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Original Paper

Data-Driven Instructional Decision-Making: Framework, Instrument, and Process

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Abstract

Instructional decision-making is the process exploring, judging, and selecting instructional implementation options to effectively achieve instructional goals. However, traditional instructional decision-making relies excessively on subjective experience. The insufficient information hinders teachers comprehensively and accurately identifying the existing problems. Educational big data provides a scientific basis for the formulation, implementation, and optimization of teaching strategies. This study elaborates on the concept, importance, and development of instructional decision-making. It explores the design of data-driven instructional decision-making based on three aspects: framework, instrument, and process. The exploration promotes the transformation of instructional decision-making from experience-driven to data-driven and provides solutions to personalized and precise instructional decision-making, so as to enhance teaching quality and students' learning outcomes.

Keywords

data-driven, instructional decision-making, big data, data analysis

1. Introduction

The modern education system faces many complex challenges, such as student diversity, learning gaps, and uneven distribution of resources, etc. Therefore, it is vital for educators to make decisions concerning the allocation of teaching resources and improvement of teaching quality. Instructional decision-making plays a crucial role in shaping the quality of classroom teaching. It is the process of exploring, judging, and selecting instructional implementation options for effectively achieving instructional goals. It includes the selection of instructional content, the design of instructional methods, the manner of student evaluation, and strategies for classroom management. The various decisions teachers make during the teaching process lead to specific instructional goals and promote student learning.

Administrators and teachers usually make analytical judgments based on previous teaching experience, with an over-reliance on subjective experience and insufficient grasp of relevant teaching information. Instructional decision-making fails to provide sufficient guarantees for effective and scientific decisions in the stage of teaching planning and design. These challenges require more accurate data and scientific methods to support education and teaching. Academics and policymakers are increasingly realizing that data-driven instructional decision-making offers a range of advantages, including objectivity, accuracy, real-time performance, and quantifiability. For example, the "*Notice of the Ministry of Education on Strengthening the Informatization of Educational Management in the New Era*" emphasizes that education management should be data-driven, using a new generation of information technology to improve the level of digitization, networking, and intelligence in education management, and to promote the transformation of instructional decision-making from empirically-driven to data-driven.

Data-driven instructional decision-making can help decision-makers better understand problems, assess policy effects, and formulate more effective solutions. Data-driven instructional decision-making avoids the "common sense" misconceptions, "subjective" errors, and "sensory" errors often occurred in the previous instructional decision-making process. It highlights the main role of teachers as decision-makers and executors and well demonstrates teachers' basic teaching skills and digital literacy. As the organizer and initiator of classroom teaching, teachers play a leading role in the entire instructional decision-making process.

Data-driven instructional decision-making makes full use of the learning data of students to discover teaching clues and generate instructional strategies. The decisions are dynamically adjusted in practice, focusing on the cognitive level and knowledge differences of individual students, and based on the guidelines of tailoring teaching to students' needs and guiding them in light of the situation. With the help of big data analysis to ensure the pertinence and scientificity of instructional decision-making, it has become a regular choice for more teachers.

2. Literature Review

Early researches on data-driven instructional decision-making are found in Europe and the United States. The concept of "data-supported instructional decision-making" was put forward in the Educational Science Reform Act (ESRA) enacted in the United States in 2002, emphasizing the importance of data application in the process of instructional decision-making. Meanwhile, the Teaching Alliance Database (TAD) established in the UK and the Regional Teacher Decision Database (RTDD) established in Germany aim to collect teaching data from all kinds of schools, connect and share data from homogeneous higher education institutions to support instructional decision-making and management. These initiatives reflect the recognition of the importance of data in instructional decision-making and continuous exploration and application in practice at state level .

