Research and Design of Decision-Making and Reference Information System for Discipline Construction in Application-Oriented Undergraduate Universities Based on Big Data Technology

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Abstract. With the increasing popularity and application of big data in Chinese colleges and universities, profound changes have taken place in school management, teaching activities, informatization level, education research paradigms, and evaluation methods for various jobs. However, the management of discipline construction is still lagging behind. The current management mode of application-oriented undergraduate universities has several shortcomings, including reliance only on basic discipline data, inaccurate results, lack of in-depth analysis of discipline data, difficulty in accurately predicting the development trend of various disciplines, and the inability to achieve targeted management and sound decision-making. In this paper, a decision-making and reference information system for discipline construction is designed based on big data technology, which can partially solve the above-mentioned problems.

Keywords: Decision-making and Reference · Decision and reference · Information System

1 Introduction

Significant changes have occurred since Alvin Toffler, a renowned American futurist, introduced the concept of big data in 1980. According to the definition of McKinsey Global Institute, big data refers to datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze. These datasets possess four distinctive features, namely, high volume, high velocity, high variety, and low-value density [1]. With the widespread application of big data, its concept has been further enriched and deepened. Big data has found extensive use in government decision-making departments, industrial enterprises, research institutes, and various other fields, continuously adding value to all walks of life. The integration of innovative technologies like the Internet, artificial intelligence, and cloud computing has revolutionized people's way of thinking, production, living, and communication, thereby promoting social change and progress on a vast scale.

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Viewing the impact of big data on education, it can be observed that big data not only accelerates the development of data science and emerging disciplines and provides new and powerful tools for scientific and technological innovation, but also enhances the educational environment and advances the reform of educational methods and the transformation of educational strategies. Smart education derived from this also shows an irresistible trend, which further testifies to the impact of big data on China's education [2]. With the widespread adoption and application of big data in Chinese colleges and universities, profound transformations have occurred in school management, teaching activities, informationization level, educational research paradigms, and job evaluation methods. However, its impact on specific work areas of colleges and universities is mainly seen in the transformation of educational content, methods, and paradigms. Additionally, it has facilitated the improvement of daily management practices in higher education institutions. However, the impact on the management practices of discipline construction in colleges and universities still lags behind.

The Education Informatization 2.0 Action Plan released by the Ministry of Education in 2018 emphasizes that "it is important to enhance the top-level design of education management informationization, comprehensively improve the ability to leverage big data to support education management, decision-making, and public services, and realize comprehensive integration of the education administrative information systems and sharing of administrative information resources."[3] Additionally, China's Education Modernization 2035 Plan, issued by the Central Committee of the Communist Party of China and the State Council, puts forth the idea of "advancing the reform of educational governance forms, expediting the establishment of a modern education management and monitoring system, and promoting precise management and sound decision-making." [4] Discipline construction is considered the "leading" project among the core responsibilities of Chinese colleges and universities. Therefore, it is imperative to ensure accurate management and sound decision-making in this area with the aid of big data.

2 Discipline Construction and Management of Application-Oriented Undergraduate Universities

Discipline is the cornerstone of running a university, and discipline construction holds a central position in this process. Educational activities, whether at the undergraduate, master's, or doctoral levels, are all organized on the basis of disciplines. The discipline development of application-oriented undergraduate universities results from multiple factors. Since most disciplines aim to contribute to the growth of regional economies and societies, they are designed with an emphasis on practical application and are evaluated based on their effectiveness in solving real-world problems.

2.1 Discipline Construction Tasks of Application-Oriented Undergraduate Universities

Considering the regional and application-oriented characteristics, the discipline construction of such universities should focus on the following aspects [5].

(1) Optimize the discipline layout and construct a "quasi-industrial" discipline structure.

(2) Explore a path of coordinated development and adopt the mode of industry-education integration.
(3) Consolidate the discipline directions and improve the applied research level.
(4) Select discipline leaders and build teams and talent pools which are good at applied research.
(5) Optimize the combination and innovate the organizational form of discipline construction.
(6) Innovate the management mechanism and strengthen the provision of necessary conditions for discipline construction.

The construction of each discipline requires teachers to make tremendous efforts in talent cultivation, scientific research, social service, and cultural inheritance. Teachers must actively participate in teaching activities and scientific research, and academic leaders should take the lead in developing disciplines.

