16], [17], [3], [4], [7]. Enable business intelligence systems to the educational environment can facilitate access to large data, analysis of efficiency, making decisions based on deep knowledge of complex business, raising the Organization's performance and that of its absorbing useful work-related information and knowledge. One of the most important achievements of access clean data, that is consistent, reliable and high quality with the elimination of doubt or suspicion, is to build a solid base for proper analysis [3], [1]. Business intelligence systems for management education and marketing can offer effective solutions to the needs and requirements of information to various stakeholders, such as managers, Governments, policy makers, allowing them to browse and access in a secure way to share data, customizable and adaptable electronic dashboards and reporting. They are also an effective tool for planning, decision making, control and predict the potential student information systems (SIS) and learning management systems (LMS), and/or customer relationship management systems (CRMS) to work through reliable and clear user interfaces. Moreover, These systems also support decision making and planning processes of students enrollment, quality assurance, search jobs, and/or formulate policies [19], [14], [3]. For example, University staff can monitor the development of the curriculum, and program completion rates and learning paths, and providing feedback and support when needed [16], [17], [7] [2] [3], [4] while students can immediately inform, as decision maker and entitled to set right directions on The basis of a Visual representation of the learning paths during the life cycle of the University [20]. To reflect that focus on business intelligence improve organization and profits, by forecasting based on extracting knowledge from historical and current data sets collected by administrative and management processes of research and learning and these analysis aim to get executable ideas to complex issues in mutual relationship handlers Between the student and the Organization, and apply knowledge of computer science and information science, mathematics, statistics and education technology. While some approaches designed for learning Analytics might focus on improving current processes and facilitate workflows, as well as educational and organizational data is measured and improved organizational performance [21], [22], other policy generally refers to learning Analytics measurement, collection, analysis and report data about students and their contexts, For deep understanding to improve learning environments [23]. Learning analytics can produce problem analysis disclosure models that can predict the future processes, for example backup and underperforming students withheld [24], [25], [26], to reflect that focus on business intelligence.

There is a number of published success cases, used business intelligence and learning analytics in higher education, which underscoring the considerable importance of this research. Many universities worldwide conducted various business intelligence enhancements' experiences and soon after learning analytics initiatives, toward enabling significant and evidenced decisions using information technology systems, expose the excessive potential of applying BI tools for analyzing the available data and mining valuable information for decision support [27], [28], [2], [3]. Referring to this broad experience, the next Section is devoted to exploiting the methodology practice and trends in a real case study, using a real students' approach dataset for the purpose of this research, and creates the basis for a novel, inclusive smart educational management.

3. METHODOLOGY

The paper has been settled from a real case study, of 1069 undergraduate students' result records of years (2013 – 2017) (mean age 19.5, 61% females), study in Computer Science and Information Technology College in one public university in Sudan, Sudan University of science and technology (SUST), registration data studying for degree of computer science.

