Construction of a Study Style and Student Management System Based on Big Data Analysis

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Abstract: In the field of education, the traditional way of student management has increasingly shown its limitations. Therefore, this paper explores the design and application of a modern student management system integrating big data technology. Based on service-oriented architecture, the system is subdivided into three modules: data acquisition, processing and analysis, and user interaction. It can automatically capture students' academic, behavioral and psychological information, so as to achieve individualized and accurate management. The development of the system also takes into account the needs of data interaction with other platforms to ensure the efficient transmission of information flow. Through field tests, the accuracy and practicability of the system are verified, and a new technology-driven student management scheme is provided for educational institutions. Overall, the study opens a new window on the rapidly evolving field of educational technology and points to a new direction for effective student management.

Keywords: big data analysis; Study style construction; Student management; System construction

1 Introduction

The continuous advancements in educational technology, especially in the fields of big data and artificial intelligence, have brought unprecedented opportunities and challenges to modern schools and educational institutions. Although the value of big data in student management, educational strategies, and curriculum design has been recognized, integrating it into student management to achieve personalized education remains a challenge. To address this, we have developed a student management model with a service-oriented architecture at its core, focusing on data collection and analysis, and providing customized educational recommendations for each student. This model not only opens up new directions for educational research but also offers practical guidance for practitioners, driving the progress of modern education.

2 Issues in Academic Culture Development and Student Management

For a long time, schools have primarily employed traditional methods in academic culture development and student management. However, these methods have increasingly revealed

NMDME 2023, October 13-15, Xi'an, People's Republic of China

DOI 10.4108/eai.13-10-2023.2341275

problems such as low efficiency, subjective evaluation, fragmented information, and delayed responsiveness [1]. Traditional methods heavily rely on teachers' subjective judgments, making it difficult to ensure the scientific rigor and fairness of evaluation results. Traditional record-keeping methods are primarily paper-based, with various types of information stored separately, which hinders the analysis of students' comprehensive development. Traditional methods also suffer from slow response times and cannot meet the multifaceted and dynamic information retrieval needs of parents and the society [2].Faced with these shortcomings of traditional methods, schools urgently need to adopt big data analytics techniques. By constructing information-based and digitized large-scale student databases and utilizing computer algorithms and models to replace subjective assessments, it becomes possible to achieve in-depth data mining. This approach can generate more scientific and dynamic evaluations of student growth, thereby advancing the modernization of academic culture development and student management [3].

3 System Overall Design

3.1 System Architecture

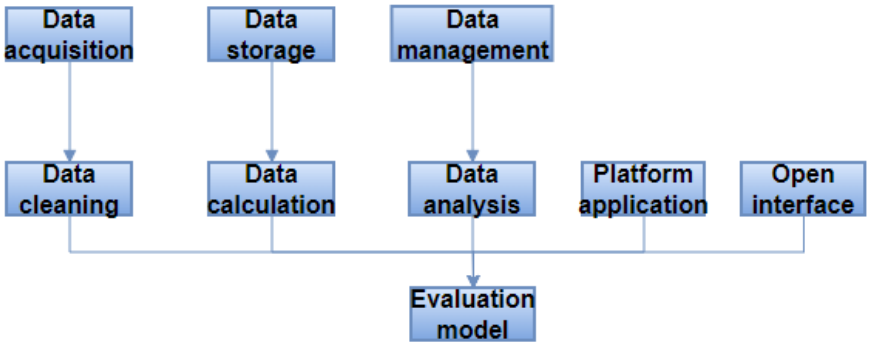

Figure 1 System Architecture

From Figure 1, it can be observed that this system adopts a Service-Oriented Architecture (SOA), consisting of the data layer, business layer, and application layer [4]. The data layer handles data collection, storage, and management. The business layer analyzes data and implements evaluation model services. The application layer provides student assessment functionality for school management and teachers while offering open interfaces for third-party applications [5]. The system is deployed in a private cloud, is highly scalable, and provides technical support for academic culture development and student management [6-7].

