A Systematic Study on Role of Big Data in Education

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Abstract

The role of big data has changed the entire world considering into account the way of functioning and delivering quality of services to stakeholders. One of the serviced industries which have witnessed drastic changes is the Education sector. The Educational institutions starting from the kinder garden, lower primary, upper primary, high school, and higher educational institutions including institutions that started with online education which improved drastically compared to its counterpart offline education in terms of collecting, storing, processing, and delivering contents readily and effectively without restrictions time, place or geographical locations. This research article emphasizes the role of big data in the education sector. The exponential growth of this data will lead to the study and provision of techniques needed to deal with the importance and knowledge of this data. In recent year's changes in Big Data Architecture, Big Data Analytics, and Big Data Technologies helped extensive usage of big data for decision making. Therefore the development of the problem-based approach and open research problems gives researchers a new horizon.

Keywords: Big Data in Education, Big Data Architecture, Big Data Analytics, Big Data Technologies.

1. Introduction

In 2002, the term "big data" was coined for the first time. The rapid evolution of the internet, wireless communication networks, increased use of various social networks, cloud computing, grid computing, and data analytics has laid the foundation for big data evolution. Big data is the massive amount of data that continuously growing in terms of volume, velocity, and having verity or veracity with heterogeneous sources the same is cannot able handled or processed using traditional database management tools and the same is widespread over a small period of time and it originates from a wide range of sources and formats, necessitating tight control over the key data extraction methods [1]. Because of the increased usage of online learning tools and interactive software in education, the volume of data has expanded, making it more difficult to assess and use big data to improve educational efficacy and promote basic research in learning. This has necessitated the development of innovative and effective methods for evaluating this large amount of data and using it to improve the educational process and conduct educational research. The large volume of data availability in the education sector, the complex architecture

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of education, and new technology evolution in data storage, data analytics, and big data influence on decision making enabled big data to play a significant role in overall research activities pertain to educational sectors as shown in Fig.1.
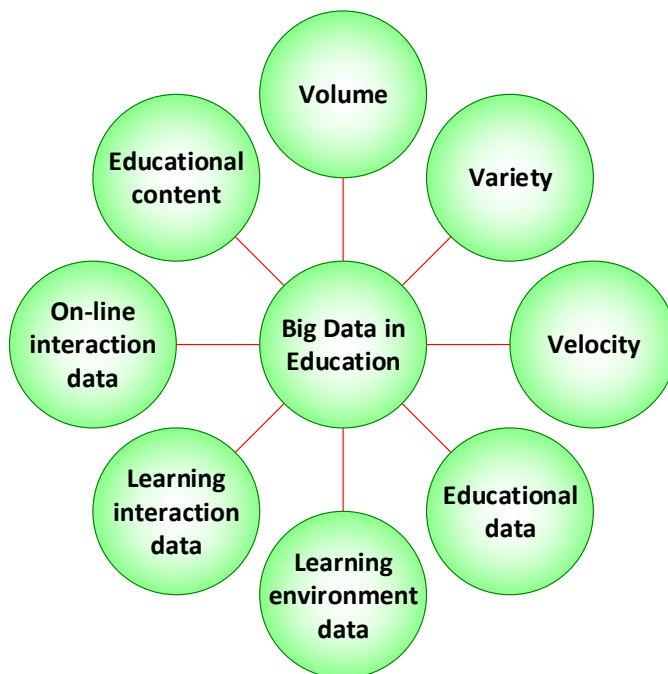

Fig 1. Big Data in Education

The area of Learning Analytics is concerned with collecting, analyzing, and visualizing data about learners and learning processes to enhance stakeholders' understanding. Hence learning analytics also demonstrates the significant influence of big data concerning learning and the contexts in which it happens [2].

The adoption of big data tools and technologies in online learning resources in education improves student, faculty interactions and student engagement can also be increased. The concentration and interest of the students can be improved with various big data and machine learning tools. We can make use of various data like texts, images, schematics, media, videos, and so on. As a result, the quality and depth of this data vary, posing issues during data pre-processing, data mining, and data analysis.

