International Education Forum, 2025, Volume 3, Issue 4
http://ojs.bbwpublisher.com/index.php/IEF
Online ISSN: 2981-8605

Research on Application Scenarios of Big Data Analysis in the Field of Education

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Abstract: With the integration of AI and the improvement of computing power, big data analysis will further empower the intelligent society and become the core engine of digital transformation. This article mainly explores the use of AI in the field of education. From student management and personalized education, teaching optimization and curriculum design, administrative management and resource allocation, campus service and health management, and education research and policy formulation, in-depth discussion is carried out, aiming to provide a reference for the promotion of intelligent education.

Keywords: Big data analysis; Education; Application scenarios

Online publication: April 28, 2025

1. Overview

Big data analytics involves the structured processing and examination of large, varied, and rapidly generated datasets to identify concealed patterns, trends, and relationships. This supports optimizing decisions and uncovering valuable insights. In the education sector, big data analytics plays a crucial role, assisting schools in enhancing administrative efficiency, refining resource allocation, improving student experiences, and fostering innovation in educational practices [1]. Initially, it is essential to gather and categorize relevant data. Regarding academic performance, key data points include exams (primarily final assessments), assignments, laboratory work, classroom participation, project submissions, competition outcomes, and more. In terms of subject scope, both general education and specialized courses are considered. From a temporal perspective, data can be grouped by semester, academic year, or learning phase. Additionally, it may incorporate elements such as student backgrounds, learning activities, and teacher evaluations, among others.

2. Application research of big data technology in the field of education

2.1. Student management and personalized education

2.1.1. Academic early warning and intervention

Academic early warning and intervention systems primarily rely on core index analysis, which encompasses four key dimensions: individual subject evaluation, interdisciplinary relationships, group comparisons, and predictive modeling. In the context of individual subject evaluation, the system assesses overall academic performance by analyzing statistical measures such as mean, median, standard deviation, and extreme scores (highest and lowest). Additionally, it evaluates learning consistency or improvement through time-series analyses, such as line graphs that track grade fluctuations over time. Regarding interdisciplinary relationships, the system employs tools like heatmaps or correlation matrices to explore connections between different subjects and perform correlation analyses. It also compares individual student grades against class or grade averages to identify students whose performance significantly deviates from expected norms, thereby pinpointing areas of weakness. For group comparisons, students can be categorized based on factors such as gender, learning clusters, or instructional methodologies. This allows for an examination of score variations across these groups, highlighting potential disparities in performance [2–3]. In terms of predictive modeling, the system leverages historical data and external variables to forecast future academic outcomes. It can identify students whose performance is consistently declining or falling below established thresholds, triggering intervention strategies and issuing risk alerts accordingly.

Data such as students' grades, homework completion rate, and class participation are analyzed, and predictive models are established to identify students at risk of dropping out or having academic difficulties, and timely counseling or psychological support can be provided. It is reported that by analyzing the frequency of students logging on to an online learning platform and their test scores, one university identified potentially problematic students in advance, and the graduation rate increased by 15% after the intervention. Generate student performance reports highlighting strengths, weaknesses, and recommendations. When various learning achievements are included in the analysis indicators, the data can be systematically analyzed from multiple dimensions to comprehensively evaluate learning outcomes, identify potential problems, and optimize teaching strategies.

2.1.2. Personalize the learning path

Customized learning resources or courses are recommended according to students' historical learning data, while some adaptive learning platforms can dynamically adjust the difficulty of exercises, and big data analysis can tap students' learning preferences and shortcomings in ability to promote the teaching model of "thousands of faces". For example, the Yantai High-tech Zone generates a comprehensive classroom evaluation report by recording the "AI classroom portrait" of teacher-student interaction data in real time, which recommends customized learning resources for students and provides a basis for teachers to improve teaching methods.

2.1.3. Behavioral analysis and mental health

By integrating data such as campus card usage, library visits, and social participation, it is possible to detect students who are isolated or experiencing emotional difficulties. This approach can also be expanded by incorporating additional campus card data to create a more detailed profile of student behavior, contributing to the development of smart campuses. For instance, a university in China identified students at risk of depression by analyzing irregular dining patterns in cafeterias and offered them psychological support. Currently, many

students face heavy academic pressures, leading to significant psychological stress. This stress often results in sleep disturbances, depression, and anxiety. The interconnected nature of mental and physical health means that prolonged anxiety or depression can cause insomnia, weakened immunity, and other physiological issues. Good mental health not only enhances resilience to stress but also aids individuals in effectively managing real-world challenges like academics and career planning. It serves as both a foundation for personal well-being and an indicator of societal progress [4]. To promote mental health, coordinated efforts in prevention, intervention, and support are essential to establish a comprehensive mental health framework spanning the entire life cycle. In the long term, college students with strong mental health will exhibit higher productivity, greater creativity, and reduced absenteeism or burnout due to psychological factors once they enter the workforce.

