Research on the Connotation, Dilemmas, and Practical Path of Digital and Intelligent Competency of University Teachers in the "Big Data + Artificial Intelligence" Era

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Abstract: In the context of the "Big Data + Artificial Intelligence" era, higher education is facing unprecedented challenges in technological transformation and educational innovation. As the core of the education system, the improvement of teachers' digital and intelligent competency directly influences the quality of education and teaching effectiveness. This paper aims to explore the connotation, development dilemmas, and practical paths of university teachers' digital and intelligent competency in the "Big Data + Artificial Intelligence" era. Through an explanation of the essence and connotation of digital and intelligent competency, this paper constructs a theoretical framework for university teachers' digital and intelligent competency and analyzes the ability bottlenecks and transformation dilemmas teachers face when applying big data and artificial intelligence technologies. The paper further discusses the current dilemmas in the development of university teachers' digital and intelligent competency and proposes targeted practical paths to provide theoretical guidance and a practical framework for enhancing university teachers' digital and intelligent competency. The research conclusions indicate that the improvement of teachers' digital and intelligent competency requires not only technological support but also joint efforts from the education system and the teachers themselves.

Keywords: Big Data, Artificial Intelligence, University Teachers, Digital and Intelligent Competency, Educational Transformation, Technological Ethics, Practical Paths

Introduction

With the rapid development of information technology, "Big Data + Artificial Intelligence" has become an important driving force for global educational reform and development. Especially in higher education, how to leverage big data and artificial intelligence technologies to improve teaching quality, optimize educational resource allocation, and promote educational equity has become a core issue that needs to be addressed. However, despite the broad prospects for the application of "Big Data + Artificial Intelligence" in teaching, university teachers still face many dilemmas in the practical application process. Insufficient technical capabilities, outdated educational philosophies, misperceptions of the teacher's role, and constraints from university management systems all serve as major obstacles to the improvement of teachers' digital and intelligent competency. Therefore, exploring the connotation of university teachers' digital and intelligent competency, identifying their development dilemmas, and proposing practical and feasible paths have significant theoretical and practical value.

1. Theoretical Foundations of University Teachers' Digital and Intelligent Competency in the "Big Data + Artificial Intelligence" Era

1.1 Essence and Connotation of Digital and Intelligent Competency

Digital and intelligent competency refers to the ability of university teachers, in the "Big Data + Artificial Intelligence" era, to not only possess traditional subject knowledge and teaching skills but also to effectively use data analysis tools and artificial intelligence technologies to collect, process, and interpret teaching data. Teachers are then able to make scientific teaching decisions based on this data. In this process, teachers need to have certain technical application abilities, particularly when using data and artificial intelligence technologies to improve teaching effectiveness. They must be able to adapt to

and take advantage of these technologies' strengths.

The core of digital and intelligent competency lies in several aspects. Firstly, teachers need to possess data application skills, meaning they can extract valuable information from teaching data to support decision-making. This includes the basic abilities of data collection, processing, and analysis. Secondly, teachers should have artificial intelligence application skills, such as using AI tools (e.g., intelligent tutoring systems, automated assessment tools, etc.) to enhance teaching efficiency and precision, and to support personalized learning. Thirdly, teachers need interdisciplinary integration abilities, which allow them to combine data analysis and AI technologies with subject knowledge to solve complex teaching problems innovatively. Additionally, teachers should be capable of handling ethical issues when using big data and AI, ensuring that their decisions in teaching practices adhere to ethical standards, especially when dealing with data privacy, algorithmic fairness, and other related concerns. [1]

In summary, digital and intelligent competency is not only a manifestation of technical skills but also a comprehensive ability to balance technology, ethics, and educational goals, driving the development of intelligent, personalized, and equitable education.

1.2 The Evolution of Digital and Intelligent Competency

The digital and intelligent competency of university teachers has evolved from "data competency" to "digital competency" and finally to "digital and intelligent competency," reflecting the profound impact of technological development on teaching and education.

In the initial phase, teachers' "data competency" was mainly focused on the collection and processing of teaching data. At the dawn of the "Big Data" era, teachers relied on data analysis tools, concentrating on how to use data to improve the teaching process. At this stage, teaching activities were largely based on data collection and preliminary analysis, with decisions often relying on experience and intuition.