2.2 Discipline Construction Management of Application-Oriented Undergraduate Universities

Application-oriented undergraduate universities should adopt a tired approach to discipline construction. Generally, there are provincial-level key disciplines, school-level key disciplines, and school-level general disciplines. The situation of discipline construction should be evaluated annually with both qualitative and quantitative assessment methods, accompanied by multiple regulations. All regulations, including the academic performance credits system, scientific research incentives system, academic journal classification system, and discipline evaluation indicators, should embody the educational philosophy of application-oriented undergraduate universities.

Typically, the performance data reported by faculty and basic disciplines at the end of the year are summarized by the Department of Discipline Construction and then evaluated by experts according to the relevant management regulations of the school. The evaluation results serve as an important basis for discipline evaluation and funding allocation for discipline construction.

However, there are some major defects in the process mentioned above: (1) The data only come from basic disciplines, with a single source and a lack of comparison with similar institutions, resulting in less accurate results. (2) The data are only collected at the specified time point, which can not reflect the development dynamics of discipline construction, and in some cases, the discipline's status has changed even before the evaluation results are announced. (3) There is a lack of in-depth analysis of discipline data, making it difficult to accurately predict the development trend of various disciplines. (4) The evaluation process fails to meet the requirements of precise management and sound decision-making proposed by the government.

In order to effectively address the aforementioned issues, it is essential to establish a comprehensive decision-making and reference information system for discipline construction by incorporating big data analysis methods.

3 Research and Design of Decision-Making and Reference Information Systems for Discipline Construction in Application-Oriented Undergraduate Universities

3.1 System Functions

(1) Requirements of the teachers: Teachers can upload their own teaching and research projects that meet or exceed the provincial level standards and important research achievements to the system at any time. In the case of Guangdong Baiyun University, significant research achievements are those with academic performance credits of 10 points or more. The system allows real-time access to information on all teachers within a particular discipline.
(2) Requirements of basic discipline organizations: The heads of basic disciplines can visit the system anytime to observe the status of their disciplines, including information on each teacher's title, age, projects, and academic performance, as well as the employment outcomes of graduates. Additionally, they can compare the status of students within the same discipline across other application-oriented undergraduate universities in Guangdong Province. If the total performance credit of this discipline in the present year falls below a certain threshold, or if a particular index is lower than the set standard, an early warning signal will be triggered to assist the head of the discipline in adjusting research direction or strengthening efforts in a specific area in a timely manner.
(3) Requirements of the school-level Department of Discipline Construction: The development trends of all disciplines of the school can be observed at any time, including the status of talent cultivation, scientific research, social services, and cultural inheritance of various disciplines, and special warnings regarding important work will be sent to the department head. All disciplines with warning signals will be displayed on the interface. Meanwhile, the development trends of all disciplines in other application-oriented undergraduate universities can also be observed. The department can timely report the development of disciplines to the school leaders, who will adjust and organize the current work according to the principles of complementary development and distinctive development, so as to propel the school toward high-quality development.

3.2 System Design Philosophy

Facing the different requirements of teachers, basic discipline organizations, and school-level discipline construction departments, we build a decision-making and reference information system for discipline construction in application-oriented undergraduate universities. A data acquisition system and a big data storage and analysis system are established by comprehensively applying multidisciplinary theories and technologies, such as data acquisition, mathematical modeling, data storage, data analysis, machine learning, and deep learning. Subsequently, basic, moderate, and in-depth analyses are conducted to provide corresponding reference information, decision-making information, and early warnings for teachers, basic discipline organizations, and school-level

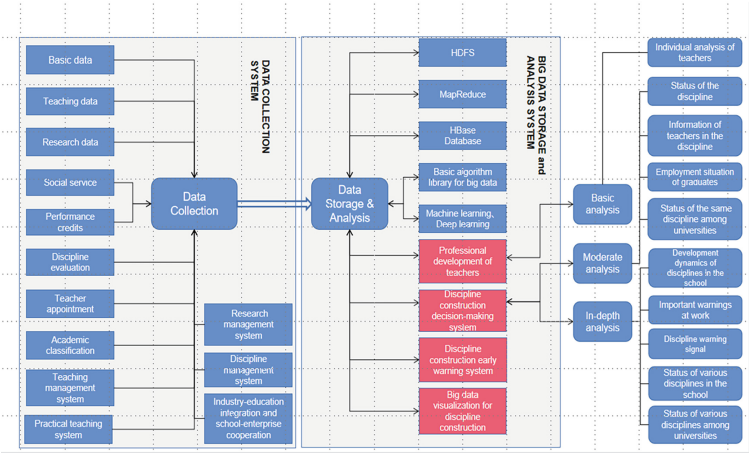

Fig. 1. Conceptual diagram of system design

discipline construction departments to promote discipline construction and development. The conceptual diagram of the system design is shown in Fig. 1.

