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A Precision Teaching Mode in Higher Vocational Colleges based on Information Technology

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Abstract: This paper explores the integration of precision teaching with information technology in higher vocational education. It identifies shortcomings in traditional teaching methods and highlights the potential of precision teaching, aided by new technologies, to address diverse student needs and optimize teaching processes. The paper proposes a three-dimensional model of precision teaching, showcasing how it can be applied in higher vocational education within an informationized context. Additionally, practical recommendations are provided to facilitate the effective implementation of this model, including government policy support, collaboration among institutions, teacher training, and technological upgrades. Overall, this research contributes to the advancement of higher vocational education by leveraging information technology for personalized learning and teaching optimization.

Keywords: Precision Teaching; Vocational Education; Information Technology; Teaching Mode.

1. Introduction

The educational philosophy of tailoring instruction to individual needs, as advocated by Confucius, has significantly influenced the development of the Chinese education sector. Similarly, the precision teaching theory proposed by Western educators shares fundamental principles with this concept. Precision teaching entails the meticulous design of educational objectives based on students' actual circumstances, systematic planning of teaching processes, and continuous adjustment of pedagogical strategies to accommodate individual differences.

In contemporary educational practices, the translation of precision teaching theory into tangible instructional strategies faces several challenges. Firstly, traditional classroom teaching systems, prevalent in both compulsory and higher education levels, often constrain educators' ability to cater to individual student needs effectively. With class sizes commonly exceeding twenty students, instructors struggle to personalize teaching methods to address diverse learning preferences and aptitudes. Secondly, technological limitations hinder the seamless integration of precision teaching principles into pedagogical practices. Additionally, apprehension towards adopting innovative teaching methods further impedes the realization of precision teaching goals.

Nevertheless, the widespread availability of the internet and advancements in information technology offer promising opportunities to overcome these challenges. By leveraging big data analytics and educational platforms, educators can collect, analyze, and visualize real-time student data to inform instructional design and delivery. This technological integration not only enhances the feasibility of precision teaching but also facilitates personalized learning experiences for student (Xie et al.,2019).

Currently, information technology-supported precision teaching has gradually unfolded in China's compulsory education stage. However, in higher education, research and practice on precision teaching are still insufficient.

This paper aims to address this gap by examining the implementation of a precision teaching mode in higher vocational colleges, particularly focusing on their integration with information technology. With the assistance of technologies such as data mining, this mode adopts more personalized and diversified teaching objectives, teaching contents, and teaching evaluations based on the personalized learning needs and characteristics of different student groups, deeply integrating information technology and teaching, conducive to improving teaching methods, enhancing classroom teaching quality, and realizing students' personalized development. Through theoretical inquiry and practical exploration, this study seeks to contribute to the existing body of research on precision teaching while fostering the integration of information technology and education, thereby enriching the quality of talent cultivation in vocational education.

2. Literature Review of Precision Teaching

As early as the 1960s, American educator Ogden Lindsley, influenced by Skinner, proposed the concept of precision teaching based on behaviorist theory. In its initial stages, precision teaching primarily involved teachers manually tracking and analyzing students' learning performance using pencil-and-paper methods, using this information as a basis for making informed teaching decisions.

Following the introduction of this concept, scholars conducted experiments to assess the effectiveness of precision teaching. White (1986) conducted teaching research that demonstrated the positive effects of precision teaching in shortening students' learning time and increasing motivation. Downer (2007) found that intervention using precision teaching significantly improved reading efficiency among children with reading difficulties. Gallagher (2006) verified the effectiveness of precision teaching in mathematics learning, with experimental groups using precision teaching methods showing a significant improvement in average scores when learning multiplication tables. Similarly, Stromgren et al. (2014) conducted experiments on teaching multiplication and division, further confirming the positive impact of precision teaching on enhancing mathematics instruction.

Although the concept of precision teaching has gained recognition from many scholars in the education field, its widespread application in schools has been limited due to technological constraints. Progress in academic research on this concept also stagnated for a period. It wasn't until breakthroughs in information technology, such as big data, began to be applied in classrooms, that the concept of precision teaching once again caught the attention of scholars.

Yang et al. (2021) demonstrated that utilizing data analytics to identify distinct learning patterns among students using an ebook system can offer educators insights to predict and enhance students' learning outcomes, thus advancing the objectives of precision education. Wu et al. (2021) proposed an integrative framework of learning analytics, employing human-and-machine symbiotic reinforcement learning to address challenges in current models, such as lack of validity and interpretability for precision education. Chen et al. (2023) examined the evolution and current state of AI robot-supported precision education, identifying key areas of application and highlighting the need for further development of truly human-centered AI in educational robotics to enhance learning outcomes.

