

# Research on the Application of Big Data and Cloud Computing Technology in Smart Campus

Shengtao Zhou\*

Heilongjiang Ecological Engineering Vocational College, Harbin 150025, Heilongjiang Province, China

\*Corresponding author: Shengtao Zhou, 95821212@qq.com

**Copyright:** © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

**Abstract:** The current education field is experiencing an innovation driven by big data and cloud technologies, and these advanced technologies play a central role in the construction of smart campuses. Big data technology has a wide range of applications in student learning behavior analysis, teaching resource management, campus safety monitoring, and decision support, which improves the quality of education and management efficiency. Cloud computing technology supports the integration, distribution, and optimal use of educational resources through cloud resource sharing, virtual classrooms, intelligent campus management systems, and Infrastructure-as-a-Service (IaaS) models, which reduce costs and increase flexibility. This paper comprehensively discusses the practical application of big data and cloud computing technologies in smart campuses, showing how these technologies can contribute to the development of smart campuses, and laying the foundation for the future innovation of education models.

**Keywords:** Big data; Cloud computing technology; Smart campus; Application

**Online publication:** August 14, 2024

## 1. Introduction

With the rapid development of science and technology, big data and cloud computing technologies are gradually integrated into people's daily lives, especially in the field of education, these technologies are opening up new paths. With the rise of smart campuses, relying on the deep insight of big data analysis and the infinite expansion of cloud computing, modern campuses have a more efficient, personalized, and smarter way of operation. This paper focuses on how big data and cloud computing technologies promote the construction of smart campuses, analyzes the practical applications of these technologies in improving the learning process, optimizing resource allocation, ensuring campus security, assisting in decision-making, and further explores the far-reaching impacts of these technologies for the sustainable development of higher education in the future.

## 2. Development of big data cloud technologies

Over the past decade, big data and cloud computing technologies have experienced rapid development, and they

have moved from conceptualization to widespread practical application. This change highlights the innovative vitality of the information technology field. Big data, as a broad field covering data collection, storage, management, analysis, and interpretation, is centered on extracting valuable information from voluminous data sets and transforming it into actionable insights. With enhanced computing power and algorithmic advances, big data can not only handle traditional structured data, but also mine complex unstructured data, such as text, images, and videos, which makes personalized services and accurate recommendations possible.

Simultaneously, cloud computing has revolutionized how Information Technology (IT) resources are acquired and managed with its flexibility, scalability, and on-demand services. Enterprises and educational institutions can obtain the required computing resources, including servers, storage, and networks, through cloud service providers without the need for heavy upfront capital investment<sup>[1]</sup>. The continuous evolution of cloud computing has brought about a variety of service models such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS), which have greatly facilitated the digital transformation of enterprises and organizations.

In the context of smart campus applications, the overlay effect of big data and cloud computing technologies has had a profound impact. Using big data analysis, educators can gain insight into students' learning habits, performance, and various behavioral patterns, thereby adjusting teaching strategies and providing more accurate educational support. Additionally, the introduction of cloud computing technology has revolutionized the storage and sharing of learning resources, with cloud-based repositories making the latest academic resources accessible promptly, along with rich online courseware and interactive tools greatly enhancing the flexibility and interactivity of learning.

### **3. Application of big data technology in the smart campus**

#### **3.1. Analysis and optimization of students' learning behavior**

Based on the smart campus concept, the application of big data technology provides strong support for the analysis and optimization of student learning behavior. By capturing data generated by students in various teaching activities, including online learning interactions, homework submissions, test scores, book borrowing, and other behavioral records, a comprehensive learning behavioral portrait can be constructed. Analyzing this data enables educators to reveal patterns and trends in student learning, which in turn provides insight into their needs and difficulties.

For example, data may show that a student is spending an unusually large amount of time in a math course with little effect, in which case the teacher can make timely adjustments to the teaching method or provide additional tutoring. Using machine learning algorithms and artificial intelligence techniques, big data analytics can further enable intelligent optimization of learning paths<sup>[2]</sup>. Based on students' past performance and learning preferences, customized recommendations of appropriate learning resources and courses not only stimulate students' interest in learning but also improve learning efficiency. The adaptive learning module in the learning management system can dynamically adjust the teaching content and difficulty according to the learning progress and effect of students, thus achieving truly personalized learning.

