In-Depth Empowerment of AI in HarmonyOS Textbooks Construction under the China-Characteristic Apprenticeship

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Abstract: *Against the dual background of the digital transformation of vocational education and the rapid development of the HarmonyOS ecosystem, the construction of HarmonyOS textbooks under the China-Characteristic Apprenticeship faces numerous practical dilemmas. The intelligent interaction and dynamic adaptation characteristics of AI provide an effective path to address these challenges. Focusing on the core requirements of the China-Characteristic Apprenticeship, this study systematically explores the internal logic of AI's in-depth empowerment in HarmonyOS textbook construction, constructs a "four-dimensional collaboration and closed-loop driven" empowerment framework, and proposes practical paths such as "AI-driven school-enterprise collaborative content development, AI-enhanced virtual supporting resource construction, AI-empowered personalized learning and evaluation, and dynamic update and feedback". Additionally, it supplements with four guarantee strategies including "policy, technology, school-enterprise collaboration, and quality". The research results form a complete system of "logic-framework-paths-guarantees", realizing the precise connection between textbooks, industrial needs, and teaching practice. This provides support for improving the training quality of HarmonyOS technical and skilled talents, and also offers guidance for the construction of new-form textbooks in vocational education and the in-depth development of industry-education integration.*

Keywords: *China-Characteristic Apprenticeship; AI; In-Depth Empowerment; HarmonyOS Textbooks; Implementation Paths; Guarantee Strategies*

1. Introduction

Driven by the accelerated penetration of the digital economy and industrial transformation and upgrading, vocational education, as the core carrier for cultivating technical and skilled talents, is transforming towards digitalization, intelligence, and deep industry-education integration. The Chinese-style apprenticeship system, with its unique advantages of "comprehensive literacy + competency-based" education [1], has become a key link connecting the education chain and the industrial chain, supplying a large number of practical talents for industrial development. Meanwhile, the ecosystem of the domestically developed HarmonyOS operating system continues to improve, with its application scenarios expanding continuously in areas such as smart terminals, industrial IoT, and vehicular networking. Textbooks, as the core carrier of talent cultivation, directly determine the effectiveness of talent development through their quality, and the construction of digital textbooks is a new trend in the digital transformation of vocational education [2]. However, current efforts in HarmonyOS textbook construction still face numerous shortcomings in adapting to the training model of the Chinese-style apprenticeship system, making it difficult to meet the precise talent demands of industrial development. The core characteristics of AI technology, such as intelligent interaction, data-driven capabilities, and dynamic adaptation, can effectively address issues inherent in traditional textbooks, such as lagging content updates, lack of practical scenarios, and insufficient personalization, injecting strong momentum into the innovation of HarmonyOS textbook construction. In this context, exploring the pathways for the in-depth empowerment of AI in HarmonyOS textbook construction under the Chinese-style apprenticeship system, to overcome the limitations of traditional textbooks [3], is both an inherent requirement for responding to the digital transformation strategy of vocational education and deepening the reform of the Chinese-style apprenticeship system, as well as an important measure for supporting the high-quality development of the HarmonyOS ecosystem industry and

safeguarding national information technology security.

This research is of great theoretical and practical significance. Theoretically, by systematically constructing the logical framework and practical system of AI empowering HarmonyOS textbook construction, it can enrich the theoretical connotation of vocational education textbook construction, expand the application research boundary of AI technology in the field of vocational education, and provide theoretical support for the construction of new-form textbooks. Practically, building HarmonyOS textbooks adapted to the China-Characteristic Apprenticeship relying on AI technology can realize the precise connection between textbook content and industrial standards, the in-depth integration of practical teaching and enterprise scenarios, and the coordinated advancement of personalized learning and dual training, effectively improving the training quality of HarmonyOS technical and skilled talents. At the same time, the research results can provide reference experience for vocational colleges to carry out the construction of similar characteristic textbooks, promote the in-depth collaboration between vocational education and the domestic technology industry, and provide a solid talent guarantee for industrial upgrading and national technological self-reliance and self-improvement.