With the development of information technology, teachers' competency gradually shifted to the "digital competency" stage. Teachers were required not only to collect and interpret data but also to proficiently use various digital tools, such as online education platforms and digital learning resources, to optimize teaching design and resource allocation. During this phase, teachers' competencies began to evolve towards the systematic and structured application of digital technologies. However, the use of artificial intelligence technology was still in its infancy, and the main task for teachers was the use of digital tools and the integration of educational resources. [2]

With the arrival of the "Big Data + Artificial Intelligence" era, teachers' digital and intelligent competency entered a new stage, namely the "digital and intelligent competency" stage. At this point, teachers were expected not only to utilize data and digital tools but also to master AI technologies, such as using AI for learning assessments, personalized recommendations, and intelligent tutoring. Additionally, teachers were required to address the ethical issues arising from working in collaboration with AI technologies, ensuring educational fairness and ethics. The core of digital and intelligent competency lies in the deep integration of technology and the collaborative optimization of teaching goals, contributing to the overall improvement of education quality.

1.3 Theoretical Model Construction of University Teachers' Digital and Intelligent Competency

Based on an analysis and summary of existing literature, this study proposes a theoretical model for university teachers' digital and intelligent competency, which includes the following core elements.

Firstly, teachers need to possess digital and intelligent integration abilities, meaning they should effectively combine digital technologies and AI technologies in innovative ways during the teaching process. This requires teachers to not only use data analysis to support teaching decisions but also to apply AI technologies to optimize teaching methods and improve teaching effectiveness.

Secondly, teachers should have high-level digital and intelligent thinking abilities, including critical thinking, systematic thinking, and innovative thinking. With the support of "Big Data + Artificial Intelligence," teachers need to transcend traditional teaching methods, extract deeper knowledge from data, identify potential teaching issues, and propose innovative solutions.

Furthermore, teachers should embrace a human-AI collaborative approach to education. This means they must be able to adjust their educational roles and teaching strategies appropriately when working with AI, promoting the complementary collaboration between artificial intelligence and human intelligence, thereby fostering students' development. Teachers should understand both the functionality

and the boundaries of AI technology and use it appropriately in the educational process, ensuring the organic integration of technology with educational goals.

At the same time, teachers need to master the application of digital and intelligent teaching, meaning they should be able to flexibly use various AI tools, such as intelligent assessments and personalized learning recommendation systems, to improve the precision and personalization of teaching and promote students' comprehensive development.

Lastly, ethical decision-making is a critical component of digital and intelligent competency. Teachers, when using big data and AI, must have a strong ethical awareness to protect data privacy, ensure fairness and transparency in algorithmic applications, and prevent technological misuse, thereby safeguarding educational fairness and moral standards.

Through the integrated functioning of these elements, teachers will be better equipped to address the challenges of digital and intelligent education and promote high-quality educational development.

2. Challenges in the Development of University Teachers' Digital and Intelligent Competency in the "Big Data + Artificial Intelligence" Era

2.1 Challenges in the Application of Data and Intelligent Technologies: Lack of Competence and Integration Barriers

In the "Big Data + Artificial Intelligence" era, although most university teachers have started to engage with data analysis and intelligent technologies, many still face significant challenges in applying these technologies, due to various reasons. Firstly, many teachers lack sufficient technological literacy, particularly in data processing and the use of artificial intelligence, which limits their ability to fully leverage technology in teaching practices. For example, when faced with large volumes of teaching data, teachers often lack the necessary skills to analyze and interpret the data effectively, making it difficult to extract valuable information, which in turn affects the scientific accuracy of teaching decisions. Moreover, the application of artificial intelligence is still in its early stages, and many teachers still have a large gap in understanding and using AI tools, which prevents them from effectively integrating these technologies into classroom teaching. The integration of technology with education often encounters significant obstacles, as teachers frequently struggle to seamlessly combine technology with teaching content and methods, resulting in limited improvements in teaching outcomes. Therefore, addressing the issue of teachers' lack of competence in applying data and intelligent technologies becomes a crucial task in enhancing university teachers' digital and intelligent competency.

