



Investigating the Enhancement Strategies for Digital Literacy among Instructors of Electrical Automation Technology in Higher Vocational Institutions

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Abstract. This study aims to investigate the pathways for enhancing the digital literacy of instructors specializing in electrical automation technology within higher vocational education. By examining the current state of research both domestically and internationally, the significance of improving digital literacy among educators is elucidated. The research proposes an exploration into the construction of a framework for digital literacy specific to professional educators, the creation of "digital literacy portraits," the leveraging of leading educators to forge training and development pathways, the establishment of hybrid digital teaching resource repositories, the guidance of instructors in exploring new digital models for "four learning" classroom teaching, and the development of assessment criteria to refine the evaluation system. This study is expected to contribute to the advancement of digital literacy for automation specialists in the educational field, thereby ensuring the cultivation of highly qualified professionals in the field of automation.

Keywords: Higher vocational power system automation technology; teacher digital literacy; digital teaching; digital teaching resource library.

1 Introduction

Within the context of the increasing significance of digitalization across all spheres of the global economy and society, the advancement of "digital classroom teaching" in education has been profound. In an era characterized by leading-edge digital technologies such as supercomputing, quantum computing, blockchain, artificial intelligence, fiber optics, and 5G, the future of education is being reshaped by digital transformation, making the digital transformation of frontline teaching staff an urgent priority. The emergence of ChatGPT has, to a certain extent, compelled the field of education to initiate deeper reforms. Teachers are pivotal in propelling educational changes to keep pace with the times, adapt to, and lead in the new digital paradigm. Particularly since March 2020, the health crisis triggered by the COVID-19 pandemic has af-

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ected over 150 million students worldwide, necessitating a shift from offline to online teaching modalities, thereby raising the bar for teachers' digital literacy^[1].

Strengthening education is contingent upon strengthening the teaching force, which serves as a vital foundation for advancing educational digitalization. Confronted with the continuous emergence of digital technologies and the challenges and issues they pose to digital education, it is imperative for teachers to shift from a technology-centric mindset to one that enhances digital literacy and competitiveness. The development of digital classroom teaching aims to cultivate talents who are adaptable to the future societal needs and possess global competitiveness.

2 Analysis of Domestic and International Research Status

2.1 Analysis of International Research Status

In his 1997 publication, *Digital Literacy*, Paul Gilster describes "digital literacy" as the ability to use and understand information in the digital age, emphasizing that digital technology constitutes a "basic survival skill." He points out that digital literacy encompasses "the ability to access and apply computer network resources." The Joint Research Center (JRC) of the European Commission released the *European Framework for the Digital Competence of Educators* in 2017, providing a scientifically sound, practical, and specialized model aimed at enhancing the digital literacy of educators across various levels and types of education, thereby advancing the digitalization process in education and shaping Europe's digital future.

On September 11, 2019, the European Education Information Network (Eurydice) published the *Digital Education Report for European Schools*, which indicated that approximately two-thirds of European countries emphasize digital literacy as a crucial competency standard for all teachers. Eight European countries have developed distinctive frameworks for teacher digital literacy, most of which are based on the EU's digital competence framework.

In recent years, countries around the world have implemented development strategies related to the digital transformation of education, integrating digital technologies into educational practices to promote a comprehensive digital transformation across all elements, fields, and processes of education. For instance, the fifth iteration of the *National Education Technology Plan* was introduced in the United States in 2017, aiming to promote educational equity and transform learning experiences. In 2020, the EU launched the *Digital Education Action Plan 2021-2027*, outlining 14 action initiatives to better apply digital technologies in teaching.

