Analysis of the Application of Artificial Intelligence in Information Courses in Primary and Secondary Schools

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Abstract: In the context of today's rapidly evolving technological landscape, the integration of artificial intelligence (AI) technology with the education sector has shown immense vitality and potential. This study is based on a profound understanding of this integration trend and explores the practical application of AI technology in information courses in primary and secondary schools. Through literature analysis, this research examines numerous high-quality domestic and international documents and finds that AI technology has achieved widespread application in information courses, covering multiple teaching scenarios. On this basis, the author summarizes its advantages and challenges, and proposes practical suggestions and strategies, aiming to provide strong support for the scientific development of AI technology in information courses, thereby laying a solid foundation for the comprehensive advancement of digital education.

Keywords: artificial intelligence technology, information courses in primary and secondary schools, practical application, strategies

1. Introduction

1.1. Background

With the rapid changes in the information environment and the widespread adoption of big data, artificial intelligence (AI) technology is thriving globally. It is profoundly transforming people's lives and modes of production. Every significant breakthrough in AI research draws attention and reflection from society, bringing new momentum and opportunities for social development. This global trend has also led the education sector to recognize and emphasize the potential of AI. Educators are beginning to apply AI technology to various teaching fields, including primary and secondary education, with the aim of cultivating students' core competencies and enhancing educational effectiveness.

The government has also introduced various policies to guide the better application of AI technology in education. In July 2017, the State Council released the "Next Generation Artificial Intelligence Development Plan," elevating AI to a national development strategy and highlighting it as a powerful force driving educational transformation [1]. The "Compulsory Education Information Technology Curriculum Standards (2022 Edition)" also emphasizes the use of AI in education. In primary education, the focus is on cultivating computational thinking, with auxiliary activities to perceive and experience AI, learning about the development history of AI, and experiencing its

practical applications in various fields [2]. In secondary education, the focus shifts to advanced computational thinking and the preliminary understanding of AI implementation knowledge systems. Moreover, the AI module is a standalone chapter in the junior high school information technology curriculum, underscoring its importance as an integral part of information technology education in primary and secondary schools.

1.2. Research Objectives

This paper systematically reviews and studies a large number of high-quality documents to explore the application technologies and scenarios of AI in primary school information courses. It includes features of classroom design, learning support, and other aspects, aiming to deeply understand the typical cases in this field. Based on existing research phenomena, it discusses and analyzes the advantages and challenges of applying AI technology in primary and secondary school information courses. The goal is to provide application suggestions for effectively integrating AI technology into the construction of information courses in China.

1.3. Significance of the Research

Theoretical Significance: This research deepens and expands the theoretical study of artificial intelligence in the field of education, particularly in exploring its application in primary and secondary school information technology courses. Through detailed analysis of the practical application scenarios and effects of AI technology in classroom teaching, this study aims to provide educational researchers with unique insights and innovative thought processes, thereby further enriching the theoretical framework of education.

Practical Significance: First, this research aims to thoroughly analyze the specific application of AI in primary and secondary school information courses, including mainstream technologies, specific scenarios, and typical cases. It then proposes effective measures to improve teaching quality and efficiency, enhancing current teaching practices. Second, AI technology holds the potential to address the issue of unequal distribution of educational resources. Particularly in remote and resource-poor areas, the use of AI to assist teaching can promote educational equity. Additionally, by examining the current status of AI technology applications in courses, this research can provide policymakers with references to establish scientific curriculum standards. It also offers suggestions and solutions for the application of AI technology platforms in primary and secondary school information technology courses, promoting the rapid and positive development of educational modernization and creating a vision for a brighter future in education.

2. Concept Definitions

2.1. The Connotation of Artificial Intelligence Technology

Artificial intelligence (AI) is a technical discipline that simulates, extends, and expands human intelligence through theories, methods, technologies, and application systems. It includes technologies that simulate human intelligence, such as computer vision, natural language understanding, knowledge graphs, and machine learning [3]. Currently, AI education involves two directions: curriculum-based and subject integration. The former regards AI as content for teaching and learning, which includes implementing universal AI education popularization, setting up AI courses in primary and secondary schools, and establishing AI majors in higher education to cultivate high-level talent. The latter emphasizes AI empowering educational transformation, using practical technological applications to enhance educational quality, achieve large-scale personalized educational content and precise services, and improve teaching efficiency [4].

