A Theoretical Framework on the Influence of Teachers' Adaptation and Confidence Improvement in Artificial Intelligence-assisted Learning Environment on Teaching Efficacy

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Abstract: This study develops a theoretical framework to analyze the intricate relationship between teachers' adaptation, confidence enhancement, and teaching efficacy within the context of artificial intelligence-assisted learning environments. By integrating theories from multiple disciplines such as technology acceptance and diffusion theory, self-efficacy theory, and teacher professional growth theory, the research employs literature review, theoretical deduction, and conceptual model construction to establish a comprehensive understanding. This framework offers novel insights into the behavioral and psychological mechanisms underlying teachers' responses to technological integration, significantly contributing to the field of behavioral sciences by providing a basis for predicting and influencing teacher behaviors in AI-driven educational reforms. Theoretical propositions suggest that individual differences among teachers, particularly those related to teaching experience and subject areas, play a significant role in their adaptation to AI-assisted teaching. The framework further postulates that personalized applications of intelligent teaching systems and AI-assisted teaching evaluation are crucial for enhancing teaching efficacy. It is also theorized that teacher training models based on AI and intelligent recommendation systems can profoundly promote professional growth and confidence, while robust school management support is conceptually identified as a strong guarantee for teachers to effectively apply AI technology in teaching. The study offers theoretical support for educational practice and proposes deepening theoretical research, promoting the practical transformation of outcomes, and strengthening interdisciplinary and intercultural studies, laying a foundation for future empirical investigations.

Keyword: Artificial intelligence-assisted learning environment; teacher adaptation; teacher confidence; teaching efficacy; theoretical framework; conceptual model

1. Introduction

1.1. Research background and significance

In today's era, artificial intelligence technology is penetrating the education sector at an unprecedented pace, profoundly reshaping the landscape of education. Intelligent teaching systems, adaptive learning platforms, and educational robots are becoming increasingly prevalent, bringing new models and opportunities to educational activities. This transformation not only enriches teaching methods but also drives fundamental changes in educational philosophy and teaching approaches, aiming to achieve more efficient and personalized educational goals (Chen et al., 2022).

Teachers, as the core subjects of educational activities, are undergoing significant transformation in AI-assisted learning environments （Fakhar et al., 2024）. They are gradually shifting from being mere transmitters of traditional knowledge to facilitators, organizers, and promoters of the learning process, requiring them to skillfully apply AI technologies to optimize teaching processes and meet students ‘personalized needs .In this process, teachers’ ability to adapt to new environments and their maintenance and enhancement of teaching confidence have a critical impact on teaching efficacy, directly affecting the quality of education and the achievement of educational goals.

From a theoretical perspective, delving into this topic can enrich the theoretical frameworks of educational technology and teacher psychology, providing new perspectives and evidence for understanding teachers' specific behaviors, cognitive processes, and psychological mechanisms in technology-driven educational reforms (Yu & Xia, 2022). This study particularly contributes to behavioral sciences by analyzing the psychological drivers behind teachers' adaptation and confidence in adopting new technologies. In practice, this study can offer targeted recommendations for teacher training, school management decisions, and educational policy formulation, helping teachers better integrate into AI-assisted teaching environments, effectively enhancing teaching efficiency, and advancing the modernization of education.

1.2. Research status at home and abroad

Abroad, the application research of artificial intelligence in education started relatively early and has yielded abundant empirical results in areas such as intelligent tutoring systems and educational data mining(Lin et al., 2023) For instance, some large-scale experimental studies have indicated that intelligent tutoring systems can significantly improve students ‘performance in mathematics (Tao, 2024). In the study of teachers' adaptation and teaching efficacy, Western scholars have constructed a series of theoretical models based on social cognitive theory, self-efficacy theory, and others, analyzing the relationship between teachers' beliefs, attitudes, and teaching behaviors.

Recent years have seen rapid development in domestic research, focusing on the practical exploration of integrating artificial intelligence technology with subject teaching and strategies for enhancing teachers' information technology application skills. Some survey-based studies have revealed the difficulties and challenges teachers face when applying AI technologies, suggesting that most teachers show deficiencies in operating AI tools and integrating teaching resources(Zheng, 2022). However, overall, both domestic and international research still needs to strengthen its theoretical depth and breadth in systematically exploring the impact mechanisms of teacher adaptation, confidence enhancement, and AI-assisted learning environments on teaching efficacy (Jin & Hu, 2024). Specifically, there is a recognized gap in comprehensive theoretical frameworks that integrate these multifaceted factors, thus limiting a complete understanding of teachers' specific behavioral patterns, cognitive shifts, and emotional responses within AI-driven educational contexts.

1.3. Research objectives, methods and innovations

This study aims to deeply analyze the internal mechanism of teachers' adaptation process, the influencing factors of confidence improvement, and the comprehensive effect path of both on teaching efficacy in the environment of artificial intelligence-assisted learning, so as to construct a perfect theoretical framework and provide a solid theoretical support for educational practice.

In terms of research methods, the literature review method is primarily used to extensively collect relevant documents and materials from both domestic and international sources, tracing the development of theories; the theoretical deduction method is employed to derive logical relationships between variables based on existing theoretical foundations; and the conceptual model construction method is utilized to build theoretical frameworks, which intuitively illustrate the hypothesized influence paths among variables and lay the groundwork for future empirical validation.

The innovation of this study lies in integrating relevant theories from multiple dimensions and a systemic perspective, breaking through the limitations of previous single-factor research to construct a comprehensive theoretical framework. The study also identifies cross-cultural theory analysis as a crucial area for future exploration, conceptually broadening the research horizon to investigate potential differences and commonalities in teacher adaptation and teaching efficacy across diverse cultural backgrounds within behavioral sciences.

2. Core concepts and theoretical foundations

2.1. Theoretical definition of core concepts

Artificial intelligence-assisted learning environment refers to a digital ecosystem that can support personalized and intelligent learning and teaching activities by integrating hardware devices, software platforms, teaching resources and other elements with the help of artificial intelligence technology. It has the characteristics of intelligent interaction, data-driven decision-making and personalized learning support.

Teacher adaptation refers to the process by which teachers, in response to new requirements and changes brought about by AI-assisted learning environments, adjust their own cognition, behavior, and teaching strategies to gradually align with the new environment. This process encompasses multiple aspects, including technological adaptation, pedagogical adaptation, and methodological adaptation.

Teaching Efficacy and Teacher Confidence: In this framework, these two closely related concepts are rooted in Bandura's Self-Efficacy Theory. Teaching efficacy is the teacher's subjective judgment of his or her ability to influence students' learning behaviors and academic performance. In the context of AI-assisted learning, this definition expands to include the teacher's belief in their capability to effectively utilize artificial intelligence technology to optimize teaching and improve students' learning outcomes.

According to Bandura (Bandura, 1997), this efficacy belief is constructed from four primary sources, all of which are uniquely manifested in the AI-assisted environment and are central to our theoretical framework:

Mastery Experiences (Enactive Attainment): The most powerful source, stemming from a teacher's own successful experiences. For instance, successfully using an intelligent system for personalized instruction or mastering a virtual simulation in an immersive VR/AR training session directly builds a strong sense of efficacy.

Vicarious Experiences: Observing peer teachers, especially those with similar backgrounds, successfully integrating AI technologies. Online teacher learning communities serve as a vital platform for such observations, where shared case studies and success stories lead teachers to believe, “If they can do it, so can I.”

Verbal or Social Persuasion: Receiving encouragement and positive, credible feedback from school leaders, mentors, or peers. Leadership support and collaborative discussions within an online community provide this crucial reinforcement, convincing teachers they possess the capabilities to succeed.

Physiological and Affective States: A teacher’s emotional reactions to the task. The process of managing and overcoming initial technology anxiety and transforming it into a sense of excitement or curiosity is critical. Effective school support and well-designed training can help manage negative affective states and foster positive ones, thereby strengthening efficacy.

Teacher confidence, as used in this study, can be understood as the broader, felt sense of assurance that emerges from these sources of efficacy. While teaching efficacy is the specific judgment of capability for a task, confidence is the more general belief in one’s overall competence in the AI-integrated teaching role. They are reciprocally related, and for the purposes of this theoretical framework, we treat them as intertwined components of a teacher’s positive self-belief system.

