



Big Data In Education: Role And Benefits

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Abstract : Big data is an essential aspect of innovation which has recently gained major attention from both academics and practitioners. Considering the importance of the education sector, the current tendency is moving towards examining the role of big data in this sector. The educational system regularly accumulates huge amounts of data, so the issue of systematic processing of that data is one of the most pressing today. Big Data in education allows to rethink approaches, close long-standing gaps, and adapt the learning experience to improve the efficiency of the system all around. Big Data in Education is revolutionizing the way we approach teaching and learning. You will also get a clear view of how institutions can ensure the privacy of student data. This paper attempts to offer a broader definition of big data in education, varied applications of big data in institutional settings, tools and technique which are used to store and process the educational data and the benefits of using big data in education.

Keywords : Big data in education, Role, Tools, Applications, Benefits.

1. INTRODUCTION

The world is changing rapidly due to the emergence of innovational technologies [1]. Currently, a large number of technological devices are used by individuals [2]. In every single moment, an enormous amount of data is produced through these devices [3]. Big Data is a massive amount of data sets that cannot be stored, processed, or analyzed using traditional tools. Today, there are millions of data sources that generate data at a very rapid rate. These data sources are present across the world. Some of the largest sources of data are social media platforms and networks. Let's use Facebook as an example—it generates more than 500 terabytes of data every day. This data includes pictures, videos, messages, and more.

Data also exists in different formats, like structured data, semi-structured data, and unstructured data. For example, in a regular Excel sheet, data is classified as structured data—with a definite format. In contrast, emails fall under semi-structured, and your pictures and videos fall under unstructured data. All this data combined makes up Big Data. [6] In order to cater for this massive data, current technologies and applications are being developed. These technologies and applications are useful for data analysis and storage [4]. The Three V's of Big Data are

1. Volume

Big data is all about quantity. Data volumes that, in reality, may reach hitherto unimaginable heights. There will be 40 zettabytes of data generated by 2020, representing a 300-fold increase from 2005, according to estimates that 2.5 quintillion bytes of data are created every day. As a result, Terabytes and even Petabytes of data in storage and servers are now commonplace for big businesses. While tracking success, this data aids in shaping a company's future and activities.

2. Velocity

The expansion of data and the significance it has taken on have changed the way we think about data. We used to underestimate the value of data in the business world, but because of changes in how we obtain it, we now often rely on it. Velocity simply gauges how quickly data is entering the system.

While some data will be provided to us in batches, others will arrive in fits and starts. Additionally, since not all systems will process incoming data at the same rate, it's critical to avoid making assumptions before obtaining all the information.

3. Variety

Data used to be given in a single format from a single source. Previously given in database files like excel, csv, and access files, it is now being delivered through tech like wearable devices and social media in non-traditional formats, including video, text, pdf, and graphics. Although this data is helpful to us, it demands more labour and analytical abilities to interpret it, manage it, and make it function.[8]

Types Of Big Data

Structured Data

Organized data is easy to evaluate and sort since it has predetermined organisational characteristics and is provided in a structured or tabular schema. Each field is independent and accessible individually or with information from other fields since it is specified. Since of this, structured data is very significant because it enables the rapid data collection from numerous database locations.

Unstructured data

Unstructured data refers to information that lacks predetermined conceptual meanings and is difficult for conventional databases or data models to comprehend or analyse. Most large data is made up of unstructured data, including facts, dates, and numbers. Video and audio files, mobile activities, satellite photos, and other types of big data

Semi-Structured Data

A combination of unstructured and structured data is semi-structured data. As a result, it incorporates some characteristics of structured data, but also lacks a clear organization and does not adhere to relational databases' or data models' official formats. For instance, semi-structured data is frequently seen in JSON and XML.[8]

