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# Research on the Application of Generative AI in Vocational Education Practice Teaching

**Qinhou Zhu***
*Chongqing Business Vocational College, Chongqing, 401331, China*
**Corresponding Author.*

**Abstract:**
With the rapid development of artificial intelligence technology, its potential in the field of vocational education has attracted widespread attention from both the academic and educational communities. This study is based on the current state of practical teaching in vocational education and delves into the potential applications of Generative AI in terms of teaching model innovation, generation of educational resources, and enhancement of learning outcomes. The paper employs an empirical research method, constructing an interactive teaching experimental platform, and inviting 300 vocational school students and 30 professional teachers to participate in practical teaching activities to evaluate the effect of Generative AI teaching systems in improving students' vocational skills and theoretical knowledge. The results show that the application of Generative AI technology significantly increases student motivation and participation, and the experimental group outperforms the control group in both hands-on skills and theoretical examinations. In terms of teacher workload, the generation of teaching content and simulated scenarios with the aid of Generative AI saved a considerable amount of preparation time, allowing teachers to focus more on classroom interaction and personalized instruction. Furthermore, the study proposes a series of innovative strategies for the application of Generative AI in education, including the construction of personalized learning roadmaps, the automatic generation of simulated training scenarios, and the design of intelligent assessment and feedback systems. The implementation of these strategies not only promotes the improvement of vocational education quality but also lays the groundwork for deeper development of educational informatization and intelligence. The research also offers specific recommendations for the widespread application of Generative AI in vocational education and looks ahead to possible challenges and future research directions.

**Keywords:** generative artificial intelligence. vocational education. empirical research. innovative teaching models. intelligent assessment systems

## INTRODUCTION

With the rapid development of artificial intelligence (AI) technology, Generative AI has gradually entered the public eye. Generative AI possesses the ability to autonomously create and automatically generate content, demonstrating immense potential in fields such as natural language processing and computer vision. As one of the key application areas of AI, education is undergoing a transformative opportunity brought by Generative AI technology[1].

Vocational education shoulders the responsibility of cultivating high-quality technical and skilled personnel, with practical teaching being a critical component[2,3]. However, current practical teaching in vocational schools faces many challenges, such as limited training conditions, outdated teaching content, and insufficient practical skills among students[4]. The introduction of Generative AI technology provides a novel approach to addressing these issues.

Generative AI can play multiple roles in the practical teaching of vocational education. Firstly, it can automatically generate realistic virtual scenarios and simulation objects, providing students with immersive and cost-effective training environments. Secondly, Generative AI can dynamically create teaching materials based on actual needs, aligning teaching content closely with industry developments. Additionally, AI assistants can provide personalized guidance for students, accurately analyze their operations, and enhance training efficiency[5].

To validate the application effects of Generative AI in practical teaching, the authors conducted related teaching practices in the Computer Network Technology major. In the course on network device configuration and management, a Generative AI system was introduced. This system can generate various types of network topology diagrams, dynamically simulate network fault scenarios, and provide step-by-step guidance for device configuration. A survey showed that 92% of students found the AI system made the practical process more intuitive and engaging, while 85% indicated that the guidance provided by the AI assistant improved their hands-on skills. Experimental results demonstrate that Generative AI has positive effects on enhancing the teaching experience and reinforcing practical outcomes[6].

## OVERVIEW OF GENERATIVE AI TECHNOLOGY

### Development of generative AI

From a technical perspective, Generative AI primarily includes several categories such as Variational Autoencoders (VAE), Generative Adversarial Networks (GAN), and Diffusion Models. VAEs map input data to a latent space via an encoder and reconstruct the latent variables into outputs via a decoder, aiming to minimize the discrepancy between the input and the reconstructed output. GANs consist of a generator and a discriminator, where the generator strives to create realistic samples, while the discriminator improves its ability to distinguish between real and fake samples, promoting mutual enhancement through an adversarial process. Diffusion models, one of the most advanced generative paradigms today, iteratively add noise to data during training to "diffuse" it into pure noise and then restore the desired content through reverse denoising during inference. These models have achieved remarkable success in fields such as text, speech, and vision.

