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Digital Transformation of Vocational Education: Connotation, Challenges and Pathways

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Abstract: Digital transformation has become a key path for vocational education reform in the new era, with its internal impetus coming from the strong drive of scientific and technological development and the urgent need for self-improvement of schools; and its external impetus including the double push of policy support and market demand. However, the digital transformation of vocational education is still facing challenges such as uneven distribution of resources, disconnection between industry and education, financial and technical bottlenecks, and insufficient digital literacy of teachers. In this regard, it is necessary to seek breakthroughs in four dimensions: technological risk prevention, government policy leadership, collaborative support from enterprises, and comprehensive efforts from schools.

Keywords: vocational education, digital transformation, realistic dilemma, digital technology

Introduction

In recent years, factors such as the technological revolution and changes in vocational education have brought opportunities and challenges. Emerging technologies such as 5G, big data, and artificial intelligence have transformed social production, lifestyles, and the digitization process in all fields. Vocational education follows this trend and transforms from IT application to digitization, which is crucial for the high-quality development of vocational education and fits with the national education policy. The vocational education policy of 2021 emphasized the integration of modern information technology with teaching and learning to improve the quality of teaching and learning; and the vocational education policy of 2022 emphasized the "1+5 " digitalization system. The report of the 20th Party Congress emphasized the importance of education, science and technology, and talent for modernization, and advocated the strategies of developing the country through science and education, strengthening the country through talent, and innovation-driven development.[1] Xi Jinping emphasized the importance of education digitization for forming new development paths and advantages.[2] This study clarifies the nature of digital transformation of vocational education, analyzes bottlenecks, and explores the path of promotion.

1. Transformation logic

The digital transformation of vocational education represents a profound change in the field of education, involving an all-round innovation of educational concepts, systems, processes and means, and is a strategic, systematic and global project. Its core objective is to synchronize the improvement of education quality and efficiency through innovation. This transformation has gone through informatization, digitization, and towards intelligence, with each stage marking the deepening of the integration of technology and education. It is driven not only by the intrinsic impetus of technological progress and the urgent need for self-improvement in vocational education, but also by strong support from external factors such as policy guidance and market demand, which together promote the overall progress of vocational education in the

digital age.

1.1 Connotation: the cornerstone of digital transformation

Digital technology is revolutionizing society, leading to digital reform in education. Vocational education, crucial for technical talent, must embrace digital transformation, integrate industrial, innovation, education, and talent chains, and lead this transformation. In recent years, from China Education Modernization 2035 to the Action Plan for Improving Quality and Excellence in Vocational Education, to the National Conference on Vocational Education and its subsequent work priorities, emphasis has been placed on accelerating the informatization process of vocational education, promoting in-depth fusion with industrial development, and constructing intelligent, networked, and personalized learning environments.[3] These policies aim to revolutionize the talent cultivation model, enhance the service capacity of vocational education, and create a flexible and diverse learning system through new educational paradigms such as “Internet+” and “Intelligence+.”[4] The digitalization of education is the future direction of vocational education. The digitalization of education, as the future development direction of vocational education, is through the construction of a digital “1+5” system[5], to promote a full range of changes in teaching, governance, etc., demand-oriented, application-centered, to improve hardware facilities, optimize the application experience, and strengthen the quality of education. The core lies in deep application and integration of digital technology, extending beyond teaching to management, systems, operations, programs, and standards. By optimizing vocational education and constructing an ecosystem centered on skilled talents, it adapts to digital era needs, improves education quality, and creates societal value.

1.2 Evolution: the leap from informatization to intelligence

From informatization to digitalization and then to digital intelligence, the transformation and upgrading of vocational education is not only a process of innovation in educational technology, but also a comprehensive reshaping of educational concepts, models and goals. In the future, with the continuous progress of technology and the continuous expansion of application scenarios, vocational education will be more closely integrated with economic and social development, contributing to the cultivation of high-quality skilled personnel to meet the needs of the times.