Faced with numerous psychological challenges, educators established academic counseling centers aimed at assisting students in refining their learning strategies [5]. Educators also organized career planning seminars to alleviate employment-related anxiety, motivated students to engage in clubs and athletic activities to combat monotony and enhance social competencies. By integrating psychological counseling services, course materials, and event updates, educators provide comprehensive mental health support, bridging informational gaps between departments. Additionally, we developed online psychological evaluation platforms and virtual counseling aids to broaden service accessibility and compensate for the scarcity of in-person resources. Leveraging the insights from big data analysis, educators refined course structures, such as incorporating a career planning segment to address college entrance stress and introducing emotional education classes to tackle relationship issues.

2.2. Teaching optimization and course design

2.2.1. Course effect evaluation

Examine the relationship between student engagement in classroom interactions and their academic performance, and refine instructional strategies accordingly. Modify the teaching emphasis as needed. Additionally, personalized learning plans can be developed for students based on analytical findings. Present an overview of class performance and compare teaching effectiveness. By analyzing classroom videos, a secondary school discovered that students seated in the back rows had low participation rates during group discussions. However, after rearranging the seating configuration, there was a notable improvement [6–7]. Recognize less effective aspects of instruction and adjust content design to enhance efficiency. Adapt the course difficulty dynamically to align with the distribution of students' abilities. Leveraging big data analysis, course evaluations have transitioned from traditional "subjective experience-based" approaches to "data-driven decision-making", offering a scientific foundation for enhancing educational quality.

2.2.2. Teacher effectiveness evaluation

The integration of teacher effectiveness evaluation with big data analysis allows for a comprehensive assessment of educators' instructional capabilities, classroom management skills, and innovation in education. This is achieved by quantifying teaching behaviors, student feedback, and outcome metrics, ultimately aiding in the optimization of teacher development programs and resource distribution. By incorporating holistic student evaluations, performance improvement rates, and research outcomes, a scientific appraisal of teacher performance can be conducted to support professional title assessments.

Teacher competency profiles can be established by analyzing instructional behavior data and research

achievements, creating professional growth records, and offering tailored training resources. Teaching efficacy can be gauged by linking student achievement gains with classroom interaction statistics. Through the examination of classroom discourse, it has been observed that when teachers wait less than three seconds for student responses during "silent pauses", student engagement decreases by 50%. This insight underscores the importance of enhancing teachers' "white space" communication techniques. Additionally, emphasis should be placed on long-term value, assessing not only short-term academic results but also the cultivation of core competencies over time.

2.2.3. Optimization of teaching materials and resources

Assessing the complexity of textbook sections and dynamically modifying the content based on students' click-through rates and dwell times on the online learning platform. Redirect teaching resources and instructor focus toward groups with greater requirements. Consider the equilibrium of teachers' workloads by utilizing teaching assessment data and course difficulty levels, allowing the system to automatically assign teaching responsibilities and prevent excessive workloads. Through the analysis of energy consumption in campus buildings, NYU Shanghai has devised energy conservation strategies, such as deactivating air conditioning and lighting systems during low-usage periods, achieving an annual energy savings of 15%. Aim to accomplish dynamic space management by integrating classroom usage statistics and course needs, enabling the system to propose the most efficient classroom arrangement solutions to minimize spatial inefficiencies.

2.3. Administrative management and resource allocation

2.3.1. Intelligent scheduling of campus resources

Campus resource management requires the integration of multi-faceted data, such as student activity records (e.g., attendance and course registration), infrastructure usage statistics, energy consumption metrics, and external environmental factors. By evaluating the usage patterns of classrooms, laboratories, and gymnasiums, it is possible to enhance course planning and resource allocation strategies. Regarding course arrangement and conflict resolution, dynamic adjustments were made to class timing and room capacities based on analyses of student course preferences and instructor teaching capabilities. The University of Jinan applied a customized DeepSeek model, achieving a 30% reduction in course scheduling conflicts [8]. Additionally, laboratory and equipment sharing can be facilitated through a data-driven reservation platform, minimizing idle resources and boosting efficiency. For instance, one university promoted interdisciplinary collaboration by examining equipment usage logs, resulting in a 25% increase in equipment utilization. Another institution employs IoT sensors to track classroom occupancy and makes study rooms available during off-peak hours.

2.3.2. Enrollment and employment strategies

Examine the enrollment statistics across different years to refine the promotional strategies; modify the program offerings based on the career paths of graduates. Big data technology can consolidate job recruitment information from companies, align it with students' skill profiles, and provide smart employment recommendations. Additionally, it evaluates industry dynamics, assisting universities in revising their course structures, cultivating suitable talents, creating a graduate employment archive, monitoring long-term professional growth, and assessing the effectiveness of specialized training. Ranging from precise forecasting to automated pairing, skill enhancement to quality supervision, big data technology is redefining the landscape of

educational admissions and employment, establishing an integrated optimization cycle [9].