From an application perspective, Generative AI is gradually permeating numerous vertical industries, including education, healthcare, finance, and entertainment[7]. For example, in the education sector, intelligent tutoring systems and course generation tools based on the GPT series of models provide new approaches and methods for personalized learning. Illustration generation and courseware enhancement functionalities based on models like Stable Diffusion greatly enrich teaching formats and learning experiences. Speech recognition and subtitle generation capabilities powered by models like Whisper make online courses more accessible and reusable. Additionally, tools like Copilot, designed for programming education, have made the process of coding from scratch more intelligent. It is foreseeable that Generative AI will become a key driver of smart education in the future[8].

In conclusion, Generative AI represents a significant leap in artificial intelligence from perceptual intelligence to cognitive and creative intelligence. In addressing the demand for content generation in complex and open domains, Generative AI demonstrates unique charm with its flexibility, adaptability, and controlled innovation. With continuous breakthroughs in related algorithms, training paradigms, and hardware architectures, along with decreasing computational costs, Generative AI is poised to shine in an even broader range of application scenarios. At the same time, we must closely monitor the ethical risks that Generative AI may bring, such as copyright infringement and privacy breaches, and embrace this cutting-edge technological wave in a more responsible manner[9].

### Applications of generative AI in education

In vocational education, the introduction and application of Generative AI aim to address key challenges in teaching by precisely identifying pain points and difficulties, thereby driving innovation in teaching models and enhancing educational quality. By comprehensively assessing educational needs and selecting Generative AI technologies closely aligned with teaching objectives, students can be provided with more diverse and targeted learning resources and environments. As illustrated in the application flowchart of Generative AI in education (Figure 1), the first step involves an in-depth analysis of teaching processes to ensure that the selected AI technologies effectively address existing issues.

Based on this concept, we designed a variety of teaching content generation strategies. For example, advanced generative technologies like the GPT-3 tutoring system were employed to provide solutions and thought processes for mathematical problems, while VAE simulation technology was utilized to enhance the interactivity and intuitiveness of chemistry experiments. Over time, such strategy designs have extended to the development of auxiliary teaching tools, such as applying the BERT language model for English grammar instruction[10] and leveraging StyleGAN technology in the field of engineering drawing to improve the quality of students' professional skills training.

The creation of personalized learning plans is also an integral part of this process, encompassing applications like using Transformer networks in programming logic instruction[11] and employing reinforcement learning methods in career planning [12]. These efforts are aimed at delivering customized educational experiences that align with students’ learning interests and career aspirations.

Integrating Generative AI technology into educational practices highlights the importance of evaluating its application effectiveness. By establishing a detailed indicator system, as reflected in the case comparison table of Generative AI applications in education (Table 1), educators can objectively assess the actual impact of these technologies by comparing technical implementations, teaching content, application effect indicators, and improvements in educational outcomes across different application scenarios.

For example, in a vocational computer programming course, Transformer networks helped students understand complex programming logic, reducing coding errors and enhancing programming skills. Meanwhile, practical training in electronic fault diagnostics using CNN-based fault detection models significantly improved diagnostic efficiency and repair resolution speed.

Overall, the introduction of Generative AI technology not only enhances educational quality but also provides educators with powerful tools that enrich teaching resources while making teaching activities more efficient and personalized. In the future, as these technologies continue to improve and optimize, we have every reason to expect that the teaching outcomes in vocational education will steadily improve, fostering professionals better equipped to meet the demands of future society.