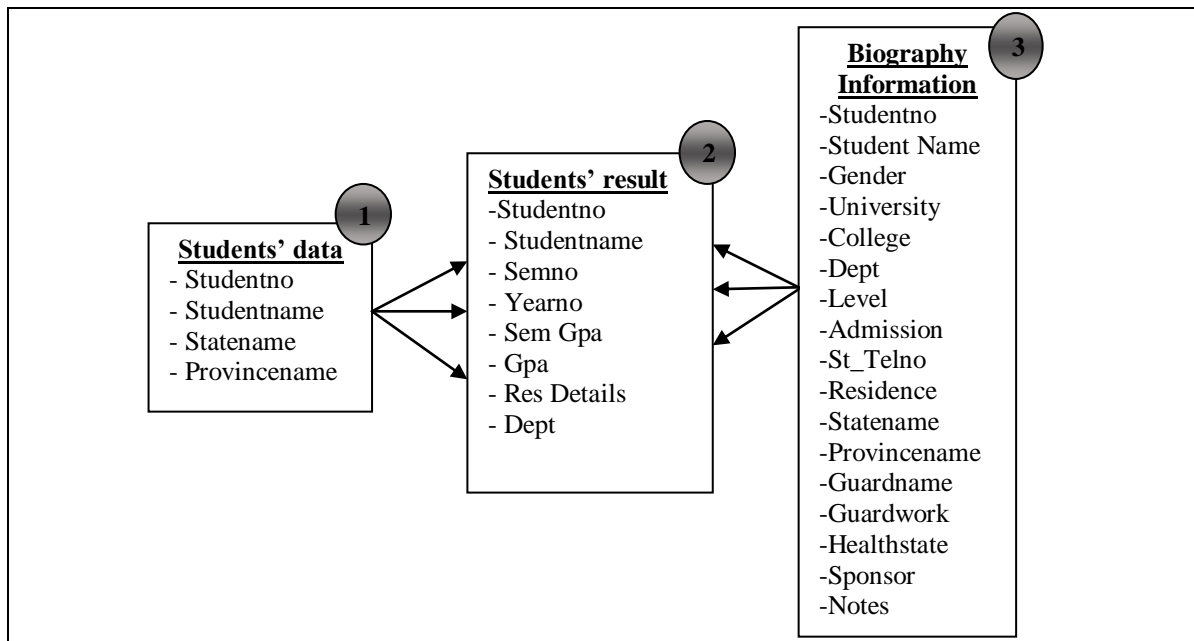
A mixed quantitative hybrid methods approach used in this research. The data was gathered from multiple heterogeneous resources through:

- I) Data collection and mining of student, students' results records (from registration office) along with biography information from the students' interior center (Fig. 1).
- II) Satisfaction survey distributed as a questionnaire to students to capture their needs, requirements, individual learning characteristics and considering their opinion as a main stakeholder.
- III) Interviews officials and quality affairs from Computer Science and Information Technology College in SUST.

A student satisfaction survey via a questionnaire has been conducted, to capture student requirements, and well understanding of their educational needs, trends, as well as individual learning

characteristics. The responses have been analyzed and described from students’ perspectives and taken into account, by considering them with information from data analysis.

Table1. System entity relationship



Starting with extracting the variables from the collected data that consisted of, (student information system from registration office, with their grades along with their biography information from the residence center) Fig. 1, to populate warehouse system that can be used by decision makers for performance measurement [30]; [31] and decision support.

The population sample is about 5.567 active students’ results (1.965 male; 3.602 females) between 2013-2017 academic years.

In addition, using Survey and Data analysis at different granularity, exploring which variables are result from the Learning Analytic, seeing it will be obtained aspects serves data discovery Fig. 1.

The students’ data have been collected in excel format, uploaded to oracle database, cleared by eliminating noisy, redundancy and inconsistent data, transformed and integrated to apply BI software solutions. Many reports and dashboards are visualized, in the light of requirements using BI software tool (Tableau), which is the dominant BI tool used in academic context. Findings are discussed leading to awareness and insights.

The paper explains that how can BI solutions have a significant and large impact on students’ success, retention, enrollment planning, strategic fact-evidenced and high-quality decisions, by identifying weaknesses to be improved in a later phase.

Thus BI & LA have the capability to permit decision' makers to vision data in different view Fig 2, to navigate and on-line query data sets to discover new factors that affect the learning processes, enhance the student success, massively increase efficiency and refining teaching-learning process.

