

# Big Data Empowers Student Management in Higher Education: Opportunities, Challenges and Optimization Paths

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**Abstract:** With the continuous development of big data technology, its application in college student management has gradually become a research hotspot. This paper first discusses the opportunities for big data to empower college student management, including promoting the empiricalization, ordering, and foresight of student management. Then, the paper analyzes the challenges faced by big data in empowering college student management, such as data security and privacy protection, data quality and accuracy, data management and governance challenges, technical implementation and talent bottlenecks, etc. Finally, the paper proposes paths to optimize big data empowerment of college student management, including establishing a sound data management system, improving data processing and analysis capabilities, strengthening data quality and standard construction, and strengthening policy guidance and training. Through the implementation of these optimization paths, the challenges faced by big data empowerment of college student management can be effectively addressed, and the efficiency and quality of college student management can be improved.

**Keywords:** Big data; College Student Management; Challenges; Optimization Paths

## I. Introduction

With the rapid development of information technology, big data has become an indispensable part of modern society. On the one hand, academic research has gradually recognized the potential value and broad application prospects of big data applications, discussing the technical challenges of big data collection and processing in the open sharing of medical, manufacturing, education, and management resources, and proposing some high-quality analysis techniques, processes and methods. On the other hand, in practical applications, many Internet companies have applied big data technology to commercial development, especially in online shopping, where companies use big data to analyze consumers' consumption habits, consumer psychology, purchasing power, etc., which can help Internet companies better establish shopping websites and sell products; government departments are also actively exploring how to use big data for refined management to improve government administrative efficiency and satisfaction of the people; the development and utilization of big data in academia is also gradually expanding. As an important position for cultivating morality and educating people, the application of big data technology in the field of student management in colleges and universities is also becoming more and more extensive, and it has brought unprecedented opportunities and challenges to student management. This article aims to explore how big data can empower college student management, improve management efficiency, optimize resource allocation, and analyze the challenges and optimization paths it faces.

## II. The Connotation and Role of Big Data Technology

Big data is a compound concept that opens up a new era in which social subjects gradually transfer their real identities, daily lives, business activities, and social interactions into the virtual world. In a narrow sense, it only refers to

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the vast, complex, and diverse information that cannot be obtained, managed, processed, and organized into decision-making support within a reasonable time through mainstream software tools, generated by various sensors, emails, videos, click streams, and all other digital signal sources that can be used now and in the future; in a broad sense, it covers the entire process of gathering, capturing, publishing, storing, circulating and processing massive information resources through the aggregation of huge data sets and other information technology branches such as artificial intelligence, data mining, and machine reading. The era of big data is a new period of rapidly integrating and processing metadata with a huge volume and low-value density, realizing high growth of massive data and optimizing the storage and flow process by using new digital management models (including expandable storage systems, large-scale parallel processing databases, distributed file systems, cloud computing platforms, and second-level data mining systems, etc.). As the application scope of big data expands from general statistics to the retail industry, manufacturing industry, and even political competition<sup>[1]</sup>, “obtaining products and services with great value, or profound insights, through the analysis of massive data in an unprecedented way”<sup>[2]</sup> has important strategic significance.

### 1. Promoting Scientific Research Development

The processing of big data with time and space coverage is the magnificent movement of the third wave, bringing about the rapid growth of data storage and flow, greatly expanding the source of objects for data analysis, and making the feasibility and accuracy of analyzing disease prediction, inferring economic prospects, and crime trends based on certain specific requirements and using various methods from massive samples rise to a new height, achieving a leap from hypothesis-driven to data-driven scientific research<sup>[3]</sup>. Researchers mine and process optimal information from massive databases to achieve breakthroughs in multiple projects<sup>[4]</sup>. The cognitive status of all personnel is grasped by mining a large amount of communication data; food shortage trends are predicted by observing price changes, immigration status, and drought levels<sup>[5]</sup>; the core reason for the decline in medical treatment rate due to price increases is revealed by re-identifying data from tens of millions of users<sup>[6]</sup>. Medical institutions even rank and compare all of Jobs’ DNA and tumor DNA, and administer drugs on demand according to the entire genetic data to treat cancer, extending his life by several years.

