Pathways for Breaking Through the Dilemmas of Vocational Education in China from the Perspective of Artificial Intelligence Empowerment

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Abstract

Against the backdrop of the rapid development of artificial intelligence technology, vocational education in China is facing deep-seated contradictions stemming from the structural mismatch between talent supply and industrial demand. These challenges are further exacerbated by social cognitive biases, uneven resource distribution, and outdated teaching models. This study systematically examines the historical evolution, scale characteristics, and current challenges of vocational education. At the same time, it draws on the successful application experiences of AI in basic education and higher education, and proposes several innovative solutions centered on AI technology, aiming to construct a theoretical framework for the deep integration of vocational education and AI technology, break through development bottlenecks, and promote the transformation of vocational education from scale expansion to connotation improvement in the digital economy era.

Keywords Artificial Intelligence; Vocational Education; Breakthrough Path; Resource Allocation; Personalized Teaching; Digital Transformation

1 Introduction

In the era of rapid technological development, artificial intelligence has become a key force driving the development of various industries. In recent years, artificial intelligence technology has made significant progress in algorithm optimization, computing power enhancement, and data processing capabilities, which has greatly expanded its application boundaries and triggered a new wave of artificial intelligence technology application boom, prompting various industries to deeply consider how to use artificial intelligence to achieve transformation, upgrading, and long-term development.

Vocational education plays a crucial role in providing high-quality skilled talents for industrial development. Closely linked to industrial practices, it urgently needs to adapt to technological innovation. By 2023, China has built the world's largest vocational education system, with more than 11,000 vocational institutions (including technical schools), nearly 35 million students, and over 10 million graduates each year [1].

However, vocational education in China also faces multiple development bottlenecks: social prejudice and discrimination, imbalance between the supply and demand of teaching resources, lack of monitoring of students' situations and personalized guidance, a lagging teaching quality assessment system, and numerous obstacles to digital transformation. These challenges seriously hinder the high-quality development of vocational education and exacerbate the structural mismatch between talent supply and industrial demand.

The rapid development of artificial intelligence technology provides new opportunities for vocational education to overcome these challenges. With its powerful data analysis, intelligent decision-making, and simulation capabilities, artificial intelligence is expected to break free from the constraints of traditional vocational education models and achieve a comprehensive transformation-from reshaping concepts to optimizing resources, from innovating teaching methods to improving educational quality [2].

This study systematically examines the innovative strategies enabled by artificial intelligence in addressing the existing problems and development challenges of vocational education, aiming to provide

theoretical insights and practical guidance for the high-quality development of vocational education in the new era.

2 Characteristics of Vocational Education

Unlike the conventional non-vocational education which focuses on academic theoretical research, vocational education presents distinct differentiating features in multiple aspects: At the level of training objectives, vocational education is employment-oriented, closely aligning with the actual demands of industries, and is dedicated to cultivating technical and skilled talents who can directly engage in production and service frontlines for society; in terms of teaching content, the curriculum system of regular education often centers on the imparting of basic theoretical knowledge, while vocational education courses emphasize practical relevance, with practical teaching typically accounting for more than 50%, thereby enhancing students' practical operational abilities; in terms of the model of operation, vocational education particularly stresses in-depth cooperation with enterprises, integrating real enterprise projects and production standards into the teaching process through diverse models such as order-based classes, modern apprenticeship systems, and industry-education integration communities, achieving seamless integration between education and industry; in the dimension of professional setting, vocational education demonstrates remarkable dynamic adaptability, necessitating timely and rapid adjustments in line with the pace of industrial transformation [3].

3 Typical Applications and Experience References of Artificial Intelligence in Other Educational Fields

3.1 Innovation of artificial intelligence in Basic Education Field

In the basic education stage, artificial intelligence technology has demonstrated powerful enabling capabilities. It has effectively promoted the transformation of teaching models and improved the quality of education at the same time. For example, in terms of personalized learning support, many online education platforms have introduced adaptive learning systems driven by artificial intelligence algorithms. These systems can, based on various data sources such as students' learning progress, knowledge mastery, and assessment performance, intelligently adjust the learning content and difficulty, thus improving learning efficiency. In the offline classroom environment, some schools have deployed intelligent teaching assistants. These assistants can record teachers' teaching behaviors in real-time, including question-asking frequency, explanation duration, and interactive activities. Through artificial intelligence-driven analysis, these assistants generate visual reports, providing teachers with actionable insights to optimize their teaching strategies.

