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Exploration of Digital Innovation Paths in Education Management of Vocational Undergraduate Colleges

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Abstract: In the context of the digital economy era, the digitalization of education management in vocational undergraduate colleges has become a crucial path to enhance governance capabilities and the quality of talent cultivation. This article systematically analyzes the development opportunities and challenges it faces, and proposes a digital innovation path guided by conceptual innovation, driven by technology empowerment, and supported by institutional guarantees. The study emphasizes that vocational undergraduate colleges need to build a data-driven education governance system, achieve in-depth application of scenarios such as intelligent scheduling, personalized teaching, and scientific evaluation through artificial intelligence technology, and also focus on digital ethics and security and the characteristics of industry-education integration. Digital transformation is not only a technological upgrade, but also a systematic reshaping of the educational ecosystem, which requires promoting the coordinated development of technology, systems, and talent cultivation from a strategic height, and ultimately forming a new digital governance model with vocational education characteristics.

1. Introduction

Globally, the Fourth Industrial Revolution, represented by artificial intelligence, big data, and cloud computing, is profoundly reshaping socio-economic structures and development models, giving rise to the digital economy era characterized by digitalization and intelligence. Within this macro context, vocational undergraduate institutions, as one of the types of higher education most closely linked to regional industrial economies, face unprecedented opportunities and challenges[1]. Their mission is to cultivate high-caliber technical and skilled talents with solid theoretical foundations, sophisticated technical skills, and excellent digital literacy to directly serve industrial upgrading and economic transformation. However, traditional experience-driven, hierarchical management-based education management models are struggling to adapt to the rapid changes in the external environment and the need for internal quality improvement[2]. Therefore, promoting the digital transformation and upgrading of education management is no longer an option but a strategic imperative for vocational undergraduate institutions to enhance governance capabilities, ensure the quality of talent cultivation, and build core competitiveness[3].

This research focuses on the "Digital Innovation Paths of Education Management in Vocational Undergraduate Institutions," which has significant theoretical and practical value. From a theoretical perspective, current research on digital education is mostly concentrated in general undergraduate institutions or higher vocational colleges, with relatively little attention paid to vocational undergraduate institutions as an emerging type. Vocational undergraduate education has both "vocational" and "undergraduate" characteristics, and its education management has its own particularities in terms of goals, content, and models[4]. Therefore, it is urgent to construct a digital governance theoretical framework suitable for it. From a practical perspective, exploring its innovation paths helps guide vocational undergraduate institutions to clarify the core elements and key links in the digital transformation process, avoid falling into the predicament of "emphasizing technology over management" or "emphasizing construction over application," and thus achieve a leap from instrumental substitution to systematic reshaping.

Based on the above background, this paper will adopt a research method combining policy text analysis, typical case studies, and management technology application analysis. The innovation lies in placing the digital transformation of education management in vocational undergraduate institutions under the dual strategic context of "Digital China" and "Modernization of Vocational Education," highlighting the fundamental task of "cultivating high-caliber technical and skilled talents," and emphasizing that digital management must serve and deeply integrate into the entire process of education and teaching. Ultimately, it aims to build an agile, efficient, open, and personalized smart education management ecosystem, providing solid support for vocational undergraduate institutions to achieve connotative and sustainable development in the fierce educational competition.

2. Development Opportunities

Currently, a new round of scientific and technological revolution and industrial transformation is developing in depth, and the digital economy has become a key force in promoting socio-economic development. As the main battlefield for cultivating high-level technical and skilled personnel, vocational undergraduate colleges are ushering in multiple strategic opportunities for the digital construction of their education management. These opportunities not only stem from the optimization of the macro policy environment, but also benefit from the continuous drive of technological innovation, and are more in line with the inherent needs of educational ecosystem reconstruction[5].