### 2. Maintaining Social Stability

The big data analysis model that summarizes the effect rules from massive “point-to-point” interaction information accurately assesses and predicts the truth or trends of events that affect society or groups, and spreads them to the whole society through diverse communication media, which is not only conducive to enhancing the government’s regulatory capabilities, enhancing the scientific nature of government decision-making, and improving the level of government services, but also conducive to warning potential lawbreakers and reminding well-intentioned counterparties. It is a useful tool for maintaining social stability and ensuring public safety, providing technical support for the modernization of the social governance system, and ensuring national security. For example, the widespread popularization of the global positioning system, Google Places, Facebook Places, Baidu positioning services, and various mobile phone applications with positioning functions have recorded user locations and movement trajectories, greatly reducing the difficulty of digital investigation. Also, big data technology increases the degree of judicial openness and changes the situation of information asymmetry in the judicial system. A big data probability assessment system is constructed by capturing, analyzing, refining, and processing the case facts and legal relationships reflected in the fully disclosed judgment documents; digital models are comprehensively used with statistical techniques and information technology to improve sentencing information systems (such as South Korea’s “Case Evaluation Database”, China’s “Sentencing Recommendation Management System” and “Computer-Aided Sentencing System for 100 Commonly Used Crimes in Criminal Law”, etc.),

striving to achieve a state of sentencing balance of “equal treatment under equal circumstances”; based on coding techniques, the time, place, and regional attributes of criminal activities are summarized to quantify the flow of crime<sup>[7]</sup>.

### 3. Improving Public Services

In the era of big data, public services have entered a new stage of convenience and efficiency. Traffic management departments analyze the driving speed and duration of each vehicle by anonymously collecting communication data transmitted by in-vehicle information service devices (which collect vehicle speed, mileage, direction, location, and other useful information at a frequency of minutes or seconds through built-in vehicle sensors), and based on effective assessment of traffic conditions<sup>[8]</sup>, formulate scientific traffic regulations and road planning regulations. The new intelligent power grid achieves multi-directional real-time linkage of the power grid system, various power sources, and user terminals through advanced transmission and control technology and decision support system integrated interactive data model, quickly reads power data, controls intelligent devices, recycles surplus power, and stabilizes critical loads, etc<sup>[9]</sup>, which helps to achieve service goals such as efficiency, economy, environmental friendliness, and safe use.<sup>[10]</sup> Social security departments calculate the medical waste component by analyzing the specific data of patients receiving treatment from medical institutions in the medical reimbursement detail table and save medical and nursing costs of government agencies at all levels with the help of huge data analysis.

### 4. Realizing Personalized Services

The era of big data has created unprecedented development opportunities and a broad market for personalized services<sup>[11]</sup>. “Green Button” plan, “Open Publishing Online Information”<sup>[12]</sup>, and “Shared Development Tools”<sup>[13]</sup> have created favorable conditions for individual users to apply in an all-round way from car navigation, and restaurant recommendations to medical services<sup>[14]</sup>, enhancing the enthusiasm of user groups in storing and flowing data in various network events<sup>[15]</sup>, and promoting the digitalization process of human life. “Today’s Headlines” recommends relatively accurate personalized information by long-term collection and analysis of users’ social networks and reading behaviors, greatly improving users’ reading comfort; the options such as “People who viewed this item also viewed” and “People who bought this item also bought” that “randomly” pop up at the bottom of the Taobao shopping page are not arbitrarily extracted information, but are called up by using the data of other users to enhance the service experience.

## II. Application of Big Data Technology in College Student Management

With the continuous change in information technology, digital technology has entered various industries in society in various forms, and with the gradual expansion of the application scope, it has been widely used in the entire operation process of educational resource acquisition, storage, integration, circulation, and processing, laying the core media interaction keynote of “data-driven decision-making” for higher education in the new era. The integration and innovation of big data-driven and student management will further change the dynamic structure of college student management, promote the emergence of new models, new methods, and new paths for college student management, and gradually enter a new stage of innovation and reform in college student management.

### 1. Promoting the imperialization of college student management

Under the background of big data technology-driven, important decisions made by social subjects will increasingly be based on data analysis, rather than based on experience and intuition. College student management can seize this opportunity to make college student management work empirically quantified and problem-presented by constructing a big data model for student mental health and quality evaluation. Based on a dynamic and massive information database,

through multi-dimensional student data capture and analysis, the learning level, ideological quality, and development potential of the management object are presented visually in real-time, actively overcoming the defects of inferences based on experience or intuition, and realizing “full sample” data analysis and overall “accurate description”, thus making the quality evaluation of college student management work more scientific and empirical. For example, big data technology can also provide decision support for student management departments, helping them formulate more scientific and reasonable student policies and measures.

