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Applicationsof Big Dataand Analytics In Higher Education-A Review

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Abstract
Usage of emerging technologies become inevitable for creating business value and to swim across the challenges in a digitally driven world. This is applicable in the field of higher education as well. Generally data analytics may enable to get more insights to obtain a better understanding about the needs and wants of all stakeholders of higher education. Higher education experiences only limited progress in hoardingreally rich data that flow through higher education.The objective of this review is to assess some of the prospective benefits of big data and analytics as applied to the world ofhigher education and to explore implementation challenges that can be expected. In addition, thisstudy reviews keypropertiesof successful analytics platforms and elucidates some of the routesthat might be taken to implement thesetechnologies in education.

Keywords
Big data, Data Analytics, enrolment management, predictive analytics, student performance management

1. INTRODUCTION

Volume and multitudeof data collected from different directions of the business at every points of the stakeholders is constantly increasing. As the world becomes smarter and smarter, data becomes the key to competitive advantagewhich means that ability of a company to compete will increasingly be driven by the extent to which itcan leverage data, apply analytics and implement new technologies.Data Analytics represents qualitative and quantitative techniques and processes used to enhance effective decision making. Data is extracted, acknowledged and bifurcated to identify and analyze behavioral data, techniques and patterns can be dynamic according to need or requirement of a particular business. Data Analytics is a broader term that has analysis as a subhead and analytics is basically the concepts used to do the analysis.

Business organizations around the world have started to include big data analytics into their business models that could provide information for more scholarly decision making.Business Intelligence (BI) and data analytics are used by the organizations to predict the future of their business progress.It is also expected that data analytics will become a criticalcore competency for professionals of all types [1]. Large companies have started using the big data and big data analytics and certainly other industries and organizations that deals with complex data system will also follow the same system and procedures for improved decision making [2].

It is estimated in India that around37 million students are currently attending some form of higher education but there has been limited progress in accumulating and analyzing data that flow through the education system. Big data can be integrated into several parts of the higher educationsystem and can lead to greater student success. Hence it is important to

explorethe opportunities and challenges associated with implementingbig data and big analytics in the higher educationsystem and presenting the findings for educators, administratorsand policymakers to consider.

2. BIG DATA ANALYTICS

The term "Big Data" has been applied to datasets that grow so large that they become difficultto work with using traditional database management systems. Theyare data sets whose size is beyond the ability of commonly used software tools and storage systems to capture, store, manage, as well as process the data within a tolerable elapsed time [3].

Big data sizes are constantly increasing, currently ranging from a few dozen terabytes (TB) to many petabytes (PB) of data in a single data set. Consequently, some of the difficulties related to big data include capture, storage, search, sharing, analytics, and visualizing. Today, enterprises are exploring large volumes of highly detailed data so as to discover facts they didn't know before [4]. Hence, big data analytics is where advanced analytic techniques are applied on big data sets. Analytics based on large data samples reveals and leverages business change. However, the larger the set of data, the more difficult it becomes to manage [4].

2.1 Characteristics of Big data

There are four main characteristics namely Volume, Variety,Velocity, and Veracity.

1. Volume represents the size of the data and it requires powerful processing technologies.
2. Variety denotes data collected from unlimited sources in three distinct types such as structured, semi-structured, and unstructured. One of the primary goals of analytics is to use technology to make sense of unstructured and semi-structured data, and combine it with what's known from structured datasets in order to unlock insights and create business value.
3. Velocity signifies that there will be more data available on any given day than the day before, but it also means that the velocity of data analysis needs to be just as high
4. Veracity refers to the quality, accuracy and trustworthiness of data that's collected. Due to the high volume, variety and velocity, high reliability is of paramount importance if a business is draw accurate conclusions from it.

2.2 Big Data Analytics Tools and Methods

With the evolution of technology and the increased multitudes of data flowing in and out of organizations daily, there has become a requirement for faster and more efficient ways of analyzing such data. It becomes cumbersome to process piles of data available to form efficient decisions at the proper time.

As the volume of data setsexpand, it becomes too complex to analyze with traditional data management,analysis techniques and infrastructures. Hence, requirement of specialized new tools and methods arises for giant data analytics, also because the required architectures for storing and managing such data. Accordingly, the emergence of massive data has an impact on everything from the data itself and its collection, to the processing, to the ultimate extracted decisions.