2.2. In-depth interpretation of theoretical basis

The theory of technology acceptance and diffusion provides a theoretical basis for understanding the process by which teachers adopt artificial intelligence technology (Bickley et al., 2022). This theory posits that an individual’s acceptance of new technology is influenced by factors such as perceived usefulness and perceived ease of use. In the educational field, the higher the perceived usefulness of AI technology among teachers, the more they believe it can effectively improve teaching quality and reduce teaching burdens, making them more likely to accept it; at the same time, the ease of use, or the convenience of operation, also affects teachers’ attitudes toward adoption. For example, when using intelligent teaching systems, it can be theoretically posited that initially, due to their powerful functions, which provide rich teaching resources and precise student analysis (high perceived usefulness), teachers have high expectations. However, because of the complex interface and difficulty in getting started (low perceived ease of use), their willingness to use the system might not be strong. As the system continues to be optimized and operations become easier, after becoming familiar with the system, teachers are likely to find that they can use it more efficiently to conduct teaching and improve teaching outcomes, leading to a significant increase in their behavioral intention and actual usage behavior of the system. This theoretical trajectory suggests a dynamic interplay between perceived usefulness and perceived ease of use in shaping technology acceptance.

Based on this, the theory of self-efficacy further influences teachers’ behavioral choices, effort levels, and persistence in applying technology. Teachers with high teaching efficacy are theoretically more inclined to proactively integrate artificial intelligence into their teaching practices. For example, after recognizing the functions of an intelligent teaching system and mastering its operation methods, a teacher, due to their high self-efficacy, is expected to actively use the system for interactive teaching in class. Even when encountering technical issues, they are more likely to strive to resolve them rather than giving up easily, demonstrating strong motivation and persistence behaviors.

The theory of teacher professional growth holds that the professional development of teachers is a continuous and dynamic process. The artificial intelligence-assisted learning environment brings opportunities and challenges to the professional growth of teachers. Teachers can improve their ability in the application of artificial intelligence technology through continuous learning and practice, realizing the transformation from novice to expert teachers. This theory highlights the importance of continuous learning behavior and skill development in response to evolving technological demands.

3.Theoretical analysis of individual differences among teachers

3.1. Theoretical model of teachers with different teaching ages

3.1.1. New teachers: theoretical model of technology acceptance and teaching experience integration

New teachers can be further segmented into stages. In their first 1-2 years on the job, new teachers are just beginning to engage in educational work and are still exploring the practical processes of teaching. According to the theory of the teacher career life cycle, they are in the exploration phase of their careers, where their acceptance of new technologies often stems from a sense of novelty and external incentives. In an AI-assisted teaching environment, they are hypothesized to be curious about various AI tools, finding these tools promising for bringing new changes to teaching, perceiving their high usefulness, and willing to actively try intelligent lesson preparation software, classroom interaction tools, etc.

However, due to a severe lack of teaching experience, they are likely to encounter difficulties in integrating artificial intelligence technology with actual teaching practices. For instance, they may struggle to systematically plan the application of technology based on teaching objectives and student characteristics. When using intelligent lesson preparation software, they might over-rely on templates, overlooking the specific circumstances of their students. At this stage, teachers ‘confidence primarily stems from their initial mastery of new technologies; for example, successfully creating high-quality courseware with smart tools can bring a sense of achievement. However, this confidence is theorized to be fragile; once issues such as software malfunctions or poor student feedback arise during technology application, it can easily be undermined, thereby affecting their sense of teaching effectiveness. In terms of teaching outcomes, there may be an increase in students’ learning enthusiasm in the short term, but the improvement in knowledge acquisition might not be significant.

Proposition 1a: For new teachers (1-2 years of experience), initial perceived usefulness of AI tools positively influences their willingness to adopt; however, their lack of teaching experience hinders effective technology integration, leading to fragile confidence and limited long-term impact on teaching efficacy.

New teachers with 3 to 5 years of experience, after a period of teaching practice, have gained a deeper understanding of the teaching process and accumulated some teaching experience. They enter the early stage of professional growth and begin to build their own teaching style. In terms of AI-assisted teaching, they are conceptually able to more selectively choose AI tools suitable for teaching content and student characteristics, attempting to integrate intelligent tutoring systems into daily teaching to help students address personalized learning issues. At this point, they are theorized to have a deeper understanding of the ease of use of AI technology, not only focusing on tool functions but also valuing operational convenience and integration with teaching.

At this stage, teachers ‘confidence is theoretically proposed to be built on the initial integration of technology application and teaching effectiveness. They may find that after using intelligent tutoring systems, some students' grades improve, which boosts their confidence and enhances their sense of teaching efficacy. In terms of teaching outcomes, students' academic performance and learning abilities are expected to show significant improvement. The characteristics of novice teachers at different stages are compared as follows:

Proposition 1b:For early-career teachers (3-5 years), enhanced perceived usability and successful AI integration foster stable confidence, significantly improving teaching efficacy and student learning outcomes.

Table 1. Comparison of characteristics of novice teachers at different stages

Compare Projects	New teacher with 1-2 years of experience	New teacher with 3-5 years of experience
Characteristics of career stages	In the career exploration period, I am not familiar with the overall process of teaching practice	At the beginning of my career, I began to build my teaching style
Reasons for acceptance of artificial intelligence technology	Job freshness and external incentives are perceived as useful	After accumulating certain experience, it is more able to judge the applicability of technology and perceive the improvement of usability
Technology application issues	Without systematic planning, it is difficult to grasp the convergence point between teaching objectives and technology application	We are still exploring more efficient ways to integrate technology and teaching
Confidence in its origin and stability	The sense of achievement brought by the initial mastery of new technology makes confidence fragile	The initial combination of technology application and teaching effect is relatively stable and increases with the effect
Performance of teaching results	Students' learning enthusiasm is improved in the short term, but their knowledge mastery degree is not obvious	Students' academic performance and learning ability have made a significant progress
The relationship between teaching experience and	Technology application provides a practical platform, but lack of	Experience growth and optimization of technical integration capabilities

technology integration	experience limits the integration effect	promote each other

New teachers generally face challenges in integrating artificial intelligence technology with actual teaching. At this point, an interactive model for accumulating teaching experience and integrating technology can be constructed. By actively participating in teaching practices, new teachers are theorized to continuously reflect on the effectiveness of technology application, gradually mastering how to select appropriate AI tools and teaching strategies based on teaching objectives and student characteristics, thus achieving rapid accumulation of teaching experience. In this process, the application of technology provides a practical platform for accumulating teaching experience, while the growth of teaching experience further optimizes the ability to integrate technology, promoting each other.

3.1.2. Senior Teachers: Theoretical dilemma and breakthrough of the integration of traditional experience and new technology

The adaptation process for senior teachers is a complex psychological journey, fundamentally involving cognitive restructuring, emotional regulation, and eventual behavioral modification. Experienced teachers possess rich teaching experience and have developed relatively stable teaching mindsets and methods through long-term teaching practice. From the perspective of Schema Theory, these can be understood as highly developed and automated "teaching schemas." While invaluable, this expertise can form a significant cognitive inertia towards the acceptance of new technologies. When faced with an AI-assisted learning environment, these entrenched schemas are challenged, leading not only to high cognitive load but also to psychological resistance.

Furthermore, the unfamiliarity with new technology operations and the fear that technical failures could disrupt their well-honed teaching flow can induce "technology anxiety." This negative emotional response requires conscious emotional regulation for teachers to overcome their apprehension. Psychologically, this cognitive inertia and anxiety lead to a lower perceived usefulness (believing their existing schemas are sufficient) and lower perceived ease of use (overestimating the difficulty and risk). This combination creates a significant barrier to initial adaptation and the willingness to modify their teaching behaviors.

Proposition 2a: Experienced teachers' cognitive inertia, rooted in established teaching schemas, and the accompanying technology anxiety initially reduce their perceived usefulness and ease of use of AI, consequently hindering their psychological and behavioral adaptation to AI in teaching.

However, the teaching experience of veteran teachers is not entirely an obstacle but can be the very key to breaking through this dilemma. The breakthrough lies in a process of cognitive restructuring, specifically through a collaborative model that integrates experience transfer with technological innovation. Instead of abandoning their existing schemas, veteran teachers can leverage their core pedagogical knowledge (e.g., deep understanding of teaching objectives, insights into student psychology) as a conceptual bridge to assimilate and accommodate new AI tools. This process, where old knowledge facilitates the integration of new technology, is fundamentally a form of schema re-structuring. They are not just learning a new tool; they are modifying and expanding their fundamental teaching schema to incorporate AI.