## 2. Promoting the ordering of college student management

Compared with the traditional college student management model, “big data management” with algorithm support can realize the orderly analysis of the huge and diverse data generated in the process of student management intelligentization under powerful mining and analysis technology, thus profoundly influencing the daily ideological tendency and behavioral development of the management object. It enables the management subject to grasp sufficient and comprehensive student information through big data analysis, fully preset the student management process, and then carry out student management practice in a fully prepared situation, to calmly deal with various situations and problems that arise in the daily management of students, and quickly make countermeasures. For example, big data technology can visualize complex student psychological data and living habits, and build a unified data collection platform to obtain information such as learning status, psychological status, and depression tendencies of various abnormal students in real-time. This information is important for student management departments to understand the overall situation of abnormal students, discover problems promptly, and take corresponding measures.

## 3. Promoting the foresight of college student management

In the practice of college student management, the management subject can rely on big data analysis to deeply refine the original data with explosive growth in total amount, speed, and form (such as classroom attendance, homework completion, and exam scores of management objects), to form a preliminary understanding of the individualized development trends of multiple student individuals. Afterward, under the combined effect of cross-validation technology and third-party verification methods, the original numerical data related to the student work of the management object is deeply mined, thereby sorting out various quantifiable indexes related to the living habits, academic potential, employment prospects, etc. of the management object. This serves as an important basis for analyzing the habits, behaviors, and thoughts of the management object, providing an important auxiliary effect for formulating differentiated counseling plans for the individual characteristics of the management object, and achieving the objective of effectively improving the objectivity, correctness, comprehensiveness, and rationality of student management work. For example, Huazhong University of Science and Technology has developed a student learning behavior analysis system based on big data. By mining and analyzing student learning behavior data, it can discover students’ learning difficulties on time and provide personalized learning suggestions and tutoring services, effectively improving students’ learning effects.

## III. Challenges Faced by Big Data Empowered Student Management in Universities

The core value of big data lies in its evaluation and prediction functions. “Scientific predictive analysis based on large data sets leads to more objective and accurate results”.<sup>[16]</sup> While relevant technologies empower university student management and effectively improve management efficiency, they also make user groups increasingly dependent on data analysis, leading to issues such as data security and privacy protection, data quality and accuracy, data management and governance, data analysis and interpretation, as well as technical implementation and talent bottlenecks.

### 1. Data Security and Privacy Protection

“Where there is no privacy, there is no dignity”. Anonymity is an important guarantee for regaining dignity. The core attraction and main driving force of the Internet lie in maximizing the free expression of personal will through anonymous registration, search, and social interaction. Big data student management systems can identify real information and situations from massive structured and unstructured data. Excessive analysis of massive correlations extensively exposes data privacy, gradually reaching the point where “as long as there is a reasonable management motive driving the data mining process, any form of privacy is ‘algorithmically impossible.’” The vast majority of management targets find themselves in the awkward situation of trading privacy for convenient personalized services, and dignity violations are becoming increasingly common. For example, as the volume of data in university student management continues to grow, data security and privacy protection have become important issues. The application of big data involves a large amount of sensitive information, such as student’s personal information and private data. How to ensure data security, prevent data leakage and abuse, and protect the privacy of teachers and students is a major challenge faced by university student management.

### 2. Data Quality and Accuracy Issues

Although big data analysis and prediction can lead humans infinitely closer to the ultimate dream of controlling the future, the collection and analysis process cannot eliminate the latent bias caused by human inference and interpretation of data. Due to their disadvantaged position in terms of resources and technical strength, data subjects find it difficult to detect illegal acts of data content tampering by mining parties. Some profit-maximizing individuals will manipulate management activities, development trends, and overall layouts by fabricating analysis and prediction results, disrupting the balance of the entire student management system. For example, the diversity of data sources in student management may lead to data inconsistencies and contradictions, and dynamic changes in data may also affect data accuracy and reliability. Therefore, university student management needs to invest a lot of time and effort in data cleaning, deduplication, formatting, and other processing to ensure data quality and accuracy.

### 3. Data Management and Governance Challenges

“It is usually not the critical confidential data that is leaked, but ordinary daily information.” Big data technology comprehensively subverts traditional student management models and operating rules by integrating massive fragmented information resources and their multi-dimensional correlations to achieve a panoramic insight into student management targets. The complexity and dynamism of big data also place higher demands on data management and governance. For example, university student management needs to establish a complete data management system and norms, clarify data ownership, usage, and management responsibilities, and ensure the standardization, normalization, and sustainability of data. At the same time, it is also necessary to establish an effective data governance mechanism and clarify data management processes, decision-making mechanisms, and monitoring measures to ensure the rational use and management of data.

