Research on the development status and transformation path of digitalization in higher education

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Abstract: This study investigates the factors influencing changes in students' learning behavior in digital higher education in China, identifying key drivers and challenges, as well as potential solutions. By reviewing existing literature and conducting a questionnaire survey, the research explores both the enablers and barriers to digital learning in higher education. Key factors impacting students' behavior include individual differences, learning environment, technological infrastructure, and policy support. Based on these findings, the study proposes the design of an improved educational system to enhance digital learning outcomes.

Keywords: digitalization of higher education; learning behaviors; influencing factors; Transformation paths

1. Introduction

At the 2022 National Education Work Conference, the Ministry of Education launched the "National Education Digital Strategy Action," aiming to enhance the national smart education platform for primary and secondary schools, share quality resources, drive educational reform, and promote the creation of a learning society, achieving three key improvements [1]. As part of the "Digital China Strategy," the national education digital strategy aims to convert the static potential of digital resources into dynamic forces for educational reform. Leveraging digital transformation as an opportunity, it seeks to reshape talent development mechanisms and education governance, driving high-quality modernization in education. With the rapid advancement of information technology, the digitalization of higher education has become an inevitable trend. Digital technology presents both opportunities and challenges for higher education, impacting areas such as teaching, research, management, communication, innovation, evaluation, security, ethics, and educational equity. The digital service system in higher education leverages digital technology to deliver efficient, intelligent, and convenient services. As its foundation, digital technology provides the technical tools and platforms essential for this system. By integrating and optimizing educational resources, the digital service system enhances personalized learning, boosts efficiency, and fosters innovation and development in higher education.

2. Literature review

2.1 Current situation of digital transformation in higher education

To some extent, there are still some gaps in the digital transformation of higher education. These gaps are mainly manifested in the following aspects: insufficient digital infrastructure construction, lack of digital teaching resources, the innovation of digital teaching mode is insufficient, the digital teaching evaluation mechanism is not perfect.

2.1.1 Insufficient digital infrastructure construction

Many universities still face shortcomings in their digital infrastructure, such as inadequate teaching equipment, limited network bandwidth, and insufficient data storage and processing capacity. For instance, while the EU and European governments have made significant investments in infrastructure,

provision at the institutional level remains inconsistent. Initial capital investments have allowed universities to offer various digital resources, with student portals and course management tools being widely used. However, much of this infrastructure primarily supports administrative functions, with limited impact on teaching and student learning [2]. Additionally, students face heavy homework burdens, and the learning process and outcomes lack visualization, with evaluation methods often unreasonable. For example, online teaching evaluation is not comprehensive. The unique demands of online teaching often prevent effective dynamic monitoring of the teaching process. This lack of evaluation and management negatively impacts the overall effectiveness of online education [3]. These challenges hinder the advancement of digital teaching and the broader digital transformation in universities. However, with technological progress, virtual simulation has emerged as a vital tool in digital education. It allows for the replication of real-world scenarios, helping students to better grasp and apply knowledge.

2.1.2 Lack of digital teaching resources

Despite efforts to advance digital transformation, many universities still face shortcomings in digital teaching resources, including materials, software, and experimental equipment. Implementation issues persist, such as inadequate resource quality, insufficient standardization, and lack of comprehensive and interactive elements [4]. The scarcity of these resources restricts the depth and scope of digital teaching in higher education. As digital technology continues to advance, higher education will increasingly integrate digital tools, facilitating a deeper fusion of technology and educational practices.

2.1.3 The innovation of digital teaching mode is insufficient

Many universities still struggle with insufficient innovation in digital teaching modes, relying heavily on traditional methods and showing limited interest in or capability for digital learning. As higher education evolves and faces a new era of technological and industrial revolutions, the traditional development model no longer meets the demands of this new stage and environment [5].

2.1.4 The digital teaching evaluation mechanism is not perfect

Many universities face issues with their digital teaching evaluation mechanisms, including the absence of scientific standards, limited evaluation methods, and delayed feedback. These problems hinder the enhancement and optimization of digital teaching. In the digital economy era, with increasing emphasis on communication, collaboration, innovation, and complex problem-solving, it is crucial for higher education to modernize and restructure its talent training to stay current with evolving demands [6].

These factors contribute to the slow progress of higher education transformation and widespread adoption in China. With ongoing upgrades in domestic education software, there is a need for stable and efficient solutions. To address these gaps, universities must enhance digital infrastructure, expand digital teaching resources, innovate teaching methods, and improve evaluation mechanisms. This will support the comprehensive development and deepening of digital transformation in higher education.