Consequently, [5] proposed the large – Data, Analytics, and Decisions (B-DAD)

framework which includes the large data analytics tools and methods into the choice making process [5]. The framework maps the various big data storage, management, and processing tools, analytics tools and methods, and visualization and evaluation tools to the various phases of the choice making process. Hence, the changes related to big data analytics are reflected in three main areas: big data storage and architecture, data and analytics processing, and, finally, the large data analyseswhich can be applied for knowledge discovery andknowledgeable decisions. However, since big data remains evolving as a crucial field of research, and new findings and tools are constantly developing.

2.3 The development of analytics

Business Intelligence is one of the forms of Analytics and is defined as a set of technologies,processes and tools that use data to predict likelybehavior by individuals, machinery or other entities [6]. In order to derive information with much deeper insight and uncover hidden patterns and relationships, the right type ofanalytics is required. The information derived from more data could provide real meaning for effective decision making with variety of possibilities for a business [7].

The new benefits that modern data analytics brings tothe table are speed and efficiency. The ability to workfaster – and stay agile – gives organizations a new competitiveedge [8]. Cloud computing technology(CCT) has emerged as the preferred technology forfulfilling the infrastructure and software needs of an enterprisevia the Internet [9-10]. A recent study indicates that the pace ofchange is accelerating and the analytics revolution is gainingmomentum, fuelled by advances in data collection andcomputational power. Widespread access to the cloud,insightful data visualizations, interactive business dashboardsand the rise of self-service analytics have madethe technology available and affordable for businessesof all sizes. Suddenly, advanced analytics is not just forthe analysts [11].

In the recent years,organisations are using analytical tools, including BI, dashboards and data mining to gain a better understanding of their present customers and to identify their needs. New analytics tools are more helpful for enterprises to pushahost of business objectives, from streamlining operations toimproving customer relations [11].

Big data analytics has brought revolution by transforming virtually every business activity, bringing opportunities for enhanced customer service, optimized production levels, superior capacity planning, reduced repair and maintenance costs andimproved working capital utilization [12].

2.4 Categories of analytics

The most popular categories of analytics are descriptive, predictive and prescriptive. Descriptive analytics is a statistical method that is used to search and summarize historical data in order to identify patterns or meaning.For learning analytics, this is a reflective analysis of learner data and is meant to provide insight into historical patterns of behaviors and performance in online learning environments.

Predictive analytics is the use of data, statistical algorithms and machine learning techniques to identify the likelihood of future outcomes based on historical data. The goal is to providing a best assessment of what will happen in the future rather than going beyond knowing what has happened [13].

Prescriptive analytics makes use of machine learning to help businesses decide a strategybased on a computer program's predictions. Prescriptive analytics works with predictive analytics, which uses data to determine near-term outcome [14].The aim is to evaluate the effect of future decisions and to present the best course of action to take in order

to adjust decisions before they are actually made [15]. This is the most valuable category of analytics and usually results in rules and recommendations for next steps.

3. BIG DATA IN EDUCATION

Schools, universities, colleges and instructive bodies the nation over holds humongous measure of information identified with students and educators which can successfully be examined to reveal experiences that can help student accomplishment and improve operational viability of the instructive organizations.

The test and openings could be assessed from the new Indian Brand Equity Foundation (IBEF) report which says that India's schooling area offers an incredible open door with around 29% of India's populace being between the age gathering of 0-14 years. The tutoring section in India is foreseen to be around $144 billion by 2020 from an expected $95.8 billion of every 2015. In 2014, with 29.63 million students and roughly 48,116 schools and organizations, India's advanced education fragment is the biggest on the planet. It is relied upon to increment to $37.8 billion by 2020 [16].

Thinking about these discoveries, it is essential for instructive establishments to track and record socioeconomics, instructive execution, participation, additional co-curricular and situation records information. They likewise need to intently screen the monetary arranging and planning measure, personnel information and other operational information. "On the operational front, examination can give intriguing experiences with regards to a few territories, for example, personnel whittling down, famous courses and student inclinations. Bits of knowledge into instructive execution can go about as a solid guide for establishments to assist their students with selecting courses in higher examinations, thusly, supporting them in their excursion to picking an ideal vocation way," says NoshinKagalwalla, overseeing chief, SAS, India [16].

