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The Use of Big Data Technology in the Evolution of Educational Database Systems

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Abstract

The use of big data in the education sector is now the main focus in efforts to improve the learning process and strategic decision making. Big data provides a valuable resource for analyzing data generated by educational institutions, such as student data, attendance, evaluations, and classroom interactions. However, the use of big data also faces various challenges, including data privacy and security protection, data integrity, and limited technological resources and analytical expertise. This research combines qualitative and quantitative approaches to describe the benefits and challenges of using big data in educational institutions. The research results show that the application of big data can improve operational efficiency, decision-making effectiveness and student learning experiences. However, the importance of protecting data privacy and security as well as developing analytical resources and expertise must be considered to maximize the benefits of big data. Recommendations for educational institutions include special attention to the use of big data in decision making, personalization of learning, and increased operational efficiency.

Keywords: Big Data, Education, Databases

Abstrak

Pemanfaatan big data di sektor pendidikan kini menjadi fokus utama dalam upaya meningkatkan proses pembelajaran dan pengambilan keputusan strategis. Big data menyediakan sumber daya berharga untuk menganalisis data yang dihasilkan oleh institusi pendidikan, seperti data siswa, kehadiran, evaluasi, dan interaksi di kelas. Namun, penggunaan big data juga menghadapi berbagai tantangan, termasuk perlindungan privasi dan keamanan data, integritas data, serta keterbatasan sumber daya teknologi dan keahlian analitik. Penelitian ini menggabungkan pendekatan kualitatif dan kuantitatif untuk menggambarkan manfaat dan tantangan dalam pemanfaatan big data di institusi pendidikan.

Hasil penelitian menunjukkan bahwa penerapan big data mampu meningkatkan efisiensi operasional, efektivitas pengambilan keputusan, dan pengalaman belajar siswa. Meski begitu, pentingnya perlindungan privasi dan keamanan data serta pengembangan sumber daya dan keahlian analitik harus diperhatikan untuk memaksimalkan manfaat big data. Rekomendasi bagi institusi pendidikan meliputi perhatian khusus terhadap penggunaan big data dalam pengambilan keputusan, personalisasi pembelajaran, dan peningkatan efisiensi operasional.

Kata kunci: Big Data, Pendidikan, Sistem Basis Data

INTRODUCTION

The use of Big Data technology has transformed the landscape of database systems across various sectors, including education, in this ever-evolving digital era. Education is one of the fields significantly impacted by this technological revolution. With the continuous growth of data from various sources—ranging from academic records to student behavior—the application of Big Data technology in the evolution of educational database systems has become increasingly important.

Big Data refers to the vast volume of data generated daily from various sources, including social media, online learning platforms, and sensors embedded within educational environments. In the context of education, Big Data presents major opportunities for analyzing and understanding trends, patterns, and the individual needs of students more effectively. As a result, educational institutions are shifting from conventional approaches to more advanced and adaptive database systems.

However, behind the great potential offered by Big Data, there are also a number of challenges that need to be addressed. Data privacy and security, data integrity, as well as limitations in technological resources and analytical expertise, are some of the key issues that must be considered in the implementation of Big Data within educational settings.

This article will explore how the use of Big Data technology has transformed the evolution of educational database systems, introducing new concepts such as predictive analytics, personalized learning, and real-time student progress monitoring. Through a deeper understanding of how Big Data affects educational database systems, we can identify existing challenges and harness its potential to improve learning outcomes and decision-making in educational institutions.

METHODS

1. Big Data

According to Torabi Asr and Taboada (2019), the term "big data" refers to large-scale storage media that encompass diverse, expansive, and continuously growing types of data. In today's digital era, the amount of data generated by users through various online platforms such as websites, social media, and other internet services has increased significantly. Big Data is a concept that involves the management, storage, and analysis of vast volumes of data from various sources.

Big Data technology involves managing complex data assets with high volume and fast accessibility. It enables institutions to manage data efficiently and drives innovation in decision-making and knowledge development. The term "Big Data" was first introduced by Doug Laney around 2005. Laney highlighted three main characteristics of data, known as the "3Vs of Data": Volume, Velocity, and Variety.

Technological advancements such as Hadoop have accelerated and reduced the cost of handling large datasets. Meanwhile, the growth of the Internet of Things (IoT) and machine learning has also contributed to the expansion of data. The operation of Big Data involves managing the volume, velocity, and variety of data, with several steps to consider when implementing it within organizations.

2. Database Systems

A database system is at the core of data storage and management within an organization or computer system. With a structure composed of interrelated data tables and DBMS (Database Management System) programs that control access and data manipulation, the system facilitates efficient information management. A commonly accepted definition describes a database system as a collection of structured data that provides meaningful information to users, serving as a foundation for various operations and decision-making across sectors.