2.2 Related Case Studies

Domestic higher education has developed a strategy for digital transformation, emphasizing organizational reforms at a strategic level to ensure fair, inclusive, and secure education. This strategy focuses on building new infrastructure, establishing standards, and fostering multilateral digital cooperation. Research on the factors influencing higher education digitization has examined aspects such as digital education connotation, practice, strategy, and transformation. However, there is limited research on changes in digital learning behavior patterns and their influencing factors. Students play a crucial role in this transformation. Internationally, digital construction in higher education encompasses teaching, learning support, and research, with Europe leading efforts since the early 21st century to integrate information and communication technology into higher education [6]. In response to the demand for face-to-face instruction, some foreign higher education institutions are adopting distance education as a teaching method. Additionally, these institutions offer learning support services to help students navigate digital learning and exams. Policies recommend that higher education institutions develop and implement flexible and technologically advanced learning resources to create an equitable and accessible learning ecosystem that supports students anytime and anywhere [7]. Some foreign higher education institutions are conducting academic research to explore the application of digital technologies, such as the Internet of Things, big data, blockchain, and generative artificial intelligence, in academic research. The advancement of these technologies is increasingly impacting educational practices, management systems, and support mechanisms, driving significant changes in higher education and fostering the development

of a digital, networked, and intelligent educational ecosystem [8].

There is a significant gap between China and foreign countries in areas such as technology, learning experience, teaching materials, learning environment, and financial investment. The digital transformation of higher education in Europe highlights the importance of fostering new forms of innovation and creativity, particularly in the digital transformation of teaching and learning [9].Technically, China needs to incorporate virtual reality (VR) and augmented reality (AR) technologies to enhance student comprehension of course material. In terms of learning experience, foreign institutions emphasize practical, innovative, and guiding approaches. However, the relatively limited digitalization in domestic higher education may result in insufficient support for some students.

3. Design practice

3.1 System architecture design

Multi-layer architecture: Adopt multi-layer architecture, such as performance layer, business logic layer, data access layer, etc. The performance layer is responsible for interacting with users, the business logic layer processes various business rules and processes, and the data access layer is responsible for interacting with the database, which improves the maintainability, scalability, and reusability of the system.

Distributed architecture: Considering the high concurrent access and high data processing of higher education system, distributed architecture is adopted to deploy different modules of the system on different servers, and coordinate and manage through distributed technology to improve the performance and reliability of the system. For example, use distributed databases to store and manage large amounts of student information, teaching resources and other data.

Microservice architecture: Divide the system into multiple small, independent microservices, each focusing on specific business functions and interacting through a lightweight communication mechanism. This architecture improves the flexibility, scalability, and development efficiency of the system, making it easier for teams to develop, test, and deploy independently. For example, course management, student management, performance management and other functions are built as independent micro-services.

3.2 Functional module design

Course management: Support teachers to create, edit and publish course information, including course introduction, syllabus, teaching plan, teaching resources (such as courseware, videos, reference materials, etc.). Teachers can set the opening time, the closing time, and the course selection conditions.

Teaching arrangement: Help teachers to arrange teaching activities, such as classroom teaching, experimental teaching, practice teaching, etc., including teaching time, place, teaching methods (online or offline), etc. At the same time, teachers are supported to adjust and change their teaching activities.

Student management: To realize the comprehensive management of students' information, including the basic information of students (such as name, student number, gender, major, etc.), school status information (such as enrollment time, length of schooling, school status, etc.), academic performance, rewards and punishments, etc. It can also support students 'course selection and withdrawal operation, as well as track and manage students' learning progress.

Performance management: Teachers can input students' test scores, homework scores, peacetime scores, etc., and the system automatically calculate the total score. Support the query, statistics and analysis of grades to facilitate teachers and students to understand the learning situation. At the same time, provide the results review and release function, to ensure the accuracy and fairness of the results.

3.3 Learning support module

Online learning platform: Provide rich online learning resources, such as online courses, electronic books, academic papers, learning videos, etc., students can study independently according to their own needs. Support online course broadcast, pause, fast forward, fast return and other operations, to facilitate students to learn.

Learning Community: Build a learning community, in which students can exchange learning experiences, discuss problems, share learning resources, and promote the interaction and cooperation

between students. Teachers can also participate in the community to provide guidance and assistance to students.

Aid to learning: Provide some learning tools, such as online notes, homework submission, examination system, study plan making, etc., to help students improve their learning efficiency and manage the learning process.

Personalized learning recommendation: According to students 'learning history, interests, learning progress and other data, students are provided with personalized learning resource recommendation and learning path planning to meet students' personalized learning needs.

3.4 Resource management module

Teaching resource management: Unified management of teaching resources, including resource uploading, downloading, classification, retrieval, sharing and other functions. Teachers can upload their own teaching resources or share the high-quality resources of other teachers. At the same time, the version management of the resources is supported to facilitate the teachers to update and maintain the resources.

Digital Library: Integrate the library resources of the school, and provide the retrieval and borrowing services of digital resources such as electronic books, journal papers, newspapers and magazines. Students can read or download the required literature materials online through the system.