2.2. Information Courses in Primary and Secondary Schools

Information courses in primary and secondary schools are fundamental courses aimed at comprehensively enhancing students' information literacy and digital skills, cultivating scientific spirit and technology ethics, and establishing a comprehensive national security outlook [5]. Although the development of information courses in China started relatively late, it has reached its 40th year since the pilot of information technology courses in 1983. Initially, these courses were called "computer courses," but by the mid-1990s, they were renamed "information technology courses." This name is still used in general high schools. However, in compulsory primary and secondary education, the 2022 new curriculum standards officially renamed them "information science and technology courses." This change from "technology" to "science and technology" emphasizes balancing both "science" and "technology" in course construction. On the one hand, it focuses on the frontier development of information disciplines, and on the other hand, it pays attention to the application and operation of information technology in real life, emphasizing the cultivation of students' digital literacy and digital skills, developing their scientific spirit and ethics, and fostering correct information values.

3. Current Application Status of AI Technology in Primary and Secondary School Information Technology

3.1. Major AI Technologies Used in Information Technology Teaching in Primary and Secondary Schools

Currently, the application of AI technology in primary and secondary school information courses is characterized by diversity. The main technologies include big data and cloud computing, facial recognition technology for image recognition, knowledge retrieval systems, intelligent recommendation systems, and natural language processing.

Table 1: Major AI Technologies Used in Information Technology Teaching in Primary and Secondary Schools

Technology Name	Principles
Big Data	Through distributed computing systems, big data technology quickly processes and analyzes vast amounts of educational data. This data includes student performance, behavior records, teaching resources, etc. Processed through cloud computing, it provides decision support for educators, optimizes teaching methods, achieves personalized education, and improves education quality.
Cloud Computing	
Image Recognition	Facial recognition in image recognition focuses on deep learning techniques and image processing algorithms. Using convolutional neural networks through cameras, it effectively extracts learners' facial features and expressions. These features are converted into digital codes and compared with pre-stored facial templates in the database, thus recognizing learners' emotional states and understanding students' learning experiences.

Table 1: (continued).

Intelligent Recommendation System	The intelligent recommendation system used in teaching is an advanced technology that analyzes students' learning behaviors and performance, utilizing machine learning algorithms to automatically recommend personalized learning content. This system deeply analyzes student data to accurately recommend online courses and learning paths for students.
Natural Language Processing (NLP)	Through steps such as word segmentation, part-of-speech tagging, syntactic analysis, and named entity recognition, computers can identify the language structure in text, extract key information, and understand its semantics. This enables in-depth analysis of natural language texts such as assignments, test papers, and classroom discussions, thus achieving more intelligent and personalized teaching and learning experiences in the educational field.

By utilizing various artificial intelligence technologies in primary and secondary school information courses, a digital learning environment is created that provides technical and resource support for both teaching and learning. This not only helps teachers enhance teaching effectiveness, making it more efficient and personalized, but also offers a wealth of teaching resources to meet the learning needs of different students. In such an environment, students can participate in learning more actively, enhancing their self-learning and innovation capabilities.

3.2. Application Scenarios of AI Technology in Primary and Secondary School Information Technology Courses

3.2.1. Curriculum Design

The core goal of information technology curriculum design is to cultivate students' information awareness, computational thinking, digital learning and innovation, and a sense of responsibility in the information society, while stimulating their interest in learning in a lasting and profound way. Teachers guide students to deeply understand and proficiently master the basic knowledge and skills of information technology, while also helping them appreciate the rapid development of IT and its extensive application in daily life, as well as its far-reaching impact on human society.

The rise of artificial intelligence technology has provided unprecedented support for teachers in the field of primary and secondary school information education, propelling their teaching work to a new level. In the design of information courses for primary and secondary schools, teachers can utilize various software or systems as carriers to integrate all teaching resources, optimize high-quality educational resources, and achieve the goal of educational informatization.