2. Current Situation and Dilemmas of In-Depth Empowerment of AI in HarmonyOS Textbooks Construction under the China-Characteristic Apprenticeship

2.1 Current Situation

The construction of HarmonyOS textbooks is generally in the initial promotion stage. Centering on the core requirements of industry-education integration and work-study combination, it has gradually developed towards aligning with industrial needs and strengthening practice orientation. In terms of resource form, it has broken through the limitations of traditional single paper textbooks, started to explore the integrated development of multi-form teaching resources, and focused on the supporting connection between theoretical content and practical resources to adapt to the alternating work-study learning model of apprenticeship. In terms of construction subjects, there is an initial trend of school-enterprise collaborative participation. The industrial adaptability of textbooks is improved by integrating enterprise resources, and the teaching adaptability of content is optimized by combining the teaching experience of colleges and universities. From the perspective of overall development, the construction of HarmonyOS textbooks has initially realized the need to conform to the core characteristics of dual training in the China-Characteristic Apprenticeship, and strived to build a content system that takes into account the imparting of theoretical knowledge and the training of practical skills. However, a mature and stable construction model has not yet been formed, and there is still much room for improvement in aspects such as technology integration, resource integration, and adaptability optimization, which still lags behind industrial development and the requirements of apprenticeship.

2.2 Core Dilemmas

In the process of adapting to the dual training requirements of the China-Characteristic Apprenticeship and aligning with the development needs of the HarmonyOS industry, the construction of HarmonyOS textbooks faces multiple core dilemmas, which restrict the full play of its educational effectiveness. Firstly, the content adaptability is insufficient. The update rhythm of textbook content is difficult to keep up with the iteration speed of HarmonyOS technology and the pace of industrial development. The coverage of cutting-edge technology applications and core post requirements is not comprehensive enough, making it difficult to accurately match the core requirement of post-course connection in apprenticeship training. Secondly, the support for practical teaching resources is weak. It is difficult to construct practical scenarios related to HarmonyOS technology, and supporting training resources are scarce. It is impossible to effectively simulate the real working environment of enterprises, which is difficult to meet the core demand of apprenticeship for work-study combination and strengthening practical skill training, leading to the disconnection between theoretical learning and practical operation. Thirdly, the school-enterprise collaborative construction mechanism is not sound. The division of responsibilities between the two parties in textbook development is not clear enough, the efficiency of resource integration and communication and collaboration is not high, and the industrial resources of enterprises and the teaching resources of colleges and universities have not achieved in-depth integration, which affects the synchronous improvement of the industrial adaptability and teaching applicability of textbooks. Finally, the personalized adaptation ability is lacking. Most of

the existing textbooks adopt unified content presentation and teaching arrangements, which fail to fully consider the individual differences of apprentices and the needs of different post directions. It is difficult to adapt to the teaching requirement of individualized instruction in the China-Characteristic Apprenticeship, and cannot effectively support the differentiated growth and precise ability improvement of apprentices.

3. Logic and Framework of In-Depth Empowerment of AI in HarmonyOS Textbooks Construction under the China-Characteristic Apprenticeship

3.1 Empowerment Logic

The in-depth empowerment of AI in HarmonyOS textbook construction is not a simple superposition of technologies, but a deep integration based on technical characteristics, training rules, and industrial needs. The core logic is to take AI technology as a link to address the practical dilemmas in the construction of HarmonyOS textbooks under the China-Characteristic Apprenticeship, and realize the precise connection between textbook content and vocational standards, teaching process and production process, and talent training and industrial needs. A complete logical chain is constructed from three dimensions: technical adaptation, training adaptation, and industrial adaptation, providing an underlying support for the deep integration of AI, HarmonyOS textbooks, and the apprenticeship training model.