2.2 Analysis of the Current State of Domestic Research

In 2018, the Central Committee of the Communist Party of China and the State Council issued the "Opinions on Comprehensively Deepening the Reform of the Construction of the Teacher Team in the New Era", which clearly stated that teachers should actively adapt to new technological changes such as artificial intelligence and informatization and actively and effectively carry out education and teaching[2]. In

2019, General Secretary Xi Jinping emphasized in his congratulatory letter to the International Conference on Artificial Intelligence and Education that China attaches great importance to the profound impact of artificial intelligence on education, actively promotes the deep integration of artificial intelligence and education, promotes educational reform and innovation, gives full play to the advantages of artificial intelligence, and accelerates the development of education that accompanies everyone's life, education that is equally accessible to everyone, education that suits everyone, and education that is more open and flexible. General Secretary Xi Jinping pointed out in the report of the 20th National Party Congress that it is necessary to promote the digitalization of education and build a learning society and a major learning country where people can learn throughout their lives. The "Key Points of the Work of the Ministry of Education in 2022" also clearly put forward the construction requirements of "implementing the strategic action of educational digitalization and accelerating the digital transformation and intelligent upgrading of education". The report of the 20th National Party Congress proposed to accelerate the building of a strong manufacturing country, a strong quality country, a strong aerospace country, a strong transportation country, a strong cyber country, and a digital China. Promote the digitalization of education and build a learning society and a major learning country where people can learn throughout their lives^[3].

In order to thoroughly implement the spirit of the 20th National Party Congress and solidly promote the national strategic action of educational digitalization, improve the standard system of educational informatization, and enhance teachers' awareness, ability and responsibility to optimize, innovate and transform educational and teaching activities by using digital technology, the Ministry of Education formulated the "Standards for Teachers' Digital Literacy" in November 2022 for the training and evaluation of teachers' digital literacy.

The "Standards for Teachers' Digital Literacy" includes five dimensions, namely digital awareness, digital technology knowledge and skills, digital application, digital social responsibility and professional development. Under each first-level dimension, there are several second-level dimensions, third-level dimensions and specific descriptions, which are of great significance for promoting the national strategic action of educational digitalization, improving the standard system of educational informatization, enhancing the level of teachers' digital literacy, promoting educational teaching innovation and quality improvement, and coping with future educational challenges^[4].

3 Significance of Research on Digital Literacy of Instructors in Higher Vocational Electrical Automation Technology Programs

3.1 Construction of a Digital Literacy Framework for Automation Instructors to Provide Theoretical Support for Deepening Educational Reform

This project focuses on the professional background and skill requirements of automation instructors, constructing a framework for digital literacy and a multi-

dimensional evaluation scheme. A three-tiered evaluation indicator system is designed with weights to cater to the intrinsic characteristics of professional instructors. This framework aims to facilitate the development of new vocational educational forms such as digital resource libraries and virtual simulation training environments, offering new directions and pathways for educational reform.

3.2 Creation of a Digital Literacy Portrait for Automation Instructors to Guide the Enhancement of Teachers' Digital Literacy

The project collects basic data on automation instructors, including foundational information, professional experience, and personality traits, as well as dynamic situational data such as teaching research behavior, online and offline learning traces, and educational outcomes. A digital literacy portrait is created to provide a comprehensive representation and characterization of instructors, enabling the establishment of tailored "talent-specific" training programs based on individual teacher characteristics.

3.3 Implementation of Classroom Digitalization Based on the "Four Learning" Model to Help Teachers Improve Digital Practice Skills

The project adopts a blended teaching model that integrates online and offline elements based on the "Four Learning" model. Digital technologies and resources are utilized to support educational teaching, allowing both instructors and students to access a variety of teaching and learning resources through multiple channels. This approach enhances teachers' digital practice teaching skills during the educational process.

3.4 Breaking Traditional Teaching Models to Conduct Diversified Digital Teaching, Aiding in Students' Personalized Growth

The project employs digital technologies for personalized and diversified teaching, practical operations, and skill training, providing technical support for individualized student learning. Technologies such as behavioral analysis, learning feedback, and intelligent interaction are used to create student portraits, enabling teachers to conduct more precise personalized teaching and thereby achieve innovation in education and teaching.