In addition, artificial intelligence technology plays a key role in promoting the fair distribution of basic education resources. Since the launch of the National Smart Education Platform for Primary and Secondary Schools in China in 2022, artificial intelligence has been used to continuously collect and accurately push high-quality curriculum resources to schools in remote areas, which has enriched the learning experience of students in underdeveloped areas, addressed the local resource shortage problem, and promoted the realization of educational equity.

3.2 The Application of Artificial Intelligence in Higher Education

In the field of higher education, artificial intelligence has been deeply integrated into teaching, research, and management, bringing all-round innovation.

In terms of teaching innovation, many universities use artificial intelligence to create smart classrooms. Especially in experimental teaching, the empowerment of artificial intelligence effectively solves the problem of limited traditional experimental resources. For example, Peking University has established an interactive online teaching platform covering virtual simulation experimental projects in multiple majors. Students can conduct experiments in a virtual environment. The artificial intelligence system will provide real-time feedback on their operation results and give guiding suggestions. Take the aviation engine experiment course as an example. Students can repeatedly try different experimental parameter settings in the virtual environment, which significantly improves the accuracy of experimental operations and enhances the effect of experimental teaching.

In terms of research assistance, artificial intelligence technology can help university researchers process massive amounts of data and discover potential patterns. For example, the artificial intelligence engine developed by Tsinghua University in the field of environmental science can conduct real-time analysis of environmental monitoring data, predict environmental change trends, and provide data support and decision-making references for research projects, greatly improving research efficiency.

In terms of educational management, artificial intelligence also plays an important role. Fudan University in China has built a "Smart Student Affairs" management platform. Through artificial intelligence technology, it integrates multi-dimensional data of students during their time at school, such as academic performance, course performance, participation in campus activities, and mental health assessments. With the help of machine learning algorithms, this platform can dig out the potential correlations behind the data, achieving dynamic monitoring and accurate profiling of students' growth and development.

3.3 The Practice of Artificial Intelligence in International Education

In the field of international education, artificial intelligence technology is becoming a significant driving force for promoting cross-border cultural exchange and language learning, especially in the aspect of virtual cultural exchange, demonstrating unique advantages. Virtual cultural exchange platforms can rely on virtual reality (VR), augmented reality (AR), and natural language processing technologies to build immersive interactive scenarios that transcend time and space. For instance, virtual cultural spaces generated through VR technology can precisely present scenes such as traditional festival celebrations and historical and cultural sites of different countries. Coupled with artificial intelligence-driven intelligent navigation systems, learners from different cultural backgrounds can break through geographical barriers and perceive the concrete forms and deep connotations of foreign cultures from a first-person perspective.

4 The Main Predicaments Currently Faced by Vocational Education in China

4.1 Vocational Education Faces Persistent Discrimination

In China, due to the influence of traditional concepts such as the official standard ideology of "excellence in learning leads to officialdom", the social perception of occupational hierarchies, and the education-background-first employment orientation, there has long been a cognitive bias against vocational education in society, which is regarded as "inferior education", which seriously hinders the development of vocational education.

In terms of educational concept, most parents are influenced by the traditional concept of "valuing general education over vocational education". They believe that their children can only achieve better development by receiving general education and entering undergraduate universities. Even if their children's academic performance is not ideal, they are reluctant to prioritize vocational education, resulting in limited quality of students admitted to vocational colleges.

In the job market, graduates from vocational colleges face obvious educational discrimination and career prejudice. When recruiting, enterprises often set the educational threshold at the undergraduate level or above. For the same positions, the salary and promotion opportunities of vocational college graduates are significantly lower than those of ordinary university graduates. According to the Report on the Educational Investment Returns of Chinese Workers released by Zhaopin, individuals with a bachelor's degree earn approximately 2 million yuan more in total income over their career than those with an associate degree, while those with a master's degree earn an additional 1.5 million yuan compared to bachelor's degree holders. When factoring in differences in promotion speed, the academic qualification premium for management positions can reach 15%-20% of the annual salary. This fully reflects graduates from vocational colleges lag behind those from regular institutions of higher education in terms of both salary and promotion opportunities. Even in some technical R&D positions, vocational college graduates with solid practical skills find it difficult to obtain fair competition opportunities due to their educational background labels. Such unfair treatment further exacerbates the negative social perception of vocational education.