The advent and implementation of big data in education can provide various opportunities which will make a positive impact on student engagement and interest with an ultimate aim to provide quality service through competency-based education leading to the overall development of the student. As a result of faster learning, technology-enabled learning demands a more in-depth diagnosis of educational data in real-time environments. Further accumulation of cumulative data during real-time learning environments needs proper evaluation of various problems encountered during the learning process.

In this research paper, we will explore the role of big data in education; discuss the benefits of analyzing it, and most prominently the challenges.

2. Literature Review

The rapid growth of the data and the quality of the huge data that may be acquired from a variety of learning contexts has resulted from the usage of online education tools during the Corona pandemic in education. Learners and learning interactions generate large amounts of data, as do other dimensions of data generated within learning environments and other detailed data generated by educational activities. Texts, media, schematics, photos, audio,

and video are all examples of data. The various analysis obtained from the big data-enabled online education system model provides various improvement opportunities for competency-based education to enhance student learning. The output of this would be used to examine a variety of educational difficulties [3][4].

The study showed that big data can outperform or perform better compare to the traditional educational system especially when taking the components or factors of the processes of extracting and analyzing important information. The study also revealed that a computer transaction with large volumes of data needs relevant technology integration in-order to overcome various problems concerning mining and analytics. Accordingly, some solutions can be adopted and work with it, and it also includes the implementation of hybrid cloud storage systems to aid in the storage and processing of data[5], but this type of solution is not embraced by all enterprises, particularly those with sensitive data. Such firms are concerned about data security issues, especially because the data will be transferred from an internal storage area to a common cloud storage area, where numerous individuals and entities would have access to it.

2.1 Big data analytics breakthroughs in the education sector

For educational institutions, administrators, policymakers, educators, and learners, big data analytics will open up many new possibilities. Improving student performance, analyzing student performance, and anticipating student achievement are just a few of these options. Teachers are always happy and excited to measure the performance of students through that teachers can assess not only student understandability ability but also teacher's capacity to teach the students with various teaching aids and techniques. Through this teachers can assess student behavior, such as interesting subjects, classroom performance, extracurricular activities, and the time it takes the student to complete the assessments [6].

2.2 Challenges of big data analytics in the education sector

When errors occur in the data for various reasons leads to the greatest challenge. When there is a large number of students pools error occurs by not eliminating already course completed students or adding the students who are yet to complete registration the same can become very costly when data is handled by a cloud storage system and also it can be costly to correct them [7]. Another significant issue is the lack of instructor participation in data analysis. Teachers are frequently viewed as data collectors, while those who are not involved in teaching are responsible for analysis, synthesis, and suggestions. Because instructors have the most understanding of acceptable strategies and procedures for fostering student growth, this may lead to the inactive adjustment of classroom practices in response to data [8].

3. Study of the Exiting System

Various instructional programming tools and learning management systems have been used to develop e-learning systems. The educational platform is a web-based interactive learning environment that combines the benefits of content management with social networking, allowing students to publish lessons and goals, set assignments, carry out educational activities, and communicate with one another using a variety of technologies. It also allows teachers to monitor and manage exams in online, remote, and virtual environments, assigning roles and allocating students into workgroups, enabling the exchange of ideas and opinions between students and teachers, allowing parents to communicate with teachers, sharing scientific content, and view their children's results, all of which contribute to better educational outcomes. Data mining techniques, technology integrations such as clustering and classification helps re-structuring and re-organization data and facilitate platforms for the next level of in-depth analysis. Big data analytics using statistical analysis, prescriptive analysis and predictive analysis using machine learning plays a significant role in the decision-making process about education sectors. These techniques, when extended, can facilitate the integration of artificial intelligence within the educational sector's decision-making processes. Data mining, machine learning, and artificial intelligence are normally embedded on top of a big data technology