4 Key Issues Addressed by Enhancing Teachers' Digital Literacy

4.1 Addressing the Polarization of Digital Teaching Methods

In the integration of education and digitalization, some older teachers in the field of electrical power system automation technology find it difficult to accept new things and must go through a tortuous and arduous learning process to achieve digital teach-

ing. On the other hand, some young teachers, born in the era of internet information, have basically mastered computer-assisted teaching tools, and using PPT for lectures has become a common and fixed form. This situation makes many teachers unable to teach normally in the event of power outages or computer failures, indicating a severe dependence of education on information technology.

4.2 Addressing the Misapplication of Digital Technology

The widespread application of information technology in education has expanded the original single-text form to include text, pictures, animations, videos, and simulations. However, in the practical teaching of the electrical power system automation technology major, some teachers do not consider the unique attributes of the discipline and the cognitive characteristics and levels of students. They pile all information technology elements into the courseware, focusing on digitalization rather than teaching effectiveness. This not only distracts students but also leads to the formalism of digital application.

4.3 Addressing the Multi-level Issue of Digital Teaching Proficiency

The explosive development of information technology has significantly improved the digital teaching proficiency of teachers in the electrical power system automation technology major overall. However, the overall level is uneven, with some showing a higher level of proficiency, where digital teaching design is scientific and reasonable, and the implementation of digital teaching is effective. However, some teachers apply information technology in a simplified manner. This is mainly manifested in young teachers prioritizing the pursuit of technology application over teaching quality, while older teachers struggle to keep up with the development requirements of technology.

5 Approaches to Addressing Issues

5.1 Literature Analysis Method

By reviewing and studying policy documents such as "Opinions on Comprehensively Deepening the Reform of the Construction of the Teaching Staff in the New Era" and "Key Points of Work of the Ministry of Education in 2022", in conjunction with the industry standards of "Teacher Digital Literacy", and based on the characteristics of the work of teachers in the automation specialty, drawing on the concepts and experience of constructing mature teacher digital literacy frameworks, and considering the current status and needs of China's social development, comprehensively considering the level of digital literacy of professional teachers, to formulate a teacher digital literacy framework that meets the needs of teachers in the automation specialty.

5.2 Questionnaire Survey Method

Conduct research on selected subjects through the "Survey Questionnaire on the Current Status of Digital Literacy of Teachers in the Automation Specialty". The questionnaire is divided into two parts: basic information and current status of literacy. Basic information includes the age group, gender, highest academic degree, and teaching specialty of teachers. The current status of literacy includes 24 items, covering five abilities: attitude and awareness, use and development of digital resources, digital teaching skills, empowerment of learners, and research and development. Analyze whether there are significant differences in the digital literacy of teachers of different genders, titles, and academic qualifications.

5.3 Case Comparison Analysis Method

Conduct an analysis in conjunction with research and practice cases of the digital literacy enhancement path of teachers in the automation specialty with different genders, titles, and academic qualifications, to determine whether there are significant differences in the cultivation of digital literacy among teachers with different genders, titles, and academic qualifications, and to consider the influencing factors of professional teachers' digital literacy.

5.4 Empirical Analysis Method

By constructing a "Digital + Teaching" vocational college subject teaching model, carry out a "four-study" model based on "pre-class self-study, in-class guided learning, post-class supervision, and full-process companionship", and use the Shandong Electric Specialized Digital Learning Platform, adopting a blended teaching model that runs online and offline in parallel. Enhance digital practical teaching skills in the teaching process, deepen theoretical understanding in the process of digital teaching research, and reveal its operability, practicality, and superiority in teaching applications.

5.5 PDCA Cycle Research Method

According to the "Plan→Do→Check→Act" (PDCA) procedure and method, improve the system for enhancing teachers' digital literacy under the background of the digital transformation of vocational education, while researching, practicing, building, and improving. Find and solve problems in a cycle, achieving the research objectives.

6 Research Approach for Digital Literacy of Instructors in Higher Vocational Electrical Automation Technology Programs

6.1 Development of a Professional Digital Literacy Framework to Guide New Directions for Teacher Professional Growth

This project constructs a comprehensive and professionally targeted digital literacy framework for instructors in higher vocational electrical automation technology programs. By delving into the practical teaching needs of the specialty and the future development trends of the industry, the framework clearly defines the requirements for instructors across various dimensions, including the application capabilities of digital technology, mastery of innovative teaching methods, efficient information management skills, and keen innovative thinking literacy. This framework illuminates a clear path for instructors' self-improvement^[5].

