

# Pathways for Innovation Development of Digital Textbooks in Higher Education in China

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**Abstract** With the rapid growth of information technology, digital textbooks, as a crucial component of education digitalization, are gradually emerging as a key tool for teaching in higher education institutions. They transcend the limitations of traditional textbooks, providing a broader scope and a wealth of resources for teaching. Digital textbooks present knowledge through diverse formats, including multimedia content and interactive sessions, thereby enhancing student's engagement and interest in learning. Furthermore, they can be updated at any time to keep abreast of the development in various disciplines and to meet the needs of the times, ensuring that students can access the latest and accurate information. In addition, digital textbooks can help promote educational equity by making quality educational resources accessible to a broader range of students. As Yang (2024) points out, integrating artificial intelligence (AI)-related courses into teaching can cultivate students' computational thinking, data analysis, and algorithmic application skills, as well as their sense of innovation and a spirit of exploration through solving practical problems. At the same time, AI technology and Big Data can be utilized to analyze students' learning data and provide customized learning paths and resources. Therefore, it is evident that digital textbooks in higher education play a vital and irreplaceable role in improving teaching quality and cultivating innovative talent.

By introducing the efforts and progress made by Higher Education Press (HEP) in the development of digital textbooks and resources, as well as the specific actions and initiatives in applying AI to develop digital textbooks, strengthening copyright management and protection, and pushing forward the implementation of standards for digital textbooks, this paper discusses the current status, challenges, and future directions of developing digital textbooks in higher education.

## 1 Development of Digital Textbooks and Resources

In all textbook categories, digital textbooks are teaching resources that have garnered significant attention in China's higher education community in recent years. The development of digital textbooks in China has progressed through various stages, which Prof. Xiaofei Xu defines as “4+1”, i.e., textbooks digitalization, knowledge-based services, intelligent services, and competency-based services, plus meta-universe services (Zhang & Pu, 2024). The first four categories can all be found in Higher Education Press (HEP), which are determined by the diverse talent training needs across various disciplines and courses, while inseparable from the characteristics and principles of higher education textbooks.

China's higher education, characterized by a large number of disciplines and majors, encompasses a large volume of courses and supporting textbooks. According to the *Catalog of Undergraduate Education Disciplines for Regular Higher Learning Institutions* (Ministry of Education of the People's Republic of China (MOE), 2024), there are 14 disciplinary categories, 93 professional categories, and 816 majors in undergraduate higher education. To date, more than 100,000 categories of higher education textbooks have been officially published in China (Song & Wang, 2024).

That is why different categories and developmental stages of digital textbooks do not follow a sequential order. Instead, different categories emerge and coexist simultaneously at different stages. From a technical standpoint, the first four categories of digital textbooks are currently available. In terms of quantity, advanced categories are not necessarily the predominant ones. Most of the current digital textbooks fall into the categories of “textbooks digitalization” and “knowledge-based services.”

HEP has rolled out plans for digital textbooks in the categories of “intelligent services” and “competency-based services.” Since 2023, HEP has been actively engaged in training large-scale models for education and developing corpora, planning to unveil large models for foundational disciplines and course agents in the fall of 2024 to support the development and application of the textbooks under the “101 Plan.” Specifically, the “101 Plan” is a foundational initiative designed to cultivate top-level innovative talent, planned by the MOE and led by Peking University. The plan pools resources from 33 top Chinese higher education institutions, distinguished faculty members, and leading publishers, aiming to promote the development of basic elements centered around core courses, core textbooks, core faculty, and core practice programs (collectively known as the “four cores”), which led to reforms in the education and teaching system. For instance, in the field of computer science, the “101 Plan” aims to continuously optimize the course systems, textbooks, and practice platforms. It also seeks to extend these optimized components to more higher education institutions to comprehensively improve computer science education in China. Looking ahead, the “101 Plan” will focus on promoting experience, adjusting and developing a computer science education system applicable to all levels of higher education institutions, innovating teaching evaluation methods with artificial intelligence (AI) and other technologies, and enhancing the scientific nature of teaching improvements. It aims to significantly increase the international competitiveness of China’s computer science education by expanding international cooperation, seeking joint reforms with overseas higher education institutions, and learning from international best practices (Hopcroft & Guo, 2024). For the aforementioned purposes, HEP will closely follow the national strategic plan for talent cultivation in the new era, strengthen the development and assessment of students’ competence graphs based on knowledge graph development, and realize the transformation of digital textbooks from knowledge transmission to competence cultivation.