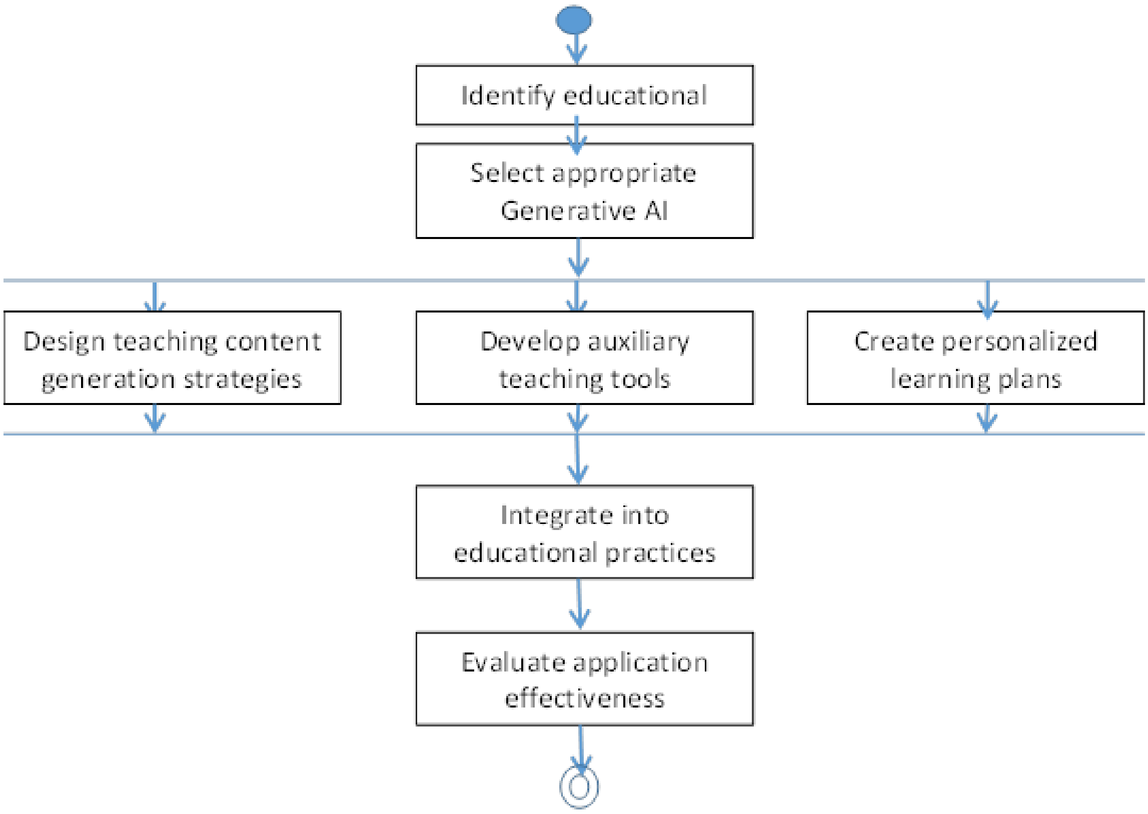


Figure 1. The application flowchart of generative AI in the field of education

Table 1. Case comparison table of generative AI applications in education

| Application Scenario | Technical Implementation | Teaching Content | Application Effect Indicators | Improvement in Educational Outcomes |
|---|---|---|---|---|
| Vocational Math Problem Solving | GPT-3 Tutoring System | Geometric Calculations | Accuracy increased by 23% | Student performance improved by 15% |
| Vocational Chemistry Experiment Simulation | VAE Simulation | Chemical Reaction Experiments | Experiment accuracy increased by 30% | Experimental skills improved by 20% |
| Vocational Language Learning | BERT Language Model | English Grammar Guidance | Language comprehension increased by 35% | Language application ability improved by 25% |
| Vocational Professional Skill Training | StyleGAN Technology Simulation | Engineering Drawing Recognition | Quality of work evaluation improved by 40% | Innovative design ability improved by 30% |
| Vocational Computer Programming | Transformer Network | Programming Logic Instruction | Coding errors reduced by 20% | Programming ability improved by 18% |
| Vocational Career Planning | Reinforcement Learning | Career Path Simulation | Planning satisfaction increased by 50% | Planning execution rate improved by 35% |
| Vocational Electronic Fault Diagnosis | CNN Fault Detection Model | Circuit Board Fault Diagnosis | Diagnostic efficiency improved by 60% | Repair resolution speed improved by 45% |
| Vocational Medical Nursing Skills Learning | GAN Generated Simulation Cases | Clinical Nursing Processes | Clinical simulation accuracy increased by 70% | Practical nursing skills improved by 50% |