environment. Basic tools that can be used within the e-learning platforms, including tools that can be used for synchronized learning and other one that is non synchronized learning as shown in Fig. 2. Synchronous gadgets require the presence of both ends of the communication during communication. In contrast, asynchronous gadgets do not require simultaneous callers [9].
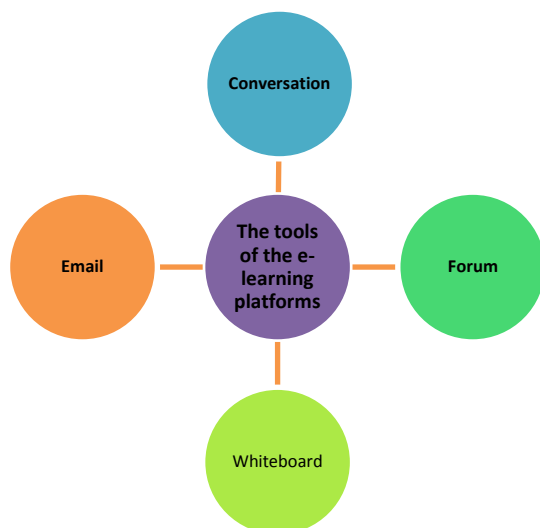

Fig 2. Basic tools of the e-learning platforms

The Ministry of Education applies   e-learning in schools in the Sultanate of Oman using two types of educational platforms.

Perspective platform: It is a specialized digital platform from the Ministry of Education in the Sultanate of Oman that enables students to log in for distance education. A viewing platform is dedicated to students of the first, second, third and fourth grades of the first cycle.

The Google Classroom platform is an organization that students use from grades 4 to 12.
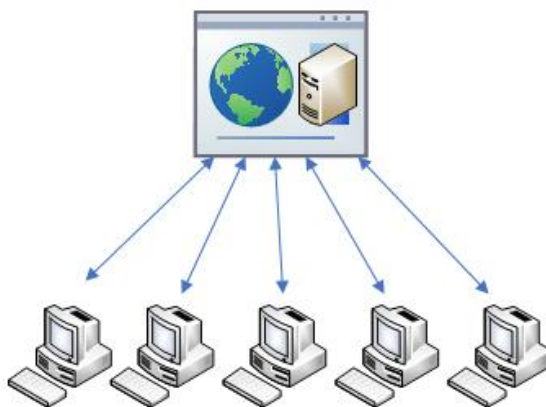

Fig 3. Technology in education

There are plenty of opportunities in education system as shown in Fig.3 to make use of big data to improve learning environment including voluminous data on learners, learners' learning experiences, data contained within learning environments, data accumulated through social interactions in learning environments, detailed content data, and data generated as a result of learning activities, such as texts, media, and videos, among other things. The quality and dimensionality of these data varies.

4. The Proposed System

The amount of data produced in a variety of fields from specialized applications around the world is expected to increase. It is useless until the data used to collect usable data is analyzed. It entails the creation of methods that allow for large-scale analysis. The ability to create effective computations is a valuable tool in order to apply those technologies that can lead to design and development of automated systems. To tackle large-scale performance analysis, including the simultaneous use of current and future data mining computing architectures, transforming data into information is definitely not a simple task. As a consequence, machine learning principles and methods have become widely common among researchers in order to produce practical results from these concepts. Data analysis, algorithms, and optimization are the core areas of study in the field of machine learning. Many big data modeling frameworks have just been launched, and they all need significant changes. We argue that, although each approach has advantages and disadvantages, hence more efficient solutions to big data challenges can be developed. Simple conceptual pyramid architecture is proposed to for big data integration in education sectors as shown in Fig.4.
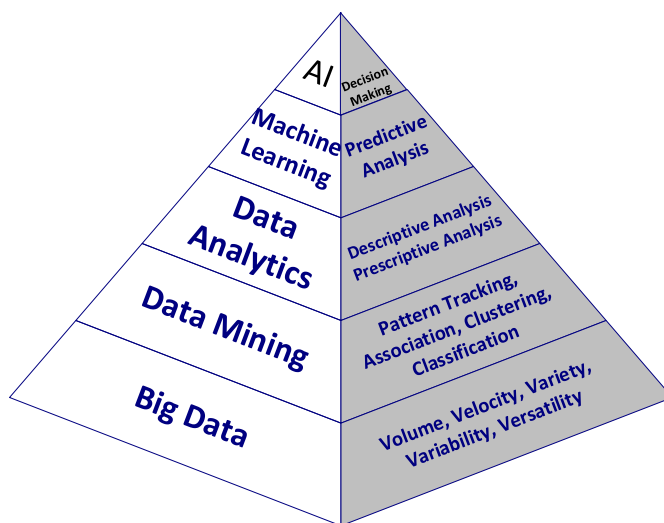

