

Big Data in Promotion of Educational Development & Digital Education—A *Scientific Study*

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ABSTRACT

Digital Education is helpful in developing new age teaching-learning systems with support of various emerging techniques and methods. Digital Education is changing traditional on-campus or classrooms, and there are new modes of education and teaching learning increasing. Blended and Hybrid Education, Virtual Learning, E-Learning is developing for the betterment of teaching and learning process. Further it is also promoting individualized education, private and personal Learning, flipped and flexible Learning. Latest information technology sub fields and tools are rising in education sector, and in this Bigdata is an important, and offers great potentialities in both academics and practitioners. Studies already been conducted in the areas of Big Data in Education, though this study is a comprehensive one merger with basic applications, issues and challenges with new and latest concept of Education 4.0. This study is focusing on advancing educational systems including better educational pedagogy using advanced technologies. This Paper is about Big Data in Education emphasizing paradigm shifting of education with futuristic models with slant to Education 4.0.

Keywords: Educational Technology, Education 4.0, ICT in Education, Digital Education, Big Data, Data Analytics

Big data is an important technology in the field of Information Technology dedicated to a complex and large amounts of data management. It is an innovation and gained attention from both academics and practitioners^{[1],[3],[27]}. A comprehensive review is still lacking in a full-fledged manner in big data in education, and current work is a systematic review on big data in education to find out the basic, trends, as well as classifying research themes, sector specific applications, and advantages of big data as a whole.

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Different subfields have developed and continuously improved in the areas of IT and Big Data is the latest addition in this domain for offering flexibility, advancement, and speed and cost effective digital education promotion and development. It has been found that learner behavior and performance in addition to the technological role also been identified by most researchers working in this field. Modeling and educational data mining, warehouse, use of appropriate technologies in the educational system, and integration of big data in different stages of education are worthy and important. Different types of educational applications including online platforms, and video conferencing platforms have been developed for the purpose of educational delivery and in this context uses of Big Data Analytics, Data Visualization tools are considered for the sophisticated development of the education sector with better facilities and opportunities. Digital Education is now not only a system and technique rather it become an interdisciplinary field of study integrated with IT and Computing in Educational areas. Different sub fields of education and teaching can be endorsed with technological integration and in this Information Technology components like Software Technology, Networking and Communication Technology, and Database and Multimedia Technology are considered worthy in managing sophisticated Digital Education Systems. Digital Education is also called as Digital Learning. In recent times particularly during the COVID-19 period various integrated Digital Education systems have been developed in many countries that promote better practice in their pedagogy including advanced instructional classes, enhancing assessment and examination processes, operation management and educational administration. Big data is an alarming tool and technology in enhancing the education segment particularly higher education and digital learning and education at large.

1.0 Objective

This proposed research work is purely conceptual and based on existing studies and additionally, this is also an interdisciplinary work. This also deals with the following agendas (but are not limited to)—

- ☐ To gather knowledge about Big Data basics viz. Feature, characteristics, and fundamentals including Data Analytics, Data Science, etc.
- ☐ To know about the Basic Applications of Big Data and emerging technologies in Education and teaching-learning process.
- ☐ To find-out the benefits and opportunities that exist in Big Data for Education and teaching learning process.
- ☐ To get knowledge about Digital Education including features, characteristics, and nature for the time being.
- ☐ To know about the functions of Digital Education emphasizing its importance and benefits in a real and sophisticated sense.
- ☐ To know about the sub technologies and systems employed in Digital Education including E-Learning, Blended Learning, etc.
- ☐ To find-out the issues and challenges of Big Data and allied technologies in Education and allied systems.
- ☐ To find-out the Education 5.0 and its potentiality for advancement in Education particularly in Digital Education in the context of Big Data Technologies.

2.0 Methods

This study entitled ‘Big Data in promotion of Educational Development & *Digital Education—A Scientific Study*’ is restricted in the areas of Big Data applications in the education sector, especially its importance, opportunities, and benefits. Therefore this work lies on an existing review of literature, including analyzing existing sources of knowledge after careful finding and identification. The work is also based on a review and analysis of existing Digital Education and E-Learning platforms available to find out the opportunities and benefits. For proper findings and results of this study contemporary companies offering such integrated services have been studied particularly involved in Big Data and Data Analytics.

3.0 Big Data, Data Analytics and Data Science

Information Technology is considered as worthy for the development and progress of modern society, and today all kind of organizations, and institutions depends on various components of IT. Within IT most important technology is Database Technology, and Big Data is considered as valuable within fall under the area of Database Technology. It is an alarming fact that data and information rising rapidly and give a different kind of complexity; managing such a large number of complex data requires expert technicians and managers. The subject of the field of study concerning with analyzing and managing large numbers of complex data is called Data Science which lies on Big Data as an emerging part of Information Technology. Big Data is considered as a concept and way and Data Analytics comprises of the techniques, tools, mechanisms, and systems in regard to data management^{[7],[8],[31]}.

3.1 Big Data and Function

Primarily Big data is dedicated in different activities and deal mainly following (but not limited to the following)—

- ❑ It is about the mining of the Data, particularly, from the Database and Data Warehousing.
- ❑ Creating and making data available, especially for big data management including managing the complexity of the data.
- ❑ Big Data is always favors pin-pointed data; therefore, it is considered as an important tool and technique.

Data is oxygen for every organization, therefore different organizational applications become known as different nomenclature viz. Business Analytics; this is about Big Data applications in Business and Corporate Sector houses. Big Data applications in medical and healthcare, hospital sector known as Health Analytics and this way other field specific Data Analytics.

3.2 Data Analytics & Features

Big Data gaining its applications in different sector and among this core business is an important one for managing large amount of complex data. Big Data Analytics is worthy in different reasons and purposes and among these important are as follows^{[11],[23],[30]}.