For example, when using an AI system to precisely deliver learning resources, they are applying their deep understanding of student differentiation (an existing schema) within a new technological context, thereby enriching and transforming that schema. This successful schema re-structuring reduces anxiety (effective emotional regulation), enhances confidence, and leads to meaningful behavioral modification—the innovative application of AI. This facilitates the transition from reliance on traditional experience to a synergistic collaboration between experience and technology. To more clearly compare the differences between novice and veteran teachers in AI-assisted teaching, the following table is provided:

Proposition 2b: The successful transfer of traditional teaching expertise to guide AI application facilitates a cognitive restructuring of teaching schemas. This process, coupled with innovative method integration, significantly enhances experienced teachers' adaptation and confidence, leading to a steady increase in teaching efficacy.

Table 2. Comparison between senior teachers and novice teachers

Comparison Items	Novice Teachers (comprehensive 1-5 years)	Senior Teacher
Teaching experience status	Lack of experience (1-2 years) to accumulation (3-5 years)	I have rich experience and formed stable teaching thinking and methods
Perception of artificial intelligence technology	The perceived usefulness is high in the early stage, and the perceived usability is improved in the later stage	Perceived usefulness and ease of use are initially low
Technical application advantages	Curious about new technologies and willing to try new tools	Traditional teaching experience can be transferred to technology application
Technology application challenges	Lack of teaching experience affects the integration of technology and teaching	Traditional teaching cognitive inertia hinders the acceptance of new technology
Change in teaching efficacy	Early promotion is fast but limited in the long term (due to lack of experience)	The initial improvement is slow, but it rises steadily after the integration of experience and technology
coping strategy	Build an interactive model of teaching experience accumulation and technology integration	Construct a collaborative model of experience migration and technological innovation

3.2. Theoretical differences among teachers of different disciplines

3.2.1. Science teachers: the theoretical model of technology assisting knowledge construction

In the field of physics, teachers in mechanics focus more on using virtual simulation platforms to replicate experimental scenarios, such as free fall motion and Newton's second law experiments . This is because mechanical concepts are relatively abstract, and many experiments cannot be accurately demonstrated in real classrooms or are limited by experimental conditions. With the help of artificial intelligence technology, teachers can enable students to observe experimental phenomena more intuitively and understand physical principles better. From the perspective of constructivist learning theory, the process of knowledge construction assisted by intelligent tools involves students building new knowledge systems through interaction with these tools, based on their existing knowledge. In mechanics learning, students use virtual simulations to transform their passive reception of concepts and laws into active exploration. The application of AI technology primarily focuses on the intuitive presentation of knowledge and explanation of principles. Through precise experimental simulations, students' understanding and application skills in mechanics are enhanced, thereby improving teaching effectiveness.This directly influences teachers' instructional decision-making behaviors and resource selection.

Teachers in the field of electrical engineering are theorized to tend to use intelligent circuit design software and smart electrical measurement tools more frequently. These tools help students better understand circuit principles and analyze circuit faults. When using these AI tools, electrical engineering teachers focus on developing students 'logical thinking and practical skills. For example, with intelligent circuit design software, students can independently design circuits and conduct simulation tests, while teachers provide targeted guidance based on the simulation results. Compared to mechanics teachers, electrical engineering teachers place greater emphasis on fostering students' independent exploration and practical operations through the application of AI technology. This approach integrates theoretical knowledge with practice, enhancing teaching effectiveness by improving students' ability to solve real-world electrical problems.

Science knowledge is characterized by strong logic and high abstraction. Intelligent tools play a unique role in promoting teaching by science teachers and the construction of students 'knowledge. Taking an intelligent tutoring system as an example, it is built on the theory of knowledge graphs and can accurately analyze students' weak points in the mathematical and physical knowledge systems, providing detailed reports to teachers. Based on these reports, teachers use problem-solving teaching methods, leveraging the interactive features of the intelligent tutoring system to guide students in exploring problems independently, thereby fostering logical thinking skills. In this process, a theoretical mechanism for promoting logical thinking through intelligent tools has been formed: intelligent tools stimulate active thinking and enhance logical thinking abilities through precise diagnosis and personalized guidance.

The theoretical mechanism of intelligent tools promoting the cultivation of logical thinking can be illustrated through the following mind map (see Figure 1). The map starts with the foundation of intelligent tool construction. Relying on knowledge graph theory, it demonstrates the process of organizing the knowledge system in mathematics and science subjects. It then presents precise analysis of students' learning conditions and the generation of learning condition reports. Following this, it covers teaching strategies adopted by teachers based on these conditions, as well as the role of intelligent tools in teacher-student interactions. Further, it shows how students use tools for independent inquiry, how their thinking is stimulated during this process, and ultimately how their logical thinking skills are enhanced and applied to the study of mathematics and science. It clearly illustrates the logical relationships and operational processes between each stage, helping us understand this theoretical mechanism more intuitively and comprehensively.

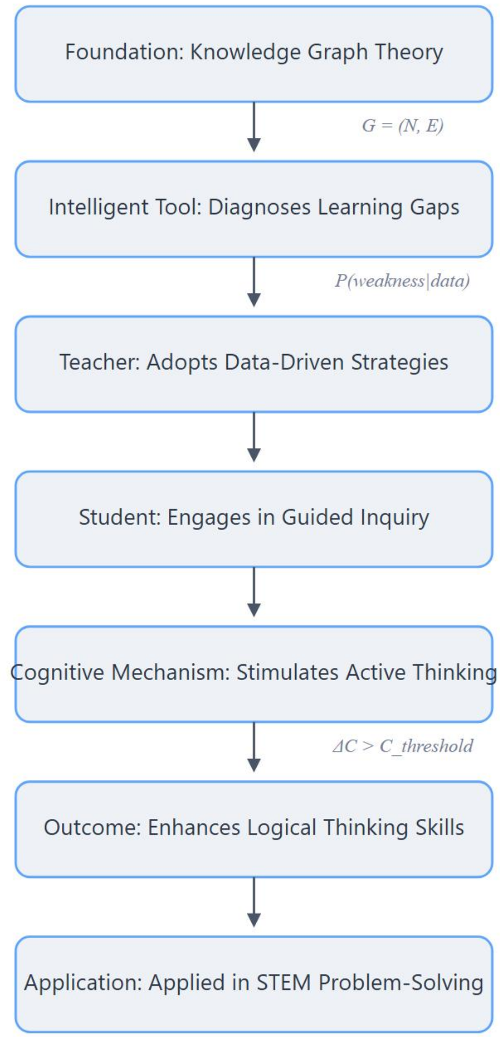

Figure 1: Path Diagram of the Theoretical Mechanism for Fostering Logical Thinking via Intelligent Tools.

At the same time, construct a teaching model theory that integrates disciplinary knowledge with technology. Science teachers use virtual simulation platforms to transform abstract theoretical knowledge into intuitive experimental phenomena, helping students understand the principles of knowledge. For example, in physics, by simulating complex physical experiments, students can perform experimental operations and observe results in a virtual environment, deepening their understanding and application of knowledge. This teaching model deeply integrates disciplinary knowledge with artificial intelligence technology, enhancing teaching effectiveness.

3.2.2. Liberal arts teachers: theoretical interpretation of technology-rich teaching situations

The humanities education focuses on cultivating students' emotional experiences and cultural literacy. Artificial intelligence technology enriches teaching resources and innovates teaching methods, bringing new opportunities for humanities teachers(Adeleye et al., 2024). Based on the theoretical path of supporting cultural literacy cultivation with intelligent resources, humanities teachers can leverage smart teaching platforms to access vast amounts of literary works and historical materials. By utilizing natural language processing technology, they can conduct in-depth text analysis, guiding students to understand the essence of works from multiple perspectives, thereby enhancing their cultural literacy(Baglieri, 2024).This directly influences their pedagogical adaptation behaviors and student interaction strategies.

From the perspective of situational cognition and learning theory, AI-generated teaching scenarios can help students better understand the socio-cultural context of knowledge, promote contextualized learning, and enhance humanistic literacy. Liberal arts teachers use multimedia technology and virtual reality to create vivid teaching scenarios, allowing students to experience the emotional atmosphere and historical context of literary works firsthand, effectively supporting the emotional experience dimension in liberal arts education.