2.2 Challenges in Educational Philosophy and Teacher Role Transformation: Adaptation and Transformation Lag

With the rapid development of "Big Data + Artificial Intelligence," universities are facing pressures to transform, particularly with respect to the changing roles of teachers. However, many teachers still encounter substantial difficulties during this transformation process. Firstly, traditional educational philosophies and teaching methods have a profound impact on teachers' teaching behaviors. Many teachers continue to adhere to the traditional "teacher-centered" model, which makes it difficult for them to adapt to the "student-centered" personalized learning approach. This philosophical lag causes teachers to struggle in adjusting their teaching methods and models when applying data and artificial intelligence technologies, preventing them from effectively utilizing technology to promote personalized learning for students. Secondly, there is a lag in teachers' recognition of their roles. In traditional teaching models, teachers are primarily responsible for knowledge transmission. However, in the context of digital and intelligent education, teachers need to shift from being knowledge transmitters to learning guides and collaborators, which is not easy for many teachers. Many have not yet adapted to this role transformation, lacking the ability to collaborate and interact with students, and have not fully leveraged the support of technological tools. Therefore, the lag in teachers' educational philosophy and role recognition becomes a significant bottleneck in the current digital and intelligent educational practices. [3]

2.3 Challenges in Technical Ethics and Institutional Constraints: Privacy Protection and Systemic Barriers

In the "Big Data + Artificial Intelligence" era, with the widespread application of technology, ethical issues in education are becoming increasingly prominent. University teachers face several ethical

challenges when using data and artificial intelligence technologies, such as data privacy protection, algorithm transparency, and the potential for technology misuse. When applying big data and AI tools, teachers are required to collect large amounts of student data, particularly sensitive information related to students' learning processes, behaviors, and academic performance. The collection, storage, and use of these data must strictly adhere to privacy protection principles, otherwise, it could lead to student privacy breaches and ethical controversies. In addition, the "black-box" problem of algorithms is another pressing ethical issue. Many AI tools operate with mechanisms that are not transparent, making it difficult for teachers to understand the decision-making process, which could lead to algorithmic bias or unfairness, affecting students' learning evaluations and outcomes. Beyond ethical concerns, the constraints of the educational system also present a significant challenge. The current management systems, curriculum designs, and teacher evaluation frameworks in universities are not aligned with the demands of digital and intelligent education. They still follow traditional evaluation standards and management models, lacking comprehensive support and development for digital and intelligent competency. Therefore, resolving privacy protection issues while adhering to ethical standards and promoting reforms in the educational system becomes essential in advancing the digital and intelligent competency of university teachers.

3. Practical Pathways for Enhancing University Teachers' Digital and Intelligent Competency in the "Big Data + Artificial Intelligence" Era

3.1 Building a Comprehensive Teacher Digital and Intelligent Competency Improvement System and Personalized Development Mechanism

In the "Big Data + Artificial Intelligence" era, establishing a comprehensive system for improving teachers' digital and intelligent competency is a key step in enhancing university teachers' competencies. First, the improvement of teachers' digital and intelligent competencies requires a multi-dimensional approach, including data analysis skills, artificial intelligence technology application, interdisciplinary integration ability, and ethical decision-making capacity. Therefore, the enhancement system should cover multiple aspects such as teachers' technical learning, teaching applications, and concept innovations. Various methods, such as online learning platforms, workshops, and seminars, can be used to provide customized training courses for teachers, helping them acquire the skills to apply data and intelligent technologies in different teaching contexts. Additionally, a personalized development mechanism is crucial. Each teacher has different starting points, needs, and development directions in terms of digital and intelligent competency. The traditional "one-size-fits-all" training model cannot meet the personalized needs of teachers. Therefore, the improvement system needs to develop personalized learning and development plans based on factors such as teachers' subject specialties, teaching levels, and technology proficiency, to support their continuous growth in digital and intelligent education[4].

On this basis, universities can establish teacher development centers or digital education platforms to regularly organize project-based learning and practical activities. These initiatives will promote the application and reflection of digital and intelligent technologies in teaching, thus improving teachers' teaching abilities and intelligent competencies. Furthermore, attention must be given to teachers' psychological support and professional identity during the digital education process, helping them overcome the discomfort and anxiety caused by technology application, and enhancing their recognition and sense of responsibility towards educational transformation in the digital and intelligent era.

3.2 Promoting Interdisciplinary Collaboration and Innovation in Digital and Intelligent Education Models

"Interdisciplinary collaboration" is one of the important connotations of digital and intelligent education. In the context of "Big Data + Artificial Intelligence," innovation in the field of education not only relies on knowledge from a single discipline but also depends on the intersection of multiple disciplines. University teachers need to have an interdisciplinary perspective, using data and intelligent technologies to break down disciplinary boundaries and enhance the overall effectiveness of education and teaching. Therefore, promoting interdisciplinary collaboration has become an important path to improve university teachers' digital and intelligent competency.