Informatization stage: Focuses on network technology and resource use for teaching modernization. Multimedia and online platforms enhance learning and resource sharing, breaking traditional limitations. However, this stage lacks deep exploration of concept and model transformations, limiting informatization's potential.

Digitalization stage: Integrates education with economic and social needs, using digital technology to innovate education mediums and knowledge acquisition. Emphasizes technological upgrading, concept, model, and goal changes, and improves operational efficiency. Introduces digital scenarios, enhances teacher digital literacy, and establishes a multi-dimensional evaluation system. This improves education quality, efficiency, and fairness.

Intelligence stage: With AI and big data, vocational education enters digital intelligence. Realizes "human-computer coupling" and promotes intelligent, personalized development. Digital intelligence impacts skilled personnel's work mode, promoting transformation. Vocational education requires reforms in connotation, supply, curriculum, and cultivation mode to cultivate future skilled personnel.

1.3 Necessity: internal and external motivation in the context of the times

Digital transformation, as a necessary path for the reform and development of vocational education in the new era, is driven by multiple factors, such as internal technology drive and the real demand for high-quality development of vocational education, as well as external policy support and market demand. These factors together promote the in-depth development of the digital transformation of vocational education.

From the viewpoint of intrinsic motivation, firstly, technology drive leads the digital transformation and quality improvement of vocational education. Artificial intelligence, 5G and other new-generation technologies accelerate the intelligentization of education, broaden the vision of reform, strengthen cooperation and improve efficiency. Digital technology also promotes the borderlessness of the educational environment and enables resource sharing. Second, inherent development needs require vocational schools to adapt to changes. Through advanced means such as intelligent

teaching systems, schools improve teaching efficiency, personalize learning paths and meet the diverse needs of students, thus ensuring their continuous progress and development.

From the extrinsic motivation perspective, policy support is crucial for vocational education's digital transformation. Guidelines from the Party and state, such as the "Digital China" strategy and 20th Party Congress report, emphasize digital transformation's centrality in education. Documents like China Education Modernization 2035 and the 14th Five-Year Plan refine the digitization path and top-level design.[6] The state has improved the digital infrastructure and upgraded the level of intelligence and collaboration in vocational colleges and universities. Second, the talent market needs digital skills, innovation and cross-border capabilities. Vocational education must accelerate the digital transformation, adjust the professional settings and curriculum system, strengthen practical teaching and school-enterprise cooperation, and cultivate high-quality skilled talents that match the market demand.

2. Realistic challenges

Digital transformation is a strategic choice for vocational education to achieve high-quality development. While integrating digital technology, several challenges emerge: resource imbalance, low matching between education and industry, technical & financial pressures, and inadequate teacher digital literacy. These issues necessitate comprehensive assessment of risks and challenges facing vocational education's digital transformation.

2.1 Uneven resources: geographical and inter-school differences

In the process of digital transformation of vocational education, resource imbalance is a problem that cannot be ignored, and it profoundly affects the improvement of educational equity and quality. Resource imbalance exists in three key areas: 1) Geographic disparity, where developed regions have superior network infrastructure, advanced computer equipment, and abundant digital resources, while underdeveloped regions lack due to funding and technology constraints; 2) School-level inequality, where prestigious schools attract more funding and resources, forming comprehensive digital ecosystems, whereas weaker or rural schools struggle to keep pace; 3) Teacher-level disparity, where varying digital literacy and skills among teachers affect resource utilization, with some adept at digital tools for innovative teaching, while others lack training, limiting application and exacerbating educational inequality, hindering student development, education innovation, and reform depth.

2.2 Disconnection between industry and education: the gap between education and industry

The mismatch between vocational education and industrial development is a pressing issue, impacting resource utilization, enterprise productivity, and overall employment. Technological advances and industrial shifts drive enterprise demands, yet some vocational institutions lag in curriculum, content, and methods, leading to a skills gap between students and enterprise needs. This results in graduates struggling to find suitable jobs and enterprises struggling to find suitable talent, exacerbating skilled personnel shortages. Due to this mismatch, enterprises incur higher costs and time investments in training and recruitment, potentially affecting productivity and competitiveness. Additionally, skilled personnel shortages may hinder enterprises' ability to respond to market changes, further worsening their competitive position. This mismatch also leads to wasted educational resources, reduced enterprise productivity and competitiveness, and increased social employment pressure, with graduates facing unemployment and enterprises having unfilled positions.