In the future, HEP will uphold its original aspiration in the development of textbooks, accelerate the development of course and textbook systems that align with the advancements in science and technology, the characteristics of higher education, and the needs of the times, emphasizing the fundamental task of cultivating individuals with high moral values. Aiming to support course and teaching reforms, and improve the quality of independent talent training, HEP will embrace openness and inclusiveness, absorb international quality education and teaching resources, continue to resonate with users and the times, and create more high-quality digital textbooks that meet

user needs and talent cultivation requirements.

## 2 AI Applications in Digital Textbooks Development

HEP is currently developing AI-powered teaching and editorial assistants. In September 2023, HEP, in collaboration with Zhejiang University and Alibaba Cloud, released a vertical large-scale model in education named “wisdomBot.” Based on the Tongyi Qianwen-7b (Qwen-7B, a 7-billion-parameter model from the Tongyi Qianwen foundation model series developed by Alibaba Cloud), wisdomBot undergoes continuous pre-training and fine-tuning using high-quality textbook-level corpora and specialized instruction datasets, including core textbooks, field-specific papers, and academic dissertations, and integrates multiple functions, acting as a search engine, a computation engine, and a local knowledge base. The model offers intelligent Q&A, test question generation, learning navigation, teaching evaluation, and other educational services for the core course *Introduction to Artificial Intelligence* (Wu & Pan, 2024) under the “101 Plan” at 14 higher education institutions, such as Zhejiang University and Tongji University. This indicates that generative AI technology in digital textbooks has transitioned from the exploratory stage to practical application in the educational field, becoming a usable AI teaching and learning assistant. In addition, the corresponding paper textbooks for the courses have been made available, creating an interactive twin resource system for teaching and learning. HEP has also collaborated with leading companies such as Huawei, Alibaba, and NetEase to train and apply large-scale models for education. The first pilot program focuses on nine fundamental disciplines (computer science and technology, mathematics, physics, chemistry, biology, basic medicine, traditional Chinese medicine, economics, and philosophy) under the “101 Plan,” with a focus on serving five application scenarios: intelligent retrieval, intelligent review, intelligent Q&A, intelligent writing, and teaching assistants (Zhang, 2023).

Meanwhile, HEP has integrated AI technology into the editing of digital textbooks by creating editorial assistants. The intelligent proofreading application, “Zhijiao Yunchou,” developed in collaboration with a technology company, is now widely used in HEP’s editorial processes. Using advanced technologies such as AI, natural language processing, content structuring, PDF layout recognition, and Big Data, this application enables intelligent review of word symbols, sensitive information, repetitive statements, knowledge citations, references, character formats, and grammars within the textbooks, as well as outline styles, diagrams, tables,

formulas, and multi-modal resources in articles, thereby enhancing the efficiency and accuracy of the editorial process.

The rapid growth of digitalization in higher education is more of a challenge for educational publishers, which urges them to accelerate digital transformation to adapt to and meet the evolving teaching and learning needs of teachers and students as well as the course requirements while ensuring the quality of their textbooks. Educational publishers have to create digital textbooks that offer excellent content, reliable quality, high applicability, advanced technology, and robust security, and deeply integrate themselves into the education digitalization ecosystem. Jinpeng Huai, Minister of Education, pointed out that, as 2024 marks the third year of China's National Strategic Action for Education Digitalization, transitioning from the "3C" model (Connection, Content, and Cooperation) to the "3I" model (Integrated, Intelligent, and International), the country will further deepen the reform of textbooks, teachers, and teaching methods, reinforce the role of classrooms as the primary ground, and consolidate the students' knowledge base (Huai, 2024). In this new era, educational publishers need to strengthen the development of new quality productive forces, undertake innovative allocation of production factors, and achieve a profound transformation of the industry.