### 4. Technical Implementation and Talent Bottlenecks

The implementation of big data technology requires personnel with relevant professional knowledge and skills. However, due to the shortage of big data technology talents and the specificity of university student management, it is difficult to find suitable talents to support the work of big data-empowered university student management. In addition, the pace of technology updates and iterations is also rapid, and university student management needs to keep up with the

pace of technological development to adapt to the ever-changing campus management environment and technical requirements.

In summary, big data-empowered university student management brings many opportunities but also faces some challenges. University student management needs to carefully consider these challenges, actively seek solutions, fully leverage the advantages of big data technology, and improve the efficiency and quality of student management.

#### **IV. Optimization Strategies for Empowering University Student Management with Big Data**

Empowering university student management with big data requires continuous exploration and practice to address various challenges and issues. Through the implementation of optimization paths such as establishing a sound data management system, enhancing data processing and analysis capabilities, strengthening data quality management, promoting interdisciplinary cooperation and resource sharing, reinforcing policy guidance and training, and improving data visualization levels, the efficiency and quality of university student management can be effectively improved, promoting the development of university student affairs.

##### **1. Improve Data Security and Privacy Protection**

Effectively improving the system of data security and privacy protection for big data student data in universities is a basic guarantee for digital student management work. Firstly, encryption technology, access control technology, auditing technology, and other means need to be adopted to ensure the confidentiality, integrity, availability, and traceability of data. At the same time, the security of data storage and transmission should be strengthened to prevent data leakage and attacks. Secondly, the responsibilities and authority of various departments and personnel in data security and privacy protection need to be clarified, and a sound organizational structure for data security and privacy protection should be established. Ensure that data security and privacy protection work has dedicated personnel in charge, and can obtain the support and cooperation of other departments and personnel. Thirdly, a sound emergency response mechanism for data security and privacy protection needs to be established to respond to and deal with security incidents such as data leakage and attacks promptly. At the same time, regular simulation drills and tests should be conducted to improve emergency response capabilities and levels. Furthermore, the data security and privacy protection system needs to be regularly assessed and improved, and adjusted and refined according to the actual operation situation and requirements. At the same time, pay attention to new technologies and methods in the field of data security and privacy protection, and introduce them into the system to improve the level of data security and privacy protection.

##### **2. Strengthen Data Quality Management**

Continuously paying attention to changes and development trends in data quality and timely adjusting and improving data quality management work can effectively strengthen the quality management of university student data and improve the accuracy and reliability of data. Firstly, based on the characteristics and needs of student data, corresponding data quality standards need to be formulated, including aspects such as data accuracy, completeness, consistency, and timeliness. Secondly, a data quality monitoring mechanism needs to be established to regularly check and evaluate data and promptly discover and solve data quality problems. Corresponding monitoring indicators can be set, such as data error rate and data missing rate, to better understand the status of data quality. Thirdly, the responsibilities and obligations of various departments and personnel in data quality management need to be clarified, and corresponding assessment and reward and punishment mechanisms should be established. For data quality problems that arise, the responsibility of relevant personnel should be investigated, and corresponding improvement measures should be taken. Furthermore,

professional data quality management tools, such as data cleansing tools and data validation tools, need to be used to improve the efficiency and accuracy of data quality management. These tools can help automatically detect and repair problems in data and provide corresponding quality reports and management recommendations.

### 3. Establish Data Management and Usage Processes

Massive data mining technology provides an important boost for the rapid expansion and aggregation growth of university student management systems, and the increasingly heavy data management dilemma requires clarifying the entire process management rules for data collection, storage, use, processing, transmission, and disclosure to ensure the standardization and normalization of data. Firstly, the goals and principles of the student system data management system need to be clarified, such as ensuring data accuracy and completeness, protecting data security and privacy, etc. This helps provide guidance and norms for subsequent data management and student management. Secondly, detailed student system data management standards and specifications need to be formulated, including standards and specifications for data collection, storage, processing, analysis, sharing, and other links. This helps ensure the uniformity and standardization of data and improves the quality and reliability of data. Thirdly, strict student system data security and privacy protection measures need to be formulated to ensure the confidentiality and security of data. This includes measures such as data access control, encrypted storage, backup and recovery, etc., to prevent data leakage and attacks. Furthermore, through the implementation of the above measures, a sound big-data student management data system for universities can be established to provide strong support for university student management.