3.3 System Function Module Design

Based on the prior requirements analysis, the function modules are designed considering five aspects: data entry, data analysis, discipline construction decision-making, early warning information, system configuration and authority management. The specific system functions are shown in Fig. 2.

The data entry subsystem is mainly responsible for the acquisition and entry of related data, which can be divided into four major types: 1) Teachers' basic information. Teachers can log in to the system to enter their basic personal information, as well as teaching, scientific research projects, important research achievements, etc. 2) School's management regulations and documents concerning discipline construction, including management regulations on teaching, scientific research, and social service, such as academic performance credits system, academic journal classification system, employment conditions of full-time teachers, discipline evaluation indicators, etc. 3) Data on the teaching and research management system. For example, the teaching management system, practical teaching system, research management system, discipline management system, management system for school-enterprise cooperation and industry-education integration, and teacher management system are all well-developed systems. 4) Online and offline classroom data, including teachers' teaching methods, students' interaction methods, homework and evaluation, etc. The data analysis subsystem collects, stores, and categorizes data before utilizing big data algorithm libraries to analyze and diagnose teaching and research behaviors, eventually realizing the analysis and diagnosis of discipline construction. The discipline construction decision-making subsystem presents the resulting decision-making and reference information obtained through big data analysis to teachers, basic discipline organizations, school-level discipline construction departments, and other relevant departments in a visual way. The early warning information

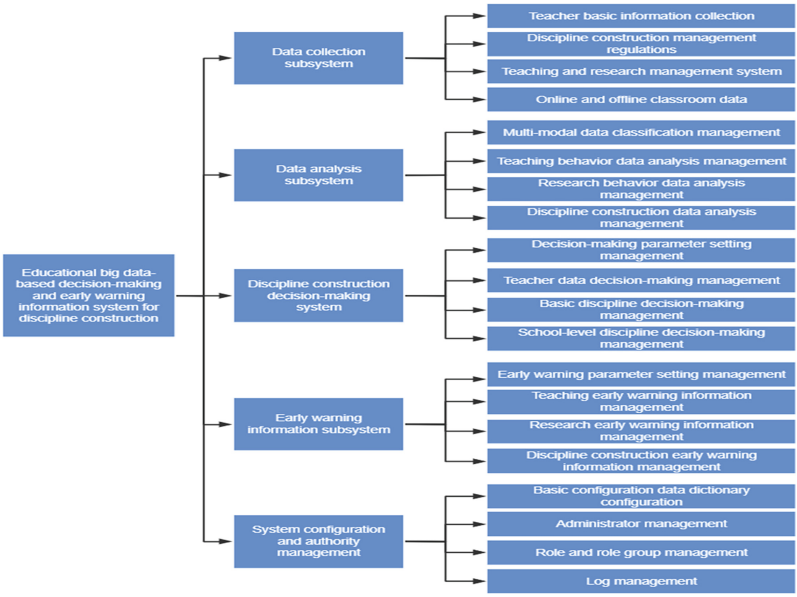

Fig. 2. System function module design

subsystem is mainly responsible for the configuration and management of data analysis parameters and thresholds. When the parameters or thresholds exceed the warning line, relevant parties are automatically notified in a visual way. The system configuration and authority management subsystem is mainly used to realize basic configuration, mail configuration, data dictionary management, role management, administrator management, log management, and other functions.

3.4 System Architecture Diagram

The system adopts the technical architecture of "JavaEE Frameworks + MySQL Database + Tomcat Clustering," as shown in Fig. 3. The server-side development adopts SSM (SpringMVC + Sping + Mybatis), Spring Boot, and JavaEE to realize the MVC development framework, as shown in Fig. 4, and the front-end development employs FreeMarker, HTML5, JSP, jQuery, Bootstrap, etc.