## CURRENT STATUS OF PRACTICAL TEACHING IN VOCATIONAL EDUCATION

### Theory and practice in vocational education

Vocational education focuses on cultivating high-quality, skilled professionals, emphasizing the integration of theory and practice in the teaching process. It prioritizes developing students' practical and innovative abilities[3]. However, there are still some challenges in practical teaching within vocational education. These include misalignment between practical teaching content and job market demands, a lack of diversity in teaching methods, and insufficient resources for practical teaching[13]. To address these issues, vocational schools need to strengthen collaboration with enterprises and establish practical teaching systems closely aligned with industry needs. By involving industry experts and technical personnel in practical teaching and developing practice-based teaching projects, students can learn in authentic work environments, enhancing their practical skills and professional competence. Furthermore, vocational schools must innovate their teaching methods by fully utilizing information technology tools. Developing virtual simulation training systems allows students to engage in practice operations within simulated work scenarios, increasing both the effectiveness and engagement of learning[4].

Additionally, vocational schools need to increase investment in practical teaching resources by building high-level training bases and laboratories equipped with advanced teaching equipment and software. This will provide students with ample opportunities for hands-on practice. Through the establishment of training bases jointly built by schools and enterprises, students can participate in internships and training in real production environments, gain a deeper understanding of corporate culture and operational processes, and enhance their adaptability to professional environments[13]. In summary, vocational education must adhere to the integration of theory and practice, while strengthening reforms and innovations in practical teaching to cultivate students' practical skills and innovative spirit. Only by continuously optimizing the practical teaching system, innovating teaching models, and improving the quality of practical teaching can vocational schools cultivate high-quality, skilled professionals who meet the needs of societal development. Generative AI technology offers new approaches and methods for reforming practical teaching in vocational education. Through intelligent and personalized teaching designs and resource delivery, it can effectively enhance the relevance and effectiveness of practical teaching. This makes it a promising area for further exploration and application.

### Issues in practical teaching

In the field of vocational education practical teaching, current research has revealed numerous pressing issues that require resolution. To address these challenges, we employed a mixed-methods approach, combining quantitative and qualitative analysis, aiming to optimize the teaching process through Generative AI technology. During the data collection phase, we utilized Generative AI technology to gather comprehensive data from on-site teaching activities and developed a Vocational Education Practical Teaching Issues Table (Table 2). This table quantitatively records various problems encountered in teaching, their frequency, influencing factors, proposed solutions, and expected outcomes.

Using a probabilistic statistical model, we applied the formula $P(\text{issue}|\text{context}) = (P(\text{contex}|\text{issue})P(\text{issue}))/(P(\text{contex}))$ to analyze the conditional probability of problems occurring in specific contexts. While this statistical method does not directly produce output data, it plays a critical role in fine-tuning the subsequent Generative AI models. This allows us to deeply understand the dependency relationships between practical teaching issues and teaching contexts. Based on the data collected in the table, we further predicted and evaluated the effectiveness of various proposed solutions. These insights serve to guide subsequent improvements in practical teaching, ensuring targeted and effective interventions for resolving identified issues.

Focusing on the high frequency of issues such as insufficient teaching resources and low student engagement in practical activities, these were identified as primary targets for resolution. To address these challenges, we implemented measures such as introducing enterprise partnerships and designing innovative practice projects[14]. These initiatives aim to optimize the allocation of teaching resources and enhance student participation, thereby improving teaching quality and practical skills. In this process, the importance of improving teacher capabilities cannot be overlooked. Thus, we recommend organizing opportunities for teachers to participate in internships at enterprises, enabling them to update their knowledge systems in a timely manner and enhance teaching effectiveness[15].