2.3 Financial and technological pressure: a double test

In the journey of digital transformation of vocational education, technology and financial pressure are two major obstacles that cannot be ignored. On the one hand, the technological threshold has become a chasm. Firstly, the infrastructure is insufficient. Due to historical or financial reasons, the information technology facilities of some institutions are backward, making it difficult to support digital teaching. Problems include insufficient bandwidth, low performance of servers, and aging equipment, which restricts the transmission of resources. Secondly, the technology is updating rapidly, how to keep pace and integrate into teaching becomes a challenge, requiring rapid learning, adaptation and substantial investment. On the other hand, financial pressure is high. First, local financial support is limited, especially in less economically developed areas. Secondly, self-financing is difficult and comes from a single source. Finally, funds

are unevenly distributed, with key institutions or specialties easily supported and weak or cold specialties short of funds, making transition more difficult.

2.4 Teacher literacy: low digital competence

Teachers' digital literacy is crucial to the digital transformation of vocational education, but in reality many teachers are deficient in this area, which has become an obstacle to the transformation. Specific problems include: first, limited ability to apply technology and a single means of teaching; insufficient ability to develop resources, making it difficult to meet personalized learning; second, lack of data management ability, making it difficult to guide teaching practice; and third, insufficient motivation for continuous learning, making it difficult to keep up with technological updates. These shortcomings affect the quality and effectiveness of teaching and the in-depth implementation of teaching reform.

3. Pathways

Vocational education's digital transformation is driven by four paths: technology, government, enterprises, and schools. Technology ensures safety and ethics; government provides policy and resource support; enterprises foster education-industry alignment; and schools enhance digital competence and adaptability. These paths work together to smoothly transform vocational education, cultivating high-quality talents.