### 3 Copyright Management and Protection of Digital Textbooks

HEP has initiated a special study to address copyright management and protection during the development of digital textbooks. The platform development for such materials involves two primary copyright concerns: ensuring the clarity and non-infringement of the copyright in the content provided by authors, and safeguarding copyrighted content from infringement by others. According to current feedback from the application, the multi-modal resources of digital textbooks have multiplied the complexity of copyright management, with the intellectual property rights involved including models, video, audio, graphics, interfaces, images, trademarks, etc., and the primary stakeholders include schools, teachers, producers, and publishers.

HEP has mainly strengthened copyright management and protection in two ways:

(1) Mechanism building. HEP has revised all existing form contracts, placing greater emphasis on copyright acquisition, utilization, and protection. This provides a solid foundation for all-media copyright operations. Additionally, HEP has intensified copyright

reviews during the content review process for all types of resources, including audio, video, images, and virtual reality.

(2) Technology empowerment. This approach involves three levels: First, HEP has strengthened and improved the copyright marking and management within various resource management systems and educational service platforms, enabling full life-cycle management and operations of copyrights; second, HEP has segmented and encapsulated textual content and digital resources in digital textbooks through technological means to prevent piracy and copyright infringement; third, HEP is currently exploring the use of blockchain technology for the authentication, utilization, and protection of all content elements in digital textbooks.

## 4 Setting and Implementation of Standards for Digital Textbooks

With the expansion and widespread adoption of digital textbooks, there arises an urgent need for normative industry standards to establish standardized, scientific, practical, and feasible systems for content creation, design, publishing, distribution, usage management, and information security of digital textbooks. For this reason, the Alliance for Innovative Development of Digital Textbooks in Higher Education was established in Beijing on November 1, 2023, with HEP serving as the first chairman unit of the alliance, the Chinese Academy of Press and Publication and 12 other entities as the first vice-chairmen units, and over 60 organizations as the first batch of members. The alliance was voluntarily organized by higher education textbook publishers, related enterprises, public institutions, and professional organizations. Its purposes are to promote the deep integration of modern information technology with textbook development, advance the development of new forms of textbooks in the era of digitalization and intelligence, establish a flexible and open mechanism for the development, publishing, operation, and service of digital textbooks, develop and apply relevant standards, facilitate exchanges within China and across the globe, boost the innovative development of digital textbooks, and position China's digital textbooks for higher education at the forefront of the global stage (Gao, 2023). Following its establishment, the alliance released eight plans for developing digital textbook standards. The chairman and vice-chairmen units were designated as the lead units, while all members were asked to serve as participating units. By the end of May 2024, 22 member units had participated in finalizing four drafts of standards for digital textbooks, which were then submitted for working

group discussion. These four standards cover the basic guidelines for the publishing, distribution, application, and management of digital textbooks.

Among these four standards, the *Standard for Metadata of Digital Textbooks in Higher Education* primarily addresses the management and exchange of fundamental data within digital textbooks. It includes the definition of terms to reflect the key common features of digital textbooks and the specification of 27 metadata elements across five aspects: publishing, education, technology, rights, and classification. Meanwhile, the *Standard for Cover and Version History of Digital Textbooks in Higher Education* outlines the specifications for covers, content elements, and requirements for digital textbooks, as well as the data items and requirements for version histories, ensuring digital textbooks can be standardized and managed as official publications. Furthermore, the *Standard for Encapsulation Requirements of Digital Textbooks in Higher Education* specifies the technical requirements for encapsulation, including encapsulation structure, formats, and file samples. This standard is primarily used for data transfer of content files for digital textbooks across different systems and platforms. Whereas the *Standard for Interface Technical Requirements for Publishing Platforms for Digital Textbooks in Higher Education* primarily establishes the interface specifications between higher education digital textbooks publishing service platforms and other platforms (digital textbooks trading platforms, online teaching platforms, etc.) to facilitate the integration and interoperability of publishing, trading, service, and online teaching platforms for higher education institutions, thereby enhancing the accessibility of digital textbooks and their adaptability to various application modes.