It can be observed that in recent years, an increasing number of scholars have begun to discuss precision teaching in the context of new technologies such as artificial intelligence and big data (Papamitsiou and Economides, 2014; Nye,2015; Popenici and Kerr, 2017)

3. Information Technology and Precision Teaching

The primary challenge faced by early precision teaching implementation was the manual collection and recording of data, heavily relying on human effort. For instance, students were expected to dedicate a specific duration daily (such as 1 minute or a few minutes) to practice and measurement, while teachers manually recorded frequency data on standard acceleration charts using pen and paper (Lindsley, 1972). This method significantly consumed teachers' energy, especially in large class settings, making it difficult for teachers to sustain such measurements and recordings over time. Additionally, the results of these measurements were challenging to compile and present visually using traditional methods. Furthermore, the traditional concept of precision teaching prioritized learning outcomes over the learning process, hindering genuine personalized growth for students. Particularly in higher education, where there is often no unified and objective standard for measuring learning outcomes, outcome-oriented precision teaching may yield suboptimal results.

With the gradual maturation and integration of information technologies, scholars have revitalized precision teaching by leveraging these technologies. Big data analysis enables the collection, storage, and analysis of vast amounts of student data, including learning behaviors and outcomes. By interpreting this data, educators gain insights into individual learning needs, facilitating targeted teaching interventions. Data mining assists educators in understanding learning preferences and identifying challenging areas by uncovering patterns and trends within extensive student datasets, informing instructional strategies tailored to individual student requirements. Machine learning algorithms analyze student data to generate personalized learning paths, recommend resources, and offer tailored learning support, enhancing student engagement and comprehension. Intelligent AI-assisted teaching systems harness artificial intelligence and natural language processing to deliver personalized learning assistance. From intelligent tutoring systems to automated grading, these tools optimize teaching efficacy and student progress. Mobile learning apps provide students with on-the-go access to educational content, supporting personalized learning experiences, social interaction, and real-time feedback. Online teaching platforms offer educators a plethora of resources for remote teaching, interactive learning, and assessment, facilitating the implementation of precision teaching methodologies in diverse educational settings.

In traditional classrooms, due to the limited number of teachers and their finite energy, precision teaching often occurs only in small class settings, making large-scale implementation unfeasible. Currently, classroom teaching in China remains predominantly in large class settings, especially in higher education, where class sizes sometimes can exceed hundreds of students. The vast data processing capabilities of big data enable precision teaching to transcend scale constraints, expanding from elementary foundational courses to various stages and types of courses, and from small class settings to large class settings, thereby giving precision teaching practical significance in higher education.

Additionally, while traditional precision teaching relied solely on outcome analysis for intervention, information technology-supported precision learning incorporates learning process analysis. With vast amounts of learning data collected, tailored intervention methods and improvement measures can be devised to ensure differentiated development and meet individualized needs, moving beyond reliance on outcome analysis alone.

4. Precision Teaching Mode for Higher Vocational Education based on Information Technology

Higher vocational education differs from general higher education. Students in vocational colleges often have poor study habits and weaker foundations. Teaching in vocational education tends to emphasize practical methods such as case studies, experiments, and hands-on training to cultivate students' practical skills. Therefore, based on the characteristics of higher vocational education, we have constructed a precise teaching model utilizing information technology.

This mode comprises three dimensions: teaching preparation, teaching process, and teaching assessment. Figure 1 illustrates the specifics.

4.1. Teaching Preparation Dimension

Combining student classification and relevant data, setting precise teaching objectives, and developing personalized teaching resources are essential. Firstly, due to limited energy and large class sizes, teachers often employ the same teaching methods and content for students with different backgrounds and learning abilities. However, vocational students come from diverse backgrounds, with varying learning abilities and habits. For instance, some students come from regular high schools while others from vocational schools. Generally, students from regular high schools demonstrate stronger learning abilities and habits, while vocational students may have some advantages in professional courses. Therefore, using identical teaching methods and content for students with different backgrounds may lead to suboptimal teaching outcomes. Precise teaching abandons the uniformity of traditional teaching. During the preparation phase, teachers analyze student situations and classify them, based on factors such as their performance in previous courses, or differentiate between classes with better or weaker foundations.

