Research on the Path of Teaching Reform in Vocational Education Empowered by Internet of Things Technology in the Context of Digital Transformation

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Abstract

Under the influence of the ongoing round of scientific and technological revolution and industrial change, the in-depth integration of digital technology and vocational education system has become a key path to promote education transformation and upgrading.This paper takes the optimization and reconstruction of the talent cultivation system of higher vocational education as the core issue, systematically analyzes the real motivation and structural challenges of the teaching reform of higher vocational education empowered by digital technology, and further proposes the reform path mainly based on the "paradigm reconstruction and mechanism innovation".The study explores the practical reform strategy of "Introduction to Internet of Things Technology" from the aspects of teaching organization, construction of teaching material system, innovation of teaching mode and allocation of curriculum resources.Specific initiatives include: promoting the specialization of course content and synergistic teaching implementation by relying on a multi-principal collaborative teaching team; replacing the traditional teaching materials with a modular and task-oriented teaching materials system to enhance the dynamic adaptability of teaching resources; and promoting the blended teaching practice of online and offline integration by means of a smart teaching platform and information technology tools, so as to optimize the learning process and the experience of the learners.On this basis, a digitally empowered higher vocational education teaching path that adapts to future industrial needs and supports high-quality development is constructed.The study results can provide theoretical support and practical reference for higher vocational colleges and universities to realize the leap in talent cultivation quality.

Keywords: Higher Vocational Education; Digital Technology; Curriculum Reform; Blended Learning; Iot Technology Course

1. Introduction

At present, the next generation of digital technologies—represented by artificial intelligence, the Internet of Things, big data, and others—is evolving at an unprecedented speed and profoundly reshaping the global industrial structure and technological ecosystem (Rane, 2023). Under the background of this change, the vocational education system, as a key channel for technology diffusion and a key support platform for industrial upgrading, is undergoing deep-level systematic remodeling. On the one hand, the technology-driven society's demand for composite and innovative talents continues to rise, prompting the transformation of vocational education training mode from single-skill transmission to multi-dimensional competence construction paradigm (Shi & Yonezawa, 2023). On the other hand, this transformation requires more dynamic education content, more diversified teaching organization, and a more accurate and efficient teaching process (Rane, 2023). Facing the pressure of transformation and new development opportunities, higher vocational colleges and universities, as the core carriers of technical and skilled personnel training, should actively buttress the development trend of industrial intelligence and digitization, and build a connotative development path by focusing on the reconstruction of the curriculum system, the optimization of the teaching organization, the updating of teaching resources and the integration of intelligent tools and other key aspects. At the same time, the mechanism of teacher collaboration, school-enterprise linkage and interdisciplinary integration should be strengthened to provide a solid guarantee and sustained momentum for the construction of a high-quality vocational education system (Bing & Zhenzhen, 2025).

2. Literature Review and Problem Statement

With the deepening of China's strategic plan to comprehensively promote the high-quality development of education, the penetration of digital technology in the education system has continued to deepen, and its role in promoting the modernization of education and building the national core competitiveness system has become increasingly prominent (Shi & Yonezawa, 2023). Especially in the field of vocational education, the systematic introduction of digital infrastructure, informatization platforms and intelligent teaching tools is profoundly changing the logic of traditional teaching organization and talent cultivation paradigm. 2025, a number of competent national departments have jointly issued policy documents, clearly proposing to strengthen the construction of the digital base of education, and to promote the in-depth fusion of technological tools and educational activities, in order to accelerate the construction of new types of education ecosystems with technological competence at their core, and to support the structure of vocational education, education ecology, supporting the overall transformation and functional reorganization of the vocational education structure (Jing, 2024).

At the same time, the rapid evolution of key technologies represented by intelligent perception, data intelligence, edge computing and ubiquitous interconnection has pushed the socio-economic system to accelerate into the "human-machine collaboration - intelligent decision-making" oriented industry.shape. Driven by this trend, the demand of employers for composite and highly adaptable talents is rising exponentially, which is no longer only concerned with the execution of job skills, but also emphasizes the comprehensive ability of practitioners in interdisciplinary thinking, data-driven application, system integration and innovation and collaboration. The vocational education system is facing a repositioning of the talent supply structure, and its internal logic needs to be shifted from "tool operation-oriented" to "technical understanding and scenario response" of the composite ability construction mode.