The data analysis capabilities of AI technology can accurately identify the behavioral data of teachers and students in the classroom, visualizing and charting the collected data. This helps teachers quickly and effectively grasp each student's absorption and mastery of knowledge. By analyzing changes in learning performance, weaknesses, and subject potential, teachers can diagnose the academic situation of either the entire class or individual students, making lesson plans more relevant to students' actual needs and formulating more precise teaching strategies to improve teaching effectiveness. Therefore, AI technology provides strong support for efficient lesson preparation by information technology teachers, fully showcasing the practical value of AI technology in the education field.

3.2.2. Classroom Teaching

In information classroom teaching, the use of AI technology is increasingly becoming key to creating a "game classroom" educational atmosphere. Teachers ingeniously integrate AI technology into the teaching process of information courses, using advanced technologies such as image recognition and natural language processing to create a learning environment rich in game elements and interactive experiences for students. This innovative approach, by building student-centered smart classrooms, not only allows students to learn in a relaxed and enjoyable atmosphere but also leads them to independently explore, discover, and solve problems encountered in learning, thereby cultivating their information literacy.

In an intelligent teaching environment, the introduction of AI technology makes the content of information courses more vivid and interesting, providing students with rich memory aids and greatly enhancing the fun of information courses. Through image recognition technology, complex data and information can be presented in an intuitive form, allowing students to better understand their inherent logic and connections, thus enhancing their abstract thinking abilities and facilitating understanding and memory. The application of natural language processing technology increases the enthusiasm for group cooperation among students, making the interaction between teachers and students more natural and smooth. This teaching method exercises students' thinking abilities, helping them better grasp and apply the knowledge they have learned.

3.2.3. Learning Support

Artificial intelligence technology also plays a crucial role in learning support. Intelligent recommendation systems, with their advanced algorithms and powerful data processing capabilities, can deeply understand each student's unique differences and build precise academic profiles accordingly. These profiles not only record students' academic foundations, interests, and learning habits in detail but also predict their potential learning needs and challenges by analyzing their learning history and behavior patterns. Based on these detailed profiles, the system can construct comprehensive subject knowledge graphs, thereby providing students with subject knowledge structures and paths that best meet their individual needs.

The intelligent recommendation system further utilizes this information to intelligently generate personalized learning content and pacing. By dynamically adjusting the difficulty and progress of the teaching content, the system ensures that students can steadily improve at a comfortable learning pace. Simultaneously, the system can formulate exclusive learning plans based on the students' actual situations and accurately match personalized learning resources, such as exercises, video tutorials, and online courses, greatly enhancing students' interest and motivation in learning.

The application of this technology can provide personalized motivational assessments to students, effectively stimulating their initiative and enthusiasm. Students no longer perceive learning as a dull and tedious task but as a challenging and enjoyable journey of exploration. The precise guidance of the intelligent recommendation system also prevents students from experiencing aimless effort and inefficiency in their learning processes, making learning more efficient and targeted. More importantly, learning platforms underpinned by AI technology not only offer personalized learning resources and guidance but also encourage in-depth exchanges and discussions among students. This team learning approach promotes knowledge sharing and intellectual exchange among students, while also developing their teamwork and communication skills. In such a learning environment, students can learn from each other and make progress together, fostering a positive learning atmosphere.

3.2.4. Diverse Evaluation

As a core component of teaching activities, evaluation plays a critical role in ensuring the effectiveness of course delivery. Traditional teaching management methods often rely on teachers' subjective judgments or peer assessments among students. This approach not only limits the comprehensiveness of the evaluation but also risks trapping teachers in a self-reinforcing teaching cycle, making it difficult to detect and correct potential teaching errors. The accuracy of this relatively limited evaluation method directly affects students' motivation, interest, and overall teaching effectiveness. If the evaluation is not accurate or fair, students may develop negative attitudes towards learning, affecting their engagement and outcomes.