3.2.3. Theoretical comparison of teacher adaptation from an interdisciplinary perspective

In the process of exploring teachers' adaptation to interdisciplinary teaching, it is crucial to construct a theoretical framework that aligns subject characteristics with technological suitability(Chugh et al., 2023). We have conducted an in-depth analysis of the compatibility differences between various subjects and artificial intelligence technology from multiple dimensions, including the structure of subject knowledge, characteristics of teaching methods, and goals for student capability development (as shown in Figure 2). For example, science subjects, due to their strong logical structure and high level of abstraction, focus more on the application of technology in precise knowledge transmission and logical thinking training; whereas humanities subjects emphasize humanism and emotion, thus paying more attention to the role of technology in creating teaching scenarios and stimulating emotional experiences. Through this theoretical framework, we can better grasp the compatibility directions between different subjects and technologies.

Proposition 3: Alignment between a subject's inherent characteristics and AI technology suitability significantly influences teachers' adaptation behaviors and perceived teaching efficacy.

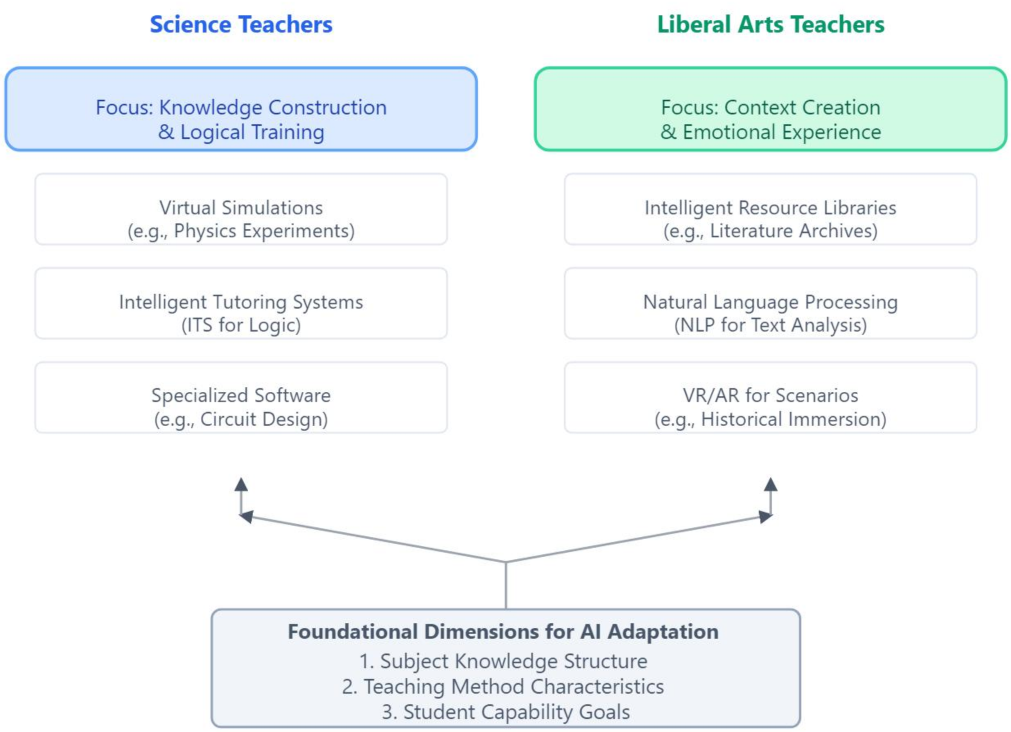

Figure 2. Theoretical Framework for Disciplinary Characteristics and AI Technology Adaptation

In addition, through the theoretical analysis of factors influencing teaching efficacy among teachers in different disciplines (see Table 3), we further identified differences between disciplines. For science teachers, the application of technology in knowledge explanation and experimental simulation is theoretically posited to have a significant impact on their sense of teaching efficacy. Additionally, technology-assisted creation of logical thinking training scenarios also plays a role in enhancing teaching efficacy, with a high impact on knowledge and moderate impact on context. In contrast, humanities teachers rely more on technology for expanding teaching resources and creating emotional experience scenarios, where the impact on knowledge is hypothesized to be moderate and on context is high.

Table 3. Comparison of factors affecting teaching efficacy of teachers in different disciplines

Branch of Learning	Main Influencing Factors (Knowledge Related)	Main Influencing Factors (Related to Teaching Context)	The Degree of Influence on Teaching Efficacy (Knowledge)	The Degree of Influence on Teaching Efficacy (Context)
Science	The accuracy of knowledge explanation and the effect of experimental simulation by intelligent tools	Technology assists in creating logical thinking training situations	High	Medium

Liberal Arts	The depth and breadth of text analysis by intelligent resources	Technology creates emotional experience and situational effects	Medium	High

4. Theoretical exploration of the integration of technology and teaching

4.1. Theoretical framework of personalized application of intelligent teaching system

In the AI-assisted learning environment, the personalized application of intelligent teaching systems has become a critical component in enhancing teaching quality and promoting effective student learning(Hashim et al., 2022). This application relies on various cutting-edge theories to construct a comprehensive and detailed theoretical framework, from the formulation of learning plans, customization of teaching content, to the transformation of teacher roles, comprehensively boosting the improvement of teaching effectiveness.

Personalized learning plans integrate deep learning style theory with intelligent matching models. Learning style theory, as a significant research achievement in psychology, categorizes students 'learning styles into various types such as visual, auditory, and kinesthetic. Intelligent teaching systems leverage advanced data collection technologies to gather multi-source behavioral data from students during the learning process in real time, including online study duration, course click frequency, and homework completion methods. By employing cutting-edge algorithms like cluster analysis and deep learning, these systems conduct in-depth mining and analysis of massive amounts of data to accurately determine students' learning style types.

Based on this, according to the theory of goal-oriented planning generation, closely integrating curriculum standards with individual student learning goals, highly personalized learning plans are tailored for students. For visual learners, the system leverages image recognition and multimedia processing technologies to prioritize high-definition images, 3D animations, and other visual learning resources. Through vivid and intuitive visual stimuli, these resources enhance students 'understanding and memory of knowledge. For kinesthetic learners, virtual reality (VR) and augmented reality (AR) technologies are utilized to create rich practical operations and simulation experiments. This allows students to deepen their understanding of knowledge and improve their practical skills through hands-on experience, achieving precise alignment between learning plans and students' learning styles.

Introducing the theory of learning analytics to further expand the depth and breadth of personalized learning plans. Learning analytics technology, through in-depth analysis of student learning behavior data, not only accurately identifies students 'learning styles but also uses methods such as time series analysis and predictive models to dynamically forecast students' learning progress and potential difficulties. For example, by analyzing hypothetical fluctuations in academic performance and trends in homework error rates, it can provide early warnings of learning challenges, offering teachers intervention suggestions and providing more forward-looking and scientific basis for formulating personalized learning plans.

Knowledge graph theory serves as the core theoretical foundation for intelligent customization of teaching content, playing a crucial role. Intelligent teaching systems use knowledge graphs as their framework to structurally organize and associate vast amounts of educational knowledge, forming a well-structured and logically rigorous knowledge network. Teachers can leverage these knowledge graphs to filter and integrate content that meets teaching needs, utilizing functions such as intelligent search and semantic analysis to quickly locate required knowledge points. The system analyzes students' learning paths and weak areas in real-time based on their learning situations, dynamically adjusting the presentation order and depth of teaching content to meet individualized learning needs.

Learning analytics technology also plays a crucial role in the intelligent customization of teaching content. By analyzing student feedback data from multiple dimensions, such as study duration, answer accuracy, and discussion participation, the smart system leverages natural language processing and sentiment analysis to accurately gauge students' understanding levels, interest preferences, and learning emotions regarding different knowledge areas. Based on these analytical results, it provides teachers with more targeted content adjustment suggestions, such as optimizing the way knowledge points are explained and supplementing additional learning materials, thereby enhancing the adaptability of teaching content.

From the perspective of student-centered teaching theory, personalized instruction fully respects individual differences among students, meets their diverse learning needs, and can effectively stimulate their interest and initiative in learning, thereby significantly enhancing learning outcomes, which is closely related to the improvement of teaching efficacy. Under traditional teaching models, students often passively receive knowledge, with their enthusiasm and creativity being somewhat suppressed. Personalized instruction, leveraging intelligent teaching systems, provides each student with learning resources and paths that align with their learning style and needs, making students the subjects of their own learning.