Big Data in Education involves collecting, processing, and analyzing vast datasets generated by educational institutions. These include student demographics, academic performance, attendance, online interactions, and assessment results. Key characteristics of Big Data in Education are volume (large amounts of data), velocity (rapid data creation), and variety (diverse data types). Beyond data collection, Big Data focuses on advanced analytics and data mining to uncover patterns and trends. These insights support data-driven decision-making, helping institutions tailor teaching methods, identify at-risk students, and improve learning experiences.[5] Big data analytics has derived various opportunities for the institutions, policy makers, educationalists, administrators and learners. The opportunities are enhanced knowledge flow and learning success over the organization, cross collaboration over the institutions become comfortable and learning effectiveness would be enhanced, cost reduction over organizing financial performance become possible and academic risk would be lowered. Through traditional application software, big data won't be processed. Hence, it requires cloud based technologies like Hadoop and Spark to mine huge amount of data. This big data approach offer organizations with effective way to stay strong and active in the business. In addition to this, Hadoop platform has received attentions as it renders various advantages to the institutions and learners. This study aims at the influence of big data in the education and how the education system will be enhanced by using big data analytics.

2. FEATURES

Big Data is revolutionizing education by providing innovative solutions to enhance educational outcomes:

- a) **Data-driven Instruction:** Big Data allows educators to analyse vast datasets of student performance, enabling them to adapt teaching methods, materials, and approaches to meet individual learning needs. This personalisation enhances the effectiveness of instruction.
- b) **Predictive Analytics for Student Success:** Utilising historical Big Data and Machine Learning algorithms, predictive analytics identifies students who may be at risk of underperformance or dropping out. Institutions can then intervene early, offering tailored support to boost student success rates.
- c) **Personalised Learning:** Big Data enables the customisation of learning experiences for each student. By analysing learning behaviour and preferences, educational platforms can offer tailored content, exercises, and resources, catering to individual learning styles and speeds.
- d) **Curriculum Enhancement:** Educational institutions can refine their curricula based on data-driven insights. By identifying which subjects or topics students struggle with the most, educators can make targeted improvements to enhance the overall quality of education.
- e) **Educational Research and Policy-making:** Researchers can harness Big Data to investigate educational trends, assess the effectiveness of teaching methods, and inform policymaking. The wealth of data available allows for evidence-based decisions at institutional and governmental levels.

3. APPLICATIONS

The applications of Big Data in Education extends far beyond data collection; it involves practical implementation that positively impacts various facets of the educational process. The following are some of its common applications:

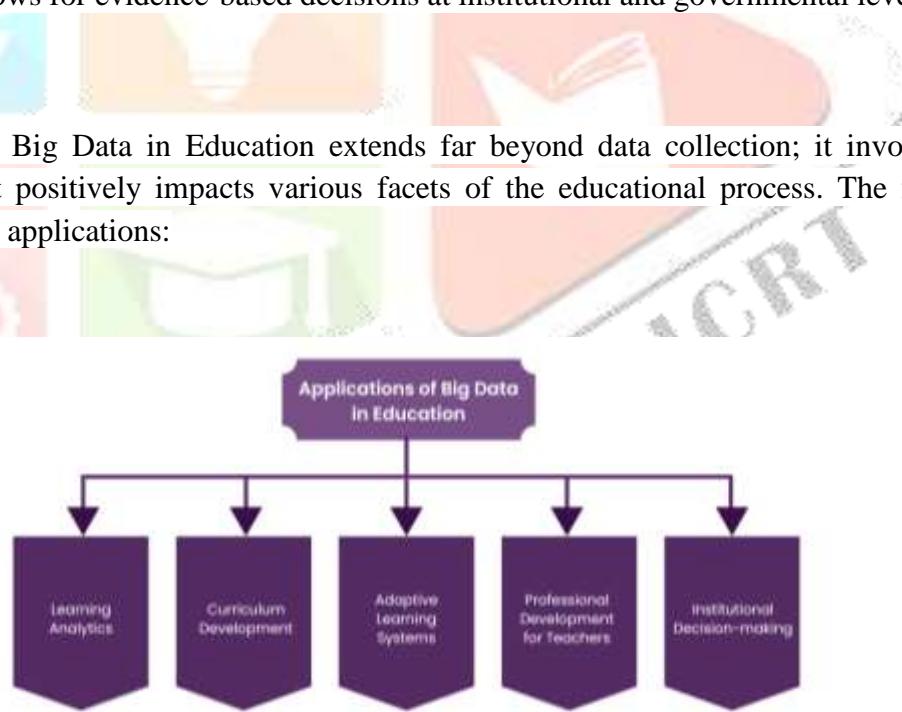


figure 1. applications of big data in education

1) Learning Analytics

Learning analytics leverages Big Data to monitor and assess student progress in real time. By tracking metrics such as time spent on course materials, quiz scores, and engagement with online resources, educators gain a holistic view of students' learning behaviour.

