Data-Driven Educational Decision-Making: How to Enhance Educational Quality and Management Efficiency

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DOI: 10.32629/jher.v5i6.3385

Abstract: This study focuses on the impact of data-driven educational decision-making on improving educational quality and management efficiency. With the rapid development of big data technology, the education field faces unprecedented opportunities and challenges. The research first elucidates the concept of educational big data and its importance in educational decision-making, then delves into the current status of educational big data applications, including issues related to data quality, technological infrastructure, and policy regulations. Based on this analysis, strategies are proposed to improve data collection and integration mechanisms, balance data-driven approaches with educational essence, and advance the application of educational big data in national strategies, aiming to provide feasible pathways for enhancing educational quality and management efficiency. The research results indicate that data-driven educational decision-making can significantly improve teaching precision, resource allocation efficiency, and management scientificity. However, it also emphasizes the importance of avoiding over-reliance on data, protecting privacy, and respecting educational principles. This study provides theoretical foundations and practical guidance for educational decision-makers, managers, and researchers, holding significant importance for promoting educational modernization and building a strong education system.
***Keywords*:** educational big data, data-driven decision-making, educational quality, management efficiency

1. Introduction

With the rapid development of digital technology, governments worldwide are viewing digital transformation as an essential path to promote human social development and enhance national competitive advantages, with particular emphasis on the digital transformation of education. In fact, the digital transformation of education has become a focus and trend in China's educational reform and development. From the essence of educational digital transformation, it involves innovation and changes driven by digital technology within the educational system. Within the educational system, the classroom is the main battlefield for digital transformation, and the digital transformation of classroom teaching is an inevitable trend. With the digital construction and development of schools, means such as data collection, intelligent tracking, and learning analytics are becoming increasingly common in classroom teaching, allowing teachers to obtain rich student data information through technological platforms and tools.

2. Explanation of Related Concepts

2.1 The Concept and Scope of Teaching Decision-Making

Currently, there are roughly three types of descriptions regarding the concept of teaching decision-making: One view considers teaching decision-making as a cognitive activity. For example, Sato Manabu sees it as a subjective cognitive activity where teachers make continuous choices and judgments in teaching based on their own ideas and theories to achieve teaching objectives. Another perspective views it as a behavioral process, defining it as the process by which teachers make choices and decisions about the direction, goals, principles, and methods of teaching practice to achieve classroom teaching purposes. A third viewpoint sees teaching decision-making as an integration of cognitive activity and behavioral process, defining it as a dynamic process where teachers determine the most effective teaching plan through prediction, analysis, and reflection on teaching practice, based on their own beliefs, professional knowledge, and practical knowledge. Regarding the types and content of teaching decision-making, Darling-Hammond et al. categorize it into planning decisions (before teaching), interactive decisions (interaction, observation, and improvement during teaching), and evaluative decisions (evaluation and reflection after teaching). William et al. divide it into the planning and preparation stage, interactive stage, and teaching evaluation and reflection stage of instruction. Domestic scholars generally agree with this stage theory and, corresponding to different stages of the teaching process, specifically divide teaching decision-making into three types: teaching plan decisions, teaching interaction decisions, and teaching evaluation decisions [1].

2.2 The Concept and Scope of Data-Driven Teaching Decision-Making

Data-driven teaching decision-making has multiple expressions, such as data-based teaching, data-driven decision-making, data-based personalized guidance, data-inspired teaching, and so on. Although these terms differ in form, they are essentially all data-driven teaching decision-making. Filderman et al. define data-driven teaching decision-making as the process of collecting and using student data to improve teaching effectiveness [2]. Ikemoto considers data-driven teaching decision-making as a form of recommending and executing decision-making plans by collecting and analyzing factual data with the assistance of intelligent technology, forming an information-driven chain[3].Synthesizing these viewpoints, this study considers data-driven teaching decision-making to mean a process that takes data as the core element of teaching decisions, extracts meaningful information and knowledge from it, and makes teaching responses accordingly.

3. Research on Data-Driven Teaching Decisions

Schildkamp et al. define "data" in the school environment as information collected and organized to represent certain aspects of the school, including student exam scores, observations of classroom teaching, or surveys of parents about school uniform choices, etc. [4]. These data are not limited to student grades but may also include other forms of structurally collected qualitative or quantitative data about school functions [5]. The data used at the classroom level is mainly divided into two major categories: one is student achievement data, covering unit assessments, formal and informal observations of student performance, standardized tests, interim and summative assessments, etc.; the second is non-achievement data, including attendance records, student course registration history, surveys, and behavioral records, etc. [6]. Ikemoto et al. further subdivide these data into four types [7]: background data such as school culture, environmental conditions, and resource construction; input data, such as student attendance, style, family background, teacher qualifications, and teaching time; process data, such as teaching strategies, teaching time, organization, classroom management, and assessment organization; outcome data, such as student assessment results, well-being surveys, and growth monitoring data.