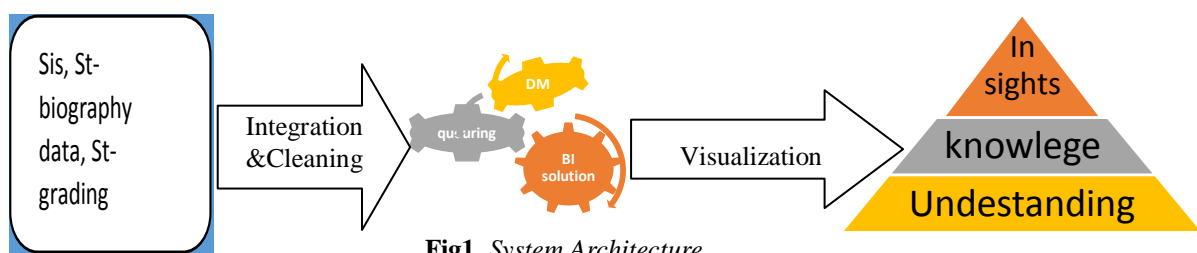


Fig1. System Architecture

This case study also conducted to validate the business intelligence enhance learning analytics ,framework (BIELA), proposed by the author in previous phase Fig 2

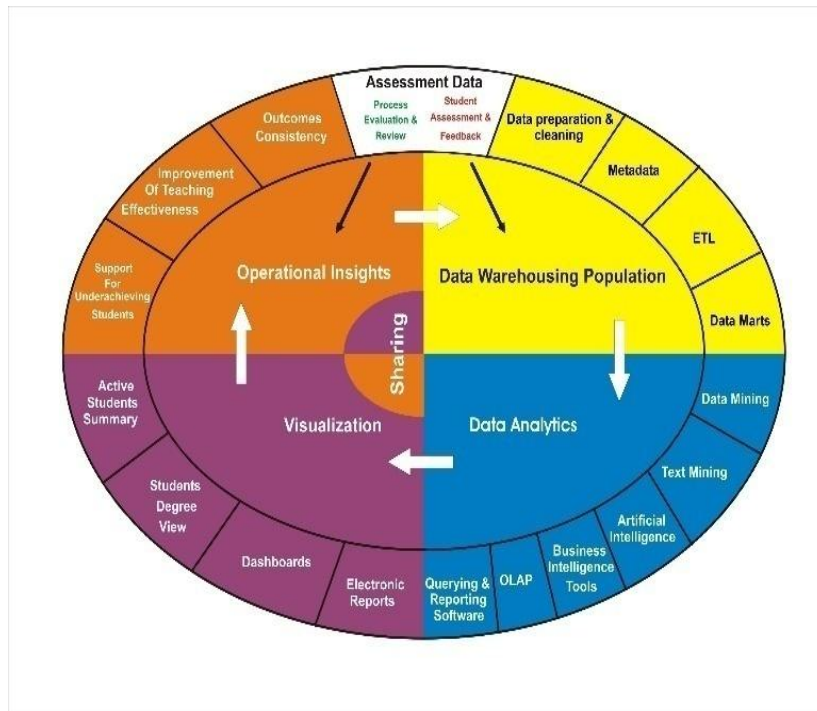


Fig2. Business intelligence enhance learning analytics framework (BIELA),Source: Authors

The proposed business intelligence enhanced learning analytics (BIELA) framework jointly applies business intelligence and learning analytics that constitute a paradigm shift in today’s higher education institutions. The author consider business intelligence as an instrument to extend the value of learning analytics in the field of education and training in proportion to retention, students’ success and satisfaction, and hence, the overall organization’s performance and ranking -in a wider scope-, namely toward data-driven, informed, timelier, high-valued, evidenced and accurate decisions related to the students, and the organization simultaneously.

Fig 2&Fig 3, provides a detailed view of BIELA framework that establishes a novel closed-loop feedback foundation for an inclusive analytics and decision support cycle targeted at understanding the students’ learning processes, learning experience and success conditions as well as the demands of the target groups in the organizational context, in essence educational management, and consistently applying this information in an iterative decision-making process. It is expected that in the fast-changing conditions of the organizational management demands might constantly require new input and modification. Thus, the framework is formed by four stages mapped onto a common business intelligence infrastructure and superposed by phases of iterative assessment providing regularly fresh data and insights from the assessment processes -performed with students as well as the organization- forward to the analytics and decision support cycle.