This data-driven approach enables educators to tailor their teaching methods and interventions, ensuring that students receive the support they need to succeed. Furthermore, learning analytics can identify early warning signs of academic struggles, enabling proactive interventions to prevent students from falling behind.

2) Curriculum Development

Big Data Database plays a necessary role in shaping curriculum development. Through the analysis of extensive datasets, educational institutions can gain insights into student performance and comprehension. This information informs decisions about curriculum adjustments, helping educators focus on areas where students may need more support or enrichment. It promotes a dynamic and responsive curriculum that evolves based on evidence rather than assumptions.

3) Adaptive Learning Systems

Adaptive learning systems harness the power of Big Data to create personalised learning experiences for each student. These systems utilise complex algorithms to analyse student performance data and adapt the difficulty and pacing of content accordingly.

As students progress, the system continually adjusts to their strengths and weaknesses, ensuring that they receive a challenging yet manageable education. This level of personalisation fosters more effective learning and improved retention rates.

4) Professional Development for Teachers

Big Data doesn't only benefit students; it also provides valuable insights for educators. Through data-driven feedback and analysis, teachers can refine their instructional strategies. For example, they can identify which teaching methods are most effective for different student groups or pinpoint areas where additional professional development may be beneficial. This continual improvement loop enhances the overall quality of education.

5) Institutional Decision-making

Educational institutions are complex organizations with numerous resource allocation decisions to make. Big Data Integration offers a valuable tool for guiding these decisions. By analysing data on enrollment trends, student performance, and demographic shifts, institutions can make informed choices about staffing, infrastructure investments, and strategic planning. Incorporating Big Data into education not only enhances the learning experience but also empowers educators, institutions, and policymakers to make informed decisions that ultimately benefit students and improve the efficiency of the education system.

4. TOOLS

In the world of big data in education, there are several tools that are commonly used to gather, process, and analyze all that valuable information. Some popular tools include:

1. Learning Management Systems (LMS): Platforms like Canvas, Blackboard, or Moodle collect data on student interactions, grades, and engagement.
2. Data Visualization Tools: Tools like Tableau or Power BI help educators and administrators visualize complex data sets to identify trends and patterns easily.
3. Predictive Analytics Software: Programs such as RapidMiner or IBM SPSS Modeler can predict student performance and behavior based on historical data.
4. Student Information Systems (SIS): Systems like Infinite Campus or PowerSchool store student data, attendance records, grades, and more for analysis.
5. Social Network Analysis Tools: Tools like NodeXL can analyze social interactions and relationships within educational settings.

These tools help educators and institutions make informed decisions to enhance teaching methods, student engagement, and overall educational outcomes.

5. PROCESSING

Analytics of big data involves spotting trends, patterns, and correlations within vast amounts of unprocessed data in order to guide data-driven decisions. These procedures employ well-known statistical analysis methods, such as clustering and regression, to larger datasets with the aid of more recent instruments.

1. Data Collecting

Every company has a distinct approach to data collection. Thanks to modern technology, businesses are now able to collect unstructured and structured data from a variety of sources, including cloud storage, mobile apps, in-store IoT sensors, and more.

2. Organise the Data

For analytical queries to yield correct answers, data must be appropriately organised once gathered and stored, especially if the data is big and unstructured.

3. Clean Data

All data, regardless of size, must be scrubbed to increase data quality and produce more robust findings. Duplicate or unnecessary data must be removed or accounted for, and all data must be structured appropriately. Dirty data may conceal and deceive, leading to inaccurate findings.