6.2 Creation of Diverse and Personalized Training Pathways to Facilitate New Leaps in Teachers' Digital Literacy

The project is dedicated to exploring an efficient and feasible approach to training in digital literacy for instructors specializing in electrical automation technology. Tailored training courses and activities are designed to address the current digital literacy status and future development needs of instructors at different levels. Innovative blended teaching methods and training are integrated, and diverse industry-education integration training channels are actively developed to meet the varied learning needs of instructors, thereby effectively promoting new leaps in their digital literacy and teaching capabilities^[6].

6.3 Innovation in Classroom Digital Teaching Models to Cultivate New Dynamics for Automation Specialty Talents

This project establishes an innovative classroom digital teaching model for the electrical automation technology specialty, closely integrating the unique advantages of digital technology. Interactive and personalized digital teaching plans are meticulously designed, with the organic integration of virtual simulation technology and a wealth of online learning resources into classroom teaching. The project deeply explores the effective application of student-centered teaching methods in digital classrooms, fully stimulating students' interest and initiative, and injecting new and powerful dynamics into the cultivation of talents in the electrical automation technology field.

7 Research Approaches for Digital Literacy of Instructors in Higher Vocational Electrical Automation Technology Programs

This study aims to construct a digital literacy enhancement system for instructors in the field of automation and to apply it in practice. The Structure diagram of project research content is shown in Figure 1.

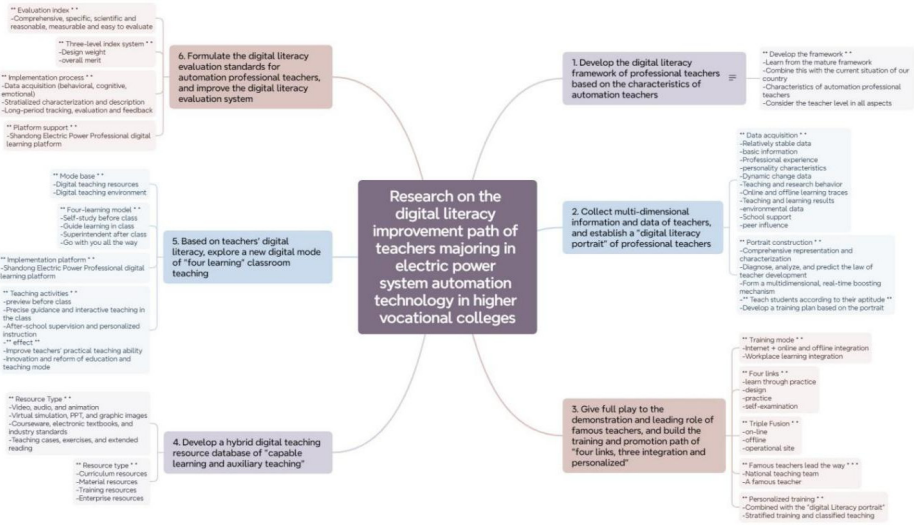


Fig. 1. Structure diagram of project research content

This project aims to build a digital literacy enhancement system for teachers in the field of automation and apply it in practice.

Firstly, by combining the characteristics of professional teachers to formulate a digital literacy framework, it clarifies the direction for development.

Secondly, it collects multi-dimensional information data to establish a "digital literacy portrait," providing a basis for precise improvement.

Next, leveraging the leading role of renowned teachers, it constructs a training and enhancement path characterized by "four stages, three integrations, and personalization," meeting the needs for personalized training. Then, based on digital literacy, it explores a new model of "four learning" classrooms to promote teaching innovation.

At the same time, starting from empowering students, it builds a "capable of learning, supportive of teaching" mixed digital teaching resource library, enriching teaching resources.