The data acquisition system adopts the Java EE SSM Framework, and the architectural design is as follows:

3.5 Architecture of Big Data Analysis System

The architecture of the big data analysis system adopts the typical Hadoop architecture, as shown in Fig. 5. From bottom to top, the architecture is divided into the following layers: data sources layer, data transmission layer, data storage layer, programming model layer, data analysis layer, and upper business-logic layer. Structured and unstructured offline data are collected by various middleware, such as sqoop, flume, and other tools, before

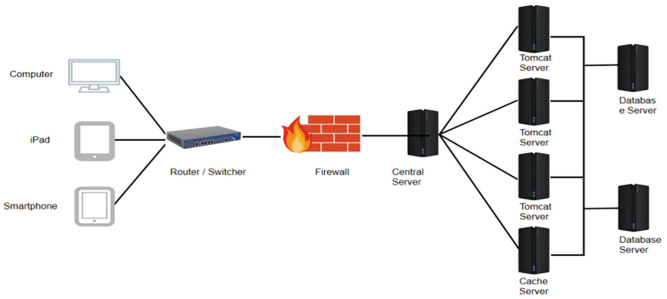

Fig. 3. System architecture diagram

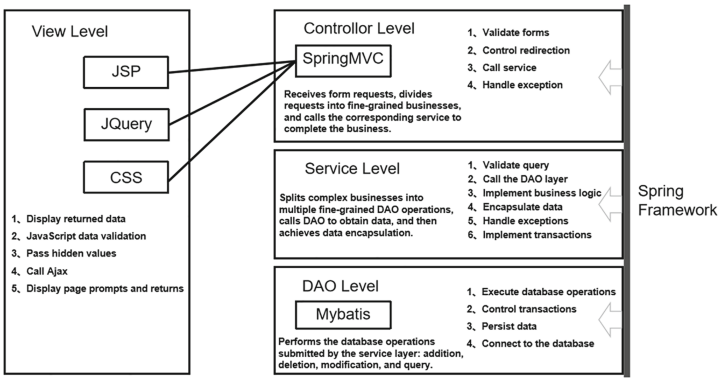

Fig. 4. Technical diagram of Java EE Framework

being stored in HDFS and HBase. The real-time streaming data are sent to Storm through the Kafka message queue. In the programming model layer, Spark interacts with the MapReduce framework by introducing the Tachyon middle layer, which is how the data exchange takes place in memory. The master of HDFS, HBase, and Tachyon clusters is managed by ZooKeeper. A new leader will be automatically selected in case of downtime, and the slave nodes will be automatically connected to the new leader. In the data analysis layer, advanced machine learning prediction models and integrated learning strategies are adopted for big data mining. The upper business-logic layer obtains data from the data analysis layer and provides users with visual representations of big data.

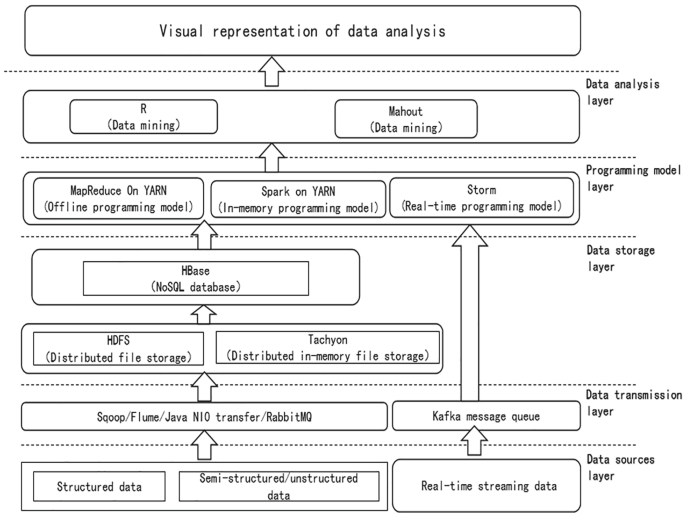

Fig. 5. Technical diagram of Java EE Frameworks

4 Conclusion

In order to meet the practical needs of discipline construction in application-oriented universities, this paper devises a decision-making and reference information system for discipline construction based on big data technology. By modeling large-scale discipline construction data to generate data sets and training data thresholds with big data algorithms, the accuracy of discipline evaluation can be improved. Moreover, the data obtained from data analysis can be presented to users, thus achieving precise management and sound decision-making of discipline construction through big data.

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