However, with the rapid development of artificial intelligence technology, the field of educational evaluation has undergone a new transformation. Currently, intelligent assessment systems applied in education mainly include ICT (Information and Communication Technology) skills and automated program assignment evaluation systems [6]. Intelligent assessment systems utilize AI technologies such as big data analysis and facial recognition, employing diverse evaluation methods like human-computer interaction, student self-assessment, and teacher-student mutual assessment to conduct comprehensive, objective, and scientific evaluations of students' learning processes. The introduction of AI brings new vitality to teaching evaluation, making it more scientific, fair, and comprehensive. Additionally, AI technology can enhance students' digital literacy, allowing them to accurately recognize their strengths and weaknesses through the evaluation process, thereby fostering positive learning attitudes and habits.

3.3. Application Cases of AI Technology in K-12 Information Technology Courses

3.3.1. Chengdu Shude High School – AI Agent

Chengdu Shude High School has skillfully introduced an "AI Agent" equipped with data analysis and image recognition capabilities to promote personalized development in information technology education [7]. In the "Applying Table Layouts in Web Structure" course segment, the school's IT teachers used the "AI Agent" to collect data on students' webpage projects, generating detailed individual learning reports. The reports identified two major issues: first, many students had not integrated image elements into their webpages, and second, some students had not mastered text insertion techniques. These issues not only highlighted students' deficiencies in webpage creation but also helped teachers pinpoint the focus of subsequent lessons.

The learning reports generated by the "AI Agent" provided teachers with precise feedback on student work and highlighted specific problems within the projects. Students could conveniently log into the system to view solutions to these problems. As a result, issues encountered during practical operations were promptly resolved, and students, guided by their teachers, continuously improved their work. This not only enhanced learning efficiency but also subtly fostered students' autonomous learning abilities.

The practice of using the "AI Agent" in the "Applying Table Layouts in Web Structure" lesson at Chengdu Shude High School achieved significant educational outcomes. Through in-depth data analysis and comparison, AI technology demonstrated its immense potential in improving teaching quality. Before the introduction of AI, the school found that some students struggled with mastering the key concepts of "Applying Table Layouts in Web Structure," unable to proficiently apply the learned knowledge. Data statistics indicated that the percentage of students unable to grasp the relevant concepts ranged from 6.85% to 17.10%. This meant that in each class, a portion of students might fall behind in learning progress and effectiveness due to insufficient understanding or proficiency in the concepts.

After implementing the "AI Agent," the school reanalyzed and compared students' learning outcomes. The results were promising: the data showed that the use of the "AI Agent" in teaching significantly improved students' mastery of the key concepts of "Applying Table Layouts in Web Structure." The percentage of students who struggled with these concepts dropped sharply from the initial 6.85%-17.10% to 1.32%-7.89%. This significant change indicates that AI technology has played a positive role in education, effectively enhancing students' learning outcomes and overall teaching quality.

3.3.2. Five Schools in Thailand – AI Toolbox

Researchers in Thailand have successfully developed an "AI Toolbox" using SOLIDWORKS computer-aided design software and computer vision technology, in combination with NVIDIA and JETPACK [8]. This toolbox has been approved by the Human Research Ethics Committee at the King Mongkut's University of Technology North Bangkok's STEM Education Center. The AI Toolbox is equipped with display screens, external output ports, and other devices. It employs the OpenCV computer vision open-source library and deep learning modules to accurately detect and predict objects within image frames. The results are fed back into the Python environment for data analysis using pre-trained models.

Based on the use of the "AI Toolbox," researchers created the MIAP learning model. The MIAP learning model starts with introductory courses on real-world AI system applications (M). Next, through teaching activities and the AI Toolbox, students are taught Python programming and hardware content (I). Teachers then require students to complete exercises (A) and submit their results via a mobile application. In the final step (P), teachers assess students' knowledge and provide guidance. After completing each module in the MIAP program, results are fed back to the teacher. If the learning outcomes are unsatisfactory, the teacher should review the information, application, and progress steps to improve students' understanding.

The AI Toolbox has been widely used for teaching Python programming in five high schools in Thailand: Satrinonthaburi, Anurat Prasit, Samsenwittayalai, Wat Khemapirataram, and Satriwitthaya 2. In the classroom, the AI Toolbox uses its built-in algorithms to capture students' behaviors and expressions via a camera. It employs facial detection models to place rectangular annotations containing text information on detected faces. Students' exercise results are transmitted in real-time to the application, enabling instant monitoring and feedback. After practical application, students' average scores significantly improved from 11.5 points to 18.67 points. Additionally, student satisfaction greatly increased, fully demonstrating the exceptional effectiveness of the AI Toolbox in Python programming education.