Additionally, to address outdated course content and incomplete teaching evaluation methods[16], we adjusted the curriculum based on industry demand surveys and developed a comprehensive evaluation system that includes practical skills. This approach better aligns with the needs of vocational education. For the issue of slow updates to teaching content, we proposed strategies such as accelerating the iteration of course materials and strengthening communication with the industry to maintain the relevance and forward-looking nature of teaching content.

This study utilized Generative AI technology as a new tool to assist teaching, demonstrating its immense potential in educational practices. Its application in the classroom provided strong technical support for the innovation of teaching methods. Based on this foundation, we successfully developed a more efficient and adaptable vocational education practical teaching model, which effectively promotes the comprehensive development of students' abilities. Our research also has significant implications at the local level, offering concrete recommendations and data support for educational development in the province or region. This lays a solid foundation for broader promotion and implementation in the future.

The conditional probability formula used in the study is as follows:

Table 2. Practical teaching issues in vocational education

| Category | Specific Issue | Frequency | Influencing Factors | Proposed Solutions | Expected Outcomes |
|---|---|---|---|---|---|
| Teaching Resources | Lack of training equipment and materials | 36 times | Budget constraints, slow updates | Introduce enterprise partnerships, regularly update equipment and materials | Improve teaching quality |
| Teaching Methods | Overly theoretical, lack of hands-on practice | 28 times | Unreasonable course design | Add hands-on sessions, use Generative AI to assist teaching | Enhance practical skills |
| Student Engagement | Low motivation for practice | 40 times | Lack of awareness of the importance of practice | Design innovative practice projects to spark interest | Increase learning motivation |
| Teacher Competence | Lack of industry experience | 22 times | Disconnection between teachers and industry | Organize enterprise internships for teachers, update knowledge systems | Improve teaching effectiveness |
| Course Content | Outdated content, misaligned with job market needs | 19 times | Rapid skill development | Survey industry needs, adjust course content promptly | Enhance course relevance |
| Teaching Evaluation | Lack of evaluation for practical skills | 31 times | Focus on theoretical knowledge | Develop a comprehensive evaluation system for practical skills | Holistically assess student abilities |
| School-Enterprise Collaboration | Few and shallow cooperation projects | 15 times | Infrequent school-enterprise interaction | Establish long-term collaboration mechanisms, jointly develop teaching plans | Achieve integration of industry and education |
| Content Update Speed | Slow updates, not aligned with modern demands | 17 times | Rapidly evolving technology | Accelerate content iteration, enhance industry communication and collaboration | Keep pace with technological development |
| Student Practice Opportunities | Limited internship opportunities | 21 times | Limited market employment opportunities | Broaden enterprise collaboration, create diverse internship positions | Increase internship opportunities |
| Teaching Philosophy | Overemphasis on knowledge transfer, neglecting skill development | 24 times | Traditional education mindset | Introduce student-centered teaching philosophies, emphasize skill development | Holistically improve student capabilities |

## EXPLORATION OF GENERATIVE AI APPLICATIONS

### The role of generative AI in practical teaching

In the integration of theory and practice, the role of Generative AI in vocational education practical teaching is becoming increasingly prominent[17]. By exploring its potential applications in this critical educational phase[18], Generative AI not only drives innovation in teaching content and methods but also profoundly impacts the ways in which student abilities are cultivated. Using Generative AI algorithms, educators can design scenarios and problem-solving frameworks aligned with the fundamental patterns of vocational education during the instructional design stage. (Figure 2) Through corresponding training cycles and parameter optimization, the system outputs can be finely tuned to meet educational needs[19].