From the perspective of policy, the top-level design of national strategy provides clear guidance and strong support for the digitalization of education management in vocational undergraduate colleges. The "14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of the Vision for 2035" clearly proposes to "build a high-quality education system" and regards "promoting the digital transformation of education" as an important implementation path. The Ministry of Education has successively issued policy documents such as the "Action Plan for Improving the Quality and Strengthening the Excellence of Vocational Education (2020-2023)" and the "Opinions on Promoting the High-Quality Development of Modern Vocational Education," emphasizing the need to "promote the deep integration of information technology and vocational education teaching." It is particularly worth noting that the newly revised "Vocational Education Law of the People's Republic of China" was officially implemented in May 2022, explicitly supporting "the use of information technology to improve teaching methods and management models" in the form of legislation. The intensive introduction of this series of policies and regulations has constructed a complete policy system to promote the digital transformation of education management in vocational undergraduate colleges, forming systematic support in terms

of institutional guarantees, resource allocation, and project promotion.

At the level of technological support, the cluster breakthroughs of a new generation of information technology have laid a solid foundation for the digitalization of education management. Artificial intelligence technology is moving from perceptual intelligence to cognitive intelligence, and its development in core areas such as natural language processing and machine learning provides technical possibilities for building intelligent education management systems. The maturity of big data technology enables colleges and universities to deeply mine and analyze the massive data generated in the teaching management process, providing a scientific basis for management decision-making. The commercial popularization of fifth-generation mobile communication technology effectively guarantees the real-time response and stable operation of education management systems. Cloud computing technology realizes the elastic supply of computing power through resource pooling, significantly reducing the operation and maintenance costs of education management systems. The Internet of Things technology realizes the deep integration of the campus physical environment and information systems through the widespread deployment of sensing equipment. The coordinated development of these technologies jointly builds a technical foundation to support the digitalization of education management.

In terms of infrastructure development, vocational undergraduate institutions demonstrate a significant late-mover advantage. Many institutions systematically plan and deploy high-speed campus networks, cloud computing centers, Internet of Things platforms, and other digital infrastructure during the construction of new campuses or the renovation of old campuses. Statistics show that in 2023, the average campus network export bandwidth of vocational undergraduate institutions nationwide reached 15.2Gbps, and the wireless network coverage rate reached 98.7%. These indicators have approached the level of regular undergraduate institutions. Particularly in practical teaching, the large-scale construction of new teaching spaces such as virtual simulation training rooms, digital twin laboratories, and intelligent training centers not only improves the quality of practical teaching but also creates favorable conditions for data collection and analysis in teaching management. The improvement of this infrastructure provides the necessary physical carriers and technology platforms for the digitalization of education management.

In terms of the construction of a lifelong learning system, digital management platforms have broken through the limitations of time and space in traditional education. Vocational undergraduate institutions provide flexible and diverse learning opportunities for employed personnel and social learners by building online learning management platforms. The establishment of a credit bank system makes the recognition, accumulation, and conversion of various learning outcomes more scientific and standardized. Data shows that by the end of 2023, 87% of vocational undergraduate institutions nationwide had established a credit bank system, providing learning outcome certification services for more than 500,000 social learners. The construction of this open education service system not only expands the social service functions of institutions but also opens up new paths for their sustainable development[6].

3. Challenges

While fully recognizing the development opportunities, it is crucial to be aware of the profound challenges that vocational undergraduate institutions still face in promoting the digitalization of education management. These challenges exist not only at the level of technology application but also involve multiple dimensions such as concept updating and institutional restructuring, constituting bottlenecks that restrict the full realization of digitalization effectiveness.