Mitesh Agarwal, VP and CTO, Oracle India, says "Schooling area can use scientific answers for increment student, workforce and staff profitability, better oversee accounts, smooth out activities, and guarantee student achievement. They can likewise follow measurements around key fragments, for example, student affirmations, student records and monetary administration" [16].

For the most part instructive organizations have been catching information identified with students and instructor's age, capabilities, demography, participation, test score, financial status and arrangement. Henceforth it very well might be hard to recognize the significant examples for analytics and operational dynamic. Establishments catch scores of students in different tests, participation and now and again execution of students in extra-curricular exercises. The participation information and grades can be broke down to discover levels of interest for a particular student. In the event that anstudent is losing interest, it will be initially showed in the participation and afterward in evaluations.

During present days, advanced education organizations have information streaming in from all headings, for example, online applications, programming based and online study hall activities, and testing, extra-curricular exercises, web-based media, web journals, and student overviews. This enlarges the requirement for going past conventional utilization of innovation.

4. NEED FOR DATA ANALYTICS IN EDUCATION

There are several need for adopting the data analytics in education such as digitization, informed decisions, delivering quality services,responding to the demands for greater accountability, availability of data and increased competition due to active private sector role in education sector.

With big data implementation, educational institutions can measure their performance against the targets set. Analytics can help in ensuring academic rigor, faculty performance, etc.

4.1 Data analytics model

Figure 1 represents the data analytic model in education.
(Source: Originally inspired by Siemens (2013))

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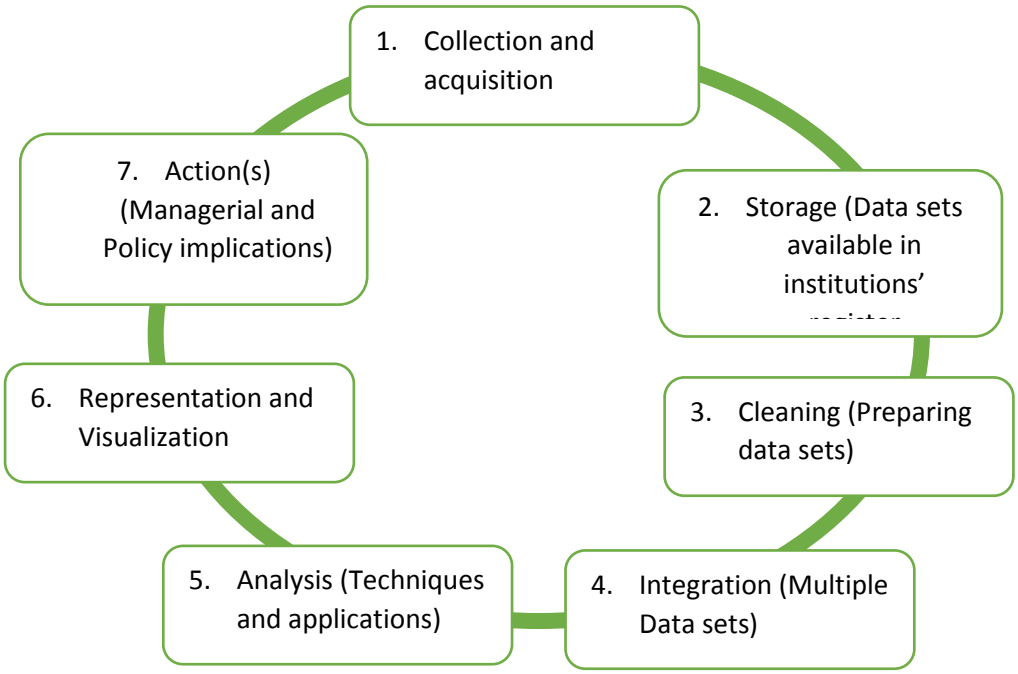

4.2 Outcome of analytics

Outcome of the different categories of analytics relevant to higher education [21] are presented in this section.

Descriptive analytics provides higher educational institutions with an opportunity to analyse transactional and interactional data about teaching learning and research to identify discernible trends and patterns that are likely to trigger important dialogue on current and future issues. Specifically, with descriptive analytics, institutions can investigate data within learning management systems by looking into the frequency of logins, page views, and course completion.

Predictive analytics could reveal hidden relationships in data that might not be apparent with descriptive models, such as demographics and completion rates. It can also be used to look at students who are exhibiting risk behaviours early in the semester that might result to dropping

out or failing a course. It can help teachers look at predicted course completion rate for a particular and tools and content in the course are directly correlated to student success.