(1) Technical Adaptation Logic: Precise Matching between AI Technical Characteristics and Textbook Construction Dilemmas. The core advantages of AI technology form a natural adaptation relationship with the dilemmas of HarmonyOS textbook construction, constituting the technical foundation for empowerment. On the one hand, AI's natural language processing and data mining technologies can realize real-time capture of massive dynamic HarmonyOS resources and automatically generate textbook content modules that conform to teaching rules [4]. On the other hand, AI-driven virtual simulation technology can allow apprentices to complete immersive practical training in a virtual environment based on real enterprise production processes.

(2) Training Adaptation Logic: Conforming to the Core Requirement of "Dual Training" in the China-Characteristic Apprenticeship. The China-Characteristic Apprenticeship is characterized by "industry-education integration, school-enterprise dual subjects, and work-study combination". The empowerment of AI in HarmonyOS textbook construction always revolves around this training requirement, forming a training adaptation logic. Firstly, at the level of talent training objectives, AI technology helps to accurately connect textbook content with enterprise post needs. Secondly, at the level of teaching process implementation, AI technology opens up the connection channel between "school learning" and "enterprise practice".

(3) Industrial Adaptation Logic: Serving the High-Quality Development Needs of the HarmonyOS Ecosystem Industry. AI empowerment is always guided by industrial needs, forming a virtuous cycle logic of "textbook construction - talent training - industrial development". Firstly, AI empowerment can improve the industrial adaptability of textbooks, ensuring that the knowledge and skills learned by apprentices keep pace with industrial development. Secondly, AI empowerment can strengthen the industrial thinking of talent training, thereby cultivating post competence. Finally, AI empowerment can promote the two-way transformation of industry-education resources, forming a virtuous ecology of coordinated development between industry and education.

3.2 Empowerment Framework

Based on the empowerment logic, a "four-dimensional integration" framework for AI's in-depth empowerment in HarmonyOS textbook construction is constructed, covering dimensions such as content generation, scenario simulation, learning situation analysis, and dynamic update. Each dimension is interrelated and works together to form a complete intelligent textbook construction system.

(1) Content Generation Dimension: With AI technology as the core, construct a textbook content generation mechanism of "school-enterprise collaboration + intelligent integration". Through AI's natural language processing technology, automatically capture HarmonyOS resources, extract core knowledge points and technical key points; combine the professional judgments of enterprise mentors and school teachers to screen, integrate, and optimize the extracted content, forming a textbook content

system adapted to apprenticeship training. Use AI technology to realize the multi-form presentation of textbook content and improve learning effects [5].

(2) Scenario Simulation Dimension: Rely on AI and virtual simulation technology to construct a "full-process, high-fidelity" HarmonyOS practical training scenario. Develop virtual training projects based on real enterprise production processes; use AI technology to realize intelligent interaction in training scenarios and simulate the guidance process of enterprise mentors; enhance the immersion of training through VR/AR technology, allowing apprentices to practice repeatedly in a virtual environment to improve practical skills and solve the training dilemma of "being unable to do or not doing well".

(3) Learning Situation Analysis Dimension: Based on AI's machine learning technology, construct a personalized learning system of "data-driven + precise adaptation". By collecting apprentices' learning behavior data, use AI models for data analysis to generate personalized learning tags; push targeted learning resources to apprentices according to the learning tags, including explanation videos of weak knowledge points, training projects adapted to post needs, etc.; track learning effects in real time and dynamically adjust learning paths to achieve personalized tutoring and precise talent training.

(4) Dynamic Update Dimension: Use AI technology to construct a textbook content update mechanism of "real-time tracking + rapid iteration". Through web crawler and data monitoring technology, real-time track the version update of HarmonyOS, industrial technical standards, and enterprise post needs; use AI models to automatically analyze the impact of these changes on textbook content and generate update suggestions; a textbook update team jointly composed of schools and enterprises reviews the suggestions and quickly completes the optimization and adjustment of textbook content to ensure that textbook content is synchronized with industrial needs.