Finally, it establishes assessment standards and improves the digital literacy evaluation system to ensure continuous improvement of literacy.

By building a comprehensive and multi-channel approach, it explores a path for enhancing the digital literacy of teachers in the field of electrical power system auto-

mation technology in vocational colleges, providing a solid guarantee for cultivating high-quality automation professionals.

7.1 Development of a Professional Digital Literacy Framework in Alignment with the Characteristics of Automation Instructors

Given the dynamic nature of the electrical automation technology field, which is closely tied to industry advancements and practical applications, and the high operational risks and difficulties involved, it is imperative for instructors to possess a robust set of digital competencies. These include digital virtual simulation, digital teaching strategies, and digital collaboration. Based on the work characteristics of higher vocational electrical automation technology instructors, and drawing on established frameworks and development experiences in teacher digital literacy, a comprehensive framework is formulated. This framework considers the current social development status and needs in China, and is designed to fully account for the digital literacy levels required by automation instructors, thereby creating a framework that meets the specific needs of these professionals[7].

7.2 Collection of Multidimensional Instructor Data to Establish a "Digital Literacy Portrait" for Professional Instructors

Data collection encompasses stable data such as basic instructor information, professional experience, and personality traits, as well as dynamic, situational data like teaching research behavior, online and offline learning traces, and educational outcomes. Environmental data that support instructor development, such as school and peer influences, are also included to form the "metadata" that characterizes instructors' digital literacy. By diagnosing, analyzing, and predicting patterns of instructor learning and development, a comprehensive representation and characterization of instructors' digital literacy states are achieved. Based on these "portraits," a multidimensional, real-time mechanism is formed to boost instructors' digital literacy, and tailored "talent-specific" training programs are created according to each instructor's unique characteristics[8].

7.3 Leveraging the Demonstrative Role of Eminent Instructors to Construct a "Four-Stage, Three-Integration, Personalized" Training and Enhancement Pathway

Innovating a "Three-Integration" blended training model that integrates online, offline, and onsite learning, instructors engage in a cyclical process of "experiencing-designing-practicing-reflecting" across four stages. This model integrates practical scenarios with professional learning scenarios. Additionally, the project utilizes the exemplary role of national teaching teams and renowned instructors, leveraging the strengths of industry-education integration, digital resource sharing, and interactive capabilities. Training in digital teaching competencies and raising awareness of data privacy and the importance of digital identity among vocational instructors are em-

phasized. Concurrently, personalized training programs are developed based on the "digital literacy portraits" of professional instructors, optimizing the scope of knowledge acquisition, expert guidance, and peer exchange for each instructor. This approach ensures tiered training and categorized teaching, enabling precise empowerment of instructors' digital literacy development and achieving a spiraling ascent in digital literacy^[9].

7.4 Construction of an "Empowering Learning, Assisting Teaching" Blended Digital Teaching Resource Library with a Student-Centric Approach

Centered on the student and aimed at empowering them, the project assists students in actively utilizing digital technologies for self-directed learning in electrical automation technology courses. A diverse blended digital teaching resource library is constructed, encompassing a rich array of materials such as videos, audio, animations, virtual simulations, PPTs, and graphic images. It covers multiple application types, including courseware, animations, electronic textbooks, industry standards, curriculum standards, teaching cases, exercises, and extended readings, as well as various resource types like course resources, material resources, training resources, and enterprise resources. This enhances instructors' digital literacy in managing, transforming, storing, innovating, creating, reconstructing, sharing, diffusing, and integrating teaching content using digital technologies^[10].

7.5 Exploration of a "Four-Learning" Classroom Digital Teaching Model Based on Instructors' Digital Literacy

A digital teaching practice and research model is constructed, based on a rich and diverse array of digital teaching resources and an advanced, efficient digital teaching environment. Utilizing the "Four-Learning" model of "self-study before class, guided study during class, supervised study after class, and continuous companionship throughout the learning process" specific to the electrical automation technology program, the project extends the teaching process from before to during and after class through the Shandong Electric Power Specialized Digital Learning Platform. A blended teaching model that parallels online and offline approaches is adopted, where students engage in self-study and access relevant digital teaching resources before class; instructors use advanced digital teaching equipment for precise guidance and interactive teaching activities during class, stimulating students' interest and participation; and after class, supervision is conducted through the platform, with assignments and online tests provided to understand and feedback on students' learning situations in a timely manner. Instructors are also present throughout the learning process, ready to answer questions and provide personalized learning guidance. This digital-based teaching practice not only helps instructors enhance their practical teaching skills but also promotes innovation and transformation in educational teaching models^[11].