Performance outcomes of the Prescriptive analytics in higher education can give better knowledge of institutional data, better understanding of the effective data preparation for analytics, improved normalized and smoothed out information measures, Consistent approaches to viably use data analytics for improved data driven decision making and practice and Foundation for hypothesis testing, web experimenting, scenario modelling, simulation, sensibility and data mining.

Process outcomes of the Prescriptive analytics can represent better tools for gathering, preparing, dissecting and understanding of data, better data system interoperability and system linking , enhanced data analytics and predictive modelling , better real-time rendering of analytics on students and instructors performances, reliable and comparable performance indicators and metrics and better utilisation of historical institutional data to make informed decisions

A theoreticalmodel for implementing analytics in higher education

Higher education institutions can leverage analytics to transform many activities, including student enrolment, studentsupport, alumni engagement, financial aid administration and other learning and operational functions. To begin this analysis, it is helpful to consider the engagement with students from a lifecycle perspective. The life cycle may be defined with three stages namely pre-student stage,student stage and post-student.

In the pre-student stage, institutions engage with prospective students in various ways, from assisting primary and secondary education in developing educational processes to evaluating individual students for potential acceptance for a higher education programme. In India, common entrance tests are conducted by different agencies for students interested to take professional courses at the undergraduate or post graduate level. To mention some are Medical (NEET), Engineering (AIEEE/JEE/GATE/TANCET), Architecture (NATA), Management (CAT/MAT/NAT/ NMAT/RMAT/etc). Data analytics certainly will help the higher educational institutions to identify the needs of the students and providing necessary support for preparing them to appear forrelevant examinations to enter into educational institutions of their career choice.

At the next stage of the lifecycle, the student stage, interactions with students while they are pursuing their degrees are encapsulated. Finally, there is the post-student stage, when the student becomes an alumnus of the higher education programme and may engage with the institution as a source of information about the efficacy of its programmes, advise on curricular and programme development, provide financial support and/or assist in recruiting future students for the institution.

Pre-student stage: Example of enrolment management

Big data and analytics can be utilized to help institutions settle on predictable choices in the student admission process. The admission office in every institution focus around a core set of data, frequently explicit to every campus, to settle on choices about which candidates to select. Ordinarily, the data utilized incorporate state administered test scores of the important classification if pertinent, qualifying test marks, course patterns, demographic data and specialized data such as ‘legacy’ connections. Despite the fact that these information have been utilized for a long time, there comes an inquiry concerning the successful utilization of the same. Through big data analytics, it is possibleto utilize a greater amount of the extensive amount of studentdata and statistics that organizations as of now have in their diverse

stockpiling to settle on more educated choices. As increasingly more information are gathered on students, the data will start to uncover certain patterns regarding various sorts of students [20].

Further, the potential for this kind of big data analytics is developing. It is now conceivable likewise to utilize subjective information. For instance, natural language processingtechnology is presently accessible for perusing expositions consequently and evaluating them without the assistance of an executive, opening the chance of automating even the application measure [18]. This kind of analyticsautomationis only one of the numerous ways that higher instructive organizations can smooth out their cycles and add to the assortment of data on student profiles. Eventually, there will be little requirement for the customary enrolment the executives work and a computer program will have the option to predictstudent's abilities and will do as such in a manner that is probably going to be more precise than the forecast of an individual. Notwithstanding better choices for candidates, this might have tremendous cost-saving ramifications whenever actualized effectively.

Student Stage

As we focus in around how big data and analytics can be utilized by key partners to expand student achievement, the essential objective is to address student consistency standards, time todegree completion, data maintenance and profession readiness. Big data analytics can help with accomplishing these objectives differently, remembering gathering data for studentperformance, distinguishing viable teaching techniques and actualizing predictive analytics dependent on performance.

Educators gather a plenty of information on students, for example, scores related to different components for assessing the performance of the students, quality and completion of assessment or projects and determining the overall performance of every student in a given class. BigData analytics could be applied to examine student entryon a course assessment, discussion board entries, blogentries or wiki activity, which could generate thousandsof transactions per student per course [19]. A large portion of the information remain with the teacher, and the student's general evaluation is accounted for into astudentdatabase. However, if the entirety of the student's stir paving the way to the last grade were likewise announced into the framework and a profile for every student were fabricated. For some bigger institutions, this would create millions of transactions throughout a year, which it would be very difficult for any department to oversee.