The functions of a database system encompass several key aspects, including reducing data redundancy and inconsistency through structured storage and accelerating data retrieval via efficient indexing. Data security is also a major concern, ensured through built-in DBMS security mechanisms that restrict access to authorized users only. Furthermore, database systems play a crucial role in supporting decision-making by providing the necessary data for accurate analysis and evaluation.

3. Education

In general, education refers to the learning process that involves the acquisition of knowledge, skills, and habits passed down from one generation to the next through teaching, training, and research. Some perspectives define education as a deliberate and structured effort to create a learning environment that encourages learners to develop their full potential.

Through education, individuals are expected to develop intelligence, noble character, personality, spiritual strength, and skills that are beneficial to themselves and society. In English, the term "education" originates from the Latin word *educatum*, which etymologically consists of *E*, meaning "to bring out from within," and *Duco*, meaning "to develop." Thus, etymologically, education is the process of developing an individual's abilities and potential.

FINDINGS AND DISCUSSION

1. Paradigm Shift in Educational Data Management

Big Data technology has transformed the traditional paradigm of educational data management in several ways:

Larger Data Scale: Big Data enables the collection, storage, and analysis of large and diverse datasets, expanding the understanding of educational systems.

Deeper Insights: Through analytical techniques such as machine learning, Big Data can identify previously unseen patterns and trends, providing deeper insights into student performance and educational programs.

Informed Decision-Making: Information derived from Big Data analysis supports more accurate decisions regarding educational policies, resource allocation, and intervention strategies.

Personalized Learning: Big Data allows for customized learning by identifying individual students' needs and learning styles.

Improved Efficiency: The use of Big Data can increase educational operational efficiency through task automation and identification of inefficiencies.

2. The Potential of Big Data in Education

In today's digital era, Big Data has become an invaluable asset for the world of education. It helps uncover deeper insights into the teaching and learning process, opens up new opportunities to optimize each individual's potential, and drives education toward a brighter future.

Data Analysis: Guiding More Accurate Decisions

By analyzing student data, educators and stakeholders can make more accurate decisions about teaching methods, curricula, and educational programs. This data provides insights into students' strengths and weaknesses, enabling more effective instructional approaches.

Predicting Student Progress

Educators can better forecast student development. This includes attendance data, exam results, and participation in extracurricular activities. Analyzing these trends allows timely support and guidance to be provided where needed.

Unique and Personalized Learning

Educators can create more personalized learning experiences. The data helps understand how students learn, their specific interests, and their level of comprehension. With this information, educators can design learning programs tailored to each student's needs and preferences.

3. Examples of Big Data Implementation in Educational Database Systems

Student Attendance Monitoring:

Some schools in Indonesia have started using Big Data to track student attendance. This data helps ensure consistent attendance and provides insights into patterns of absenteeism.

Teacher Performance Evaluation:

Using Big Data, schools can monitor teacher performance, including teaching methods, exam outcomes, and student interactions. These evaluations help identify areas where teachers may need professional development or additional support.

Personalized Learning:

Big Data enables curriculum and instructional adjustments based on individual student data. By understanding learning styles, specific interests, and comprehension levels, educators can develop customized learning programs.

Daily Activity Reports:

Data on the daily use of tools and task performance can be collected and analyzed. These reports help identify students who are struggling and ensure appropriate corrective action is taken.

Student Data Management:

Big Data can be used to manage student information, including personal data, academic history, and exam results. With an efficient database system, this information can be accessed easily and securely.

4. Challenges in Implementing Big Data in Education

The implementation of Big Data in education poses several complex challenges. Data privacy and security are top priorities, requiring careful protection of student data in accordance with applicable privacy regulations. Resource limitations, both in terms of infrastructure and analytical skills, often hinder progress, especially for institutions with limited budgets.

Integrating data from various incompatible sources requires standardization efforts and cross-departmental collaboration. The adoption of new technologies demands cultural and organizational process changes, which may be met with resistance. Raising awareness of the benefits of Big Data and ensuring staff readiness for its implementation are additional challenges. Ethical concerns and biases in data analysis require careful management to ensure fair and transparent data use. By addressing these challenges through collaboration and appropriate strategies, Big Data implementation can significantly contribute to educational advancement.

CONCLUSION

In facing the digital era and the increasing need for distance learning, the implementation of Big Data technology in the development of educational databases has become a necessity. Big Data enables the storage and analysis of large and diverse datasets, offering significant benefits to all stakeholders in the field of education. From students to educators, from parents to educational institutions, everyone can leverage the available data to improve the quality of learning and make better-informed decisions.

However, challenges such as inaccurate information and the risk of plagiarism must still be carefully considered. Collaboration between the government, educational institutions, and the broader community is essential to ensure that the use of Big Data in education is conducted effectively and yields maximum benefits. With this collaborative effort, the implementation of Big Data in the development of educational databases is expected to continue evolving and have a significant positive impact on improving the quality of education in Indonesia.

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