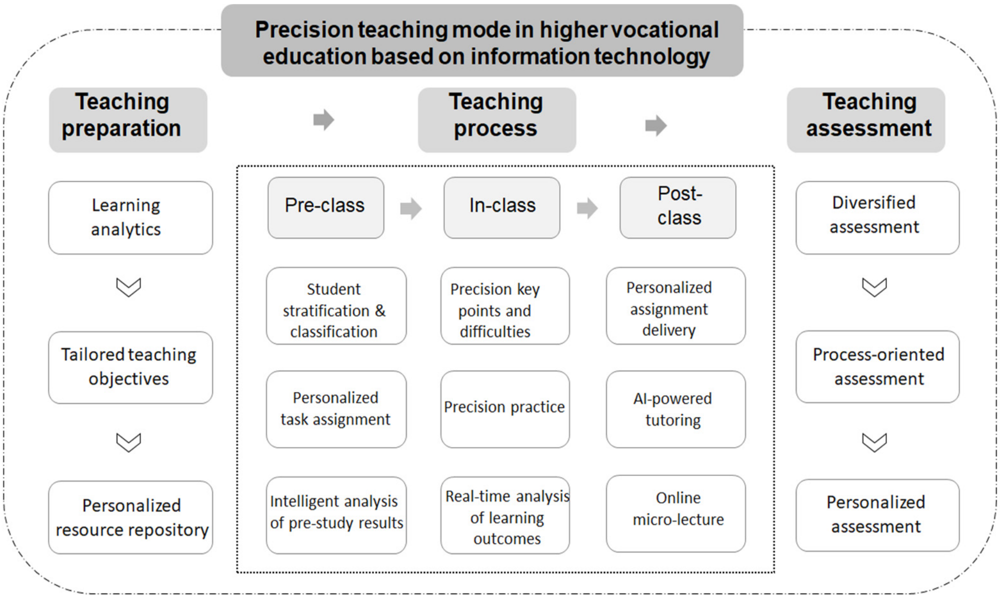

Figure 1. Precision teaching mode in higher vocational education based on information technology

Secondly, precise teaching requires formulating tailored teaching objectives for different types of students or classes. In traditional teaching environments, teaching objectives tend to be vague, with most goals being qualitative rather than quantitative. However, in precise teaching, to accurately assess students' mastery of knowledge, precise teaching objectives need to be designed. These objectives provide a more accurate interpretation and description of students' knowledge or skill levels. Different classes can have slightly different competency objectives; for instance, a task duration might be set at 30 minutes for classes with better foundations and 40 minutes for those with weaker foundations.

Additionally, to facilitate precise teaching during the teaching process, appropriate information technology platforms need to be selected to establish personalized resource repository. For example, the resource repository can categorize exercises into basic and advanced categories. Students with weaker foundations primarily use the basic repository, while those with stronger foundations can utilize the advanced repository. With the advancement of AI technology, in the future, artificial intelligence can analyze students' learning processes and directly provide targeted exercises and practice materials tailored to individual students.

4.2. Teaching Process Dimension

The teaching process generally consists of three specific stages: pre-class, in-class, and post-class.

During the pre-class stage, emphasis is placed on students' independent previewing. Teachers assign preview tasks on the digital platform, such as requiring students to watch instructional videos and complete certain exercises within a specified time frame. Based on students' video viewing and answer accuracy, more precise key points for the class are determined.

In the in-class stage, common errors from the preview are highlighted for focused explanation, and in-class exercises are selected from the database to reinforce learning outcomes. For example, if students demonstrate poor understanding of a certain concept during the pre-class preview, more time should be allocated in class to explain the principle and provide examples for students to judge and practice within a set time. Real-time correction of exercises using big data is utilized to assess learning outcomes. Students with poor pre-class learning outcomes, such as those who did not complete the preview tasks, should receive special attention in class, increasing their participation through methods like calling on them to answer questions. Moreover, AI can serve as an intelligent assistant in the classroom, providing instant answers to students' questions. This helps to improve teaching efficiency, allowing teachers to have more time to focus on interacting with students and guiding learning.

In the post-class stage, different types and difficulty levels of homework are assigned based on the pre-class and in-class learning performances of different classes or students. Foundational exercises are prioritized for classes and students with weaker learning abilities, while exploratory and advanced exercises are emphasized for those with stronger learning abilities, respectively. Teachers provide personalized guidance and feedback on individual issues through the digital platform, and micro-lessons addressing common problems can be released for the entire class.

If the platform incorporates AI technology, it can provide instant personalized feedback and guidance based on students' learning performance. By analyzing students' answering patterns and errors, AI can identify their weaknesses and offer targeted suggestions and assistance.

4.3. Teaching Assessment Dimension

Traditional teaching assessments are generally outcome-oriented. Taking universities as an example, final exam scores usually carry significant weight in overall grades. However, teacher-centered, outcome-oriented assessment systems have the following drawbacks:

Firstly, they often fail to stimulate students' classroom participation. Some students may be passive during regular classes but cram before final exams and still achieve good grades. This leads to a tendency among students to focus more on last-minute studying rather than consistent learning.

Secondly, teacher-centered assessment systems are often vague and somewhat subjective for students. They may not understand how their grades are determined, and some teachers may assign grades somewhat arbitrarily. As a result, some students may question their final grades.

The precision teaching mode in the assessment stage emphasizes personalization, diversification, process-oriented assessment, and real-time feedback.