First, the education system should support and encourage interdisciplinary cooperation. Universities should create multi-disciplinary collaboration platforms to encourage teachers to collaborate and explore digital and intelligent education models together. Interdisciplinary cooperation can help teachers expand

their knowledge and skill boundaries, thereby enhancing their comprehensive abilities in data analysis, AI applications, and other areas. For example, science and engineering teachers can collaborate with education faculty to jointly develop AI-based teaching platforms, exploring how to integrate the characteristics of different disciplines into teaching design and student assessments through data-driven practices[5].

Second, universities should promote innovation in digital and intelligent education models. In terms of educational model innovation, teachers should be encouraged to combine artificial intelligence technology with educational content and teaching strategies to explore new teaching modes such as "intelligent tutoring," "personalized learning," and "adaptive learning." By utilizing AI to analyze students' learning behaviors, teachers can provide personalized learning resources and feedback, helping students achieve more precise knowledge mastery and skill development. Additionally, the use of online learning platforms and intelligent education tools outside the classroom is also an important method for promoting innovation in education models. These tools can enhance interaction and collaboration between teachers and students, increasing the flexibility and personalization of education.

3.3 Establishing a Standardized Digital Education Ethics and Assessment Feedback Mechanism

With the widespread application of big data and artificial intelligence technologies in education, ethical issues in education have become a crucial aspect that must be addressed. Teachers must ensure data privacy protection, fairness, and transparency when using digital and intelligent technologies. This is not only a matter of respecting students but also a prerequisite for enhancing the quality and effectiveness of education. Therefore, universities should establish a standardized digital education ethics system as early as possible to ensure the ethical compliance of educational technologies.

First, the education ethics system should clarify the code of conduct for teachers using data and artificial intelligence, particularly in areas such as data privacy protection and algorithm fairness. For example, when using AI-assisted tools for student assessments, teachers should ensure algorithm transparency and fairness, avoiding algorithmic bias that could affect student grades and learning evaluations. Universities should provide teachers with relevant ethics training, helping them understand and address ethical risks in teaching practices, ensuring that moral guidelines are followed in educational decision-making[6].

Second, establishing an effective assessment and feedback mechanism is also an important measure to enhance teachers' digital and intelligent competency. The improvement of teachers' digital and intelligent competency is not only about enhancing their technical application skills but also about continuously improving teaching effectiveness. Therefore, building a data-driven assessment system and feedback mechanism is a necessary means to promote the progress of digital education. The assessment mechanism should measure teachers' digital and intelligent application levels in various dimensions, such as data analysis skills, AI tool usage, and teaching model innovation. Additionally, through continuous feedback and reflection, teachers can identify shortcomings and improve their teaching methods. Moreover, universities should construct dynamic teacher development portfolios, using data tracking and analysis to document teachers' growth trajectories and intelligent competency development, providing personalized career development advice and support for teachers.

Conclusion

This paper presents the theoretical exploration and practical pathways for enhancing university teachers' digital and intelligent competency in the "Big Data + Artificial Intelligence" era. The main conclusions are as follows: First, university teachers' digital and intelligent competency includes multiple dimensions such as data processing ability, artificial intelligence application ability, interdisciplinary integration ability, and ethical decision-making ability. Constructing a scientifically sound model of digital and intelligent competency helps teachers adapt to the demands of modern educational technologies and promotes the intelligent transformation of education. Second, university teachers face multiple challenges in enhancing their digital and intelligent competency, including insufficient technological application, delayed transformation of educational philosophy, role confusion, and institutional constraints. Overcoming these challenges requires measures from the perspectives of teachers, the education system, and the social environment. Therefore, this paper proposes practical pathways such as building a comprehensive competency improvement system, promoting interdisciplinary collaboration and digital education model innovation, and establishing standardized digital education ethics and assessment feedback mechanisms to effectively enhance teachers' digital and

intelligent competency and improve educational quality. Future research can further explore the assessment systems for digital and intelligent competency, interdisciplinary teaching practices, and ethical issues related to technology and privacy protection, promoting the healthy development of digital education.

Fund Projects

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