4.2 The Imbalance Between Supply and Demand of Teaching Resources

There exists a serious imbalance between supply and demand and uneven distribution of vocational education teaching resources. The gap in teaching resources among different regions and institutions is significant. Vocational colleges in developed areas are equipped with advanced training facilities and rich course resources, while those in less developed areas not only have outdated hardware facilities but also lack high-quality course resources. Especially when it comes to educational funding, the gap between different regions is quite obvious. As shown in Table 1, there is a huge gap in vocational education funding between economically developed and underdeveloped provinces in China. In 2025, the median annual budget of vocational colleges in Zhejiang Province reached 460.32 million yuan, while the median annual budget of vocational colleges in Shanxi Province was only 117.93 million yuan. At the same time, teaching resources are difficult to precisely match students' personalized learning needs. Due to the lack of effective analysis of multi-dimensional data such as students' learning foundation, interests and specialties, and career planning, schools find it hard to precisely push teaching resources. Teachers also have difficulty in formulating differentiated teaching plans for different students during the teaching process, resulting in some students lagging behind in their learning progress, while those with more potential cannot be further improved. Thus, the utilization efficiency of resources is extremely low.

Table 1. 2025 Annual budget funds statistics of higher vocational colleges by province in China
(Unit: ten thousand yuan)

Number	Province	Number of Schools Disclosing Budgets	Maximum Budget	Minimum Budget	Median Budget
1	Zhejiang	36	138,082	10,105	46,032
2	Shanghai	8	64,203	20,964	39,826
3	Guangdong	52	324,159	10,314	35,321
4	Tibet	2	59,947	8,066	34,006
5	Guangxi	31	91,069	12,000	33,639
6	Shandong	59	91,005	12,922	33,486
7	Chongqing	23	77,946	19,760	33,376
8	Yunnan	39	150,336	1,806	33,338
9	Beijing	16	77,325	7,910	32,515
10	Jiangsu	68	147,800	2,864	32,177
11	Jilin	16	62,636	10,008	32,148
12	Henan	56	203,263	7,831	29,955
13	Xinjiang	18	52,880	1,329	28,738
14	Jiangxi	46	66,572	5,315	28,653
15	Fujian	28	64,337	10,006	27,767
16	Hubei	43	81,609	3,825	27,696
17	Sichuan	41	95,219	4,117	27,378
18	Tianjin	22	52,535	7,854	26,596
19	Anhui	49	92,502	2,372	25,376
20	Guizhou	40	58,087	452	24,559
21	Hainan	6	59,015	14,590	24,242
22	Shaanxi	26	57,829	6,997	23,322
23	Hebei	46	90,701	4,734	21,633
24	Gansu	22	71,752	3,745	20,497
25	Inner Mongolia	27	44,049	3,682	19,707
26	Qinghai	7	41,482	14,458	17,775
27	Hunan	61	45,016	5,715	17,151
28	Heilongjiang	30	43,945	3,894	15,823
29	Liaoning	33	79,791	5,873	14,823
30	Ningxia	11	51,933	5,512	11,958
31	Shanxi	39	77,658	4,663	11,793

Source: 2025 annual departmental budgets publicly released by respective higher vocational colleges

4.3 Lack of Dynamic Monitoring of Students' Learning Conditions and Personalized Guidance

At present, the monitoring methods for students' learning situations in vocational education are relatively single and lagging behind. They mostly rely on traditional exams and homework for phased evaluations, which cannot provide real-time and comprehensive understanding of students' learning dynamics. Teachers also find it difficult to obtain detailed data on students' knowledge acquisition, skill training, and learning attitudes, and thus cannot promptly identify problems in students' learning processes, nor can they offer targeted and personalized guidance. Especially in practical teaching, it is hard to effectively collect and analyze data such as students' operation processes and skill mastery levels, resulting in a lack of precise feedback in practical teaching and an inability to meet students' personalized development needs, which restricts the improvement of students' vocational skills.