4. Analysis of Data

It takes time to transform huge amounts of data into a usable form. Advanced analytics techniques may transform huge data into significant insights once available. Among these large data analysis techniques are:

By finding anomalies and forming data clusters, data mining sifts through enormous datasets to find patterns and linkages.

Using historical data from a business, predictive analytics analyses future projections to discover potential hazards and opportunities.

Deep learning layers algorithms to uncover patterns in even the most complicated abstract data, emulating human learning patterns.[8]

6. BENEFITS

When considering the use of Big Data in education, there are many benefits of this technology, particularly in optimising remote learning. It is a great help for teachers as it provides them with up-to-date training tools and allows them to grow and adapt their methods to the new educational models. They can also identify content and teaching resources that will enhance the environment to engage students.

Teachers and school managers can also find out how students are using different educational resources and which methods give them the best results, as they can see the real-time performance of each student and analyse the academic results achieved and their evolution.[6]

Big Data is revolutionising various sectors, and education is no exception. Here are some key benefits of Big Data in Education:

1) Personalised Learning

Big Data allows educators to tailor learning experiences to individual students. By analysing data on student performance, learning styles, and engagement, teachers can create customised lesson plans that address each student's strengths and weaknesses.

This personalised approach can enhance student outcomes and foster a more engaging learning environment.

2) Improved Student Performance

Big Data helps track and analyse student performance over time. Educators can identify patterns and trends, such as which subjects' students struggle with or excel in. This data allows for prompt

interventions and support, aiding students to improve their academic performance and reach their educational objectives.

3) Enhanced Decision-Making

Educational institutions can leverage Big Data to make informed decisions. By analysing data on enrollment trends, resource allocation, and student demographics, administrators can develop strategies to improve institutional efficiency and effectiveness. Data-driven decision-making can lead to better resource management and improved educational outcomes.

4) Predictive Analytics

Big Data facilitates predictive analytics, enabling educators to anticipate student outcomes and detect potential problems before they occur. For example, predictive models can help identify students at risk of dropping out, enabling early interventions to keep them on track. This proactive approach can highly reduce dropout rates and improve overall student retention.

5) Enhanced Teaching Method

By analysing data on teaching methods and student feedback, educators can refine their instructional techniques. Big Data provides insights into which teaching strategies are most effective, allowing teachers to adapt their methods to better meet student needs. This continuous improvement process can lead to more effective teaching and better student engagement.[7]

7. FUTURE SCOPE

As Big Data continues to reshape the landscape of education, ongoing research is essential to refine practices, address emerging challenges, and unlock new possibilities. The following pointers offer insights into where the future of Big Data in education may lead:



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figure 2 future of big data in education

- More work needs to be done on the ethical angle of applying Big Data in Education. Thus, future research ought to target the implementation of more effective ethical measures when it comes to the collection, storing, and use of student data while promoting equality.
- While quantitative data dominates the Big Data landscape, qualitative data, such as student feedback and open-ended responses, can provide valuable insights. Research should investigate methods for effectively integrating and analysing qualitative data in educational contexts.
- Artificial intelligence (AI) and Machine Learning (ML) are poised to play a more prominent role in educational Data Analysis. Future research should explore how these technologies can be harnessed to provide real-time insights, personalised learning experiences, and early intervention strategies.

d) To gauge the true impact of Big Data in Education, long-term studies are needed. Research should focus on tracking the academic and socio-emotional development of students over time to determine the sustained benefits and potential drawbacks of data-driven interventions.

e) The field of data privacy is evolving rapidly. Future research should concentrate on developing cutting-edge encryption techniques, secure data sharing protocols, and privacy-preserving algorithms to ensure data security while maximising the utility of educational data.

8. CONCLUSION

Big Data in Education has immense potential to transform learning. Continued evolution of Big Data promises new opportunities and innovations in teaching and learning. It has the potential to revolutionize the way we teach and learn. By harnessing the power of data analytics, educators can gain valuable insights into student performance, tailor instruction to individual needs, and improve overall educational outcomes. It's all about using information to make education more effective and personalized.

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