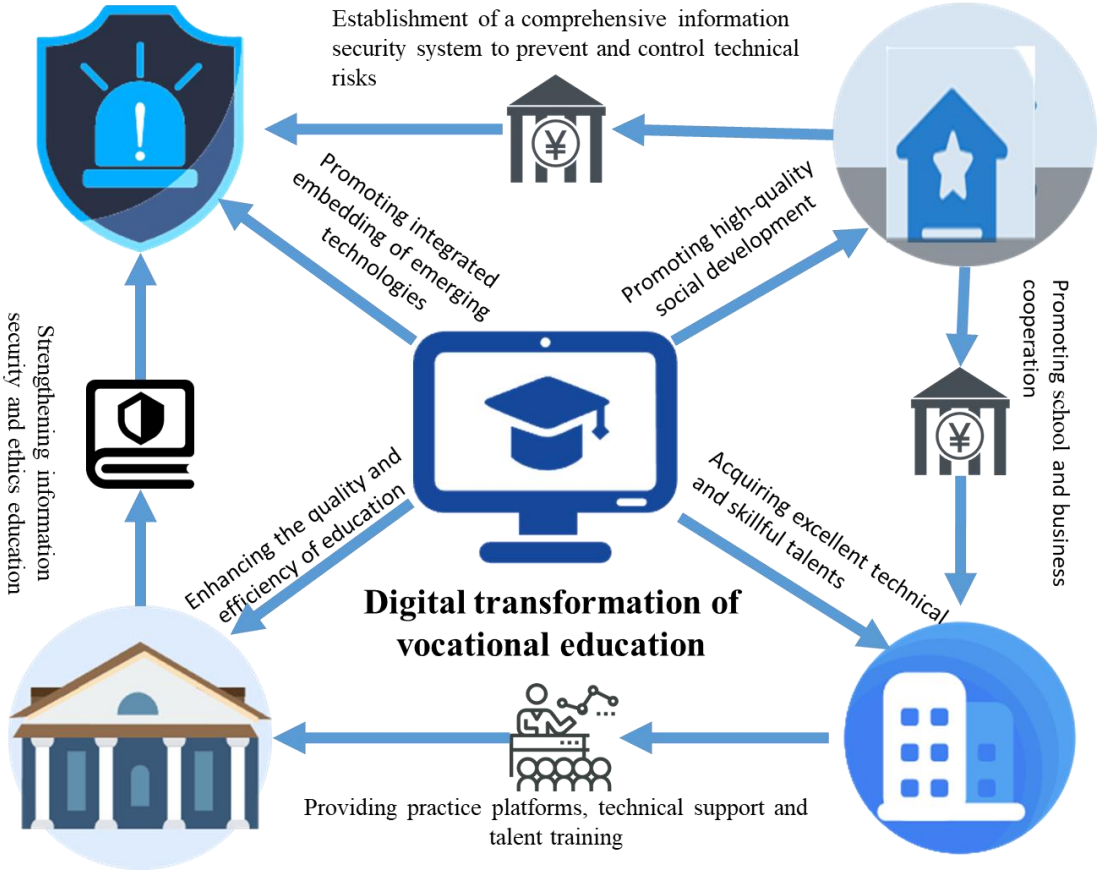

Figure 1 Pathway relationship diagram

3.1 Prevention and control of technological risks: guaranteeing the security of transformation

On the one hand, the promotion of the digital transformation of vocational education needs to overcome the traditional technological inertia thinking. Although digitalization has become the dominant way of human production and life, the digital transformation of education is still limited by the mindset of industrial society, and the application of information technology in education reform is limited to the optimization of the existing framework, failing to take it as the core content of a comprehensive transformation.[7] The effectiveness of new technologies in the digital transformation of vocational education has been questioned by the public, making it difficult for new technologies to be widely accepted and

applied.[8] Therefore, in order to promote the transformation, it is necessary to get rid of the inertia thinking, take measures such as thinking outside the box, establish pilots, strengthen teacher training and digital literacy, and build a digital culture ecology and incentive mechanism.

On the other hand, to promote the digital transformation of vocational education, it is necessary to strengthen the prevention of technological risks and focus on security and ethics. At the security level, an information security system should be established, including management system, technical protection, security audit, etc., and teachers' and students' awareness of information security should be strengthened. At the ethical level, ethical norms should be formulated, a monitoring and evaluation mechanism should be established, and the integration of technology and humanity should be emphasized to avoid the lack of humanistic care.

3.2 Government-led transformation: all-round support in terms of policy and funding

In promoting the development of vocational education, the government has always played a leading role. First, improving the policy system is the foundation. The government needs to formulate specific, targeted and coordinated policies to solve the problems of poor articulation and non-uniform terminology, to ensure that the policies are effectively implemented and to provide institutional guarantee for the transformation.[9] Second, the establishment of uniform standards is the key to guaranteeing standardization and consistency, and the government should take the lead in formulating standards for digital literacy, skills assessment and vocational literacy assessment to promote the standardization of transformation and enhance operability and effectiveness. Third, increasing financial investment is an important support. The government should increase financial support to provide funds for informatization construction, purchase of teaching equipment and software, and teacher training, so as to rationally allocate resources and improve utilization efficiency. Fourth, strengthening cooperation between vocational colleges and enterprises is the key. The government should promote information exchange, rationally distribute benefits, solve problems together, realize efficient integration of resources and complementary advantages, and promote in-depth development of transformation. Finally, appropriate decentralization is an important means to stimulate innovation and vitality. The government should give vocational colleges and enterprises more autonomy to flexibly respond to market and technological challenges, improve decision-making efficiency and resilience, and provide guarantee for the success of transformation.[10] In summary, the government should improve the policy system, establish unified standards, increase financial investment, strengthen cooperation between schools and enterprises, and appropriately decentralize the power in promoting the digital transformation of vocational education, so as to form a synergy to promote the digital transformation of vocational education and achieve significant results.