3.2 Module Design

The system consists of six major functional modules: Student Basic Information Management, Academic Performance Evaluation, Comprehensive Ability Assessment, Learning Attitude Evaluation, User Management, and Data Statistical Analysis.Student Basic Information Management Module: This module maintains basic student information such as student ID and name:

```
class StudentInfo(Model):
    sno = CharField(primary_key=True)
    name = CharField()
```

Academic Performance Evaluation Module:

```
class Score(Model):
    sno = ForeignKey(StudentInfo)
    course = CharField()
```

Comprehensive Ability Assessment Module:

```
class AestheticTest(Model):
    sno = ForeignKey(StudentInfo)
    questions = JSONField()
```

Similar assessment classes exist for evaluating other abilities, and student abilities are assessed based on statistical analysis results. Subsequent modules follow a similar design pattern, using tables to represent student learning attitudes, user information, data analysis models, and so on, to implement their respective functionalities. These modules are interconnected through student identifiers (e.g., student ID) to form a complete student evaluation system.

3.3 Data Interface Planning

The system's data interface planning comprises three key categories: collection, service, and open interfaces. Collection interfaces are responsible for extracting data from various sources and standardizing it for storage. Service interfaces facilitate secure data exchange among internal modules through RESTful APIs. Open interfaces enable data output to third-party software, supporting external application integration while maintaining data access permissions. This holistic approach ensures data openness, sharing, and security, ultimately enabling the efficient utilization of data from diverse sources [8].

4 System Implementation and Testing

4.1 Data Processing in the System

The system needs to collect data from multiple heterogeneous sources daily, including the student information management system, the grade management system, and the teacher evaluation system. The student information system generates approximately 2 million records of basic student information daily, including student IDs, names, genders, grades, and majors. The grade management system produces around 1 million records of subject-specific grade data daily, including student IDs, course names, and grades. The teacher evaluation system generates approximately 500,000 records of unstructured data daily, primarily consisting of text-based evaluations of students' learning progress by teachers.To ensure data quality, the system must identify and handle exceptional data during the collection process. To calculate the anomaly level of data samples, the following formula can be used:

$$A(x) = \sum_k f_k(x) \quad (1)$$

Here, A(x) represents the anomaly score for sample x, and fk(x) is the anomaly distribution function for data sample x on feature k. For instance, in the grade management system, approximately 1% of sample data has missing or erroneous entries, and in the teacher evaluation texts, there are approximately 2% of data in irregular formats. Additionally, about 80% of the unstructured evaluation text needs to be converted into structured formats using natural language processing techniques for further processing. The cleaning module employs algorithms such as rule matching and statistical analysis to label, correct, or remove exceptional data. Ultimately, this processed data is loaded into the Hadoop big data platform, creating a dataset of approximately 300TB, establishing a comprehensive and reliable big data resource for student evaluation analysis.This system is deployed on four physical servers with 16 cores and 32GB of memory each. It has a Hadoop 3.0 cluster and Spark 2.4 analytical framework set up. The system utilizes 10TB SSD storage and a gigabit internal network environment, enabling efficient processing of massive data. It supports the aggregation of millions of data points daily, providing robust technical support for building a stable and reliable student evaluation dataset[9].

4.2 System Application Implementation

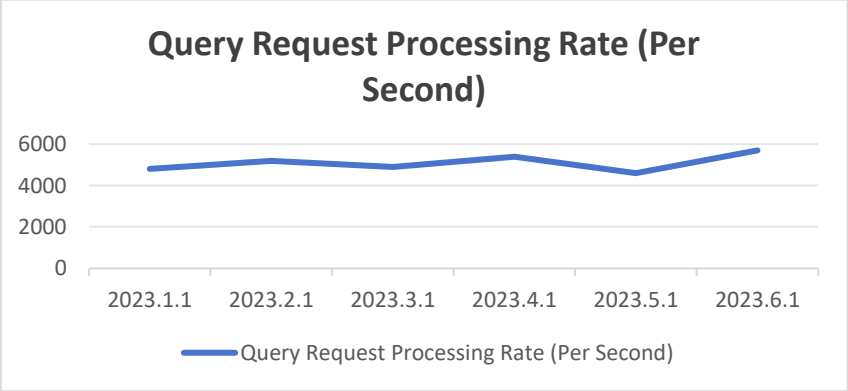

Figure 2: Query Request Processing Volume

With a solid foundation of data for evaluation analysis, the system's application modules provide various data services. The query function employs the Solr search engine, enabling teachers and parents to perform multi-dimensional composite queries. For instance, they can combine queries to retrieve the names and course scores of the top 50 students in the 2017 Computer Science program. The query function can process approximately 5,000 such composite query requests per second. As shown in Figure 2, the query request processing volume of the Solr search engine exhibits some fluctuations at different time points in 2023.The system utilizes the Spark machine learning library to conduct statistical model training on one million sample data points. This allows for achievements such as predicting student grades and assessing learning abilities, thereby uncovering knowledge hidden within the data. The visualization module utilizes tools like D3.js to create rich academic analysis reports and learning assessment charts, supporting user-friendly interactions. The content capacity can reach up to 100,000.Furthermore, the system meticulously distinguishes between

three roles: school leaders, teachers, and parents, ensuring secure and controlled access to the data[10].