- ❑ Big Data requires and supports data having diversity, complexity, and massiveness for all kind of data related problems.

- ❑ DBMS including programming languages, required mathematics, and statistical skills, core computational sciences such as artificial intelligence/ expert systems are important in proper Data Analytics practice.
- ❑ Various advanced computing tools and procedure such as parallel computing, and business intelligence are treated as important in proper designing and development of Big Data Analytics.
- ❑ Big Data tools such as tableau, RapidMiner, KNIME, Power BI, Apache Spark, QlikView, etc. are worthy in proper functioning of Big Data Systems.

4.0 Digital Education and other Emerging Forms

Digital Education is a as a broad concept now incorporating different Digital tools and technologies specially Information Technology components viz. Communication, Database, Networking, Multimedia, Software etc in respect of healthy and sophisticated Digital Education System development. Digital Education is also called as Digital Learning and practiced in Higher Educational Institutes, globally. However in developed nations (or in developing nations exceptionally) concepts has wider acceptance in school education for the purpose like areas classes, examinations, operation and administration. There are different form of Digital Education and Adaptive learning considered as important one based classroom systems, Digital textbooks and learning, contents and object management, data analytics, free educational contents & resources, Streaming contents, Learning enabled technology etc. Digital Education is also refers as *E-Learning* or Educational technology and treated as branch of Digital Education according to some expert^{[9],[10],[29]}. Digital Education enhanced in different corporate houses and companies, organizations in recent past for the On Job Training to tackle various offering in Higher Studies of their own or in association with any universities or educational institute. Digital Education seeks Big Data like Technologies for various new age Continuing Learning, Skills development program including blended learning. Digital Education becomes a field of study with availability of Minor/ Major/ Specialization in Digital Education. Digital Education is therefore concern about the—

- ❑ Adaptive learning supported by proper systems & technologies.
- ❑ Implementation of digital records, documents, text and reference books including encyclopedias.
- ❑ Learning and researching in online or blended mode with support of live streaming.
- ❑ Availability of contents, objects as well as analytical tools.
- ❑ Open and free educational contents & resources.
- ❑ Recorded contents sharing for the purpose of teaching and learning.

Digital Learning is considered as important nomenclature in place of Digital Education, and *Education Technology* too, however according to some expert this is about the IT applications in Education and Teaching only. *Online Education* is simply knowledge delivery or teaching learning with live streaming benefits. In such type of learning cloud, big data and allied technologies play a leading role for proper and effective and healthy performances in educational practice. *Virtual Learning* is a kind of remote learning supported by online and other IT mechanism. *Blended Learning* is a mix educational platform emphasizes Physical or On Campus education including Distance, Self Studies, online education etc. For proper and effective educational practice digitally among the core stakeholders important are technology, content (manual or digital), peoples (both teachers & learners), and instructions, refer Fig. 1 to learn about

the Digital Education stakeholders^{[13],[17]}. Here use of Big Data is important in Online, Blended and On Campus education supported by ICT.

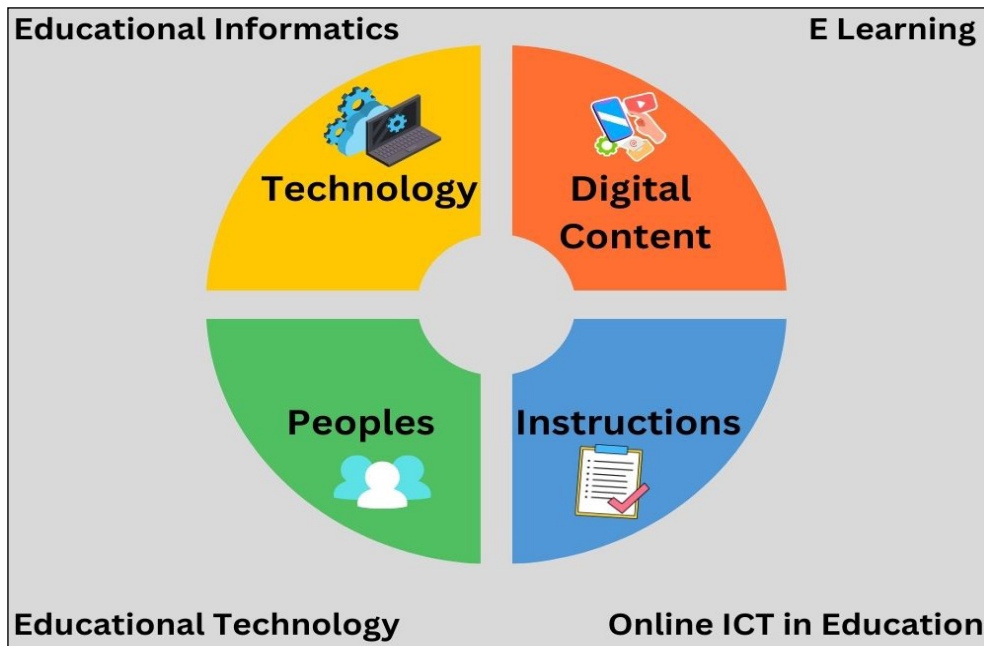


Fig. 1: Digital Education and its basic stakeholders

5.0 Big Data in Educational Management

Various emerging Technologies have used in digital education. Big Data Analytics is one of the important Technologies which play an important role in digital education. Big Data Analytics provides a better management framework to deal with extremely large volume of data which may have structured or unstructured data sets that may come from multiple data sources. The application of Big Data analysis has brought many benefits in the field of education. The benefits can be classified into educational benefits, organizational benefits, financial benefits and technological benefits (please refer Fig. 2).