4. Current Status and Challenges of Educational Big Data Applications

4.1 The Dilemma of Data Quality and Integration

The issue of data quality in educational big data is the primary challenge faced in current applications, with its complexity mainly reflected in the diversity of data and the heterogeneity of systems. The sources of educational data exhibit a highly fragmented characteristic, covering multiple dimensions of information systems from student enrollment management to book borrowing. This fragmentation not only increases the difficulty of data integration but also directly affects the completeness and consistency of the data. At the same time, the differences in data formats and standards between different systems further exacerbate this issue, making data cleaning and integration a burdensome and challenging task.

4.2 Limitations of Technical Infrastructure and Analytical Tools

The application of educational big data faces multiple challenges at the technical level, which involve not only the construction of infrastructure but also data processing, security protection, and the development of analytical tools. Firstly, the hardware facilities and network environments of many educational institutions are still not sufficient to support large-scale data collection and processing, and this fundamental issue severely restricts the scale and effectiveness of big data applications. Secondly, in the face of the increasing volume of educational data, traditional storage and processing technologies have become inadequate, and it is urgent to introduce more advanced big data technologies to meet this challenge [14].

4.3 Insufficiencies in Policies, Regulations, and Management Mechanisms

At the policy and institutional level, the application of educational big data faces a series of problems that need to be solved urgently. The primary challenge lies in the lack of a top-level design for the development of educational big data at the national level, with a lack of systematic overall planning and long-term development strategy. This issue directly affects the directionality and continuity of the application of educational big data. At the same time, the lag in existing laws and regulations is also increasingly prominent, especially in key areas such as data privacy protection and the boundaries of use, where there is a lack of clarity, making it difficult to provide clear guidance for practice.

5. Enhancing the Effectiveness of Educational Big Data Applications

5.1 Establishing a Systematic Data Collection and Integration Mechanism

In the process of applying educational big data, improving the mechanisms for data collection and integration is fundamental to enhancing educational quality and management efficiency. This process involves not only technological

innovation but also comprehensive consideration in terms of systems, management, and ethics. Firstly, establishing unified data collection standards is key to achieving high-quality data collection. This requires leadership from educational departments, in conjunction with educational institutions at all levels, technology experts, and data scientists, to jointly formulate data collection standards that cover various aspects such as student learning, teacher instruction, and school management. These standards should clearly define data items, collection frequencies, and format requirements to ensure the consistency and comparability of data. Additionally, the timeliness of data should be considered by designing dynamic updating mechanisms to adapt to the rapid changes in the educational environment. Secondly, optimizing data collection processes and methods is crucial. Traditional manual entry methods are not only time-consuming and labor-intensive but also prone to errors. Therefore, automated data collection technologies should be widely promoted, such as using IoT devices to collect real-time data on student attendance and classroom participation, and using intelligent learning platforms to automatically record students' learning behaviors and performance. Furthermore, natural language processing technologies can be explored to extract valuable qualitative information from teachers' lesson logs, students' assignments, and evaluations, enriching the dimensions of data.

5.2 Balancing the Relationship between Data-Driven Approaches and the Essence of Education

The incompleteness of big data is manifested in the potential absences, omissions, or incomplete information in the data set, which affects the overall and integrity of the data to a certain extent. Education, as a discipline of "people," can only be partially represented by data. In the field of education, it is difficult to achieve a holistic understanding through partial information, such as unconscious, enlightening, leisurely, and implicit learning and educational activities that are difficult to record. In addition, the inaccessibility of big data involves certain data that cannot be easily obtained or collected, possibly due to technical, legal, or other restrictions that make data collection difficult. The non-representativeness of big data means that the samples in the data set may not fully reflect the characteristics of the entire population, with a certain bias. The drift problem refers to the changes in data distribution over time or space, making it difficult to directly compare and generalize data collected at different times or in different places. Algorithmic interference refers to the distortion of data results due to complex algorithmic calculations, which may cause analysts to misinterpret or misunderstand the data. Dirty data indicates the presence of errors, anomalies, or inconsistencies in the data set, possibly due to input errors, sensor failures, and other factors. The sensitivity issue emphasizes that big data may contain personal privacy and sensitive information, which requires strict consideration of data privacy and security when used and shared.

5.3 Promoting the Application of Educational Big Data in National Strategy

In the new era and new journey, it is necessary to thoroughly implement the overall deployment of the Party's twentieth national congress on education, science and technology, and talent work, to fully grasp the requirements of building a strong educational country, to give play to our country's institutional advantages, to effectively integrate relevant data information inside and outside education, to make full use of advanced technology and intelligent means, to accelerate the intelligent governance of major country education through the digital transformation of education, and to support and serve the construction of a strong educational country. First, strengthen the standardization of educational big data. Establish a working system that covers all elements of educational management informatization work, clarify management requirements in aspects of information systems, educational data, management services, etc., standardize the entire lifecycle data activities such as data collection, storage transmission, and use processing, establish a complete data standard system, and further improve technical, service, and quality standards.

6. Conclusion

Data-driven educational decision-making provides new possibilities for improving educational quality and management efficiency. However, this process requires the concerted efforts of educators, technology experts, and policy-makers to ensure that the application of educational big data can fully exert its potential while respecting the essence and laws of education, thus truly promoting the healthy development of the educational enterprise and the construction of a strong educational country.

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