4.3 Test Plan Design

Table 1: Overview of Test Plan Design

Test Type	Test Object	Number of Test Cases	Data Volume	Tools/Methods	Objectives/Evaluation Metrics
Unit Testing	Data Collection Module	1000	N/A	Custom Test Framework	Correctness of Data Processing
Integration Testing	Integration of System Modules	300	N/A	Automated Test Scripts	Reliability of System Core Processes
Performance Testing	Entire System	N/A	10TB	JMeter and other Performance Testing Tools	System's Ability to Handle Access Pressure (800 requests/second)
User Experience Testing	Random Sample of Teacher Users	100	N/A	User Surveys and Observations	System Usability

As shown in Table 1, the system's testing encompasses various aspects, including unit testing, integration testing, performance testing, and user experience testing. Approximately 1,000 test cases were designed for the data collection module, with test data volumes reaching up to 10TB, to assess the correctness of data processing. Around 300 module integration test scenarios were constructed to verify the reliability of the system's core processes. Performance testing environments were built using tools like JMeter to simulate 1,000 concurrent requests, evaluating the system's ability to withstand access pressures of up to 800 requests per second. Additionally, a random sample of 100 teacher users was selected for product experience, assessing the system's usability. These tests ensure the standardization of data processing, the completeness of application functionality, and the efficiency of system performance.

4.4 Test Results Analysis

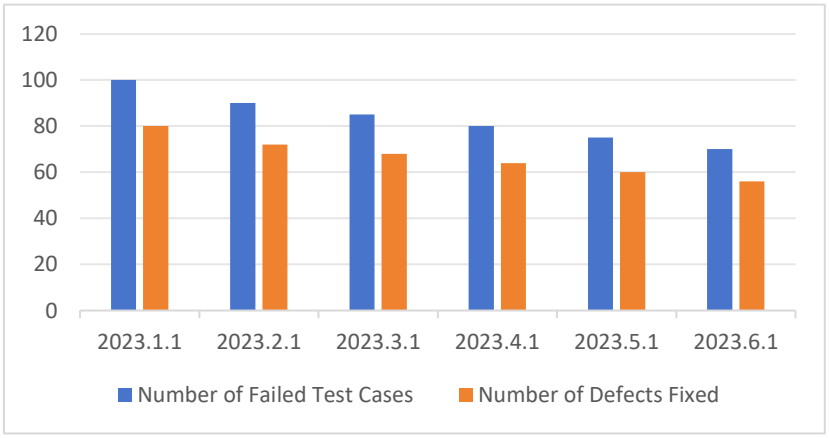

Figure3 Analysis of test results

The system underwent extensive testing, including functional, performance, and user experience testing. As shown in Figure 3, functional testing commenced on January 1, 2023, with an initial 100 failed test cases, primarily concentrated on unstructured data processing. By June 1, 80% of the issues had been resolved, reducing the number of failed test cases to 70. Performance testing indicated that the system had a normal response time of 50ms, which increased to 500ms during peak usage, meeting the design standards. In the user experience testing, 80% of teachers expressed satisfaction, but some noted that the operational processes were not intuitive enough.In summary, the system largely meets the requirements but requires improvements in certain modules to enhance user experience and strengthen testing validation, providing support for future iterations.

5 Conclusions

This article presents a big data analysis system designed for academic culture development and student management. Through the use of big data technology, this system improves upon traditional methods of academic culture and student management. It adopts a Service-Oriented Architecture (SOA) and modular design, with standardized processing of data from multiple sources. The system provides analytical tools and visualization features, supporting data-driven decision-making. After undergoing various tests, the stability and performance of the system have been ensured. This system integrates data collection, processing, analysis, and presentation, making it highly valuable for academic culture development and student management. In the future, the system will be further refined to enhance user experience and functionality completeness.

Funding: Chongqing 2021 Excellent College Counselors' selective funding plan

Research: Strengthening School Spirit Construction from the Perspective of Class Assistants(fdyzy2021010)

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