4. Practical Paths of In-Depth Empowerment of AI in HarmonyOS Textbooks Construction under the China-Characteristic Apprenticeship

The construction of practical paths must closely focus on the core of dual training in the China-Characteristic Apprenticeship, take AI technology as a link, open up the connection channels between textbook construction and post needs, teaching implementation, and industrial development, realize the full-process upgrade of textbooks from content development to application optimization, and provide solid support for the training of HarmonyOS technical and skilled talents.

4.1 Construct an AI-Driven School-Enterprise Collaborative Content Development System

Constructing an AI-driven school-enterprise collaborative content development system needs to be based on the essence of industry-education integration and fully activate the resource advantages of both schools and enterprises. Rely on AI technology to build an integrated collaborative development platform, integrate diverse HarmonyOS resources, and through natural language processing technology, complete automatic classification of resources, extraction of core knowledge points, and screening of redundant information, forming a dynamically updated textbook material library. Establish a division of labor and collaboration mechanism between dual school-enterprise subjects. Enterprise technical experts lead the control of the industrial adaptability of content, sort out the core skills and practical difficulties of HarmonyOS development combined with front-line post needs, and transform declassified project processes and debugging specifications into teaching content; school professional teachers are responsible for optimizing the teaching adaptability of content, and design knowledge presentation logic and learning progression paths according to the cognitive rules of apprentices. Use AI-assisted editing and proofreading tools to realize the modular construction of textbook content. Divide the content into modules according to dimensions such as HarmonyOS basic theory, distributed core technology, multi-device collaborative development, and post-specific applications. Each module is matched with corresponding theoretical explanations, case analyses, and practical tasks to ensure that the textbook content is not only in line with cutting-edge industrial technologies but also conforms to the alternating work-study training model of the China-Characteristic Apprenticeship, realizing precise connection between posts and courses.

4.2 Develop AI-Enhanced Virtual Supporting Teaching Resources

The core of developing AI-enhanced virtual supporting teaching resources is to address the lack of HarmonyOS practical teaching scenarios and improve the effectiveness of apprentices' practical skill

training. Based on real enterprise production processes, use AI and virtual simulation technology to construct a full-process training scenario for HarmonyOS development, covering key links such as development environment construction, application code writing, and equipment debugging and adaptation. Integrate real work scenarios into the scenario to allow apprentices to immerse themselves in the enterprise work process. Embed AI intelligent interaction guidance function to real-time monitor apprentices' training operation behaviors, issue immediate warnings for incorrect operations, and simulate the one-on-one guidance process of enterprise mentors; develop an AI intelligent Q&A module to quickly respond to apprentices' learning questions and generate accurate answers by combining textbook content and industrial knowledge bases [6]. Create multi-terminal collaborative learning resources. Relying on the distributed technical characteristics of HarmonyOS, realize seamless synchronization of virtual training resources across multiple types of terminals, supporting apprentices to learn flexibly in multiple scenarios such as school classrooms, enterprise training bases, and home self-study. Support the development of an AI-assisted exercise question bank, which automatically pushes targeted intensive exercises according to apprentices' weak points in training, forming a practical teaching resource system of "virtual training + intelligent guidance + precise enhancement" to consolidate the basic skills of apprentices.