At the same time, scholars are increasingly aware of the importance data-driven instructional decision-making. Romero and Ventura (2010) reviewed research status of educational data mining, introduced the methods, techniques, and applications in the field, and explored how educational data can be utilized to improve instructional decision-making. Baker and Inventado (2016) explored the theoretical foundations and practical applications of educational data mining and learning analytics, investigating the use of these methods to guide instructional decision-making. Lynch and Dembo (2023) reviewed the current practices of data-driven decision-making in the field of education, discussed the effects and challenges of data-driven decision-making, and explored the maximization of its potential, aiming to show directions for future development. Li and Liu (2023) explored the concept, paradigm, significance, operational logic, and development path of data-driven instructional decision-making. Liu and Koedinger (2023) conducted a meta-analysis to systematically assess the application effects of educational data mining in personalized learning. Kaplan and LaPierre (2023) delved into effective practices for improving student success through data-driven decision-making, sharing some cases and strategies and proposing suggestions on how to implement these strategies in schools and classrooms.

Current research on data-driven instructional decision-making provides important information about the latest research findings and development trends. However, current literature focuses primarily on decision-making models and practice cases, with less attention paid to the process of data organization, collection, and analysis that support teachers' instructional decision-making (Zhang, Xuebo, Li, Wangwei et al., n.d.). Therefore, this study follows the data-driven instructional paradigm, using educational data mining and learning analytics technologies to conveniently obtain relevant information by analyzing instructional big data. The generated teaching data are "translated" into valuable information to provide teachers with more scientific, accurate, intelligent and personalized support, and ultimately achieve data-driven instructional decision-making.

3. Data-Driven Instructional Decision-Making

3.1 Framework Design

In the big data environment, various types of data of the whole teaching process are generated during teaching and learning, including data of learning process, learning evaluation, and learning behavior. Real-time teaching situation can be obtained comprehensively by means of extracting these data and conducting in-depth mining and systematic analysis, and thus personalized decision-making recommendations are put forward. Teachers can choose to implement the instructional decision-making suggestions according to the actual situation, observe the effect of decision-making implementation, and give feedback to students, teachers, and teaching administrators. In this way, the teaching and learning track forms a closed loop, namely "teaching and learning process—data mining and analysis—decision-making support—assessment and feedback—teaching and learning process", thereby promoting teaching improvement. The data-driven instructional decision-making framework is shown in Figure 1:

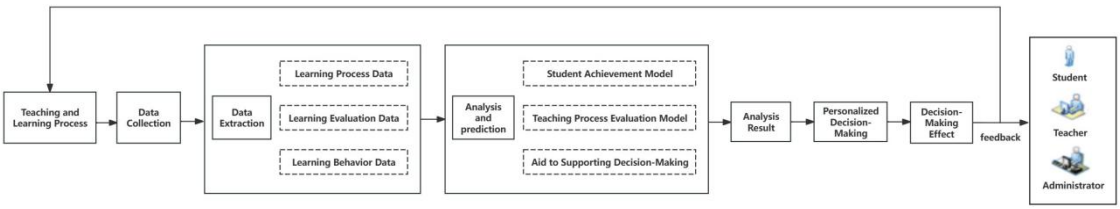

Figure 1. Framework of Data-Driven Instructional Decision-Making

3.2 Data Collection

With the advancement of education informatization, the learning space is moving towards a boundless learning field with a fusion of virtual-actual reality, and the learning process is moving towards a learning continuum that connects home and school, online and offline. Network teaching platforms, wearable devices, and other technologies record the behavior and process of teaching and learning in detail. Teachers' interactions, students' answers, click rates of teaching resources, online questions, and other behavioral data of teaching and learning are recorded and stored in the form of structured data. Teaching resources are released on various teaching platforms through graphic-text, audio and video, virtual scenarios, etc. These teaching mediums not only provide rich teaching resources, but also provide an essential support for collecting teaching data. Through these media, all kinds of data during the teaching process can be efficiently collected, stored and analyzed, thereby providing valuable resources for educational research and improving teaching quality.