4.4 The Teaching Quality Evaluation System is Outdated and Lacks Sufficient Feedback

At present, there are many shortcomings in China's vocational education teaching quality evaluation system. The evaluation indicators mainly focus on the assessment of theoretical knowledge. The evaluation weight for practical skills and professional qualities is low, and there is a lack of process-based evaluation. As a result, there is a mismatch between the skills of vocational college graduates and job requirements. The report on the market-oriented employment of secondary vocational school graduates released by the Nantong Bureau of Statistics in 2023 shows that during the employment process, 38.7% of secondary vocational school graduates think that the professional skills teaching in school is not practical enough and cannot meet the needs of employers.

At the same time, the feedback mechanism of evaluation results is not perfect. Teachers can't adjust teaching strategies in a timely manner according to the evaluation results, and it's also difficult for schools to optimize teaching management based on evaluation data. In addition, a large amount of data involved in the evaluation process lacks effective integration and in - depth analysis. It's hard to find potential problems in the teaching process, and there is no strong data support for the improvement of teaching quality.

4.5 Shortage of High-Quality Digital Teaching Resources

At present, there are only 203 national-level vocational education professional teaching resource libraries in China, which is far from meeting the demand of the country's vigorous promotion of the digital transformation of vocational education. Meanwhile, the development of digital teaching resources lacks systematicness and standardization, and the content is not updated in a timely manner, making it difficult to reflect the latest technologies and practical achievements in the industry. In front-line teaching, traditional online teaching shows the drawbacks of insufficient immersion and interaction experience, as well as poor remote practical training effects, which cannot meet the diverse and personalized learning needs of students. Taking the mechanical manufacturing major as an example, the existing online courses are mostly theoretical knowledge explanations, lacking virtual simulation experiments, practical operation videos and other resources. As a result, students find it difficult to master practical operation skills through online learning, and the learning effect is greatly reduced.

5 Innovative Paths for Artificial Intelligence to Break Through the Dilemma of Vocational Education

5.1 Eliminating Discrimination and Reshaping Social Perception

Artificial intelligence technology can reverse society's prejudice against vocational education by building a multi-dimensional publicity and guidance system. On one hand, vocational colleges can use artificial intelligence-generated content (AIGC) technology to create immersive publicity materials such as VR and AR. These materials can directly show the innovative achievements and practical abilities of vocational college students in fields like intelligent manufacturing and digital creativity, which can break the stereotype that "vocational education is inferior" held by the public. On the other hand, the government can use artificial intelligence-based public opinion monitoring and analysis systems to track social public opinion trends in real-time. It can accurately identify the public's misunderstandings about

vocational education, and then conduct targeted popular science and positive guidance through channels such as social media and short-video platforms.

In addition, social media and short-video platforms can also use artificial intelligence-driven intelligent recommendation algorithms. According to the interest preferences of different groups, these algorithms can push successful cases of vocational education and employment prospect data in a personalized way, which can gradually increase social recognition and improve the public opinion environment for vocational education.

5.2 Allocating Educational Resources Precisely

In response to the imbalance between supply and demand of teaching resources and the uneven distribution across regions, artificial intelligence technology can achieve intelligent optimization and dynamic allocation of resources. Firstly, through big data analysis and machine learning algorithms, artificial intelligence can deeply mine multi-dimensional data such as students' learning foundations, interests and specialties, and career plans, customize personalized learning paths for each student, and precisely push high-quality courses, practical training resources to improve the efficiency of resource utilization. Secondly, artificial intelligence can quantitatively assess the resource gaps in different regions and institutions, providing scientific decision-making basis for educational authorities on resource allocation, and guiding financial investment and social resources to lean towards weak areas. Additionally, artificial intelligence can build a national vocational education resource sharing platform, through intelligent search and recommendation functions, to achieve cross-regional sharing of high-quality courses, teaching cases and other resources, narrowing the gap in educational resources among regions.