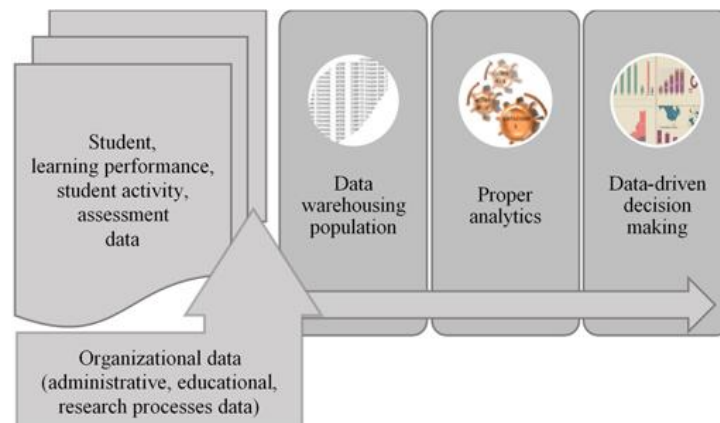


Fig3. Detailed view of the closed-loop feedback-based BIELA framework

4. FINDINGS AND DISCUSSION

The experiments obtain many aspects leads to profound understanding of students’ learning experience, as follows:

Fig 4. Shows the number of students (male & female) came to university from all states and provinces in Sudan. Bigger the size of circle in state chart or the square in the province chart shows the highest distinct number of students came to university from that states or province. It shows that percentage of (Male: Female) is approximately (1: 2) fig 5, and that the total number of females coming from remote states, is bigger than those are coming from Khartoum state (capital city), resulting high requirement for internal housing. The bigger number of students are coming from the following states (Khartoum, Gazira, Northern state, White Nile state, Nile river state, North Kordofan, Sinnar, North Darfor, Gadarif, Kasala, Red Sea, South Kordofan, South Darfor, East Darfor, East Kordofan), respectively.

University need to investigate the states and provinces that have very small number of students that if there are some other universities in that states or the states are far away from this university. Therefore, university or ministry of higher education need to build new universities of sub camps in distant states or provinces to increase literacy rate.

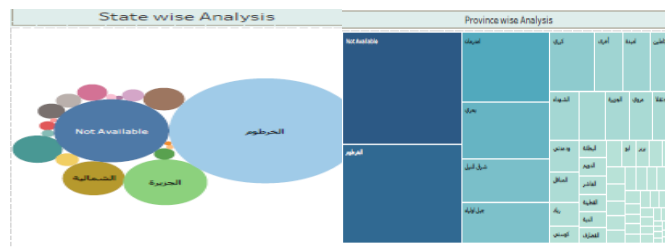


Fig4. State and province wise analysis

In addition, analysis obtains that, the number of females is 1.8 times more than the number of males in all departments except computer science where the number of male students is slightly more, nevertheless the males’ GPA is equal to or slightly above females’ one, except in the information system and computer science departments where females demonstrate superior Fig 5.



Fig5. Gender vs GPA Analysis

4.1. Student GPA Analysis

This shows number of students per department and the avg. GPA, to analyze that what is the effect of number of students per department on avg. GPA. As a result, Fig. 8 shows that, high number of students in a department gives higher avg. GPA. However, this still need Cohort analysis. Here some other key factors also required for such analysis, from student survey about quality of education, although most of students agreed on, this college has a great desire and good academic reputation, but also they complained about lack of labs and preparation, low teaching quality and improper time table. Most of them prefer to learn with images, videos or other media and they in need of academic and social advisor.

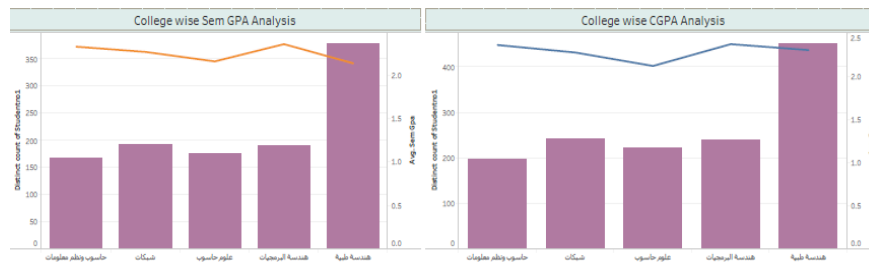


Fig6. Dep. wise sem. GPA, CGPA

4.2. Student Semester GPA Analysis

This also shows number of students per department per semester and the avg. Semester GPA per department per semester to analyze the effect of number of students per department on avg. semester GPA, semester over semester (Fig. 6).