The aforementioned standards are currently under development and require further validation and analysis of practical feedback for improvement. The formulation of standards is a dynamic process, necessitating synchronization with practice to ensure their application and updating through a process of “survival of the fittest” and collaborative innovation. The alliance will continue to work on the advancement and application of digital textbooks standards, continually building consensus, improving the ecosystem, and pushing forward the high-quality development of the industry.

## 5 Education Digitalization Strategy and High-Quality Development of Education

The education digitalization strategy involves the

strategic implementation of modern information technology to foster innovation and transformation in teaching, management, and service models within the education sector, aiming to improve the quality and efficiency of education, promote equity, and support personalized educational development. The education digitalization strategy is closely linked to the high-quality development of education, providing the technical support and innovative momentum necessary to boost changes and innovations in educational and teaching models, improving quality and efficiency, and promoting equity and personalized educational development. Conversely, the high-quality development of education can point the way to the needs and application scenarios for the digitalization strategy, driving research and development and application of education digitalization technology, and facilitating the implementation and advancement of education digitalization technologies.

Under the leadership of the MOE and with the collaborative efforts of 109 alliance members, HEP, as the first chairman unit of the alliance, has pursued the alliance’s objectives with significant achievements. These include conducting project research, organizing the formulation of standards, planning national and international conferences, and selecting and presenting exemplary cases. By integrating the alliance’s digital resources with those of various higher education institutions and publishers, and by connecting and coordinating the Smart Education of China with other platforms, these efforts have advanced the education digitalization strategy and promoted the high-quality development of education.

## 6 Conclusions

With the advancement of information technology, digital textbooks will hold a greater prospect for widespread application. In the future, HEP will continue to foster integrated development and serve the National Strategic Action for Education Digitalization, aiming at integration, intelligence, and internationalization. HEP is committed to fully supporting the development of two smart education platforms for higher education and vocational education, and actively leveraging cutting-edge technologies, including AI, Big Data, and blockchain, to empower the publishing of textbooks, online education services, and faculty training. It will also continue to develop a digital textbook resource system, establishing a new model based on high-quality content resources. As part of advancing the digitalization strategy plan, HEP

leverages its extensive and high-quality content to accelerate the in-depth integration of textbook publishing and information technology. This will result in a textbook resource development pattern that combines “textbooks + resources + platforms + services.” In other words, it centers on new forms of textbooks and integrates multimedia teaching resources, digital courses, online platforms, intelligent services, and other products, establishing a multi-directional integration and collaborative sharing mechanism across these products, and achieving breakthroughs in educational concept innovation and textbook publishing models driven by information technology (Tan, 2023).

HEP is actively amassing extensive multi-modal educational and teaching resources, processing and structuring multi-modal datasets for educational purposes. In collaboration with leading high-tech companies like Huawei and Alibaba, HEP is also making advancements in the research and development of the large-scale model for disciplines in higher education (LOVONG), scaling up the development of digital textbooks and smart textbooks, and rapidly transforming into an integrated knowledge service provider with leading content, advanced technology, diversified services, and robust security, thereby contributing to the digitalization of higher education within the broader education digitalization strategy.

**Conflict of Interest** Fangzheng Tan is the Editor-in-Chief of *Frontiers of Digital Education*, who was excluded from the peer-review process and all editorial decisions related to the acceptance and publication of this article. Peer-review was handled independently by the other editors to minimise bias.

**Data Availability Statements** The author confirms that all data generated or analysed during this study are included in this published article.

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