In terms of the theoretical connection between the transformation of teachers' roles and the optimization of teaching effectiveness, teachers in personalized teaching processes have shifted from traditional knowledge transmitters to learning guides. This transformation is reflected in multiple dimensions, as shown in Figure 3, which clearly contrasts the significant differences in teaching methods, focus areas, decision-making bases, and core responsibilities between traditional and personalized teaching models.

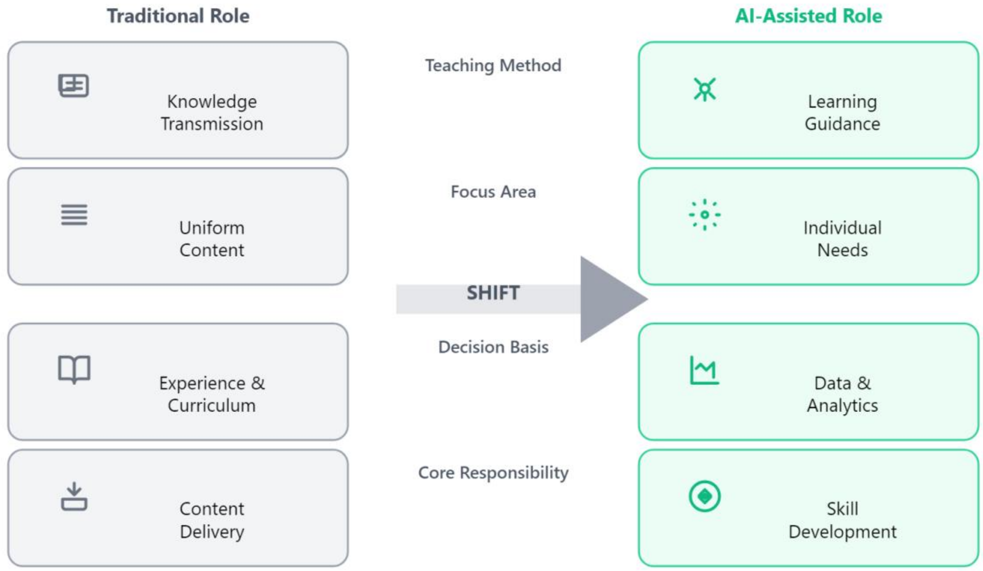

Figure 3. Comparison chart of the transformation of teachers' roles.

This transformation requires teachers to gain a deep understanding of student characteristics and skillfully apply artificial intelligence technology for precise analysis of learning conditions and dynamic adjustment of teaching strategies. In the process of analyzing learning conditions, teachers leverage the data analysis functions of intelligent teaching systems to obtain detailed information such as students' learning styles, knowledge mastery levels, and learning progress, providing data support for teaching decisions. When adjusting teaching strategies, teachers flexibly select teaching methods and optimize teaching content based on the results of learning condition analysis, achieving precise teaching. This process encourages teachers to continuously learn new educational technologies and teaching methods, enhance their professional skills, boost teaching confidence, and ultimately improve their sense of teaching effectiveness.

Proposition 4: Personalized AI teaching systems, through dynamic learning plan and content adaptation, significantly enhance teacher adaptation, confidence, and teaching efficacy by fostering a shift towards learning guidance.

4.2. Theoretical innovation of teaching evaluation assisted by artificial intelligence

At present, when artificial intelligence is deeply integrated into the field of education, the teaching evaluation system is undergoing profound changes(Xin et al., 2022). Intelligent evaluation tools, with the help of advanced machine learning algorithms, bring new theoretical innovation and practical paths to teaching evaluation, which is crucial to improving the sense of teaching effectiveness.

The intelligent evaluation tool is centered on machine learning algorithms, grounded in data-driven evaluation theory. It collects student learning data from multiple channels, such as classroom interactions, assignments, online learning behaviors, and exam scores. By employing deep learning and clustering analysis algorithms to mine and analyze the data, it constructs precise models of student learning behavior, capturing learning characteristics and trends, predicting learning performance, and providing forward-looking evidence for instructional interventions.

The integration of value-added assessment theory has expanded the functionality of intelligent evaluation tools. Unlike traditional assessments that focus on learning outcomes, value-added assessment emphasizes students' learning progress and growth trajectory. Intelligent evaluation tools leverage big data to conduct longitudinal analysis of student learning data, measuring learning value-added at different stages. This provides teachers with rich teaching feedback, helping them understand student needs and develop targeted teaching strategies.

When teachers apply the results of intelligent evaluation, they need to have data literacy in the complex cognitive process involving data interpretation and teaching decision-making. Teachers should use data mining, statistical analysis and other methods to extract useful information from massive data reports to provide a basis for personalized teaching. This involves specific cognitive behaviors for data interpretation and decision-making behaviors for pedagogical adjustments.

Based on the evaluation feedback and teaching improvement cycle theory, after teachers obtain data information, they formulate teaching improvement strategies, including optimizing teaching content, innovating teaching methods, and providing personalized tutoring. After implementing these strategies, continuous monitoring of evaluation results is conducted to adjust teaching strategies, forming a closed loop for teaching improvement, thereby enhancing student learning outcomes. This constitutes a feedback-driven behavioral modification cycle for teachers.

From the perspective of precise teaching theory, intelligent evaluation provides data support for precise teaching. Precise teaching requires understanding the gap between teaching objectives and student levels, and intelligent evaluation tools provide student situation analysis reports. Teachers can accurately position teaching content and select teaching methods based on these reports, achieving precise alignment of teaching content, methods, and student needs, thereby enhancing teaching effectiveness. This process forms a continuous cycle of improvement, which is illustrated in the Feedback Closed-loop Model of Precision Teaching in Figure 4. The model clearly shows the four key stages: Precision Teaching Practice, Data Collection, Intelligent Evaluation, and Data-Driven Adjustment, demonstrating how AI-driven feedback creates a dynamic loop that continuously enhances teaching effectiveness.

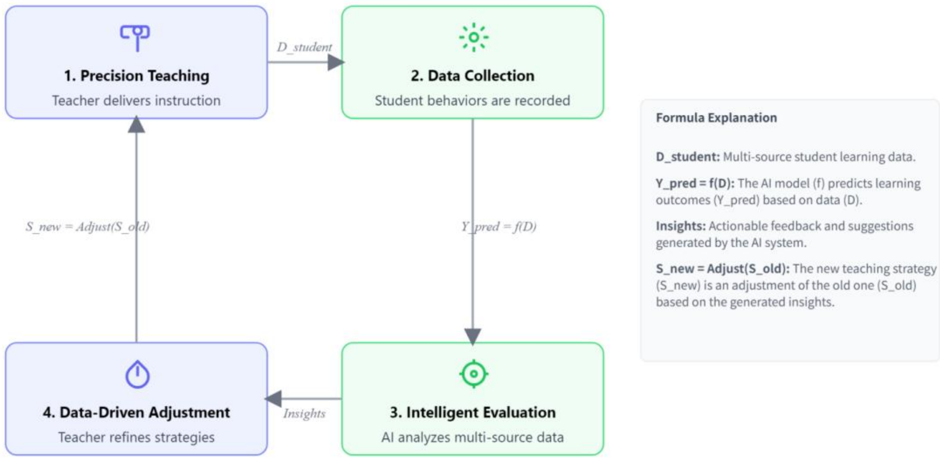

Figure 4. Intelligent Evaluation Supporting Feedback Closed-loop Model of Precision Teaching.

Under the framework of teacher professional development theory, teachers continuously enhance their data analysis and reflective teaching skills as they apply intelligent evaluation results, thereby achieving professional growth. The improvement in data analysis skills enables teachers to better understand the educational significance behind the data, identifying teaching issues and potential patterns from it; the enhancement of reflective teaching skills prompts teachers to deeply reflect on their teaching practices, summarize lessons learned, and continuously optimize their teaching behaviors. This theoretical connection suggests a reciprocal relationship where professional ability enhancement fosters teaching efficacy.

Proposition 5: Intelligent evaluation tools, by providing data-driven insights and supporting a teaching improvement cycle, enhance teachers' data analysis and reflective teaching behaviors, thereby improving their adaptation, confidence, and teaching efficacy.

5.Theoretical construction of teacher training and development

In the context of deep integration of artificial intelligence into education, teacher training and development have become a critical component in enhancing educational quality(Mustoip et al., 2023). This section will delve into the theoretical models of AI-based teacher training, as well as the theoretical frameworks for online learning communities and intelligent recommendations for teachers, aiming to provide comprehensive and scientific theoretical support for professional growth.