Laboratory management: For the subjects with experimental teaching needs, we should manage laboratory resources, including laboratory equipment management, experimental project management, experimental reservation management, etc. Students can make an appointment with the experiment time and equipment through the system, and teachers can check the experiment arrangement and the students' experiment situation.

3.5 Scientific research management module

Scientific research project management: Support teachers to apply for scientific research projects, including the filling in and submission of basic information, research content, research objectives, research plans, and budgets, etc. At the same time, the approval, project approval, process management and final management of scientific research projects, to facilitate the university to track and supervise the whole process of scientific research projects.

Management of scientific research achievements: To manage teachers' scientific research achievements, such as academic papers, patents, works, scientific research awards, etc., and to support the input, review, inquiry and statistical analysis of the achievements. It is convenient for the school to understand the teachers' scientific research achievements and provide the basis for scientific research evaluation and reward.

Academic exchange management: Organize and manage academic exchange activities, such as academic lectures, seminars, academic conferences, etc., including the release, registration, sign-in, record and other functions. It provides a platform for teachers and students for academic exchange and promotes academic innovation and cooperation.

3.6 Administrative management module

Personnel management involves managing school staff information, including basic details, job positions, professional titles, salary data, and other relevant information. Financial management involves overseeing the school's finances, including tuition collection, fund reimbursements, budget management, financial reporting, and other related functions. Logistics management involves overseeing the school's logistics services, including campus facility maintenance, dormitory management, canteen operations, office supplies procurement, and other related tasks.

3.7 Design strategy

Concise and intuitive: A simple and intuitive user interface design enables users to quickly find the desired features and information. To prevent the interface from becoming too complex and cumbersome, it is important to simplify it, thereby reducing the user's operational difficulty and learning costs [9].

Responsive design: The responsive design enables the system to adapt to the screen size and resolution of different devices, such as computers, tablets, mobile phones, etc., which is convenient for users to use the system on different devices. For special user groups such as visual impairment and hearing impairment, the corresponding barrier-free access function is provided.

4. Discussion

4.1 Technical route of digital transformation of higher education

Considering the problems caused by the development of technology, resources, students and teachers in the teaching industry, it is necessary to conduct the technical route and feasibility analysis of the program, and conduct the program in combination with the national development strategy Reasonable and effective practice and evaluation.

The collected data were cleaned and preprocessed to ensure the quality and consistency of the data. The study will utilize data analysis methods to explore the influencing factors and mechanisms behind changes in students' learning behavior patterns. Using statistical analysis and machine learning techniques, corresponding models are established to reveal the rules and trends of students' learning behavior patterns.

4.2 Feasibility analysis of the digital transformation of higher education

Technology has made rapid progress. In recent years, the development of information technology has provided a strong technical support for the digitization of higher education. The continuous progress of cloud computing, big data, artificial intelligence, the Internet of Things and other technologies enables universities to collect, process and analyze data more effectively, and provide guidance for teaching and research. At the same time, the application of the new generation of network technology and multimedia technology also provides a better platform and tool for online education. A unified development platform is needed to realize the reasonable and fair distribution of educational resources, and have a perfect function.

Online education Trends. The popularization and development of online education have provided new possibilities for the digitalization of higher education. Through online education, students can study at any time and anywhere, making learning more flexible and convenient. In addition, online education can also improve students' learning effect and interest through interactive learning and adaptive learning. Therefore, the digital research of higher education has important practical significance and market demand.

Potential for data analysis. The application of big data technology provides a new perspective and method for higher education. The collection and analysis of data from students and teachers allows for a better understanding of their needs and behaviors, providing support for individualized teaching and educational decision-making. At the same time, data analysis can also help universities to optimize resource allocation and improve the quality and efficiency of education. In the aspect of digital learning service system design, the technology can use the acceptance model, combine with the service design theory, and set the dimension of questionnaire questions, so as to clarify the influencing factors of the change of students' learning behavior mode, and the elements of service system design.

Educational equity. Digital education can break the limitation of time and space, so that more people can receive higher education. For students in remote areas and economically underdeveloped areas, digital education provides them with more opportunities and resources, which is conducive to improving the fairness and penetration rate of education.

Improvement of learners' ability. Digital education can not only provide more abundant and diversified learning resources, but also improve students' independent learning ability and innovative thinking ability through interactive learning, problem-solving learning and other ways. In addition, digital education can also cultivate students' information literacy and digital skills, and lay a solid foundation for their future career development.

5. Conclusion

We initially developed the interface using small programs and then engaged in ongoing improvements.

By focusing on user needs from both students' and teachers' perspectives, we have worked to refine and enhance the system's functionality, with a particular emphasis on student requirements. As a result, our students have provided positive feedback on the system's user interface design and interactive elements, indicating that the interface effectively meets their needs and expectations.

Acknowledgements

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