3.1 Conceptual Lag and Insufficient Digital Leadership

Lagging concepts and cognitive biases are the primary obstacles. Most managers of vocational undergraduate institutions have not yet established an education governance philosophy that adapts to the digital age. The traditional hierarchical management thinking still dominates, simply understanding digitalization as the superposition of technical tools, rather than the systematic reshaping of the education management system. This cognitive bias directly leads to the stagnation of digitalization construction at a superficial level, making it difficult to touch the core of the management system and mechanism. Specific manifestations include: managers' limited acceptance of data-driven decision-making models, still over-relying on empirical judgment; obvious data barriers between departments, with the phenomenon of information silos being widespread; and the lack of strategic coordination in digital project management, presenting a fragmented development trend[7]. A deeper problem lies in the general lack of digital leadership among managers, making it difficult to manage the increasingly complex digital education ecosystem, which to a large extent weakens the strategic execution of digital transformation.

3.2 Technical Integration and Data Governance Dilemmas

Structural contradictions in the process of technology integration should not be ignored. When promoting the digitalization of education management, vocational undergraduate institutions face the adaptation problem between the existing technology architecture and new digital needs. Traditional education management systems mostly adopt a closed architecture, which has significant compatibility obstacles with new technologies such as artificial intelligence and big data. The lack of a data governance system is particularly prominent, with inconsistent standards, uneven quality, and unsound sharing mechanisms for various types of education data, resulting in the difficulty of fully releasing data value. According to a survey, more than 65% of vocational undergraduate institutions have problems such as non-standard data collection and untimely data updates, which seriously restricts data-based precision management and scientific decision-making. In addition, when introducing commercial technology solutions, colleges and universities often face the contradiction between the low degree of system customization and the characteristic needs of the school, making it difficult to achieve the organic integration of technological innovation and education management.

Data security and privacy protection constitute a major challenge. With the increasing degree of digitalization of education management, the amount of sensitive data collected and processed by colleges and universities is growing exponentially, including students' personal information, academic records, and behavioral data. The centralized storage and widespread use of these data significantly increase the risk of data leakage and abuse. At present, vocational undergraduate institutions are generally lagging behind in the construction of data security protection systems, with problems such as imperfect security strategies, inadequate protection measures, and unsound emergency mechanisms. In particular, when using artificial intelligence technology for data analysis, how to balance data utilization and privacy protection becomes a thorny issue. Discriminatory results that may be caused by algorithmic biases, and the implementation of the informed consent principle in the data collection process, are ethical issues that need to be resolved urgently.

3.3 Lagging Institutional Innovation

Institutional innovation lags behind the pace of technological development. The existing education management system is largely designed based on traditional management models, making it difficult to adapt to the management needs of the digital era. For example, unclear data ownership

hinders the reasonable flow and use of data; the lack of digital teaching quality evaluation standards affects the quality monitoring of online teaching; and unsound cross-departmental collaboration mechanisms restrict the overall effectiveness of digital management. In addition, insufficient innovation in incentive mechanisms such as teacher workload assessment and performance evaluation in the digital context also affects the enthusiasm of faculty and staff to participate in digital transformation[8].

There are significant differences in access to digital resources and capacity building among different majors and groups. Science and engineering majors tend to receive more digital construction resources, while support for humanities and social science majors is relatively insufficient. Students from rural and low-income families are at a disadvantage in terms of digital device ownership and digital skills levels, and this digital divide may exacerbate educational inequality. There are also significant differences in digital literacy among teachers, with some older teachers facing greater pressure from digital transformation. If these equity issues are not effectively resolved, the overall effectiveness of digital construction will be affected.

The digitalization of education management in vocational undergraduate colleges should fully reflect the characteristics of industry-education integration and school-enterprise cooperation. However, in practice, digital collaboration between colleges and enterprises still faces many obstacles. Unsound data sharing mechanisms make it difficult for schools and enterprises to achieve interconnection of talent training data; inconsistent technical standards hinder the efficient connection between education management systems and enterprise management systems; and unclear benefit distribution mechanisms affect the enthusiasm of enterprises to participate in digital construction. These factors make it difficult for the digitalization of education management in vocational undergraduate colleges to fully reflect the characteristics of vocational education, which to some extent weakens their core competitiveness.