Fig 4. Proposed big data integration framework

5. Critical Evaluation

The critical evaluation is done by considering the benefits of big data analysis in the education sector and challenges of big data analysis in education sector.

5.1 Benefits of big data analysis in the education sector

1. Academic analysis add great value to educational institutions in the Sultanate by improving decision-making, increasing students 'success rate by identifying risks at an early stage, improving learning effectiveness through self-measurement of teachers, and increasing the ability to predict student levels and future majors [10].

2. Employing big data to boost success rates with learning analytics. It is possible to find out how students learn and the resources they choose especially in the presence of huge potential for e-learning resources in higher education. Educational data analyses focus on the individuality of the learner and on giving learners actionable information to make their decisions.

3. Expect success in a short time by observing the level of student participation through the LMS (learning management System). Supervisors and teachers can quickly access solutions that help students make remarkable progress in a short time.

5.2 Challenges of big data analysis in the education sector

Although there are many educational opportunities, there are a host of challenges to implementing big data analytics, including:

1. Training of practitioners**:** It is necessary for leaders to invest in developing teachers' capabilities in collecting and analyzing data and how to control teaching in response to data analysis in the use of lessons and allocating them based on student data [11]. Learning how to use technology must be concurrently implemented at the level of learning how to teach with technology [12].

2. Data integrity concerns: Data integrity is the biggest concern facing big data officials [13]. The security protocols in place must be well equipped to handle huge amounts of data.

3. Ensuring the flow of data: Accessing data for analysis is one of the major challenges due to the difficulty in accessing the required data. It is possible that the poor quality of the databases will lead to major challenges and problems [14].

There are advantages to big data that can be included in the educational decision-making process with the ability to measure these features as shown in the table 1 below.

Table 1 Big data "feature versus influence" mapping

MOE Decision process / Big data Features	Academic Performance	Infrastructure	Education Technology	Capacity Building	Learning Management System
Variability	High	High	Medium	Medium	Medium
Versatility	High	Medium	Medium	Medium	Medium
Variety	High	Medium	Medium	Medium	Medium
Volume	High	High	Medium	Medium	High
Velocity	High	High	Medium	Low	Low
Scalability	High	High	Medium	Low	Medium
Descriptive	High	Low	Medium	Low	High
Predictive	High	Medium	Medium	Low	Medium
Decision Making	High	Medium	Medium	Low	High

Data mining and the integration of the Big data framework show superior results because the advantages of big data are clearly included in the decision-making processes of the Ministry of Education.

6. Conclusion

This article outlines the role of big data in education. As many educational institutions are witnessing a quantum leap and an increasing demand by teachers and students to use e-learning systems, which are available efficiently and effectively and easy to obtain by experts in this field. Today, in light of this technological revolution and big data, there is no longer an excuse to maintain the traditional pattern of education. What we need today is an education that is open to the future and is able to keep pace with the era of big data. The big data created by technology must be harnessed and the enormous potential offered by learning analytics must be harnessed to produce results that satisfy the student. Learning analytics has proven students' ability to determine the most appropriate time of day to learn and which methods are most effective for them.

Acknowledgements

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