4.3 Build an AI-Driven Personalized Learning and Evaluation System

Construct a comprehensive learning data collection mechanism through AI technology, real-time record core data such as apprentices' theoretical learning progress, mastery of knowledge points, and training operation trajectories, and use machine learning algorithms to construct personalized learning portraits, accurately locating the advantages and weak links of apprentices in HarmonyOS technology learning. Generate customized learning plans based on learning portraits, push entry-level training projects for apprentices with weak foundations, and provide advanced skill development tasks for apprentices with outstanding abilities, realizing precise push of learning resources and dynamic optimization of learning paths. Establish a multi-dimensional intelligent evaluation system, integrating core elements of process evaluation and outcome evaluation. Process evaluation relies on AI to track learning data in real time to assess learning attitude and ability improvement process; outcome evaluation conducts quantitative evaluation combined with HarmonyOS skill level assessment and project completion quality; introduce an enterprise evaluation dimension, synchronize apprentices' training results to enterprise mentors through an AI platform, and collect enterprise-side post adaptability evaluation opinions. Integrate multi-dimensional evaluation data through AI technology, automatically generate personalized growth reports, clearly present the trajectory of apprentices' ability improvement, and provide data support for schools to optimize teaching strategies and enterprises to carry out talent selection.

4.4 Establish an AI-Empowered Dynamic Update and Feedback Mechanism

Use AI web crawler and data mining technology to real-time monitor changes in HarmonyOS system information and enterprise post needs, automatically identify the key points of textbook content that need to be updated through intelligent analysis models, and generate a preliminary list of update suggestions. Set up a joint school-enterprise update review team to professionally review the update suggestions generated by AI, optimize the updated content in combination with teaching practice needs, and quickly complete the revision and integration of textbook content relying on AI-assisted editing tools, realizing rapid iteration of core textbook content. Build a multi-subject intelligent feedback platform, open feedback channels for different subjects such as apprentices, school teachers, and enterprise mentors, and through AI technology, automatically classify feedback information, extract keywords, and analyze core demands, accurately locating problems in textbooks in terms of content presentation, resource matching, and teaching adaptation. Establish a closed loop of feedback processing and effect verification, formulate optimization plans for issues with concentrated feedback, push optimization instructions through the AI platform after completing textbook adjustments, track and collect subsequent usage feedback, and continuously verify optimization effects, forming a virtuous cycle of "dynamic monitoring - intelligent analysis - rapid update - feedback optimization" to ensure that textbooks are always adapted to technological development and talent training needs.

5. Guarantee Strategies of In-Depth Empowerment of AI in HarmonyOS Textbooks Construction under the China-Characteristic Apprenticeship

The in-depth empowerment of AI in HarmonyOS textbook construction requires the construction of a comprehensive guarantee system to provide support for its steady advancement. The following four core guarantee strategies cooperate with each other and have their own focuses, laying a solid foundation from four key dimensions: policy, technology, collaboration, and quality, ensuring that textbook construction not only meets the dual training requirements of the China-Characteristic Apprenticeship but also accurately aligns with the development needs of the HarmonyOS ecosystem industry.

5.1 Policy Guidance Guarantee

Policy guidance guarantee needs to give play to the government's macro-control and overall coordination role, providing institutional support and resource guarantee for textbook construction. The government should incorporate AI-empowered HarmonyOS textbook construction into the digital transformation plan of vocational education, introduce special support policies, and set up special funds for textbook development, technology research and development, and pilot promotion. Clarify the standards and specifications for textbook construction, formulate development guidelines and quality evaluation indicators for AI-empowered vocational education textbooks, and standardize key links such as content selection, technology application, and teaching adaptation. Establish an incentive and restraint mechanism, provide rewards such as honors and funds for institutions actively participating in textbook construction, and incorporate textbook construction results into the school-running quality evaluation of vocational colleges and the social responsibility evaluation system of enterprises. Build an inter-departmental coordination platform, coordinate resources from multiple departments, and open up channels for policy implementation, technology transformation, and industrial connection, forming a joint force to promote textbook construction.