### 4. Strengthen the Cultivation of Data Student Talents

Effectively strengthening the cultivation of big data student data talents in universities is an inherent requirement for providing sufficient talent support for university student management work. Firstly, investment in data processing and analysis technology needs to be increased, professional talents should be cultivated, and data processing efficiency and analysis accuracy should be improved. At the same time, actively explore new data analysis methods and models to provide more scientific and accurate decision support for student management. Secondly, disciplinary barriers need to be broken, and cooperation between different disciplines should be encouraged to achieve resource sharing. Through interdisciplinary cooperation, the advantages of various disciplines can be fully utilized to improve the overall level of student management. At the same time, strengthens cooperation and exchanges with external institutions to expand the horizons and resources of student management. Thirdly, relevant policies need to be formulated to encourage and support university student management personnel to strengthen learning and improve their qualities. At the same time, strengthens training and exchanges, promotes advanced management concepts and methods, and promotes the innovation and development of student management. In addition, an incentive mechanism can be established to encourage student management personnel to actively explore and practice new management models and methods.

## IV. Conclusion

Big data technology has enormous application value in university student management. By empowering university student management with big data technology, management efficiency can be improved, resource allocation can be optimized, and the quality of student development can be enhanced. Therefore, universities should actively embrace big data technology, fully leverage its advantages, and provide strong support for student development. At the same time, universities should also strengthen data security protection to ensure that big data applications do not infringe on the legitimate rights and interests of students. Through continuously improving the institutional construction and standardized management of big data technology applications, the modernization process of university student management can be promoted.

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## REFERENCES

- [1] Thomas Edsall. Let the Nanotargeting Begin[N]. The New York Times, 2012-04-15.
- [2] Viktor Mayer-Schönberger, Kenneth Cukier. Big Data: A Revolution That Will Transform How We Live, Work, and Think[M]. Zhejiang People's Publishing House, 2013: 1.
- [3] Chris Anderson. The End of Theory: The Data Deluge Makes the Scientific Method Obsolete[EB/OL]. [http://www.wired.com/science/discoveries/magazine/16-07/pb\\_theory](http://www.wired.com/science/discoveries/magazine/16-07/pb_theory).
- [4] Big Data for Social Good[EB/OL]. <http://www.hsph.harvard.edu/ess/bigdata.html>.
- [5] Washington Okori, Joseph Obua. Machine Learning Classification Technique for Famine Prediction[J]. Proceedings of the World Congress on Engineering, 2011(2):991.
- [6] N.C. Aizenman. Data Trove may Shed Light on Health-care Uncertainties. The Washington Post, 2012-05-21.
- [7] Jameson Toole, Nathan Eagle, Joshua Plotkin. Quantifying Behavioral Data Sets of Criminal Activity[EB/OL]. <http://ai-d.org/pdfs/Toole.pdf>.
- [8] Carlo Ratti, Riccardo Maria Pulselli, Sarah Williams, Dennis Frenchman. Mobile Landscapes: Using Location Data from Cell-Phones for Urban Analysis[C]. Environment and Planning B: Planning and Design, 2006(33): 727.
- [9] Information and Privacy Commissioner. Smart Privacy for the Smart Grid: Embedding Privacy into the Design of Electricity Conservation[EB/OL]. <http://www.ipc.on.ca/images/Resources/pbd-smartpriv-smartgrid.pdf>.
- [10] Katie Fehrenbacher. Introducing the Facebook Social Energy App[EB/OL]. <http://gigaom.com/cleantech/introducing-the-facebook-social-energy-app>.
- [11] The Emerging Market that could Kill the Iphone [EB/OL]. <http://tech.fortune.cnn.com/2012/08/01/iphone>.
- [12] Introducing the Green Button [EB/OL]. <http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/GreenButtonInitiative>.
- [13] "Click a Simple Blue Button and Download" Data: President's Open Government Agenda Defaults to Transparency[EB/OL]. <http://www.whitehouse.gov/sites/default/files/microsites/ostp/smartgrid09-15-11.pdf>.
- [14] Steven Overly. Mobile Health Apps Prompt Questions about Privacy[N]. The Washington Post., 2012-04-27.
- [15] Kevin Ashton. That "Internet of Things" [J]. RFID Journal, 2009(7): 25.
- [16] Danah Boyd, Kate Crawford. Critical Questions for Big Data: Provocations for a Cultural, Technological, and Scholarly Phenomenon[J]. Information, Communication & Society, 2012(15): 662.