5.1. Theoretical model of teacher training based on artificial intelligence

5.1.1.VR/AR The theoretical basis of immersive training

VR/AR immersive training, relying on situational learning theory and immersive experience design, has opened up a new model for teacher training. Situational learning theory emphasizes that learning should take place in real-life contexts to enhance the understanding and application of knowledge(Li et al., 2024). By leveraging VR/AR technology to create virtual classroom scenarios, it can highly replicate real teaching environments, including details such as classroom layout and student interaction, allowing teachers to truly experience the practical application of artificial intelligence technology in teaching.

Embodied cognition theory further elucidates the impact of body-environment interaction on cognitive processes. Teachers ‘operations and practices in virtual scenarios allow their bodies to directly participate in learning. This embodied learning approach is theorized to enhance teachers’ understanding and memory of knowledge and skills, thereby significantly improving training effectiveness. For example, when teachers use AI teaching tools in virtual classrooms, they can conceptually grasp usage techniques through interactions with virtual students, while deeply understanding the advantages and challenges of AI technology in actual teaching. This directly influences their skill acquisition behaviors and self-efficacy beliefs regarding AI tools.

5.1.2. Theoretical mechanism of intelligent feedback and guidance training

The core of intelligent feedback in training lies in the theoretical methods of teaching behavior analysis(Wu et al., 2022). Intelligent systems use advanced techniques such as computer vision and speech recognition to monitor and deeply analyze teachers’ verbal communication, body language, and interaction styles in virtual classrooms in real time. Based on behaviorist learning theory, the system evaluates teacher behavior according to predefined standards. If any deviation from best practices is detected, timely feedback can be provided.

The theoretical basis for personalized guidance strategies originates from individualized instruction theory. The intelligent system tailors improvement suggestions and learning resources based on the characteristics of individual teachers, their training needs, and behavioral analysis results, helping teachers enhance their teaching skills in a targeted manner. This theoretical model suggests that such personalized guidance can lead to more effective skill development and behavioral modification.This immediate feedback serves as a powerful behavioral reinforcement mechanism.

Proposition 6: AI-based training (VR/AR immersive experiences, intelligent feedback) enhances teachers’ skill acquisition and behavioral refinement, directly increasing their adaptation and confidence in using AI, and consequently boosting teaching efficacy.

5.2. Theoretical system of teacher online learning community and intelligent recommendation

5.2.1. Learning the social construction theory of community

The online learning community for teachers is built on the theory of social constructivism, emphasizing that knowledge is constructed through social interaction. The resource sharing and interactive modules within the community provide a platform for teachers to discuss and share experiences related to AI teaching applications. Social network theory further explains the connections between teachers in the community, where teachers from different disciplines and with varying teaching experience form diverse network nodes. Resources such as shared teaching cases and insights into technology application spread across the network, promoting the growth and innovation of collective knowledge. The theory of teacher learning communities suggests that through continuous interaction, teachers gradually form a learning community with common goals and values, enhancing their professional identity and sense of belonging, and increasing their enthusiasm for participating in learning.This fosters collaborative knowledge-sharing behaviors and provides valuable social support.

Theoretically, in such a community, new teachers could quickly grasp how to initially apply AI technology in their teaching practices through exchanges with experienced teachers; meanwhile, senior teachers could gain new perspectives and ideas about applying new technologies from the newcomers. Such interactions are expected to increase teachers' confidence in AI applications and encourage the adoption of new integrated methods.

5.2.2. Theoretical principles and educational applications of intelligent recommendation algorithm

The intelligent recommendation system integrates collaborative filtering and content recommendation algorithms to provide teachers with precise learning resource recommendations(Afoudi et al., 2021). The collaborative filtering algorithm analyzes the interest similarities among teachers based on their behavior data in the community, such as browsing records and likes/comments, to recommend learning resources that align with the preferences of similar teachers. The content recommendation algorithm, on the other hand, is based on the analysis of resource text content, teachers' professional backgrounds, and needs, to deliver highly matched resources precisely. The user profiling theory in educational resource recommendations plays a crucial role here, by integrating multi-dimensional information about teachers to build precise user profiles, enabling the recommendation system to deeply understand teacher needs and significantly enhance the accuracy and effectiveness of resource recommendations.

Theoretically, to enhance recommendation accuracy, the platform can build detailed profiles for teacher users by collecting multi-dimensional information such as subject area, teaching experience, teaching style, and learning preferences, generating unique user profiles for each teacher. For example, a primary school math teacher with 10 years of teaching experience, who prefers inquiry-based teaching methods and is interested in the application of educational technology innovations, could be precisely recommended an AI-based training course on mathematical thinking expansion. This directly influences teachers' information-seeking and learning behaviors.

5.3. Theoretical path of intelligent recommendation system to promote teachers' professional development

From the perspective of teacher self-learning theory, intelligent recommendation systems provide teachers with a wealth of resources that meet their individual needs, stimulating the intrinsic motivation for self-learning. Teachers actively explore learning resources based on their interests, achieving self-construction of knowledge and skill enhancement. In terms of the alignment between professional development needs and precise resource delivery, as teachers progress through different stages of professional development, their requirements for AI-assisted teaching applications continuously evolve. Intelligent recommendation systems can dynamically track these needs and continuously provide suitable resources.

Taking novice teachers as an example, they have just started their teaching careers and are not yet familiar with all aspects of teaching practice. In terms of AI teaching applications, they tend to focus more on learning basic technical operation guides and teaching methods. The intelligent recommendation system analyzes the behavioral data of novice teachers in learning communities, such as frequently searching for keywords like "how to use smart lesson preparation software" and "basic operations of classroom interaction tools" .By combining this with their professional background and subject areas, it can accurately recommend foundational resources like "tutorial on using smart lesson preparation software" and "essential classroom interaction techniques and tool applications for novice teachers," helping them quickly get up to speed with AI teaching tools and enhance their teaching skills.

For experienced teachers, who possess rich teaching experience and are eager to innovate and break through in the application of artificial intelligence in education, they need cutting-edge application cases and research findings to broaden their teaching perspectives and enhance their teaching research level. The intelligent recommendation system, based on senior teachers' browsing records on academic platforms, directions of participating in scientific research projects, and sharing of advanced teaching concepts in learning communities, can recommend in-depth resources such as "Analysis of Personalized Teaching Practice Cases under AI Empowerment" and "Latest Research Advances and Trends in AI Education Applications."

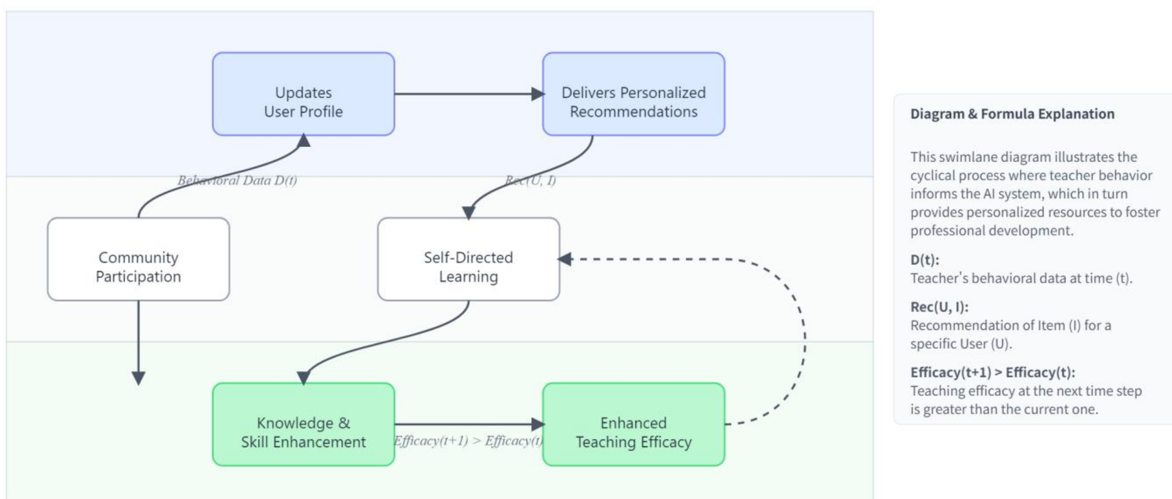

Figure 5. Path Model of Intelligent Recommendation System Promoting Teachers' Professional Development.