In addition, intelligent learning environments are able to acquire students' status and performance in multiple aspects in detail through wearable devices, sensors, eye tracking, and other advanced perceptual technologies. These aspects include students' learning interests, participation, engagement, classroom interactions, knowledge absorption, and even emotional states. These perception equipment

and technologies provide real-time, multi-dimensional data sources, which significantly enrich the big data content of online teaching. These data collection methods in intelligent learning environments capture students' various behaviors and reactions during the learning process and enable instant analysis and feedback. By analyzing these meticulous data, teachers and teaching systems can more accurately understand the learning situations and needs, so that targeted teaching interventions and resource allocation can be made. The real-time acquisition and analysis of these data effectively supplements the deficiencies of traditional teaching data, making online teaching big data more comprehensive and precise and providing a solid foundation for improving education quality and personalized teaching.

3.3 Data-Driven Instructional Decision-Making Process

The data-driven instructional decision-making process can play a crucial role in the three phases of instructional design, interaction, and feedback.

(1) During the instructional design stage, the goal of data-driven decision-making is to improve the effectiveness of courses and teaching methods. Students' academic performance, learning behavior, and learning interest can be identified by analyzing the data from the teaching platform, the teaching resources platform, and the teaching management system. On the basis of the student's learning situation and needs, the course objectives, personalized course content and differentiated teaching strategies are designed to optimize teaching resources and methods. During the process of teaching practice, real-time data feedback is utilized to track students' learning progress, predict learning trajectory, and evaluate learning effects, so as to timely adjust teaching strategies.

(2) During the instructional interaction stage, the goal of data-driven instructional decision-making is to improve teaching effectiveness and student engagement. Data of students' learning progress and engagement can be accessed through the teaching platform, and data of student learning status can be collected by devices in the smart classroom. For example, by analysing the movements of "heads-up", teachers can obtain information about students' engagement and classroom interaction. Teachers can flexibly adapt the content and techniques of instruction to new situation, implement personalized tutoring plans and differentiated teaching, and timely provide personalized feedback and support. In addition, teachers can adjust their teaching content and methods based on the results of data analysis to ensure students' full understanding and participation. At the same time, through data feedback, teachers can optimize the design of interactive activities to increase classroom interactivity and students' participation.

(3) During the instructional feedback stage, the goal of data-driven instructional decision-making is to promote instructional optimization and enhance teaching effectiveness. Teachers can identify problems encountered by students and understand the barriers to students' learning timely through analyzing the data received. Therefore, teachers are able to provide students with timely help, support, and targeted guidance. In addition, teachers can also provide students with specific action suggestions and learning strategies based on the results of data analysis. At the same time, through the implementation of the

information feedback, teachers can receive the feedback and evaluation of learning, and continuously improve teaching strategies. In addition, teachers can provide students with specific action suggestions and learning strategies to encourage them to make continuous progress. The assessment mechanism of teaching effectiveness is carried out through combining formative and summative assessment means in the teaching platform, continuously accumulating multi-dimensional data on learning effectiveness, and forming a teaching cycle of continuous optimization through continuous data collection, analysis, and data-based reflection and improvement.

Through the scientific application of big data, the instructional decision-making process in these three phases can be carried out more accurately, dynamically and effectively, thereby enhancing the overall instructional quality and students' learning experience.

4. Conclusion

The data-driven approach provides a powerful action paradigm, injecting new vitality into the future reforms of school education. Traditional instructional decision-making usually relies on subjective experience and lacks scientific basis for decision-making. However, intelligent teaching activities generate a large amount of process data, including teaching data, learning behavior data and evaluation data. With the continuous accumulation and massive growth of various types of teaching data, big data technology provides technical support for building a new teaching paradigm and lays the foundation for more scientific and accurate instructional decision-making and assessments. This study takes data-driven approach as the core and realizes personalized and precise instructional decision-making schemes through collecting and using teaching and learning data in the intelligent classroom environment. It also promotes the transformation of instructional decision-making from experience-driven to data-driven.

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