Big Data Analytics directly plays a vital role in modern education system. It helps to improve *the student learning experience* of the learners by providing appropriate, efficient, and effective teaching and learning environment. By the use of effective analysis it will help to create *customize learning* procedure to the students^{[12],[18],[31]}. It is more students centric. The students' needs are always given the higher parity. It is always analysis students' performance, assessment process, assessment method, the course structure, feedback from the student and effectiveness of the teaching. By analyzing the programs, course and content it provides the *predictive teaching* which is another benefit of the Big Data Analytics. By analyzing the past performance, past grades, formative assessment response, actively engaged pedagogy and present performance of the student can *predict* the future grade of the student. It helps to creating *smart assessment* strategy^{[5],[6],[26]}. It directly improves the *quality of education* by tracking the learners' performance continuously.

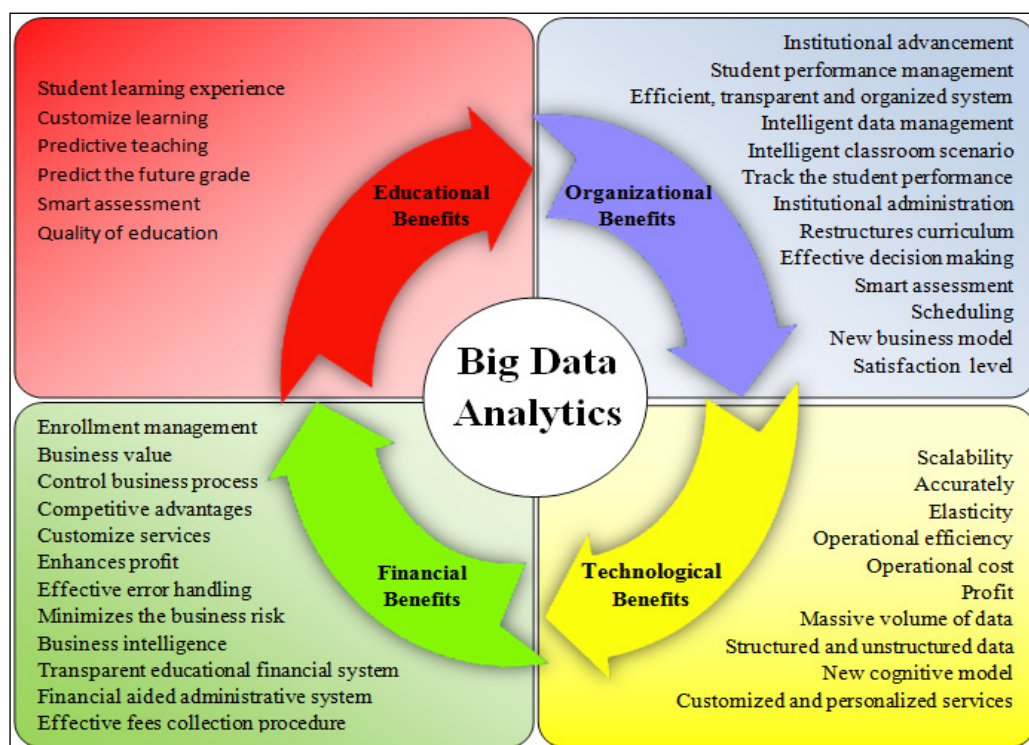


Fig. 2: Various opportunities of Big Data in Education in Digital Education context

Big Data Analytics provides lots of benefit to the educational institutions. It plays a vital role in *institutional advancement*. *Student performance management* is an important task for the institution. By implementing *intelligent data management* technique it could manage the student related data and able to *track the student performance*. It helps to create *smart assessment* report of the student in digital format. By analyzing the teachers' performance and student feedback it creates *intelligent classroom scenario*. It *restructures the learning curriculum* to create better assessment strategy. *Proper scheduling* of the class helps to improve the *students' concentration* and better faculty management. Advanced Big Data management Technologies plays a vital role to take *effective decision making*. It helps to matching students to performance and matching student to employment^{[14],[28]}. It creates *efficient, transparent and organized* system for better *institutional administration*. The Institutions get more opportunities to create, Store and analysis more transactional data in digital form. It helps to create a holistic vision of the institution by creating *new business model*, synthesizing students' behavior, increasing loyalty, personalizes student centric study material and increases the *satisfaction level* of the students and parents^{[10],[24]}.

By the use of Big Data Analytics the educational institutions have lots of financial benefits. It helps to manage a *transparent educational financial system*. *Enrollment management* is one of the tough tasks for the institutions. From admission fee to tuition fee collection, from cultural fee to examination fee and various others fees collections are very challenging task. Thus Big Data Analytics provide an organized *financial aided administrative system*. By making the information more transparent, it helps to unlock the *business value*. It creates a *control business process* and provides many *competitive advantages*. It

analysis the real time data to create a *customize services*. It provides a *quick service* to the learner. It suggests an *effective fees collection* procedure and *enhances profit* with satisfied services. It has an efficient *business error detection* and *control process* which provides *effective error handling* and *minimizes the business risk*. It provides sophisticated Analytics to analyze data which improve *business intelligence* and help to improve the *quality of the service*. It also helped to take better *decision making* and *effective planning*^{[4],[12],[30]}.

Big Data Analytics in education has lots of technological benefits. It is able to deal with *massive volume of data*. It can integrate with both *structured* and *unstructured* data. It has a power to maintain and analyze the data. Big Data Analytics enables the *scalability* of the system. The data can be accessed from anywhere and from anytime. The high performance system could analysis the data more *accurately*. The data can be distributed among different storage and it can be reorganized easily which increases the *elasticity* of the data. The *operational efficiency* can be improved by the use of different Big Data tools. One of the important benefits of use Big Data Analytics in educational institutions is to reduce the *operational cost* and improve the *profit*. It can create detailed stakeholders information and able to provide *customized* and *personalized services*. It has the potentiality to emerge *new cognitive model* for the student.