Figure 5 presents this pathway as a swimlane diagram, which clearly delineates the distinct roles and interactions between the Intelligent System, Teacher Behavior, and the resulting Professional Development. The diagram visually separates the system's actions (e.g., updating user profiles, delivering recommendations) from the teacher's actions (e.g., community participation, self-directed learning), illustrating how their interplay leads to tangible outcomes like knowledge enhancement and improved efficacy. This conceptual model suggests that the intelligent recommendation system, by orchestrating this synergistic process, can effectively support teachers at different stages of development in achieving professional growth, thereby enhancing teaching efficacy and driving overall improvements in educational quality.

Proposition 7: Online learning communities, supported by intelligent recommendation systems, foster collaborative learning and personalized professional development, leading to enhanced teacher adaptation, confidence, and teaching efficacy.

6.Theoretical analysis of school management support

6.1. Theoretical model of school leadership support and guidance

6.1.1. Theoretical basis of policy formulation and resource guarantee

At present, with the acceleration of digital transformation in education, the deep integration of artificial intelligence into teaching has become a key trend in educational development. When schools formulate policies to promote AI teaching, they should scientifically apply the rational decision-making model in educational policy theory, which involves multi-dimensional and deep consideration.

The core of the rational decision-making model lies in comprehensively and systematically analyzing all factors involved in decision-making to achieve scientific and rational decisions. For schools, clarifying educational goals is the foundation of policy formulation. Artificial intelligence teaching should not be seen merely as an innovation in teaching methods; it should focus on the comprehensive improvement of students 'overall qualities, including critical thinking, innovation ability, and digital literacy—key competencies essential for future social development. Theoretically, in schools that effectively introduce AI teaching, students participating in AI programming courses could show improved logical thinking, and the cultivation of innovation ability could be enhanced. Schools need to accurately position the role and function of AI teaching in fostering these abilities, ensuring that teaching activities closely align with the demands of future society for talent.

Keeping up with the development trends of artificial intelligence technology is a necessary condition to ensure the foresight of policies. AI technology evolves rapidly, with new algorithms and applications constantly emerging. Schools need to closely monitor technological developments and promptly introduce promising new technologies into teaching. For example, as natural language processing technology advances, intelligent writing assistance tools and smart language learning systems are increasingly being applied in education. Theoretically, the adoption of smart language learning systems could lead to improvements in students' language proficiency and learning efficiency. Schools should grasp these technological trends and plan corresponding strategies for technology introduction and application in their policies, avoiding limitations in teaching effectiveness due to technological lag.

To achieve optimal resource allocation, schools can adopt a method that combines quantitative analysis with qualitative assessment. This strategic thinking can be guided by the AI Teaching Application Strategic Choice Matrix shown in Figure 6. The matrix helps decision-makers prioritize investments by categorizing AI applications into four strategic quadrants based on their “Potential Impact” and “Implementation Maturity & Ease of Use”: ‘Prioritize & Scale’ for high-impact, mature technologies like Intelligent Tutoring Systems; ‘Explore & Pilot’ for high-potential, emerging tools like Generative AI Lesson Planners; ‘Leverage for Efficiency’ for mature but lower-impact tools like Automated Grading Tools; and ‘Monitor

& Wait' for technologies like Brain-Computer Interfaces that are not yet mature. This matrix provides clear, actionable decision support for schools to prioritize and allocate resources among numerous technical options, ensuring that limited educational resources achieve maximum value and laying a solid material foundation for the sustainable development of AI-assisted education.

Figure 6: AI Teaching Application Strategic Choice Matrix

6.1.2. Theoretical mechanism of the relationship between leadership support and teacher teaching efficacy

In the wave of AI empowering education, based on the transformational leadership theory within leadership behavior theory, school leaders play a crucial role in promoting AI teaching. Transformational leadership can paint a beautiful vision for teachers about AI teaching, igniting their enthusiasm for applying new technologies. For example, a school leader might propose the goal of "building a smart campus and achieving precise teaching," explaining this vision to teachers through internal meetings and lectures, helping them recognize that AI teaching is a trend in educational development. Theoretically, such vision-casting could increase the proportion of teachers actively participating in AI teaching training.

Transformational leadership also provides teachers with intellectual stimulation, encouraging them to break through traditional thinking and explore new applications of artificial intelligence in teaching. The school leadership could organize interdisciplinary seminars, inviting experts to share cutting-edge cases, such as using intelligent algorithms to analyze student performance for precise teaching, inspiring teachers to put these practices into action. At the same time, they pay attention to individual challenges faced by teachers, addressing the issue of older teachers struggling with operating smart devices by arranging specialized training to help them integrate into AI-assisted teaching.This directly influences teachers' motivational and learning behaviors.

The theory of organizational support suggests that teachers who feel supported by the school in terms of policies, resources, and atmosphere will experience enhanced organizational support, which in turn boosts job satisfaction and teaching engagement, ultimately improving their sense of teaching effectiveness. In terms of policy, the school could theoretically stipulate that teachers involved in AI teaching research should be given priority in evaluations and title promotions; regarding resources, advanced intelligent equipment and high-quality teaching software could be provided, along with professional training; for the atmosphere, teaching achievement exhibitions and innovation competitions could be organized. These measures are theorized to ensure that teachers genuinely feel supported, significantly enhancing their sense of teaching effectiveness and their organizational commitment.

Proposition 8: Strong school leadership support (transparent policy, adequate resources, intellectual stimulation) positively influences teachers' proactive AI engagement, enhancing their adaptation, confidence, and teaching efficacy.

6.2. Theoretical framework of school resource allocation and management

6.2.1. Theoretical model of artificial intelligence teaching resource allocation

According to the theory of educational technology equipment, schools need to comprehensively consider multiple factors such as teaching objectives, subject characteristics, and student needs when allocating resources for AI teaching. From the perspective of teaching objectives, different stages and subjects have distinct teaching priorities and specific requirements for students' skill development, which directly determine the type of resources needed.

When building the resource configuration model, scientific planning should be carried out from three dimensions: hardware, software and resource base. In terms of hardware, corresponding equipment should be equipped according to the actual needs of subject teaching.

In terms of software selection, it should be compatible with intelligent teaching platforms and subject-specific tools for various disciplines. Theoretically, after selecting specialized mathematical modeling software for mathematics, students 'enthusiasm for participating in mathematical modeling activities could significantly increase, potentially leading to a rise in participation rates and awards won. Similarly, for English, using intelligent language learning software could notably improve students' oral expression and listening skills.

The construction of resource libraries focuses on collecting and integrating high-quality digital teaching resources, such as courseware, case studies, and test questions, while ensuring the timeliness and relevance of these resources. For example, in a school with an optimized resource library, updated courseware is expected to be used more frequently than older versions, and student satisfaction with learning based on new courseware could be high. It is crucial to evaluate and optimize resource allocation schemes using cost-benefit theory. By accurately calculating the procurement costs, usage costs, maintenance costs, and the resulting teaching benefits, it ensures that the resource input-output ratio is optimized. Theoretically, after optimizing the resource allocation plan for a specific subject, a school could improve its teaching input-output ratio, enhancing teaching quality while achieving efficient resource utilization.This directly impacts teachers' resource utilization behaviors.

6.2.2. Theoretical system of resource management and maintenance

Using information resource management theory to establish a comprehensive resource management process is key to ensuring the effective utilization of AI teaching resources. Information resource management theory emphasizes the effective management of planning, organizing, storing, retrieving, and utilizing information resources. In managing AI teaching resources, schools start from the procurement stage by setting strict standards and procedures. For example, when purchasing intelligent teaching equipment, a school will base its decisions on teaching needs and market research, clearly defining specific indicators such as functionality, performance, and compatibility, to ensure that the procured resources meet both teaching requirements and quality standards. In terms of storage, a reasonable storage architecture and technology are adopted, with resources categorized for storage, such as by subject, grade, and resource type, significantly improving the efficiency of retrieval and access. Theoretically, an optimized storage architecture could reduce the average time teachers spend searching for resources.

Regular updates to resources are crucial for ensuring their timeliness and effectiveness. Schools need to track the development of artificial intelligence technology and changes in teaching needs, promptly replacing outdated resources. For example, after updating its intelligent teaching software with new algorithms and features, a school could theoretically see an increase in student engagement and a significant improvement in learning outcomes.