5.2 Technical Support Guarantee

Technical support guarantee focuses on addressing the core bottlenecks of the integration of AI and HarmonyOS technologies and constructing a full-chain technical service system. Increase investment in core technology research and development, support schools and enterprises to jointly form technical research teams, focus on breaking through key technologies such as AI model adaptation under the HarmonyOS system, lightweight development of virtual simulation scenarios, and multi-terminal collaborative interaction, and form independent and controllable technical solutions. Build a safe and reliable technical service platform, integrate core elements such as AI development tools, HarmonyOS development environment, and virtual training resources, and provide regular services such as technical consultation and troubleshooting. Strictly implement data security laws and regulations, encrypt and store sensitive information and conduct hierarchical management to ensure the security and compliance of technology applications. Establish a dynamic technology adaptation mechanism, real-time track the version update of HarmonyOS and the development trend of AI technology, and timely optimize the technical adaptation plan of textbooks.

5.3 School-Enterprise Collaboration Guarantee

School-enterprise collaboration guarantee aims to deepen dual-subject cooperation and open up the connection channel between textbook construction and industrial needs. Establish a regular collaborative decision-making mechanism. Schools and enterprises jointly set up a textbook construction working group to regularly study and judge the technical trends of the HarmonyOS industry and post competence needs, and coordinate the promotion of content development, training design, and quality evaluation. Construct an interest-sharing and risk-sharing mechanism. Through carriers such as co-building industrial colleges and training bases, bind textbook construction results with technology research and development to achieve mutual benefit and win-win results between schools and enterprises. Build an efficient collaborative communication platform, relying on AI technology to realize the sharing of textbook development materials, synchronization of progress, and real-time feedback of problems, improving the efficiency of collaborative development. Clarify the division of responsibilities between schools and enterprises. Enterprises take the lead in providing industrial resources and post needs, and colleges and universities are responsible for the optimization of teaching content and the adaptation of teaching models, forming a cooperative pattern of

complementary advantages.

5.4 Quality Improvement Guarantee

Quality improvement guarantee needs to construct a full-process and multi-dimensional quality control system to ensure the scientificity and effectiveness of textbook construction. Establish multiple quality evaluation subjects. Form an evaluation team composed of college teachers, enterprise technical experts, industry scholars, and third-party evaluation institutions to conduct comprehensive evaluations from dimensions such as content scientificity, technical adaptability, teaching practicality, and industrial adaptability. Implement full-process quality control. Strictly control content selection and technology integration in the textbook development stage, track and collect feedback from teachers, students, and enterprises in the pilot application stage, and establish a dynamic optimization mechanism in the promotion stage. Build a quality feedback platform, conduct real-time analysis of textbook usage data through AI technology, and accurately locate quality problems. Establish a textbook quality certification system, link the certification results with textbook promotion and resource support, and guide the construction of textbooks towards high quality.

6. Conclusions

This study clarifies the three-dimensional empowerment logic of "technology, training, and industry", constructs a "four-dimensional collaboration and closed-loop driven" empowerment framework, proposes practical paths including "content development system, virtual supporting teaching resources, personalized learning and evaluation system, and dynamic update and feedback mechanism", as well as four guarantee strategies of "policy, technology, school-enterprise collaboration, and quality", forming a complete research system of "logic-framework-paths-guarantees". It provides a systematic solution for addressing the practical dilemmas of HarmonyOS textbooks adapting to apprenticeship training. However, the research mainly focuses on theoretical construction and path design, with insufficient depth and breadth of empirical testing, and has not verified the practical effectiveness of the scheme through large-scale pilots; the differentiated adaptability of vocational colleges in different regions and at different levels is not fully considered. Future research can focus on three directions: first, carry out large-scale empirical research, track the application effects of pilot colleges and universities, and optimize and improve the empowerment framework and practical paths; second, explore hierarchical and classified textbook construction schemes in combination with the differentiated characteristics of colleges and universities; third, deepen the integration and innovation of AI and HarmonyOS technologies, explore the application of generative AI in textbook content creation and training scenario design, further improve the intelligence level of textbook construction, and promote the coordinated and high-quality development of vocational education and the HarmonyOS industry.

Acknowledgements

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