2.4. Campus service and health management

2.4.1. Health monitoring and early warning

Integrate the heart rate monitoring of physical education class and the food data of the canteen to provide personalized health suggestions. Through data analysis, students can carry out data analysis on what kinds of dishes they like to eat, understanding of consumption behaviors, and identifying students' dining habits, preferences, and financial status. It can also combine the height and weight information of students, as well as eating behavior, and give reasonable suggestions to avoid excessive obesity and other situations. In terms of student service improvement, it can also provide precise financial assistance, identify potential students with financial difficulties, and provide invisible financial assistance for low-consumption students. For some students who lose their cards, they can also monitor abnormalities, find risky behaviors, such as misuse, meal card loss, and find them in time.

2.4.2. Campus security prevention and control

Detect unusual activities, such as frequent visits by unfamiliar individuals to the laboratory, by analyzing data from cameras and access control systems, and integrate AI to issue alerts regarding potential security concerns [10]. A camera is placed at the library entrance, enabling real-time facial recognition analysis when images are sent to the backend system. To safeguard privacy and ensure data security, the information is only stored or utilized after authorized students grant permission; otherwise, it is immediately discarded. Authorization occurs via a WeChat mini-program, where users upload photos for facial verification and approval. This approach not only enhances student safety monitoring but also facilitates data collection, such as tracking when students enter the library and how long they spend studying there—information that can be documented [15].

Monitoring is installed at the dormitory gate, data processing is carried out in real time, facial features are extracted and compared with the data in the database, abnormal situation is warned and the situation report is pushed to the dormitory administrator, although the dormitory administrator also takes care of the dormitory, but it is difficult to remember all the students, and the form of monitoring and early warning through the camera greatly reduces its burden. This also improves security, especially in girls' dormitories, to prevent the illegal elements from outside from breaking into the dormitory, greatly improving the safety of girls' dormitories, to eliminate the occurrence of illegal incidents.

2.4.3. Canteen operation optimization

Analyze the sales of dishes and the amount of leftovers, adjust the menu, and reduce waste. A middle school found through the data that "there are many leftovers on Wednesdays" because of the intensive course schedule, it provided portable lunch boxes instead.

It can also optimize the operation of the canteen, analyze the sales of dishes and the amount of leftovers, adjust the menu, and reduce waste. On the other hand, in the canteen operation optimization, the hot window staff can be increased during peak hours to reduce queuing time. Set meals are designed according to the relevance of dishes. Student meal card consumption analysis is an important tool to connect data with campus management. Through refined analysis, schools can improve the quality of logistics services, optimize the allocation of resources, and provide more responsive support to students.

2.5. Educational research and policy formulation

2.5.1. Research on educational trends

Examine educational data from different regions and time periods to evaluate the influence of teaching approaches or policies. Educational institutions or districts can refine their evaluation criteria or curricula by leveraging big data analytics. Through the fusion of diverse data sources, including student behavioral patterns, course material usage, and regional educational development metrics, schools are able to forecast upcoming educational requirements [11-12] and develop adaptive adjustment plans.

2.5.2. Scientific research management

Tracking academic papers and patent data, evaluating the development potential of disciplines, and assisting in the allocation of scientific research funds. Colleges and universities build a standardized scientific research management system covering project application, fund management, and achievement evaluation modules with the help of big data to solve the problem of data islands and promote the transparency of the scientific research process [13–14]. There is a common problem of inconsistent data formats in the scientific research management of colleges and universities, and it is necessary to establish unified data standards and sharing platforms, for example, classifying and managing scientific research project data through tree diagrams.

3. Concluding remarks

Through systematic performance analysis, educators can more accurately understand the learning effect, promote data-driven teaching improvement, and ultimately improve the overall quality of education. Big data technology is pushing education trend research from “experience-oriented” to “data-driven.” Its core value lies in the dual improvement of educational equity and efficiency through accurate analysis. Through big data analysis, schools can shift from experience-driven to data-driven decision-making to achieve precision in education, but there needs to be a balance between technological innovation and humanistic care. But at the same time, there are many challenges and precautions, data privacy, desensitization of sensitive student information (such as mental health data), etc. need to comply with the Personal Information Protection Law, student information processing should be anonymized, and education data security regulations should be complied with. In terms of ethical risks, it is necessary to avoid labeling students due to data analysis (such as “low potential group”), which needs to be combined with human judgment, and to avoid over-reliance on statistical results due to teacher experience, which requires qualitative analysis.

Disclosure statement

The author declares no conflict of interest.

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