6.0 Application of Big Data in different fields of Educational Sector

The rise of big data has significantly transformed the educational landscape in recent years. A huge amount of data have been produced as a result of the quick development of technology and the spread of digital learning environments, and these data have the potential to significantly improve educational practices and outcomes. Big data analytics provides useful insights into learner behaviors, preferences, and needs due to its capacity to gather, analyze, and interpret huge and complex datasets. This plethora of knowledge has the capacity to guide evidence-based educational practices, tailor learning experiences, and support instructional decision-making. Despite the enormous promise of big data in education, there are several issues that need to be resolved. Since the gathering, storing, and use of student data raises issues with privacy, permission, and data security, ethical considerations are crucial. Maintaining trust and encouraging the ethical use of big data depend on protecting student privacy and making sure that their data is protected. To extract meaningful insights from the complexity and volume of data, it is also necessary to have a strong infrastructure, analytical tools, and qualified personnel. To fully realize the promise of big data in educational contexts, it is also necessary to solve the issues of data integration, interoperability, and quality. Big data integration in various educational contexts has enormous potential to improve education and enhance learning results. Educational institutions can get insightful knowledge into student habits, preferences, and needs by utilizing big data analytics, allowing for individualized instruction, reasoned decisions, and evidence-based practices.

6.1 Big Data in Higher Education Institutions

The potential of big data to alter teaching, learning, and administrative procedures is becoming more and more apparent to higher education institutions. Due to the quantity of data available within these institutions, it is possible to learn more about how students perform, engage with their learning, and stick with it^[1]. This information may also be used to help establish strategic decisions and policies. We will look at the uses and advantages of big data in higher education institutions in this part. Initiatives for student

success are one crucial area where big data analytics can have a substantial impact. By analyzing data from multiple sources, such as learning management systems, student information systems, and online platforms, institutions can identify early warning signs and patterns that may predict student success or risk of attrition. This information can help academic advisors and support services intervene and provide targeted interventions to struggling students, thereby increasing their chances of academic success.

Moreover, big data can support research and scholarly activities in higher education institutions. Researchers can analyze large datasets to identify research trends, conduct predictive modeling, and gain insights into societal issues. By leveraging big data, institutions can foster interdisciplinary collaborations, address complex research questions, and contribute to the advancement of knowledge. Big data analytics holds tremendous potential for higher education institutions. Institutions may improve student success initiatives, enable customized learning experiences, inform decision-making, and support research and scholarly activities by utilizing the potential of big data. To take advantage of the promise of big data in higher education, institutions have to address the problems related to data privacy, security, governance, and technical support^[9]. Higher education institutions might make use of big data analytics, pave the road for data-informed practices, and enhance educational outcomes by carefully taking into account these aspects.

6.2 Challenges and Opportunities of Big Data in Educational Settings

Big data raises a variety of challenges that have to be addressed despite the fact that it shows enormous promise for enhancing educational methods and results. The enormous volume and complexity of the data are two of the primary challenges associated with using big data in education. Large volumes of data are produced by educational institutions from a variety of sources, such as educational management systems, student information systems, online platforms, and assessments^[26]. Strong infrastructure, potent analytics tools, and knowledgeable individuals are needed for processing and evaluating such huge and varied datasets. For institutions to manage big data effectively and get valuable insights, they must invest in data storage, processing power, and staff training^[16].

Data interoperability and integration present another difficulty. Since educational data is frequently maintained in various systems and forms, it is challenging to gather and conduct a thorough analysis of the data. Institutions must set up systems for integrating data from numerous sources and guarantee system compatibility. To enable a seamless exchange of information and analysis, this calls for meticulous preparation, standardized data formats, and frameworks for data integration. Big data in education has great opportunities despite its difficulties. Large and varied datasets can be analyzed to gain important insights regarding student needs, preferences, and behaviors. To promote student achievement, this data can be used to guide decisions about how to deliver teaching, create individualized learning experiences, and implement focused interventions. Educational institutions can identify at-risk students, monitor their progress, and execute prompt interventions to increase retention and graduation rates by utilizing big data analytics. Big data has important benefits for educational settings, but there are obstacles that must be overcome in order to realize its full potential. To manage massive and complicated datasets, educational institutions must invest in infrastructure, analytics skills, and staff training. To ensure ethical and responsible data use, data integration, quality assurance, privacy, and moral concerns should be taken into account. Institutions can profit from big data analytics, enhance methods of instruction, and increase student results by overcoming these challenges.

6.3 Future Trends and Directions in Big Data for Education

The field of big data in education is continually evolving, driven by advancements in technology, changing educational needs, and emerging research.

Artificial Intelligence and Machine Learning: In the future of big data in education, artificial intelligence (AI) and machine learning (ML) technologies will be of importance. Large-scale data analysis, pattern recognition, and data-driven recommendations are all characteristics of AI-powered systems that can be used to improve teaching and learning. Applications of artificial intelligence (AI) that can give students individualized support, direction, and feedback include chatbots, virtual assistants, and intelligent tutoring systems. **Sentiment analysis and Natural Language Processing:** NLP and sentiment analysis methods will become more common in educational settings. NLP can examine textual data, like as essays, forum posts, or feedback, to learn more about the comprehension, engagement, and emotional states of students. Sentiment analysis can assist instructors in assessing how students feel about particular courses, resources, or instructional strategies, allowing for focused interventions and changes. **Wearable technologies with the Internet of Things:** In educational contexts, the growth of IoT devices and wearable technology will produce enormous quantities of data. These tools can gather information on the actions, activities, and physiological responses of students. Institutions may learn more about student engagement, well-being and health, and environmental elements that affect learning by incorporating IoT and wearable devices into educational settings.