However, at present, most of the higher vocational colleges and universities are still lagging behind in the design of the curriculum system and the allocation of teaching resources, and the technical teaching content stays in the shallow stage such as software application, basic programming, and so on, and lacks the systematic guidance and scenario-based application training of the cutting-edge key technologies, and there is an obvious disconnect between the teaching process and the real industrial demand. This problem has seriously restricted the pace of professional education in line with the intelligent society. Therefore, accelerating the reconstruction of the curriculum system, innovating teaching methods, and iteratively updating teaching resources are urgent tasks. At the same time, constructing a vocational education pathway that adapts to the wave of digital technological change has become a pressing issue for higher vocational colleges and universities (Ridsdale, 2015).

2.1. Shift of Teaching Focus and Lagging Core Literacy

With the comprehensive promotion of the strategy of "deepening education digitization" at the national level, the institutionalized introduction of digital technology in vocational education has entered a stage of extensive development. In recent years, many higher vocational colleges and universities have formulated medium- and long-term technology development strategies to adapt to the future shape of education based on policy guidance, covering campus network infrastructure construction, intelligent teaching platform construction, and education informatization resource allocation and other dimensions.Under the joint promotion of institutional and financial support, all kinds of digital facilities and platform systems have achieved certain results in terms of technical architecture and functional integration. This presents a good situation for the construction of "an online campus"(Alier et al., 2012).

However, from a practical point of view, most institutions still have the tendency of "focusing on construction but not on education" and "concentrating on system but not on kernel" in the process of implementation, and the digital transformation work is mainly concentrated on the optimization and upgrading of the peripheral systems such as the automation of administrative affairs and the intelligent teaching environment, and fails to penetrate deeply into the course content and the content of the curriculum.Digital transformation mainly focuses on the optimization and upgrading of peripheral systems such as the automation of administrative affairs and the intelligence of the teaching environment. It fails to penetrate deeply into core aspects of teaching such as course content, teaching methods and the cultivation of students' core abilities.Especially in the complete cognitive path of "cutting-edge technology cognition - understanding - practical", institutions still lack systematic curriculum guidance, scenario-based teaching design and stage-by-stage competence evaluation mechanism, resulting in students' mastery of emerging technologies and the application of the ability to build an obvious gap.There is an obvious gap, which affects the deep integration of digital technology and the growth process of talents(Opfer & Pedder,2011).

2.2. Outdated Teaching Content and Lack of Foresight

Most vocational institutions still prioritize basic digital skills courses, such as software applications, which fail to keep pace with the dynamic industrial demand. A national survey by the China Education Development Research Institute (2023) found that over 62% of institutions focus on basic computer operation, while only 15% have introduced advanced modules like cloud computing or data analysis. This mismatch reduces students' motivation and limits their ability to adapt to emerging industry contexts.

With the popularization of smart terminals and the diversification of information access paths, students' demand for technical learning has gradually shifted to comprehensive practice and the cultivation of application ability in complex situations.However, the traditional curriculum lacks adaptability in the form of teaching and content organization, which is difficult to stimulate students' cognitive interest and cannot effectively support them to build a digital mindset in line with the actual industry.Therefore, it is urgent for higher vocational education to reconfigure the existing curriculum system as a whole, integrate the core technology system of key areas such as cloud computing architecture, data governance concepts, perceptual network technology, intelligent algorithmic models and virtual simulation platforms into the teaching framework, and gradually build a curriculum content system oriented to the forefront of the industry and support for continuous updating, so as to push forward the synchronization between the teaching structure and the development of technology.

2.3. Lack of Effective Connection Between Technical Basic Courses and Professional Learning

Through the comparative analysis of the curriculum systems of many higher vocational colleges and universities, it is found that most of the current professional training programs have not yet realized the organic integration of digital technology content and professional core courses at the level of structural design.Although the basic information courses have been included in the teaching plan of most majors, and are usually set in the early stage of students' enrollment as a mandatory general education course, such courses are mostly based on the teaching of instrumental knowledge, and lack a systematic linkage mechanism with the content of professional learning.