All things considered, a complex analytics framework would have the option to catch, analyze and produce significant data correlations and patterns. This kind of framework could then make correlations, for example, that between the number of nonattendances from class and the student's last grade. In the event that there were a critical relationship, at that point the framework could be set up to distinguish students in danger from often missing class. This sort of framework could likewise investigate patterns in individual students across time. On the off chance that, for instance, an student were performing ineffectively recorded as a hard copy tasks in various classes, the framework could advise the student and grounds composing focus. Further, it could suggest extra coursework for specific students dependent on their outcomes across classes. Utilizing the information gathered, directors could distinguish those territories in which they were over the public normal and those where they were underneath it, making educational plan changes appropriately.

Institutions could likewise utilize data analytics framework to distinguish which encouraging teaching strategies lead to better understandingand all the more long term retention. One approach to execute this is to have a same teacher teaches a class in a few distinct manners. Maybe one class would be set up with studentprojects, presentations and no exams, while another would comprise essentially of exams and essays. The competenceof teaching strategies would then be able to be tried by giving students an assessment toward the start of the term to test their basic knowledge and giving them similar assessment toward the finish of the term to test their cumulative knowledge about the concept. It would likewise be possible to look all the more profoundly into the kind of learning advancementsrequired. For instance, in the quantitative zone, more information would permit administrators to decide if a learning issue was in understanding and formulating thequestion, in the real calculations or in the analysis afterwards and sorting out the calculations. As opposed to a summed up finding of a requirement for better quantitative aptitudes; a finding that doesn't generally offer a perfect solution; a more focused on finding would offer a more clear and more viable course of remediation. Following a couple of long periods of testing, a well-definedanalytics framework can show trend analysis and exhibit which teaching techniques are best in evolvingin general studentretention.

Post-student stage

Alumni serve numerous significant jobs, for example, assisting with building and grow image of an institution through word-of-mouth promoting. For example, positive posts via online media can make buzz and increase in application rates. Universities additionally depend on alumni to give coaching, temporary positions, and vocation occasions to understudies. Alumni can assume a functioning job in deliberate projects like coaching students in their specialized topics. They likewise assume a huge part in contributing scholarships to meriting students. Alumni connect with students and offer their mastery and best practices in a given field. Making a connected with, steady alumni network is urgent to an institution’s prosperity. On the off chance that correspondence stops once graduates leave an organization, their comprehension of the college will get lifeless. All things being equal, they should be kept educated so they can stay drew in and keep side by side on the advancement of the college. Great alumni network carry numerous advantages to both the foundation and the graduated class. Big data and data analytics shall help to maintain the detailed data about the alumni along with their current status and deriving information based on analytics for making effective decisions to seamlessly integrate all operations effectively to help the studentscurrently in the institution.

Challenges of Data Analytics in Higher education

There are many challenges expected when implementing data analytics in higher education[21] and few of them are listed below.

1. Cost associated with the data collecting, storage , algorithms for analyzing the data and time consumption
2. Integration of data received from different sources.
3. Ensuring the accuracy, quality and correctness of data collected.
4. Lack of risks and security procedures for data protection and privacy

5. CONCLUSION

Higher education institutions are working in an undeniably unpredictable and competitive environment. This article utilizes three lifecycle phases of studentengagement and proposes a

reasonable structure for application of analytics in higher education. As has been appeared, higher education institutionscan utilize big data and data analytics in varietyof approaches to help them make better decisions. All the more explicitly, big data analytics can help enrolment the management staff with their admission choices, empower college experts to recognize students who are needing campus resources and assist colleges with acquiring financing through sponsorships. All things considered, in light of the fact that lone a little extent of advanced education organizations at present use data analytics, there will be a huge requirement for guidelines and best practices when more foundations have presented these kinds of projects. Executing such projects may experience obstruction from the individuals who don't believe that the advantages legitimize the speculation. For a smooth and successful execution, subsequently, it is fundamental that the pioneers are totally dedicated to the activity and prepared to help its turn of events. Furthermore, lines should be drawn as to how much data colleges can gather and, explicitly, to what exactly utilizes it tends to be put. Despite the fact that gathering information to assist students with succeeding classes is most likely a smart thought, gathering over the top information with an absence of severe utilization controls may be viewed as disregarding student rights and protection.

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