Ethical Considerations and Data Governance: As big data is used more frequently in education, ethical issues and data management will be increasingly more important. Clear policies and procedures must be established by institutions for responsible data collection, storage, usage, and privacy protection. To preserve confidence and guarantee the ethical use of data, transparent data governance procedures, informed permission, and data anonymization techniques will be necessary. Big data in education has a bright future ahead of it, full of intriguing potential. The application of big data in education will be influenced by predictive analytics, learning analytics, AI, NLP, IoT, and interdisciplinary collaboration^[5]. To ensure ethical data use, algorithm openness, and data governance, however, it is essential to solve these issues. Educational institutions can use the potential of big data to enhance teaching and learning, increase student performance, and promote the field of education as a whole by adopting these future trends and approaches.

6.4 Big Data and Learning Management Systems

In educational institutions, learning management systems (LMS) are crucial because they offer a platform for organizing and delivering online courses, monitoring student progress, and fostering communication and teamwork. Big data has made it possible for LMS systems to use the enormous amount of data created by the system to enhance teaching and learning outcomes. This section will examine the connection between learning management systems and big data^[5].

Having access to information about student involvement and performance is one major advantage of incorporating big data analytics into LMS platforms. LMS platforms gather a plethora of information, such as how students interact with the course materials, participate in conversations, finish tasks, and the outcomes of assessments. Institutions can use this data to analyze patterns and trends that provide important details about the performance and learning habits of students. These insights can be used

by teachers to target interventions to help difficult pupils, identify areas for progress, and personalize instruction. Furthermore, big data analytics can support early intervention and student retention efforts. By leveraging data from LMS platforms, institutions can identify students who may be at risk of falling behind or dropping out. Early warning systems can be implemented to detect signs of disengagement or poor performance, triggering targeted interventions such as additional support, tutoring, or counseling. These proactive measures can help improve student retention rates and enhance overall student success. For management reasons, data analytics within LMS platforms can also offer useful insights. To help in decision-making and resource allocation, institutions can evaluate data on student demographics, resource usage, and course enrollments. Institutions can use this information to more efficiently allocate resources, plan for capacity, and identify trends. These insights can be used by administrators to make well-informed choices about the creation of curricula, the distribution of faculty members, and the acquisition of educational technology^[37].

The incorporation of big data analytics into learning management systems presents significant prospects for enhancing teaching and learning outcomes. Institutions can learn more about student performance, customize training, and aid in early intervention efforts by utilizing the enormous amount of data collected within LMS platforms. Data analytics can also improve administrative procedures, support decision-making on instruction, and promote ongoing development of methods for instruction. To enable the ethical and beneficial use of data within LMS platforms, institutions must address privacy issues, data governance, and technical difficulties. The educational landscape will continue to be shaped by predictive analytics^[19], AI, machine learning, and IoT technologies, which will make individualized learning experiences, ongoing data feedback, and evidence-based practices possible. Innovative educational techniques will be sparked by collaborative activities and data sharing that will enable multidisciplinary study and benchmarking.

The field of education has undergone a revolution thanks to big data, which has created new opportunities and insights to improve administrative, teaching, and learning processes. Institutions can employ big data analytics in educational settings to make data-driven decisions, customize lessons, boost student performance, and enhance overall educational outcomes.

Big data has a wide range of benefits for education. Institutions can identify at-risk students and offer tailored interventions to raise retention and graduation rates thanks to predictive analytics and early warning systems. Customized education and resources are made possible through learning analytics and personalized learning, which improves student engagement and academic results. Strategic decision-making, resource allocation, and policy formation are all influenced by big data, which results in more effective and efficient educational procedures. In terms of the future, the use of big data in education is showing some promising trends and possibilities. Big data has revolutionized education by enhancing student results, promoting evidence-based decision-making, and offering insightful information. It is vital to negotiate the difficulties and ethical issues involved with data use as educational institutions continue to employ big data. By doing this, organizations can fully utilize the potential of big data to develop environments that are inclusive, successful, and learner-centered. Big data in education has a bright future, and by utilizing it properly, we can create a system that is better and more equitable for everyone.

7.0 Big Data and Other Futuristic Technologies in Promoting Digital Education

Digital Education is rejuvenating and enhancing existing and new-age teaching-learning systems and in this context, various methods are being used in support of traditional classrooms and also empowering

other form of education viz. Blended and Hybrid Education, Online Education and Flexible Learning, Corporate Education, etc. Digital Education ensures advanced Designing of teaching-learning such as —

- ❑ Universal Designing and Development of Learning materials.
- ❑ Sophisticated and advanced User Experience based Designing for traditional and digital classrooms.
- ❑ Interactive Content Management Systems (CMS) for onsite and online programs and teaching-learning processes^{[18],[28]}.
- ❑ Enterprise Resource Planning for complete technological solutions and systems.

The technologies are required for proper mechanism as well as system development in respect of sophisticated teaching-learning pedagogies and to bring proper and healthy digital learning environment creation using smarter learning systems, and other supportive tools viz. RSS, YouTube & Video Channels, Google Classroom, and different kind of classroom platforms such as Zoom, Microsoft Team, CiscoWebex, etc. Digital Education also empowers various other Meeting applications, Intelligent Networking Systems, Skype and other Cloud-based Word Processing system, and document management systems, and thus various types of electronic gadgets are increasing gradually including their day by day operation for their proper and digital educational platforms.