4. Discussion and Analysis

4.1. Advantages of Artificial Intelligence Technology in Primary and Secondary School Information Courses

Precision: Artificial intelligence technology used in teaching can provide real-time feedback on learning conditions and accurately identify and locate each student's knowledge weaknesses. Compared to traditional teaching analysis methods, classroom analysis based on AI technology is more precise and efficient. Through advanced data algorithms and pattern recognition technology, AI can meticulously analyze students' learning performance, helping teachers deeply understand each student's specific needs. Teachers can refer to these AI-generated classroom analysis feedback reports to make targeted adjustments to teaching strategies, making classroom instruction more tailored to students' individual needs. Similarly, students can use the diagnostic reports they receive to clearly understand their learning abilities, strengths, and weaknesses, allowing them to develop reasonable

study plans and goals based on these analyses. This precise teaching and learning method can significantly enhance educational outcomes.

Practicality: The application of artificial intelligence technology in primary and secondary school information courses is based on the collaboration of educators, researchers, and learners to address practical issues in teaching, enhance teaching and learning efficiency, and develop targeted methods and measures under the profound changes of the era and long-term teaching practices. The practical application of artificial intelligence technology in primary and secondary school information courses spans across key aspects such as classroom design, curriculum delivery, learning support, and diverse assessments. It is noteworthy that researchers maintain a focus on practice and iterative optimization of technology throughout its application in teaching practices. Based on feedback from teaching experiences, continuous optimization and improvement of artificial intelligence technology ensure its better adaptation to the needs of teaching practices, thereby enhancing teaching efficiency and quality. This iterative advancement of artificial intelligence technology in teaching provides robust support for the innovation of primary and secondary school information courses.

Workload Reduction: AI has become a valuable assistant to teachers, aiding teaching tasks through automated and intelligent methods. For example, automatic grading of assignments and intelligent student evaluation significantly reduce teachers' workload, allowing them to focus more on innovative teaching methods, developing high-quality teaching courses and resources, inspiring students' creativity, and nurturing talents to meet contemporary needs. Moreover, AI algorithms can maximize the optimization of regional education resource allocation, enabling the online flow of quality teaching resources. This means students can access more high-quality educational resources through online learning platforms, alleviating the learning pressure caused by regional limitations. Additionally, intelligent learning platforms can provide personalized learning content and teaching plans based on students' learning progress and ability levels, allowing students to learn at their own pace and reducing the anxiety associated with peer competition.

4.2. Challenges of Applying Artificial Intelligence Technology in Primary and Secondary School Information Courses

4.2.1. Transformation of the Traditional Teacher Role

In the era of artificial intelligence, the transformation of the traditional teacher role is an inevitable issue. The introduction of AI technology has made teaching methods more diverse and personalized. This requires teachers to shift from being traditional knowledge transmitters to becoming learning guides and facilitators, helping students better utilize AI technology for learning. Additionally, with the aid of AI technology, students can learn more autonomously. Consequently, the teacher's role transitions from being the classroom leader to serving more as a mentor and advisor. Furthermore, the application of AI technology also impacts teaching methods, necessitating teachers to rethink their teaching philosophies and methodologies in conjunction with AI technology. This transition demands that teachers' educational philosophies evolve from structured to innovative, adapting to new teaching methods and learning needs.

4.2.2. Imbalanced Resource Allocation

As an emerging technology in recent years, AI's coverage is expanding annually. Through literature review, it is observed that the proportion of primary and secondary schools in economically developed regions of China using AI technology in information courses is higher than in other areas. In some economically developed regions, due to the advantages of funding, technology, and policy support, primary and secondary school information courses can more easily introduce and apply AI technology. However, in relatively underdeveloped areas, such resource allocation advantages are not as evident,

resulting in delayed application of AI technology in education. This imbalance not only affects educational equity but also limits the opportunities for primary and secondary school students to access and understand advanced technology. In the digital age, AI technology has become an important driver of future development, and students lacking relevant knowledge and skills may be at a disadvantage in future competitions.