7.6 Development of Digital Literacy Assessment Standards for Automation Instructors and Refinement of the Digital Literacy Evaluation System

Following the logical relationship of evaluation content, dimensions, and entities, assessment indicators for digital literacy of automation instructors are developed. Adhering to the principles of "comprehensiveness and specificity," "scientific rationality," and "measurability and ease of evaluation," a three-tiered indicator system is established with corresponding weights to emphasize a comprehensive assessment of instructors' digital literacy. Classification evaluation and assessment standards for enhancing instructors' digital literacy, departmental implementation plans, divisional implementation processes, and instructor action plans are formulated according to different executing entities and the levels of instructors' digital literacy development. A "four-in-one" teacher digital literacy training and evaluation system is formed. Meanwhile, the Shandong Electric Power Specialized Digital Learning Platform is utilized to collect comprehensive and processual behavioral, cognitive, and emotional data generated by teachers and students in informatized teaching activities. Detailed characterization and description of instructors are conducted at different levels, forming an objective, standardized, mature, and fair digital literacy evaluation implementation process, enabling long-cycle tracking and feedback of instructors' digital literacy.

8 Innovations of the Project

8.1 Innovative Reform Concept

Based on the characteristics of the work of vocational college teachers, comprehensively consider the level of digital literacy of teachers in the specialty of electrical power system automation technology, and formulate a teacher digital literacy framework that meets the needs of professional teachers.

8.2 Innovative Identity Portrait

Collect multi-dimensional information data of teachers to establish a "digital literacy portrait" for professional teachers. Diagnose, analyze, and predict the laws of teachers' learning and development, provide a comprehensive representation and portrayal of the state of teachers' digital literacy, and create corresponding "tailored teaching" training programs based on this.

8.3 Innovative Training Model

Construct a training promotion path that integrates online and offline learning with workplace learning, iterates through "experience-design-practice-reflection" four stages, and formulates "personalized" training programs. Empower the precision cultivation of teachers' digital literacy and achieve a spiral rise in teachers' digital literacy.

8.4 Innovative Evaluation Standards

Develop digital literacy evaluation indicators, highlight comprehensive evaluation of teachers' digital literacy, strengthen process-oriented evaluation methods, embed evaluation into the teaching and learning process, and examine digital literacy as a subject teaching goal to form an objective, standardized, mature, and fair digital literacy evaluation implementation process.

9 Conclusion

This study aims to construct a digital literacy enhancement system for instructors in the field of automation and to apply it in practice. First, a digital literacy framework will be developed by integrating the characteristics of professional instructors, thereby providing a clear direction for development. Second, multidimensional data will be collected to establish a "digital literacy portrait," offering a comprehensive understanding of the current status of instructors and serving as a basis for targeted improvements. Third, the exemplary role of distinguished educators will be leveraged to create a "Four-Stage, Three-Integration, Personalized" training pathway, addressing individual needs and facilitating instructor growth. Subsequently, a new classroom model based on digital literacy will be explored through the "Four Learning" approach, promoting teaching innovation. Additionally, a blended digital teaching resource library will be constructed with a focus on empowering students, thereby enriching teaching resources. Finally, assessment standards will be established to refine the digital literacy evaluation system, ensuring continuous enhancement of competencies. By implementing a comprehensive and multi-channel approach, this research seeks to explore pathways for enhancing the digital literacy of instructors in higher vocational electrical automation technology programs, significantly promoting their digital literacy and providing a solid foundation for cultivating high-quality professionals in automation.

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