In regard to Big Data and allied technologies it has a sophisticated role in educational planning, designing and development and thus it enhances Digital Education systems and culture. Various allied technologies such as Networking Technologies, Software Technologies, Multimedia Technologies, Security Technologies are being considered as vital in digital educational system development and promotion. As in the traditional classroom setting each day lot of data is being generated therefore it is important to introduce and implement Data Analytical tools and systems.

8.0 Education 4.0, Big Data & Digital Education

Education 4.0 is one of the latest and emerging concept in Education 4.0 and it is a prime concern of the forth industrial revolution towards advancing education systems by the sophisticated support of healthy and proper educational pedagogy delivery model implantation with advanced technologies. Education 4.0 also believes in increasing automation practice with a higher amount of creativity. IT and computing are playing a vital role in paradigm shifting of educational systems with futuristic concepts. Education 4.0 required proper skill sets and technological implementation with sophisticated skills. Further Education 4.0 seeks concentration on leadership in traditional as well as vocational education, both should be enriched with Education 4.0 context. Education 4.0 today comes to this stage after three previous phases and it is focused on flexible learning, advanced learning, skill based learning, etc. Among the technologies important are Cloud Computing, Big Data, Internet of Things, Blockchain, etc., and here role and significance of Big Data emerging due to wider potentialities in self learning environments, virtual data and content management of the educational sectors and areas. Big Data in Digital Education gives the opportunity is storing all kinds of recorded videos and content and can be visible using advanced technologies and systems^[30]. Next section elaborates on some of the fundamental and alarming concerns regarding Big Data in education toward sophisticated Education 4.0 practice.

8.1 Issues of Big Data Management in Digital Education

It is very challenging to deal with huge volume of structured and unstructured data set. There are several major challenges in the way of collecting, processing and storing data which come from multiple sources. The Challenges can be classified into educational issues, organizational issues, financial issues and technological issues (also refer to Fig. 3).

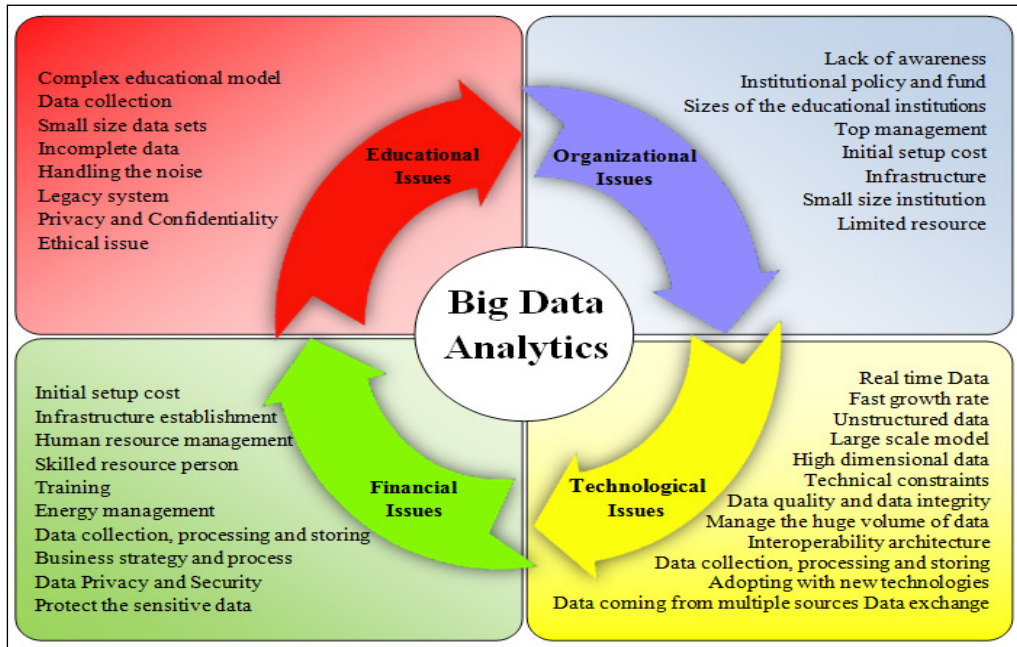


Fig. 3: Depecting various issues of Big Data in Digital Education context

It is one of the challenging tasks to implement the Big Data management technology in education. It is very difficult to implement the Big Data management technologies in *complex educational model* which creates a *complex system*. Big Data Analytics is one of the emerging technologies which are used to improve the performance of the system. Data mining technologies will perform better with more collection of data. *Data collection* is another important aspect as Big Data Analytics. But in a particular institution the numbers of students are constant. As the *data sets are very less* so it is very tough to generate accurate pattern for a particular data. Another challenging task is to deal with *incomplete data*. It has shown in real life that the records are incomplete in nature so it is very challenging to *handling the noise* of the data set. To give a better data visualization it is tough to integrate the present system with the *Legacy system*. Students' data are very sensitive, so maintaining the *privacy* and *confidentiality* are another aspect of the Big Data management Technologies. There is an *ethical issue* to use the student's personal data and bank information which are stored in the Database^{[21],[22]}.

It is very tough to implement The Big Data Analytics Technologies in an institution. The main challenge to implement Big Data Analytics technology in an institution is the *lack of awareness* about the Big Data Analytics Technologies. The top management is quite satisfied with the existing system so they give the excuse that the *institutional policy and funds* do not support emerging technologies like Big Data

Analytics Technology. Top management does not want to take the advantage of the decision support system Big Data Analytics. The *initial setup cost* of Big Data Analytics *infrastructure* is quite high so it is very costly to implement for any *small size institution*. There is very *limited resource* for data collection and very complex to deal with unstructured data. The *sizes* of the educational institutions are too small for Big Data Analytics Technology adaptation.