#### **3.2. Teaching resource management and intelligent scheduling**

Big data technology can effectively categorize, label, and index resources by integrating the massive teaching resource data scattered in educational institutions, including e-books, online courses, multimedia content, etc. These resources, after in-depth analysis and carving, will provide teachers and students with an all-encompassing and conveniently accessible resource library, which greatly improves the transparency of

information and the utilization efficiency of teaching resources. The recommendation system within the smart campus benefits from in-depth data mining and learning algorithms to recommend the most appropriate teaching materials and tutorial resources to teachers and students. In terms of intelligent scheduling, big data technology realizes the dynamic allocation of teaching resources by analyzing classroom usage, frequency of course offerings, and teacher-student interaction patterns. When there are changes in teaching needs, the system can automatically adjust the allocation of resources, such as space allocation and course scheduling, to ensure the maximization of resource utilization and reduce unnecessary waste<sup>[3]</sup>. Teachers can adjust the teaching plan and content distribution according to the information provided by the system to adapt to the specific needs of students and achieve personalized teaching in the true sense. Moreover, big data plays an equally indispensable role in logistics management and budget allocation. Accurate analysis of historical data and future trends can assist management in making more scientific decisions and optimizing the efficiency of school operations.

### **3.3. Campus safety and environmental monitoring analysis**

Big data technology with its powerful data processing and analysis capabilities for this field has brought about profound changes. Integrating real-time data streams generated by video surveillance, identity recognition, access control, and other systems, the big data platform is capable of comprehensive analysis and real-time monitoring of campus security, from the intrusion of loiterers to the misbehavior of students in dangerous areas can be effectively identified and responded to promptly. Furthermore, environmental monitoring, temperature, humidity, Particulate Matter with a diameter of 2.5  $\mu\text{m}$  or smaller (PM2.5), and other sensors collect data to provide a healthy, comfortable learning and working environment for the campus.

The application of big data technology also extends to the construction of risk assessment and early warning systems<sup>[4]</sup>. By analyzing the comparison between historical security events and current behavioral patterns, a more accurate risk model can be constructed for predicting potential security problems and taking preventive measures before risks are formed. Embedding such an early warning mechanism at the beginning of the design of a smart campus means that security management is no longer a single after-the-fact response, but a shift to a proactive preventive posture. Big data analytics also demonstrates its value in optimizing the emergency response process. Once potential safety hazards or environmental anomalies are detected, the system can quickly communicate the information to the relevant departments and guide the implementation of emergency disposal measures<sup>[5]</sup>. This data-driven decision-making process speeds up emergency response time and minimizes the scope and extent of risk.

### **3.4. Campus decision support and operation optimization**

Big data technology has become an indispensable nerve center for campus decision support and operation optimization. By aggregating massive amounts of data from various education information systems, such as student registration management systems, library databases, and e-learning platforms, decision-makers can obtain a panoramic view of campus operations. Relying on these valuable data resources, academic staff, management, and policymakers can conduct multi-dimensional analyses, such as the evaluation of key indicators like student employment rate, course satisfaction, teacher performance, etc., to make efficient strategic planning and decision-making based on a solid data foundation. In terms of operation optimization, big data technology can promote campus service process reengineering by identifying high-frequency teaching process bottlenecks and achieving continuous improvement in school efficiency.

Additionally, combined with predictive analytics tools, big data can also help campus administrators make trend and demand forecasts for forward-looking curricula, faculty layout, and facility planning. Together with

the efficient computing power and resource elasticity of cloud computing, precise adjustments in resource allocation can be realized, which not only reduces redundant expenditures but also increases the efficient utilization of the input-output ratio<sup>[6]</sup>. The smart campus carries out scientific and refined management of campus decision support and operation optimization with the help of big data technology, which makes the placement of educational resources more accurate, the service more efficient, and realizes the optimization and high-quality development of educational resource allocation.

## **4. Application of cloud computing technology in the smart campus**

### **4.1. Cloud-based educational resource-sharing platform**

In the construction of a smart campus, cloud computing technology has given birth to an innovative model, a cloud-based educational resource-sharing platform. This platform breaks the barrier that traditional teaching resources are limited to use within a certain school or region, opens high-quality educational content and services to a wider range of users through the network, and realizes resource sharing and optimal allocation. Teachers, students, and researchers can easily access and use the platform, which includes e-books, online courseware, experimental simulation software, and massive research materials. The flexibility and scalability of the cloud platform make it possible to store and process these huge resources while ensuring that users can access these resources in real time no matter where they are, greatly improving the efficiency and convenience of learning and research<sup>[7]</sup>.

Based on cloud computing technology, the cloud-based educational resource-sharing platform is not just a simple data warehousing center, it also has efficient data processing capabilities and supports complex analysis and management functions. Tracking and analysis of resource usage and access can provide valuable insights to further guide the development and optimization of resource adjustments. Superior data security management is another core feature of cloud-based educational resource-sharing platforms. On the cloud platform, user access is finely controlled to ensure the originality and authenticity of resources and prevent intellectual property infringement. As many educational activities move online, the platform uses the latest encryption technologies and security strategies to safeguard data and ensure that every user can learn and communicate in a secure environment.