In actual teaching, these courses show the characteristics of "module isolation", and lack of effective transition and integration design with the subsequent professional courses, which makes it difficult for students to understand the real value of related technologies in professional applications. In order to further verify this problem, this paper conducted a questionnaire survey on the third-year students (192 in total) of the mechatronics program of Hunan Bio-mechanical and Electrical Vocational and Technical College.The results show that the proportion of those who can understand the application value of technology in professional learning in a more in-depth way is only 6%, the proportion of those who have a basic understanding is 18%, the proportion of those who have superficial cognition reaches 41%, the proportion of those who think that the technical content is not very relevant to their specialty is 33%, and the proportion of those who have no cognition at all is about 2%.

The results of this survey fully indicate that although digital skills courses have taken their place in the teaching system, there is still an obvious lack of cross-curricular integration and application deepening, which makes it difficult to effectively support the simultaneous enhancement of students' digital literacy and professional competence, and exposes the existence of a "disconnect between technology teaching and professional development" in the current teaching system. It also reveals that the current teaching system has the structural problem of "disconnection between technical teaching and professional development".

3. Methodology and Reform Strategies

Under the dual background of the continuous evolution of new-generation information technology and the deep reshaping of industrial structure, higher vocational education is faced with multiple challenges, such as lagging curriculum content, single teaching method and unbalanced teacher structure. In order to realize the transformation and upgrading of education and teaching mode, it is urgent to implement systematic reconstruction in multiple dimensions, such as teaching organization, resource development, teacher system and teaching evaluation, so as to promote the in-depth coupling of digital technology and the whole process of teaching. This paper takes the "Internet of Things Technology" course as an entry point to explore the path of change of the higher vocational education system in the context of technological empowerment, and puts forward four core implementation strategies in an attempt to build a reform program that meets the needs of future industries and is both innovative and operable.

3.1. Cross-border Collaborative Teaching Team

Reform requires collaborative teaching teams involving university professors, lecturers, and enterprise engineers. In the IoT course team, 45% are associate professors, 35% lecturers, and 20% enterprise experts, forming a dual-qualified structure that ensures 'two-way empowerment'. Figure 1 illustrates the team structure by professional title and industry participation.

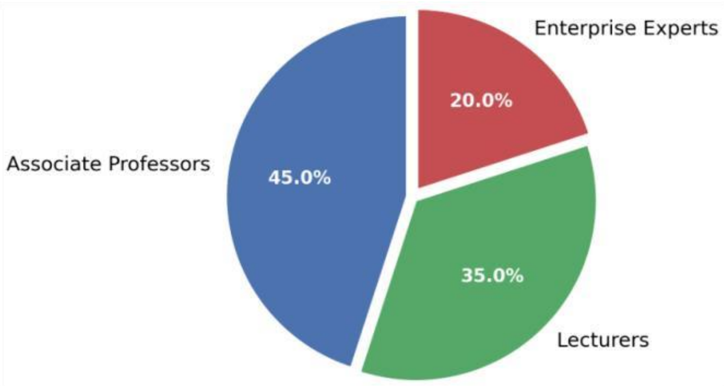

Figure 1. Composition of IoT course teaching team by professional title and enterprise participation

The first step to promote the reform of the professional curriculum system is to break through the traditional teaching mode of a single lecturer and build a composite teaching team characterized by "cross-border collaboration".The team should be composed of university teachers, enterprise engineers and technicians and industry experts, through the division of labor and cooperation, the industrial line of practical experience and academic knowledge system effectively integrated to achieve "two-way entry, two-way empowerment" teaching and learning collaboration mechanism. In the construction of the "Internet of Things Technology" course, enterprise tutors can lead the project case analysis and practical training guidance, while school teachers are responsible for theoretical explanations and curriculum integration, to further enhance the industry suitability of the teaching content and the comprehensive effectiveness of the implementation of the curriculum.

3.2. Modular Teaching Resources

Restricted by the compilation cycle and publication mechanism of traditional teaching materials, there are problems such as fixed content and lagging update of teaching materials in the current higher vocational teaching, which is difficult to respond to the demand for dynamic adjustment of teaching content brought about by the rapid change of digital technology. To this end, we should promote the transformation of the teaching material system from closed to open, and encourage teachers to independently develop teaching resources with task-oriented and modularized structure according to the teaching objectives and industry needs.Each module can be developed around specific technical topics, examples include "IoT device integration and deployment," "data governance and cloud services," and "smart agriculture monitoring systems", to support the implementation of project-based teaching and personalized teaching design, thus enhancing the flexibility and effectiveness of teaching resources. It supports project-based teaching implementation and personalized teaching design, thus enhancing the flexibility and effectiveness of teaching resources.