Implementation of big data Analytics is associated with financial challenges. The *initial setup cost* of Big Data Analytics is quite high that is a bigger issue for *infrastructure establishment*. *Data collection, processing and storing* is also need the financial support. *Human resource management* is also an important aspect. To operate the system smoothly it is necessary to recruit resource person^{[5],[19]}. It is also a challenge to get properly *skilled resource person*. It is also a challenge to give the *training* existing staff with new technologies. *Energy management* is also associated with financial management. *Business strategy and process* is directly affecting the financial areas of any institution. To maintain the *data privacy and security* is also important. Implementation of MOOC (*Massive Open Online Courses*) is very important for the student with larger opportunities but to keep all the records and to *protect the sensitive data* is very challenging task.

To implement Big Data Analytics in education is technically a challenging task. The main challenge is *data collection, processing and storing* in an organized manner. It is also difficult to *manage the huge volume of data*. The quality of the knowledge stored in the databases of the data centers are increasing with a *fast growth rate*. Most of the data are *unstructured* and coming from *multiple sources*. *Data exchange and interoperability architecture* to provide personalized service is also a big challenge. To maintain all the data it is necessary to implement *large scale model*. It is also tough to maintain the *data quality and data integrity*. *High dimensional data* generated in *real time* is very difficult to maintain with *technical constraints*. It is a significant challenge to *adopting with new technologies* like Cloud Computing, Internet of Things (IoT), Bio-inspired Computing, Quantum Computing, and so on^[29].

9.0 CONCLUDING REMARKS

Solid and proper educational activities can led to grow-up with the support of many concern and many sub technologies of Information Technology, Management Systems also worthy in enhancing new age educational systems. Digital Education rising rapidly in academia and also in industries and organizations for different reasons, and as a result, various forms of education have been generated viz. Digital Education, E-Learning, Educational Informatics, Online Education etc. and a significant growth is noticeable in the recent COVID-19 pandemic throughout the world. Big Data in education empowers classroom management, online teaching, learning material and laboratory management, traditional and digital library management, and so on. As Education 4.0 gives the opportunity in flexibility therefore it is to be adopted in many institutes globally and a country like India. Education Technology is considered as prime in enhancing Education 4.0 and in this context Data Analytics and allied technologies viz. Cloud Computing, Internet of Things are considered worthy. Today Higher Educational Institutions are putting their best in offering real-life and accurate educational delivery and in this context Education 4.0 is crucial and important. Today it is essential to adopt the latest skill sets to reach actual goal sets in different educational formats, and thus higher educational institutions and universities including corporate education players are implementing Education 4.0 in their systems or mechanism. Identification of skill shortage and incorporation of required skill set considered as worthy in new age curriculum for overall

and complete development of the educational program, and here the role of educational planner treated as worthy. Up-skilling according to the international scenario and interdisciplinary aspect inclusion considered as worthy deal and to teach properly the required and new age skill sets in IT is crucial, particularly Big Data and allied technologies. *Digital and Technology Skill* is required in advancing and realizing Education 4.0 and here proper skilling to the faculty and staffs considered as worthy. *Soft skills* are considered as important in the holistic development of all the researchers and academic community, especially to the students. Today *Online Tools* are treated as important for complete Virtual Learning environment and to support traditional teaching-learning modes.

REFERENCES

1. Adnan, M. and Anwar, K. 2017. The Role of Big Data in Educational Data Mining and Learning Analytics. *International Journal of Advanced Computer Science and Applications*, **8**(3): 90-99.
2. Aithal, P.S. and Aithal, S. 2016. Ekalavya Model of Higher Education—An Innovation of IBM's Big Data University. *International Journal of Current Research and Modern Education (IJCRME)*, **1**(2): 190-205.
3. Almeida, F.L. 2017. Benefits, challenges and tools of big data management. *Journal of Systems Integration (1804-2724)*, **8**(4).
4. Alsheikh, N.A. 2019. Developing an integrated framework to utilize big data for higher education institutions in Saudi Arabia. *International Journal of Computer Science & Information Technology (IJCSIT)* **11**(1): 31-42.
5. Anohina-Naumeca, A., Siliņa, I. and Kapenieks, J. 2019. Implementation of Learning Analytics to Support Decision-Making in Learning Management Systems. *Proceedings of the International Conference on Information Technology and Digital Applications*, pp. 1-8.
6. Bamiah, S.N., Brohi, S.N. and Rad, B.B. 2018. Big data technology in education: Advantages, implementations, and challenges. *Journal of Engineering Science and Technology*, **13**: 229-241.
7. Blikstein, P. 2013. Digital fabrication and 'making' in education: The democratization of invention. *FabLabs: Of machines, makers and inventors*, **4**(1): 1-21.
8. Buchanan, R. 2011. Paradox, Promise and Public Pedagogy: Implications of the Federal Government's Digital Education Revolution. *Australian Journal of Teacher Education*, **36**(2): 67-78.
9. Campbell, J.P. 2007. Maximizing the Value of Big Data Analytics in Higher Education. *Research & Practice in Assessment*, **2**: 42-45.
10. Dillenbourg, P. 2016. The evolution of research on digital education. *International Journal of Artificial Intelligence in Education*, **26**(2): 544-560.
11. Dunleavy, G. Nikolaou, C.K., Nifakos, S., Atun, R., Law, G.C.Y. and Car, L.T. 2019. Mobile digital education for health professions: systematic review and meta-analysis by the Digital Health Education Collaboration. *Journal of medical Internet Research*, **21**(2): 1-17.
12. Edwards, R. 2015. Software and the hidden curriculum in digital education. *Pedagogy, Culture & Society*, **23**(2): 265-279.