3.3 Enterprise support: new heights of school-enterprise cooperation

The core of vocational education lies in practice orientation and occupational relevance, which is directly oriented to the front line of production and the cultivation of technical and skilled talents, and enterprises are its core practice platform. Therefore, in the digital transformation, the deep participation of enterprises and the market is crucial.

On the one hand, school-enterprise cooperation should be strengthened in order to accurately meet market demand. Specific measures include establishing a regular school-enterprise communication platform, promoting information exchange and sharing through industry seminars and school-enterprise matchmaking meetings; introducing an enterprise mentor system, inviting enterprise experts to participate in teaching, and integrating enterprise needs and technical standards.

On the other hand, jointly building digital resources to improve the quality of vocational education. Enterprises can cooperate with vocational colleges and universities to build digital training bases, provide equipment, software and technical support, and allow students to practice in real or simulated environments; cooperate in scientific research projects and technological research and development, promote the in-depth integration of education and industry, and enhance the innovation ability of students; through these measures, we can promote the docking of education and industry, and cultivate high-quality skilled personnel to meet the needs of the digital economy.

3.4 School empowerment: teachers and students facilitating digital transformation

Schools' efforts to promote digital transformation need to be carried out comprehensively at three levels: administrators, educators and educated people. By establishing a digital philosophy, building an efficient organization, strengthening teacher capacity building, establishing an assessment system, improving digital literacy, adapting to the digital environment and paying attention to individual differences, we can jointly promote the in-depth development of digital education in schools and lay a solid foundation for the overall development of students.

From the level of school administrators, the first is to establish the concept of digitalization, clarify the goals, paths and results of transformation, and ensure school-wide awareness of digital education. Second, build an efficient organizational management model, use digitalization to optimize management processes, and strengthen data analysis to guide decision-making. Third, use advanced technology to improve management efficiency, establish an intelligent campus management system, and pay attention to the construction of information security.

From the level of educators, the first is to strengthen the construction of teachers' digital capacity, enhance IT application and digital teaching capacity through training and seminars, and encourage innovative teaching models. Second, establish a system to measure teachers' digital teaching ability, scientifically formulate assessment standards, and regularly measure and use them as the basis for assessment and title evaluation, so as to motivate teachers to continuously improve their digital teaching ability. Thirdly, digital teaching competence is incorporated into teachers' professional standards, with clear requirements to support teachers' continuous growth and development in the field of digital teaching through the formulation of professional development plans and the provision of learning resources.

From the level of the educated, first, to enhance digital literacy, increase the content of information technology education through the curriculum, acquire the necessary skills, and develop information literacy and independent learning ability. Second, adapting to the digital learning environment, encouraging students to use a variety of digital learning tools, participate in digital learning activities, and stimulate their interest and creativity in learning. Third, to pay attention to individual differences, provide personalized learning support, develop innovative thinking, critical thinking and teamwork skills, and lay the foundation for all-round development.

4. Conclusion

The digital transformation of vocational education is a crucial aspect of current education reform, aiming to enhance education quality and align with digital economy demands. This transformation hinges on the deep integration of digital technology, which overhauls teaching, management, system architecture, and operation modes. Vocational education is continuously evolving from informatization to digitization to intelligence to keep pace with the digital era. However, challenges persist, including uneven resource distribution, education-industry disconnect, financial and technological constraints, and inadequate teacher digital literacy. These obstacles directly impact the transformation's progress and effectiveness. To overcome these hurdles, multi-faceted efforts are required. In technical level, with advancements in new technologies, vocational education will become more intelligent and personalized, while ensuring safety and ethics through risk prevention. In policy level, the government should refine policies and increase funding to support the transformation. In enterprise level, deepening school-enterprise cooperation will provide more practical opportunities and employment pathways, aligning education with industry needs. In school level, institutions must adopt digital concepts, enhance teacher digital skills, address student individuality, and fully propel the digital transformation. The digital transformation of vocational education is a systemic endeavor necessitating collaboration among governments, enterprises, and schools. By comprehensively understanding the transformation's essence and path, we can smoothly advance this process and cultivate high-quality skilled talents for the digital economy era.

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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