3.3. Blended Teaching Mode

In the context of the rapid expansion of the digital learning environment, the teaching mode is no longer limited to the traditional offline classroom. It is urgent to build a blended teaching system that combines online and offline.Relying on the intelligent teaching platform, simulation experiment system, practical training data collection equipment and other technical tools, it can form a full-process teaching scenario covering "theoretical learning-skills training-task implementation".In the "Internet of Things Technology" course, the basic theoretical content can be transferred to the online module, through microclasses, visualization animation and other forms of self-study; while the project practice link is conducted offline, with the help of equipment construction and system debugging in the real environment, to strengthen the students' practical ability and technology transfer ability, and to build a "learning-practice-doing" teaching environment.The project practice session is completed offline with the help of equipment construction and system debugging in a real environment. This is done to strengthen students' practical operation ability and technology transfer ability, so as to build a complete closed loop of "learning-practice-doing".

3.4. Multi-dimensional Evaluation

In the competence-oriented talent cultivation mode, the traditional evaluation mechanism based on summative examination is difficult to fully reflect students' knowledge mastery and skill development.A diversified evaluation system based on formative evaluation and emphasizing both process and outcome should be constructed to strengthen the tracking and motivation of the whole process of students' learning behavior.Specifically, the quality of learning tasks, project implementation performance, teamwork ability, innovation and practice results can be incorporated into the evaluation index system, realizing the comprehensive evaluation of "quantitative + qualitative", "subjective + objective", and promoting the integrated operation of "teaching, learning, doing and evaluation", effectively enhancing students' learning initiative,Learning, doing, evaluation" integrated operation, effectively enhance students' learning initiative and comprehensive ability development level.

4. Case Study: IoT Technology Course Reform

Under the dual background of the accelerated evolution of the current new wave of digital technology and the deepening of the national agricultural modernization strategy, Internet of Things (IoT) technology, as the basic support platform for the construction of the intelligent agricultural system, has increasingly become an important module for the cultivation of technical and skilled personnel.Higher vocational education as a core type of education to support the transformation and upgrading of the national industry, the construction of its curriculum system urgently needs to closely follow the changes in the industrial structure and the forefront of technological development, to build the teaching content and teaching methods that are highly compatible with the emerging job competencies. This paper takes the "Internet of Things Technology" course of a higher vocational college as the research object, and systematically combs through the reform practices of the course in terms of reshaping the teaching concept, constructing the teaching path and optimizing the evaluation mechanism, aiming at providing a practical paradigm and theoretical support for the digital transformation of the relevant courses in the field of higher vocational education and the competence-oriented teaching mode (Yang et al.,2020).

4.1. Reconstruction of Teaching Objectives: From Knowledge Transmission to Competence Cultivation

In the traditional curriculum system, the design of "Internet of Things technology" courses generally focus on the linear transmission of basic knowledge, emphasizing the conceptual understanding and introduction of technical principles, but in the teaching practice, the precise docking with the actual needs of vocational positions is ignored, resulting in the lack of the ability to migrate students to the real work scenarios, even though they have mastered a certain amount of theoretical knowledge .As a result, although students master certain theoretical knowledge, they lack the ability to transfer it to real work scenarios .

This round of curriculum reform is based on the principle of "competence-oriented and task-driven", and the original teaching objectives have been systematically reconstructed, and the core orientation of "staying close to industrial scenarios and strengthening the comprehensive ability" has been clearly put forward,highlighting technical practice" as the core orientation. In terms of specific goal setting, the course is no longer limited to enabling students to understand the components of the Internet of Things system and deployment process, but requires them to have the ability to independently complete the design, deployment and debugging of the greenhouse environment monitoring system in a real situation; at the same time, the course also focuses on students' comprehensive application ability training in the key links, such as data acquisition, remote control and visualization analysis, to promote the construction of a complete cognitive chain from "sensing - communication - analysis - management".At the same time, the course also focuses on students' comprehensive application ability training in data acquisition, remote control, visualization and analysis, and promotes the construction of a complete cognitive chain from "sensing-communication-analysis-management".Through the upgrading of the target level and the advancement of task scenarios, the course tries to realize the essential transformation from "knowledge inculcation" to "ability generation", which is truly in line with the talent cultivation logic of vocational education of "learning by doing, learning by doing".It truly fits the logic of vocational education, which is "learning by doing and learning by doing"(Tian,2025).