The fault handling process is constructed based on service management theory. Service management theory emphasizes a service-oriented approach to ensure the stability and reliability of services. The school can establish a dedicated technical support team to develop a fault handling plan. In a hypothetical scenario where a smart teaching platform malfunctions, the technical support team could respond rapidly and resolve the issue efficiently, significantly reducing the impact on teaching. To enhance the efficiency of teacher resource utilization, training on teacher resource usage is conducted based on user training theory. Through this training, teachers are expected to become more familiar with methods for accessing and applying resources, leading to a noticeable improvement in resource utilization efficiency. For example, after such training, the frequency of teachers using smart teaching resources could increase, and they could more skillfully use these resources to conduct diverse teaching activities.This directly shapes teachers' operational behaviors and resource engagement.

Proposition 9: Effective school resource allocation and comprehensive management (well-designed resource library, robust technical support) directly facilitate teachers' efficient AI tool utilization, enhancing their adaptation, confidence, and teaching efficacy.

7. A Holistic Theoretical Model and Conclusion

7.1. A Holistic Theoretical Model of Teacher Efficacy in AI-assisted Environments

To synthesize the multifaceted arguments presented in this paper, we propose a holistic conceptual model, visualized as a concentric circle framework in Figure 7. This model illustrates the ecosystem of teacher efficacy, with 'Teacher-AI Collaboration' at its very core. This core is directly supported by the first layer, 'Direct Interaction' (Teaching Applications & Student Learning). This interaction layer is, in turn, enabled by the second layer, 'Enabling Factors' (AI Technology & Teacher Professional Development). Finally, the entire system is situated within the outermost layer, the 'Environmental Support' (Organizational Support & Ethical Norms), which provides the essential context for sustainable success.

Figure 7. An Integrated Model of the Influence of Teachers' Adaptability and Confidence on Teaching Efficacy in AI-Assisted Environment.

This layered structure represents a comprehensive causal pathway:

The Core and Its Direct Interactions (Inner Two Circles): The ultimate goal is effective Teacher-AI Collaboration. This collaboration manifests in the layer of Direct Interaction, where AI is applied to teaching and impacts student learning. The success of these interactions forms the basis for a teacher's sense of efficacy.

The Engine of Enablement (Middle Circle): The effectiveness of the inner circles is powered by the Enabling Factors. This layer represents the crucial inputs discussed in Sections 4 and 5: the available AI Technology (its capabilities and usability) and the Teacher Professional Development (training, skills, and mindset). These factors directly influence a teacher's ability to adapt and build confidence.

The Supportive Ecosystem (Outermost Circle): The entire framework operates within and is moderated by the Environmental Support layer. This includes the Organizational Support from the school (Section 6) and the broader Ethical & Legal Norms. This context can either amplify or inhibit the potential of the inner layers. Crucially, it also encompasses the Teacher Individual Differences (Section 3), such as experience and discipline, which moderate how teachers experience and benefit from this ecosystem.

Psychological Mediation and Feedback: While not explicitly drawn as separate boxes, the psychological states of Teacher Adaptation and Teacher Confidence are the critical mediators that translate the influence of the layers into the final outcome of Teaching Efficacy. For example, effective Enabling Factors and a supportive Environment foster adaptation and confidence, which then enhances the quality of Direct Interactions and boosts efficacy. A dashed feedback loop is implied: as teachers develop higher teaching efficacy, they are more likely to engage more deeply with the enabling and interactive layers, leading to a virtuous cycle of continuous improvement.

In essence, this holistic model provides a theoretical map for understanding and predicting how and why teachers succeed or struggle in AI-driven educational reforms. It highlights that enhancing teaching efficacy is not merely a matter of providing technology, but requires a systemic approach that fosters psychological adaptation and confidence within a supportive, multi-layered ecosystem.

7.2. Research conclusions

This study focuses on the theoretical relationship between teacher adaptation, confidence enhancement, and teaching efficacy in the context of AI-assisted learning. Through the integration of multidisciplinary theories and the application of theoretical deduction and conceptual model construction, the following key conclusions are drawn:

At the theoretical level, the connotations and characteristics of artificial intelligence-assisted learning environments, teacher adaptation, teacher confidence, and teaching efficacy have been clarified. The important roles of theories such as technology acceptance and diffusion theory, self-efficacy theory, and teacher professional growth theory in explaining teacher behavior and psychological mechanisms have been outlined. Theoretically, teachers with different years of experience and subject areas are posited to exhibit significant differences when adapting to AI-assisted teaching environments. New teachers are theorized to start by curiously experimenting with new technologies during their early career stages, gradually focusing on integrating technology with teaching as they gain more experience; veteran teachers, despite facing challenges from traditional teaching mindsets, are conceptually able to achieve integration through experience transfer and technological innovation. Science teachers are expected to use intelligent tools to aid knowledge construction, while humanities teachers are theorized to leverage technology to enrich teaching contexts. Moreover, the factors influencing teaching efficacy are conceptually understood to vary across different subject areas in terms of knowledge and context dimensions.This comprehensive theoretical framework provides a robust foundation for understanding and predicting teachers' behavioral responses to AI integration in education, thus making a significant contribution to behavioral sciences.

In the integration of technology and teaching, personalized applications of intelligent teaching systems rely on various theories to play a significant role in learning plan formulation, customized teaching content, and the transformation of teacher roles, all theoretically leading to enhanced teaching efficacy. Artificial intelligence supports teaching evaluation by innovating from traditional assessments to comprehensive and dynamic evaluations, providing support for precise teaching while promoting the professional development of teachers, thus mutually reinforcing teaching efficacy.

In the field of teacher training and development, AI-based training models, such as VR/AR immersive training, are theorized to enhance training effectiveness through situational learning theory and embodied cognition theory; online teacher learning communities and intelligent recommendation systems are conceptually described as promoting knowledge sharing and professional growth based on social constructivism theory and intelligent recommendation algorithms. Support from school management is crucial for improving teachers 'teaching efficacy. School leaders' support in policy-making, atmosphere creation, and reasonable resource allocation and management are theorized to provide guarantees for teachers to apply AI technology in their teaching from various perspectives.

7.3. Research Prospects

Although this study has achieved certain theoretical results, there are still many aspects worth further exploration in the context of the deep integration of artificial intelligence and education.

In terms of theoretical deepening, although this study has constructed a relatively systematic theoretical framework, the relationships between variables are recognized to vary across different educational settings. Future research should conduct more empirical studies to thoroughly test and validate the characteristics and patterns of teachers in different regions and at different levels adapting to AI-assisted teaching processes. Specifically, future studies should empirically test the theoretical propositions (e.g., Proposition 1a, 1b, 2a, 2b, 3, 4, 5, 6, 7, 8, 9) presented in this framework, using quantitative methods (e.g., surveys, experimental designs measuring behavioral intentions and actual usage) and qualitative approaches (e.g., in-depth interviews exploring cognitive shifts and emotional experiences). This will refine the theoretical model, enhancing its explanatory power and general applicability. At the same time, with the rapid development of artificial intelligence technology, new technological forms and application models continue to emerge, such as the potential applications of generative AI in education (Song & Lin, 2023). These need continuous attention and inclusion in the research scope to expand the boundaries of theory.

In practical application, the transformation of research findings still faces challenges. Schools and educational institutions need to provide comprehensive support to teachers when applying AI teaching technologies, ensuring they can skillfully use these technologies to enhance teaching effectiveness. More training courses and tools that meet the actual needs of teachers should be developed, promoting the optimization and upgrading of intelligent teaching systems and evaluation tools, improving their usability and adaptability. Additionally, efforts should focus on narrowing the gap in AI educational resource allocation between regions and schools, promoting educational equity, so that more teachers and students can benefit from the educational reforms brought about by AI technology.

Interdisciplinary research is a crucial direction for the future. Although this study involves theories from multiple disciplines, there is still room for improvement in the depth and breadth of interdisciplinary integration. Future research can enhance collaborative innovation among education, psychology, computer science, and other fields, delving into complex issues in AI-assisted teaching from different disciplinary perspectives to provide more innovative and comprehensive solutions for educational practice. At the same time, conducting cross-cultural studies to compare the acceptance and application effects of AI education among teachers and students in different cultural contexts is a critical future research direction, offering references for global educational digital transformation.Such studies should specifically investigate how cultural factors influence teachers' technology acceptance behaviors, adaptation strategies, and confidence levels, along with the underlying social psychological mechanisms.

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