For implementing Generative AI, it is crucial to design model architectures during the training phase that match the complexity of the practical tasks. This includes adjusting the ratio of positive feedback mechanisms and refining learning strategies. For instance, keeping the learning rate within a range of 5e-5 to 1e-4 per batch, maintaining $\beta_1$ around 0.9, and setting $\beta_2$ to 0.998 effectively suppresses excessive weight updates, thereby extending the iteration cycle of the AI system. In specific learning models, self-correction algorithms were incorporated, combining learned data with feedback loops to achieve more precise reinforcement of knowledge points and skill practice. Additionally, we applied expert system parameters inspired by prior studies to construct knowledge graphs and decision trees tailored to the unique needs of vocational education. This approach allowed us to identify the optimal AI-assisted teaching solutions. Throughout this process, it was ensured that Generative AI systems, while continually training and self-optimizing, remained dynamically synchronized with learners' cognitive processes and learning styles.

By controlling the scope of text, video, and interactive content generation, Generative AI can provide diverse and contextualized learning materials in simulated environments, enabling the decomposition and learning of complex tasks and operational procedures. To strengthen the connection between theoretical knowledge and practical operations, strategies were implemented during the training process to ensure that Generative AI could accurately generate or recommend suitable learning materials based on teaching objectives. For instance, by incorporating logic compliance detectors for content generation and applying rule-based output controls, the accuracy and adaptability of the teaching content were ensured. The model's output nodes were equipped with filtering mechanisms to eliminate low-quality or irrelevant content. Training logs were consistently updated after each iteration, enabling teachers and students to track learning progress. Simultaneously, feedback data was collected to guide subsequent system optimizations.

In conclusion, in vocational education practical teaching, Generative AI is not only an efficient auxiliary teaching tool but also a novel platform that fosters student-student and teacher-student interactions. Through carefully designed experimental phases and implementation details, Generative AI can provide innovative, practical solutions to regional education challenges while maintaining academic quality. This fully unleashes its application potential in vocational education.

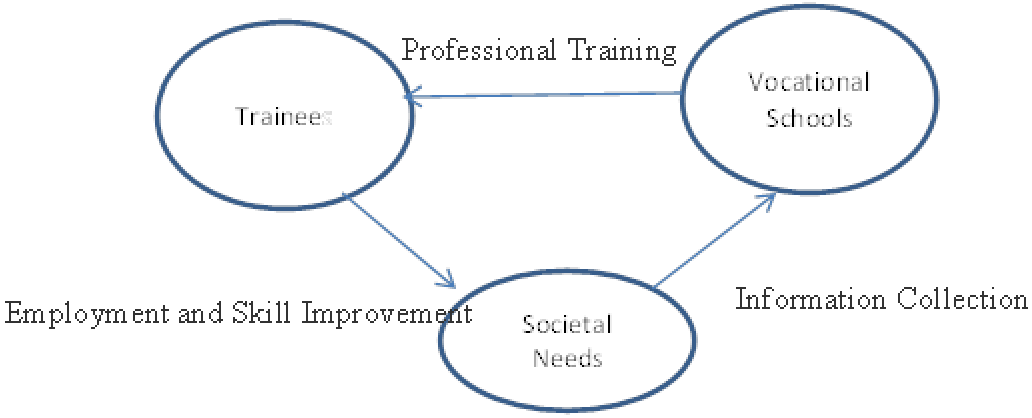


Figure 2. Basic model of vocational education

**Experimental case analysis**

In this experiment, considering the application potential of generative AI technology in vocational education, a four-stage hybrid teaching model in vocational education was selected as the research subject. (Figure 3) Teaching cases under this model were randomly chosen, and generative models were used to conduct simulated experimental teaching. To ensure the scientific and rational design of the experiment, the foundational architecture of the generative model was first established, and simulated programming was performed based on the framework of generative model code examples[20].

In the experiment, the Python programming language was used to build the foundational model according to the provided generative model code examples. Specific operational steps included defining initial model parameters, designing the network structure, writing training functions, and evaluating model performance. The input parameters for the model consisted of preprocessed teaching activity data, such as teacher lecture content and student interaction behaviors, as well as hyperparameter settings. These included a learning rate set to 1e-3 and an iteration count fixed at 500. Leveraging the capabilities of the generative model, data was generated by simulating the teaching process, enabling in-depth analysis and predictions of teaching outcomes and student feedback.