First, precise teaching assessment places more emphasis on regular performance and classroom participation. Besides final assessments, grades are determined by factors such as class attendance, interaction in class, quality of assignments, practical exercises, group work, and enthusiasm in pre-class preparation. If a student frequently skips classes, shows little engagement in class activities, or fails to complete tasks, they may not receive a high overall evaluation even with high final exam scores.

Secondly, the one-size-fits-all approach of traditional teaching assessment may demotivate diligent students with weaker foundations. In the precision teaching model, students receive personalized tasks and assignments that match their abilities. Students with weaker foundations can start with tasks of lower difficulty, which helps build their confidence and motivation.

Thirdly, the precision teaching mode includes assessments not only by teachers but also by peers. For example, after completing group exercises on online learning platforms, students receive scores from both their peers and teachers. This diversified assessment approach ensures more accurate grading and enhances students' sense of participation in the classroom.

Finally, the precision teaching mode under the framework of information technology enables real-time feedback in assessment. In traditional university classrooms, students sometimes submit assignments and exercises without receiving feedback, unaware of their scores or where they went wrong. Through intelligent learning platforms, teachers can grade assignments online and provide feedback promptly. For objective questions like multiple-choice questions, the system can even auto-grade, providing instant feedback to students. This not only allows students to understand their grasp of the material but also enables teachers to gauge the class's understanding of specific topics in real-time, allowing for precise adjustments to teaching content in subsequent sessions.

5. Suggestions for Promoting Precision Teaching Mode Based on Information Technology in Vocational Education

5.1. Educational Policy Support

Government departments can formulate policies to support precision teaching, encouraging schools and educational institutions to fully utilize big data technology in teaching. Currently, China's education sector is increasingly focusing on the application of precision teaching in basic education. However, there is a lack of corresponding policies to promote precision teaching in vocational education. Relevant departments should promote precision teaching in higher vocational colleges by providing financial support, establishing educational standards, and creating data sharing platforms, among other measures, to prioritize precision teaching based on information technology.

5.2. Teacher Training and Support

Some teachers in higher vocational education may resist new technologies and be unwilling to learn actively. However, the integration of information technology in the classroom has become a trend, and teachers must proactively change their mindset and embrace new educational technologies. Schools should provide comprehensive support for teachers, including tailored training courses and resources to help them understand and master the application of big data technology in teaching. Additionally, establishing dedicated support teams or resource centers to provide technical assistance and guidance for teachers is crucial.

5.3. Cooperation and Demonstration in Higher Vocational Colleges

Establish collaboration mechanisms among higher vocational colleges to facilitate the sharing of experiences and resources. Promote successful cases and best practices to enable more schools and educational institutions to understand and adopt the precision teaching mode based on information technology.

5.4. Platform Technology Upgrade

Learning platforms should actively adopt the latest technologies to meet teaching needs. While there are many online education websites and learning software in China, the technologies used by these platforms are often outdated. For example, there is currently a lack of learning software that can leverage mature natural language processing technology, resulting in the underutilization of highly intelligent AI learning assistants in actual teaching. In classrooms, teachers' use of information technology is often limited to basic functions such as attendance tracking, random selection, and slideshow presentations, with relatively low levels of sophistication and informatization. Therefore, learning platforms need timely technological upgrades to introduce more advanced technologies that can enhance teaching effectiveness and improve learning experiences. Through continuous technological updates and enhancements, learning platforms can better meet the needs of students and teachers, promoting the effective implementation of precision teaching mode.

6. Conclusion

The rapid development of information technology has presented both significant opportunities and challenges to the field of education. Precision teaching, as a personalized instructional mode, emerges as a promising approach to meet students' diverse learning needs and enhance teaching effectiveness. This paper has delineated the limitations of traditional teaching methodologies in accommodating various student requirements and overcoming teaching hurdles. Moreover, it has elucidated the benefits and future prospects of precision teaching infused with information technology, particularly in personalized instruction, dynamic student learning tracking, and instructional process optimization.

In the realm of higher vocational education, the advocacy and implementation of precision teaching mode hold paramount practical implications and profound repercussions. By delineating and elucidating the three-dimensional framework of information-based precision teaching, we have showcased its potential and application scope in higher vocational education. Finally, to catalyze the efficacious implementation of information-based precision teaching mode in higher vocational education, we have proffered a series of promotional suggestions, encompassing policy support, teacher training, institutional collaboration, and learning platform technological upgrades. These recommendations aim to furnish higher vocational institutions with guidance and facilitate the pragmatic deployment and dissemination of information-based precision teaching mode.

In summary, this study bears significant theoretical and practical ramifications for advancing the informatization of higher vocational education, ameliorating educational quality and pedagogical efficacy, and nurturing students' individualized development. Through a comprehensive inquiry into the amalgamation of information technology and precision teaching, we have proffered novel insights and methodologies for the reform and advancement of higher vocational education, thus contributing to the establishment of a contemporary higher vocational education framework.

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