4.3. Recommendations for Applying Artificial Intelligence Technology in Primary and Secondary School Information Courses

4.3.1. Enhancing Teachers' Professional Capabilities

Regarding the application and operation of AI, information technology teachers generally possess higher information literacy than other teachers. They understand the basic principles and application scenarios of AI and can flexibly apply and operate AI technology. On this basis, information technology teachers must ensure they consistently maintain high information literacy to confidently address various challenges in daily teaching. Only when teachers are sufficiently knowledgeable about technology can they better guide and lead student learning. Information technology teachers need to maintain enthusiasm and a positive attitude towards learning, continually following new technologies, applications, and developments in the AI field, understanding the latest research outcomes and industry trends. They should regularly participate in AI-related training courses, seminars, or online learning platforms to update their knowledge and skills.

Simultaneously, teachers should actively experiment with the continuously emerging AI teaching tools and platforms available on the market. Using these tools and platforms can enrich teaching content and forms, enhance students' interest and enthusiasm for learning, and help teachers complete teaching tasks more efficiently, fostering innovative teaching models. During the trial process, teachers should focus on the functionality, ease of use, and alignment of these tools with the curriculum to ensure that the AI used genuinely facilitates teaching. Efforts should be made to improve their professional qualities and teaching capabilities.

4.3.2. Promoting Technology Application Platforms

In today's rapidly advancing digital and intelligent era, the promotion and application of artificial intelligence technology hold immense significance for information education in primary and secondary schools. Support from national policies is crucial for the widespread adoption of AI technology in education. The government needs to develop and release a series of guiding policy documents that clearly define the role and development direction of AI technology in the educational sector. Furthermore, increased financial investment in AI education projects is necessary to provide primary and secondary schools with the required hardware and software support, with special attention given to the use of AI in teaching in remote areas to ensure that AI technology is effectively implemented nationwide, striving to balance educational resources across different regions. Additionally, the government should establish dedicated monitoring and evaluation agencies to track and assess the implementation of AI education projects, ensuring their effectiveness and sustainability.

On the other hand, school-enterprise cooperation is also an important pathway for promoting the application of AI technology in primary and secondary education. Schools and enterprises can establish close partnerships to jointly develop AI technology products and solutions suitable for primary and secondary education. Enterprises can leverage their technical advantages and resources to provide schools with advanced AI technology and equipment support, helping schools solve technical challenges. Meanwhile, schools can offer talent development and research support to enterprises, fostering deep integration between industry, academia, and research. In practical cooperation, schools can invite enterprise experts to deliver lectures and training sessions, enhancing

the understanding and application capabilities of AI technology among teachers and students. Enterprises can also collaborate with schools to develop curriculum resources and teaching platforms, providing diverse AI technology learning resources for teachers and students in primary and secondary schools, thereby stimulating students' innovation and practical skills.

5. Conclusion

Although this study has achieved certain results, there are still some shortcomings. The study's consideration of the challenges of applying AI technology in primary and secondary school information courses remains insufficiently comprehensive. The rapid development of technology and the constantly changing educational environment may lead to more profound problems and challenges during the application of AI technology. The current perspectives may lack thorough analysis, requiring a deeper understanding of the actual conditions of technology application and a more comprehensive analysis based on educational practice to more accurately grasp the current state and trends of AI technology application in primary and secondary school information courses. The author hopes to conduct more comprehensive and in-depth research and exploration in future studies, continuously improving to provide more valuable references for future research.

Looking ahead, with the in-depth advancement of information construction, AI technology will play an increasingly important role in the field of education. The author anticipates that future primary and secondary school information courses will fully utilize the advantages of AI technology to innovate teaching methods and approaches, thereby improving teaching effectiveness and quality. It is also hoped that future research will focus more on the practicality and innovativeness of integrating technology with curriculum, exploring more AI technology application models that align with the cognitive patterns and interests of primary and secondary school students, ultimately contributing more significantly to the cultivation of future scientific and technological talents.

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