4. Innovative Approaches

Addressing the multifaceted challenges in the digitalization of education management, vocational undergraduate institutions need to adopt systematic and structured innovative approaches, synergistically advancing from multiple dimensions such as concept reshaping, technology empowerment, and institutional guarantees to construct a new paradigm of digital education governance with vocational education characteristics.

4.1 Conceptual Innovation

Conceptual innovation is the logical starting point for promoting the digitalization of education management. Vocational undergraduate institutions should break through the limitations of traditional management thinking and establish a digital governance concept of "data-driven, service-oriented, and collaborative co-governance." Data-driven requires institutions to establish a sound educational data governance system, embedding data analysis into the entire decision-making process, and realizing the transformation from experience-oriented to evidence-oriented management models. Service-oriented emphasizes that digital construction should be centered on the needs of teachers and students, improving the convenience and accuracy of management services through process reengineering and service reconstruction. Collaborative co-governance requires breaking down departmental barriers, establishing cross-level and cross-departmental collaborative work mechanisms, and forming a governance structure with the participation of multiple stakeholders. The key to conceptual innovation lies in cultivating the organization's digital culture, enhancing the digital literacy and digital leadership of all faculty and staff through systematic training and practice, and laying the ideological foundation for digital transformation.

4.2 Technology Integration

Technology empowerment is the core driving force for the digitalization of education management. In terms of intelligent course scheduling and dispatch, vocational undergraduate institutions can build a multi-objective optimized intelligent course scheduling system based on machine learning algorithms. The system needs to comprehensively consider multi-dimensional factors such as classroom resources, teacher preferences, course characteristics, and student course selection, and achieve optimal allocation of teaching resources through constraint satisfaction and optimization algorithms. Practice shows that a mature intelligent course scheduling system can improve scheduling efficiency by more than 40% while significantly reducing the error rate of manual scheduling. In the field of personalized teaching and tutoring, institutions should build an intelligent education platform based on learning analytics. The platform collects and analyzes students' learning behavior data to establish precise student ability profiles, enabling adaptive learning path planning and personalized learning resource recommendations. The intelligent tutoring system should have natural language processing capabilities, be able to automatically grade assignments, identify knowledge weaknesses, and provide targeted practice recommendations and tutoring suggestions.

4.3 Security Management

System guarantees are a critical support for ensuring the sustainable development of digital construction. Vocational undergraduate colleges should establish a comprehensive digital governance organizational structure, clarifying the responsibilities and authority of each department in digital transformation. It is necessary to formulate systematic digital resource management systems to standardize the entire process of data collection, storage, use, and destruction. In terms of incentive mechanisms, digital application capabilities should be incorporated into the evaluation system for teachers and management personnel to stimulate the enthusiasm of all staff in participating in digital transformation. In addition, colleges also need to establish a continuous funding input mechanism to ensure the stability and continuity of digital construction.

Ethical norms are the bottom line that must be adhered to in digital construction. Vocational undergraduate colleges should attach great importance to the ethical issues of technology applications in the process of promoting the digitalization of education management. It is necessary to establish an artificial intelligence ethics review mechanism to regularly evaluate the fairness and transparency of algorithm models. Regarding data usage, the informed consent principle must be strictly followed to protect the privacy rights of teachers and students. Colleges should also establish a dedicated ethics committee responsible for formulating ethical guidelines for digital applications, supervising the compliance of technology use, and handling related complaints and disputes.

5. Conclusion

This study systematically explores innovative pathways for the digitalization of education management in vocational undergraduate institutions, revealing that digital transformation is not only a process of technological upgrading but also a profound transformation of the education governance system. The research indicates that vocational undergraduate institutions need to construct a digital governance system with data-driven approaches at its core, artificial intelligence technology as its support, and institutional innovation as its guarantee. This system should not only reflect the characteristics of vocational education but also conform to the laws of digital transformation, achieving the transformation of education management from experience-based to

precise and from extensive to intelligent through the coordinated advancement of concept reshaping, technology empowerment, and institutional innovation.

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