5.3 Building a Learning Situation Detection System and a Personalized Teaching System

Artificial intelligence technology can establish a comprehensive and real-time learning situation monitoring and feedback mechanism, addressing the insufficiency of personalized teaching. By collecting data on students' theoretical learning, practical operations, learning attitudes through multiple channels such as IOT devices and smart terminals, artificial intelligence can utilize deep learning algorithms for real-time analysis, generating dynamic student learning profiles and accurately identifying knowledge weaknesses and skill deficiencies. Teachers can then adjust their teaching strategies in a timely manner based on the learning situation analysis reports generated by artificial intelligence, providing personalized learning guidance for students. For instance, in practical teaching, artificial intelligence can monitor students' operation processes in real time through motion capture and image recognition technologies, promptly correct mistakes and offer targeted improvement suggestions. Additionally, artificial intelligence can simulate real work scenarios, providing students with virtual training environments. Through intelligent scoring and feedback systems, it helps students enhance their vocational skills through repeated practice, meeting their personalized development needs [4-6].

5.4 Optimizing the Assessment of Teaching Quality

Artificial intelligence technology can be utilized to reshape the quality evaluation system of vocational education, and produce scientific and intelligent assessment. On the one hand, artificial intelligence can combine multi-dimensional data, such as theoretical examinations, practical operations, students' professional qualities, and return a system of evaluation index that is more comprehensive and objective than when done manually. The quality of teaching can be assessed more accurately when the evaluation combines, dynamic process quality evaluations and static terminal evaluations. During the teaching quality assessment, the assessment team can evaluate the students' knowing and expression practicums by using natural language processing (NLP) technology to analyze student text data. In addition, computer vision technology can be applied to further evaluate the standardization outcomes of students' practical operations. On the other hand, artificial intelligence can mine in-depth assessment data and present them visually, which allows teachers to identify issues in the teaching process and allow timely updates to teaching plans. Similarly, the data can be used to support school management, inform decisions regarding updates to discipline such as major setting adjustments or curriculum system-reform, and heighten the continual enhancement of vocational education quality [7].

5.5 Accelerating the Digital Transformation of Vocational Education

In the digital development of vocational education, artificial intelligence can offer support in two aspects: resource development and governance capacity.

Regarding resource development, artificial intelligence-generated technology can quickly create digital resources like virtual simulation experiments and interactive teaching courseware. And it can ensure that the content keeps up with the latest industry technologies through an intelligent update mechanism. In terms of digital governance, artificial intelligence can break down the data barriers within vocational schools. It enables data interconnection, interoperability among various departments through a data center. Furthermore, it can use intelligent analysis tools to provide decision-making support for school management, thus enhancing the school's digital governance level.

6 Conclusion

Presently, we are experiencing a time of rapid development in artificial intelligence, and new advancements in technology, warrant important opportunities for vocational education to overcome challenges surrounding development. This study delves into the practical dilemmas in vocational education in China, as it relates to social perception, resource allocation and teaching designs, and applications through artificial intelligence. This study puts forward a number of applications grounded in artificial intelligence as solutions to the identified problems. While these applications need to be further substantiated in practice, they already give us a basis for thinking about reforming vocational education and developing education that is technologically enabled and empowered. Looking ahead, it is expected that these applications will provide a reference for the intelligent transformation of vocational education, and facilitate more comprehensive advancements in the adoption of artificial intelligence technology in industry-education partnerships that will aid vocational education in producing more high-quality talent for the digital economy.

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Conflicts of Interest

The authors declare no conflicts of interest.

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人工智能賦能視域下中國職業教育困境的突圍路徑

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摘要：在人工智能（AI）技術迅猛發展的背景下，中國職業教育面臨着人才供給與產業需求結構不匹配所帶來的深層次矛盾。社會認知偏見、資源分配不均衡以及教學模式陳舊等問題，更是加劇了這些挑戰。本文系統考察了職業教育的歷史沿革、規模特徵以及當前面臨的挑戰，同時借鑑了人工智能在基礎教育和高等教育中的成功應用經驗，提出了以人工智能技術爲核心的若干創新解決方案，旨在構建職業教育與人工智能技術深度融合的理論框架，突破發展瓶頸，推動職業教育在數字經濟時代從規模擴張向內涵提升轉變。

關鍵詞：人工智能；職業教育；突破路徑；資源分配；個性化教學；數字化轉型

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