13. Ekong, E.E., Adiat, Q.E., Ejemeyovwi, J.O. and Alalade, A.M. 2019. Harnessing big data technology to benefit effective delivery and performance maximization in pedagogy. *International Journal of Civil Engineering and Technology*, **10**(1): 2170-2178.
14. Elboubekri, A. 2017. The intercultural communicative competence and digital education: The case of Moroccan University students of English in Oujda. *Journal of Educational Technology Systems*, **45**(4): 520-545.
15. Ferguson, R. and Buckingham Shum, S. 2012. Learning Analytics to Identify Exploratory Dialogue within Synchronous Text Chat. *The Internet and Higher Education*, **15**(1): 1-8.
16. Gasevic, D., Kovanovic, V., Joksimovic, S. and Siemens, G. 2014. Where is Research on Massive Open Online Courses Heading? A Data Analysis of the MOOC Research Initiative. *The International Review of Research in Open and Distributed Learning*, **15**(5): 134-176.
17. Hanna, D.E. 1998. Higher education in an era of digital competition: Emerging organizational models. *Journal of Asynchronous Learning Networks*, **2**(1): 66-95
18. Heller, L., Parker, P.A., Youssef, A. and Miller, M.J. 2008. Interactive digital education aid in breast reconstruction. *Plastic and reconstructive Surgery*, **122**(3): 717-724.
19. Hew, K.F. and Cheung, W.S. 2013. Use of Web 2.0 Technologies in K-12 and Higher Education: The Search for Evidence-Based Practice. *Educational Research Review*, **9**: 47-64.
20. Hiltz, S.R. and Turoff, M. 2005. Education goes digital: The evolution of online learning and the revolution in higher education. *Communications of the ACM*, **48**(10): 59-64.
21. Huang, Z. *et al.* 2019. Digital health professions education on diabetes management: systematic review by the Digital Health Education Collaboration. *Journal of Medical Internet Research*, **21**(2): 1-12.
22. Knox, J. 2016. Posthumanism and the MOOC: opening the subject of digital education. *Studies in Philosophy and Education*, **35**(3): 305-320.
23. Muthuprasad, T., Aiswarya, S., Aditya, K.S. and Jha, G.K. 2021. Students' perception and preference for online education in India during COVID-19 pandemic. *Social Sciences & Humanities Open*, **3**(1): 100101.
24. Narciss, S. 2013. Designing and evaluating tutoring feedback strategies for digital learning. *Digital Education Review*, **23**(2) 7-26.
25. Oguntimilehin, A. and Ademola, E.O. 2014. A review of big data management, benefits and challenges. *A Review of Big Data Management, Benefits and Challenges*, **5**(6): 1-7.
26. Olmos-Migueláñez, S., Fernández-Diego, M., Martín-Suárez, A. and López-Menéndez, M. 2021. Challenges and Opportunities of Big Data Analytics in Higher Education: A Systematic Review. *Sustainability*, **13**(4): 2200.
27. Ozga, J. 2016. Trust in numbers? Digital education governance and the inspection process. *European Educational Research Journal*, **15**(1): 69-81.
28. Paul, P.K. 2021. Digital Education: From the Discipline to Academic Opportunities and Possible Academic Innovations-International Context and Indian Strategies. *Digital Education for the 21st Century: Technologies and Protocols*, 255

29. Paul, P.K. *et al.* 2014. Education Technology: Emphasizing EduNxt Knowledge Transformation Systems of Sikkim Manipal University (SMU), Gangtok, Sikkim, India. *International Journal of Embedded Systems and Computer Engineering*, **4**(2): 109-113.
30. Paul, P.K., Dangwal, K.L. and Garg, A.K. 2012. Education Technology and Sophisticated Knowledge Delivery. *Techno-Learn-International Journal of Education Technology*, **2**(2): 169-175.
31. Paul, P.K., Sridevi, K.V., Ghosh, M. and Lama, A. 2012. Education Technology: The Transparent Knowledge Delivery through QPN and Cloud Computing. *IJSD-An International Journal*, **12**(2): 455-462.
32. Paul, P.K., Bhuimali, A., Kalishankar, T., Aithal, P.S. and Rajesh, R. 2018. Digital Education and Learning: The Growing Trend in Academic and Business Spaces—An International Overview. *International Journal on Recent Researches in Science, Engineering & Technology*, **6**(5): 11-18.
33. Reeves, T.C. 2003. Storms clouds on the digital education horizon. *Journal of Computing in Higher Education*, **15**(1): 3-12.
34. Robin, B.R. and McNeil, S.G. 2012. What educators should know about teaching digital storytelling. *Digital Education Review*, **22**: 37-51.
35. Simović, A. 2018. A Big Data smart library recommender system for an educational institution. *Library Hi Tech.*, **36**(3): 498-523.
36. Wahabi, H.A. *et al.* 2019. Medical Doctors' Offline Computer-Assisted Digital Education: Systematic Review by the Digital Health Education Collaboration. *Journal of Medical Internet Research*, **21**(3): 1-14.
37. Wang, S. and Wang, H. 2017. Exploring the Potential of Learning Analytics in the Context of Learning Management Systems: A Review. *IEEE Transactions on Education*, **60**(4): 296-304.
38. Xu, X., Posadzki, P.P., Lee, G.E., Car, J. and Smith, H.E. 2019. Digital education for health professions in the field of dermatology: a systematic review by Digital Health Education Collaboration. *Actadermatovenereologica*, **99**(1-2): 133-138.
39. Xu, Y. 2022. Assisting Laboratory Management Based on Network Big Data Mining Technology. *Journal of Function Spaces*, pp. 1-7.
40. Zhang, Z. 2017. The role of big-data in clinical studies in laboratory medicine. *Journal of Functional Spaces*, pp. 1-7.