4.2. Optimization of Teaching Content: Constructing a Three-Tier Structure of "Basic-Application-Project"

In order to break the problems of fragmented knowledge and disjointed content, the course content is reconstructed according to "technical principles - core modules - typical tasks", and a three-tier knowledge structure system is constructed as shown in Table 1.

Table 1. Tertiary knowledge structure system table

Serial number	Structural system	content
1	Base layer	Includes sensor fundamentals, communication protocols, an introduction to embedded systems, etc.
2	Application layer (computing)	Covering agricultural information collection technology, wireless communication network construction, edge computing primer, etc.
3	Project level	Setting up typical tasks such as "intelligent irrigation system construction" and "agricultural data visualization platform development".

4.3. Innovative Teaching Modes: Exploring Diversified and Interactive Teaching Strategies

In terms of teaching organization, the curriculum reform actively introduces diversified teaching concepts and explores the teaching strategy of "task-oriented, project-driven and active participation" as the core.Through the integration of task-oriented teaching method, project-based learning path and flipped classroom mechanism, it realizes the teaching transformation from "knowledge instilling" to "ability constructing".The overall structure of the course adopts the dual-track operation mode of "online theoretical module + offline practical module", which expands the teaching flexibility in time and space, and enhances the initiative and interactivity of students in different learning stages.For example, in the "wireless communication module configuration" teaching unit, students need to complete the theoretical learning and pre-testing tasks pushed by the online platform before the class; and then enter the offline phase, using real equipment to carry out the construction and debugging operation of LoRa or NB-IoT communication nodes .With the support of teachers' whole process guidance and on-site Q&A, students can realize the in-depth internalization of knowledge and scenario-based migration of skills, and promote the transformation of technical cognition into practical application ability(Miao et al.,2023).

4.4. Teaching Resource Construction: Developing Digital Resources and Simulation Platforms

In order to respond to the dual demand for diversity and real-time updating of resources in the digital teaching environment, the teaching team has developed and constructed a multi-form, scalable digital teaching resource system around the course content system.The resource types cover micro-course videos, knowledge mapping structure, interactive courseware and virtual simulation experiment platform, constituting a teaching resource matrix that supports multi-path learning.This resource system not only supports students' learning and task rehearsal in stages through modular structure. It also provides technical support for teachers to implement differentiated teaching and design personalized teaching scenarios.The virtual simulation system is based on the modeling of real engineering scenarios. This allows students to complete key process simulation and system debugging training in non-training environments, effectively breaking through the limitations of the traditional classroom in terms of space, time and resource allocation. At the same time, the platform also integrates process learning monitoring and data collection functions. This provides objective data support for teaching process management, learning behavior analysis and accurate evaluation, and enhances the effectiveness of closed-loop teaching(Wang & Li,2021).

4.5. Assessment of Teaching Effectiveness: Focusing on the Process of Data and Ability Performance

In the design of the course assessment system, the reform abandons the traditional mode of taking the summative examination as the only judgment standard, and builds a comprehensive evaluation system that integrates formative evaluation and multiple competency assessment.The system emphasizes the whole process of data-driven, and the evaluation dimensions cover the completion of learning tasks at different stages, the demonstration of project training results, online learning activity indicators, teamwork efficiency and innovative practice performance. By quantifying and systematically archiving students' performance in different learning stages, the system builds a closed loop of "evaluation-feedback-optimization", forming a mechanism for continuous improvement and positive incentives.The overall evaluation framework emphasizes "results and process, cognition and practice", strengthens students' adaptability and independent problem solving ability in the real technology environment, and comprehensively improves their comprehensive literacy and professional competence (Darling-Hammond, 2010; Siemens, 2014).

5. Conclusion

This study demonstrates that IoT-empowered teaching reform in vocational education requires simultaneous improvement in teaching concepts, curriculum content, teaching methods, resource allocation, and evaluation mechanisms. The case study of the "IoT Technology" course shows that modular teaching resources, collaborative teaching teams, and blended teaching modes significantly enhance students' competence development. In future research, integrating advanced educational theories such as constructivism and connectivism can further strengthen the theoretical foundation of vocational education reform.

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Yule Xia: conceptualization, writing—original draft, methodology; Rongyu He, Yanru Chen, Min Zhou, Hao Wu: supervision, review & editing, project administration.

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The authors declare no conflict of interest.

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