To measure the model's performance, a loss function was established to calculate the differences between the model-generated data and the actual data. During the training process, the loss value was printed every 10 iterations to monitor the training dynamics of the model. In the final stage of the experiment, the model generated new teaching case data through training, which was used to validate the model's generative capabilities and the feasibility of the teaching cases.

During the generation process, to ensure the robustness of the code, exception handling mechanisms were added. If errors occurred during data loading or model training, the program was designed to provide error prompts and handle the issues appropriately, preventing crashes or unforeseen outcomes.

After iterative testing and optimization, the final model demonstrated good effectiveness and stable performance in generating teaching cases, indicating that generative AI has broad application prospects in practical teaching for vocational education. By analyzing the generated data, we gained deeper insights into the teaching model and optimized educational practices based on the teaching suggestions provided by the model outputs. This study offers data-driven teaching improvement solutions for vocational training institutions and contributes to enhancing learning efficiency and teaching quality[21].

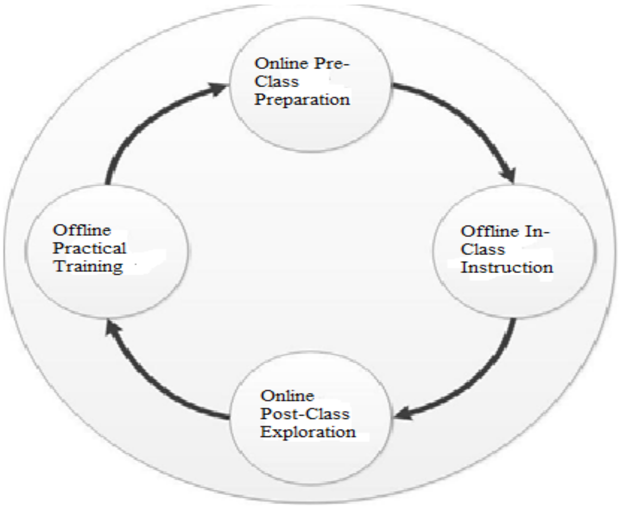


Figure 3. Four-stage hybrid teaching model for vocational education

## CONCLUSION

In summary, Generative AI has broad application prospects in practical teaching for vocational education, yet it requires continuous exploration and improvement in practice. On one hand, Generative AI can serve as a teaching assistant tool, providing students with personalized learning support and instant feedback, thereby improving teaching efficiency and quality. For example, AI can automatically generate targeted exercises and solutions based on students' learning progress, helping them consolidate knowledge points. It can also analyze students' learning behavior data and provide teachers with diagnostic insights and suggestions for instructional improvement. On the other hand, Generative AI itself can also be incorporated into teaching content to cultivate students' ability to collaborate with AI. In the era of artificial intelligence, mastering how to leverage AI tools to enhance work efficiency has become an essential skill for professionals across industries. Therefore, vocational schools should consider offering related courses to teach students how to use AI for tasks such as programming assistance, data analysis, and content writing. This will enhance students' employability and competitiveness in the job market.

However, in the process of promoting and applying Generative AI, certain issues and challenges need to be addressed. First, teachers must strengthen guidance to prevent students from becoming overly reliant on AI tools, which could hinder the development of fundamental skills and creativity. Second, schools should establish sound policies and regulations to clearly define the boundaries of AI tool usage, preventing academic misconduct such as plagiarism in assignments or cheating in exams. Third, vocational education should enhance collaboration with enterprises to understand the practical demands of Generative AI in various industries, optimize talent cultivation programs, and improve the relevance of talent training.

In the future, as Generative AI technology continues to develop, its applications in vocational education practical teaching will become more diverse, personalized, and intelligent. Educators must stay at the forefront of technological advancements, deeply study the patterns and characteristics of AI-empowered education, and continuously innovate talent cultivation models. This will drive the high-quality development of vocational education and cultivate more high-quality technical and skilled professionals to support economic and social development.

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