### **4.2. Cloud computing-based virtual classrooms and distance education**

With the development of cloud computing technology, the services provided by cloud computing make the virtual classroom free from geographical and time constraints. Teachers and students can meet in a shared learning space through the network, using the platform for face-to-face lectures, whether through simulation, communication, or interaction, to achieve ease of performance. Efficient and reliable cloud services ensure that classroom activities are carried out smoothly and are not affected by the increase in the number of users or the increase in the volume of data, maintaining the consistency and stability of the learning experience. Using cloud-based platforms, educational content can be greatly enriched and expanded, teaching resources can be rapidly updated and deployed in response to demand. Teachers can use a variety of online tools and resources to innovate their teaching methods, and students can master knowledge through personalized learning paths.

In terms of distance education, cloud-based technologies lower the threshold of access to education, allowing a wider audience to receive quality education. From children in remote mountainous areas to urban lifelong learners, everyone can learn at their own pace without worrying about resource constraints. Security and stability are also part of the advantages of cloud computing, ensuring that user data, especially sensitive information such as exam information and personal grades, are appropriately protected and managed<sup>[8]</sup>. In

short, the virtual classroom and distance education created by cloud computing not only make learning easier and more convenient, it also completely subvert the spatial and temporal concepts of education through the seamless connection of teaching and learning resources in the cloud, making learning a ubiquitous and accessible way of life.

### **4.3. Smart campus management system supported by cloud services**

When cloud computing technology is integrated with classroom management, facility operation and maintenance, and even administrative decision-making, it constitutes a powerful integration platform of a cloud service-supported smart campus management system. Such a system utilizes the flexible storage and computing power of cloud services for real-time collection, processing, and analysis of massive educational data, ensuring the security, reliability, and accessibility of campus operational data <sup>[9]</sup>. From teachers' lectures, and students' course selection, to logistic services, each link realizes seamless informationization and efficient collaboration, which significantly improves the intelligent level of campus management.

Through the system, campus administrators can access key information such as the use of educational resources, analysis of student performance and behavior, and assessment of teaching quality at any time to make more informed decisions. Academic administrators can quickly generate reports, schedule resources, and optimize course scheduling and faculty allocation with the help of automated tools <sup>[10]</sup>. Logistics such as energy monitoring, campus security, and facility maintenance are also made more scientific, accurate, and manageable by this system. It is worth mentioning that this management system is also advanced in emergency response. Cloud services are characterized by rapid response. Once an emergency occurs, the system can immediately activate the preset program, send alerts quickly and efficiently, and guide teachers and students to evacuate or avoid danger, significantly enhancing the ability to respond to emergencies.

## **5. Conclusion**

In summary, big data and cloud computing technology can not only support more accurate analysis of student behavior, more efficient scheduling of teaching resources, more advanced security monitoring systems, and more scientific decision-making processes but also provide efficient and reliable IT infrastructure through the flexible cloud service architecture. By comprehensively utilizing big data and cloud computing technologies, smart campuses can better adapt to the diversification of education needs, respond to the challenges of education model change, and provide a solid technical foundation for building an education ecosystem with knowledge sharing, balanced resources, and a harmonious environment.

## **Disclosure statement**

The author declares no conflict of interest.

## **References**

- [1] Yan F, Wang J, Yu J, et al., 2023, Research on Smart Campus Applications based on Big Data Technology and Cloud Computing. *Information and Computer (Theoretical Edition)*, 35(24): 233–236.
- [2] Zhao X, 2023, Application of Big Data and Cloud Computing Technology in Smart Campus. *Information Record Material*, 24(12): 186–188 + 191.
- [3] Ren L, 2023, Application of Big Data and Cloud Computing Technology in Smart Campus. *Integrated Circuit*

Application, 40(09): 98–99.

- [4] Kwon H, 2023, Practical Analysis of Big Data and Cloud Computing Technology Applied to Smart Campus. *Wireless Internet Technology*, 20(15): 55–57.
- [5] Ren H, 2023, Application Analysis of Cloud Computing Technology in Smart Campus. *Communication and Information Technology*, 2023(01): 38–40.
- [6] Wang L, Tian M, Gu R, 2021, Research on the Application of Big Data and Cloud Computing Technology in Smart Campuses. *Yangtze River Information and Communication*, 34(12): 105–107.
- [7] Lv Z, 2021, Application of Big Data and Cloud Computing Technology in Smart Campus. *Computer Knowledge and Technology*, 17(35): 25–26.
- [8] Wang C, Song W, Wang X, 2021, Research on the Application of Big Data and Cloud Computing Technology in Smart Campuses. *China New Communication*, 23(21): 85–86.
- [9] Yan X, 2021, A Test Study on the Application of Big Data and Cloud Computing Technology in Smart Campus. *Information Record Material*, 22(10): 102–103.
- [10] Yang X, 2021, Research on the Application of Big Data and Cloud Computing in Smart Campuses. *Wireless Internet Technology*, 18(11): 87–88.

**Publisher's note**

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.