Results shows that in second and third semester most students are doing well, but in sixth semester, they are going below average, then what are the factors involved in that, like more credit hours, poor faculty or improper timetable in such semester. Here some other key factors also required for such analysis like number of faculty per college per semester, total credit hours, timetable per semester, student survey about their semester’ teachers in a specified semester.

4.3. Student Detail Analysis

This shows individual student details, such as his personal profile and his results in his complete educational life, Fig 7. To analyze that the student is improving his scores semester over semester or going on risk (see Fig. 8) or withdrawn. This will help in counseling, support and improvements week individual student, by investigating what the factors making him “dull student” gradually. Visualization of student grades also shows the drop in semester six in most of students’ details, confirms what has already emerged from surveys of students and decision makers.



Fig7. Student Grades



Fig8. At-risk student

4.4. Graduation Analysis

It shows number of graduated breaks down by gender or by departments, their admitted and graduated years are detected, so that “completion rate” is detected. It shows that few students graduated in (4 years) as required, and females are more succeeded in that, confirming the bigger number of females enrolled. Most students graduated in six years indicating a failure problem, few of them admitted in

2009 and 2007 meaning studying for seven to nine years, taking into account the study suspension due to political or weather or any other external factors. Fig 9. State and province wise graduated dashboards, shows that most graduated students are from Khartoum Fig 10.

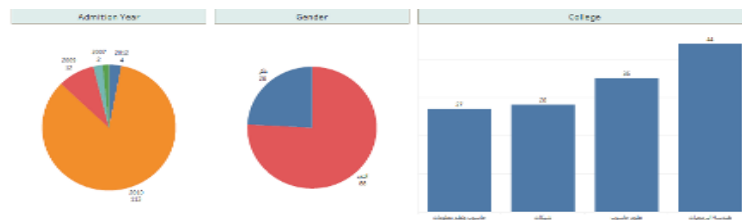


Fig9. Graduated students' analysis



Fig10. State and province wise graduated

5. OTHER OBSERVATIONS

Dashboards also shows that; most students are sponsored by the university and most parents are from the workers category Fig. 11. Note that the word "worker" is very flexible and may include small/large business owners.



Fig11. Students' distribution over sponsor and parent work

6. CONCLUSION

Today, higher education institutions are highly interested in gathering and storing student and learning experience data in large data bases' repositories for further analysis. Most of them are now being aware of their potential business value, provides insights on the facets they should monitor and help simplify, mark a competitive improvement. The use of business intelligence in learning analytics improves the collection of raw unstructured data, which can never thought before, allowing for high-quality data as needed in higher education institutions by eliminating doubt before uploading and starting with building performance models, and decision making. Furthermore, due to exploring and exploiting the organizational as well as student data the resultant business-related insights open up new paths for the organization's performance and progress in a middle term, and society advancement in a longer term.

Building a profound knowledge about students' learning experience can improve the prediction of individual performance, and therefore, related Institutional performance, retention and students' success to achieve a better learning environment, student satisfaction, support for decision making and increasing the performance in higher education institutes towards learning analytics and thus overall institutions' performance and ranking by attracting in the same time more and better students and researchers.

One of the big challenge is the dataset, because students' data is considered personal and not allowable.

Future work will address active community partnership and collaboration toward the deployment of the BIELA framework in further educational domains. This can be achieved by, for example, customizing the framework to accommodate education and social partner requirements. Furthermore, investigating sources for collecting additional student activity information and ensuring an automated retrieval of organizational information by accommodating real time analysis, is envisaged.

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