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On the Differences Between Digital Textbooks and Electronic Textbooks: A Case Study of the Groundwater Engineering Knowledge Micro-Unit at Tongji University

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Abstract: The development and construction of digital textbooks have become the focus and difficulty in promoting the digital transformation of education. Currently, there is no recognized model for the concept and connotation of digital textbooks at home and abroad, and they are often confused with electronic textbooks, which seriously hinders the development of digital textbooks. Electronic textbooks are electronic versions of text-based textbooks that only provide information to students; digital textbooks not only provide information but also collect students' learning data to improve learning effects and textbook quality. They are characterized by personalization, intelligence, and interactivity, constructing a course scenario-based teaching environment for students. Digital textbooks adopt a knowledge graph structure, collect and analyze learning data, generate individual learning behavior portraits for each student, propose and dynamically update intelligent learning management suggestions, and present visual and interactive learning data analysis results. Taking the groundwater engineering knowledge micro-unit at Tongji University as an example, this paper illustrates how digital textbooks help students intuitively understand the hard-to-observe laws of groundwater movement and recognize engineering practices. For similar engineering courses with complex knowledge systems, strong practicality, and rapid updates, the construction of digital textbooks is imperative.

Keywords: Educational digitalization; Digital textbooks; Electronic textbooks; Groundwater engineering

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1. Introduction

With the rapid breakthrough and widespread application of a new generation of information technologies represented by 5G and artificial intelligence, the digital transformation of various industries has become an irresistible trend. The digital transformation of the education industry is crucial to a country's future

competitiveness and an inevitable path to accelerate the modernization of education, attracting widespread attention from countries around the world [1–3]. China also attaches great importance to the digital transformation of education. In 2021, the Ministry of Education approved Shanghai as the first national "pilot zone for educational digital transformation". In 2022, the Report to the 20th National Congress of the Communist Party of China proposed "promoting the digitalization of education" for the first time, launching the strategic action for educational digitalization.

Textbooks are important carriers of teaching content for teachers and learning content for students. The development and construction of digital textbooks have become the focus and difficulty in promoting the digital transformation of education. In the task of "promoting new educational infrastructure and creating a new environment for the development of educational digitalization", Shanghai clearly proposed "promoting the integrated application of educational terminals, digital textbooks, and new educational resources" [4]. The "Specifications for the Construction of Digital Campuses in Institutions of Higher Education (Trial)" issued by the Ministry of Education also explicitly encourages teachers to actively develop digital textbooks.

However, there is no recognized model for the concept and connotation of digital textbooks at home and abroad. It is a common misunderstanding to confuse digital textbooks with electronic textbooks. In the design, development, and research of digital textbooks, problems such as unclear concepts and ambiguous connotations seriously hinder their development [5–7]. Therefore, this paper defines the concepts of digital textbooks and electronic textbooks, elaborates on the connotative differences between them in detail, and further explains the concept and connotation of digital textbooks proposed in this paper with the groundwater engineering knowledge micro-unit at Tongji University as an example, aiming to provide reference for relevant scholars and technicians in the design, development, and research of digital textbooks.

2. Conceptual definition of digital textbooks and electronic textbooks

At present, with the continuous development of the education industry and the advancement of science and technology, the form of textbooks is evolving from static paper-based forms to dynamic multimedia forms and then to interactive digital forms [8]. It is necessary to accurately define the concept of digital textbooks as a reference for their future promotion and construction.

Textbooks refer to basic materials compiled in accordance with curriculum standards for teaching and require students to master. The most common form of textbooks currently is text-based textbooks, which mainly include textbooks, lecture notes, and teaching outlines. Text-based textbooks are the most traditional form of textbooks, with very mature standards for concepts, design, publication, and use. Electronic textbooks are electronic versions of text-based textbooks, serving as multimedia resource libraries containing text, audio, video, and other materials. They can break the limitations of paper-based textbooks with more flexible layout designs, ranging from simple e-books to rich media forms that embed audio, video, animations, and other multimedia resources and interactive tools into textual and graphical content, making them more expressive and appealing [9].

On the basis of electronic textbooks providing students with rich information, digital textbooks also collect students' learning data to improve learning effects and textbook quality. They are characterized by personalization, intelligence, and interactivity, constructing a scenario-based teaching environment for students. Digital textbooks are not only an integration of multimedia information required for textbooks but also include an evaluation system for students' learning, an intelligent management system for learning progress, and an interactive system for learning data. As a digital teaching system and three-dimensional learning support platform

that integrates different forms of learning resources and meets various learning needs, digital textbooks help expand the dimensions of learning resources, comprehensively record the learning process, conduct precise learning evaluations, and effectively promote the improvement of students' information literacy and problem-solving abilities [10,11].

3. Connotative differences between digital textbooks and electronic textbooks

Based on the above conceptual definitions, the fundamental connotative differences between digital textbooks and electronic textbooks lie in personalization, intelligence, and interactivity. The following elaborates on these differences from five aspects: data interaction, learning behavior portraits, knowledge structure, intelligence, and update methods.

3.1. Knowledge structure

Digital textbooks adopt knowledge graphs to construct the knowledge structure of the courses they teach. A knowledge graph is a large-scale semantic network rich in concepts, entities, and various semantic relationships. It visually displays the core structure, development history, cutting-edge fields, and overall knowledge framework of specific disciplines through visual graphs, and is currently the fastest-growing and most widely used knowledge expression and processing tool [12]. As a carrier of educational knowledge, the educational knowledge graph is a core component of the educational knowledge engine, aiming to connect fragmented and scattered teaching resources with related entities into a huge semantic network, thereby providing knowledge support for the intelligent application of education [13].

With the help of a graph-based structure, digital textbooks connect knowledge points into an organic whole. The graph-based knowledge structure is a complex network composed of various knowledge points and their relationships. Each knowledge point includes teaching content in various forms, such as text, charts, formulas, and videos, and is associated with other knowledge points. This design not only helps students quickly grasp the textbook knowledge system and plan their learning progress but also provides the optimal learning path for individual knowledge points, improving learning efficiency. Currently, most electronic textbooks and traditional text-based textbooks still adopt linear or tree-like knowledge structures. Although the main line is clear, it is difficult to reflect the complex connections between knowledge points. Even if electronic textbooks add multimedia resources, their knowledge structure remains consistent with traditional textbooks, failing to achieve true graph-based correlation.

3.2. Learning behavior portraits

During students' learning using digital textbooks, all generated learning data will be recorded by the digital textbooks, forming unique learning behavior portraits for each student. A learning behavior portrait refers to a virtual learning behavior model constructed by collecting data closely related to the learning process through multiple channels and methods, and using analytical mining technologies, which can be visually presented in forms such as word clouds and dashboards. This model is a collection of individual student tag systems that can describe students' characteristics, needs, preferences, and behaviors, providing data support for subsequent learning behavior analysis [14]. As a typical application of learning analytics technology, the potential of learning behavior portraits is gradually being tapped, and their value is increasingly being verified. Learning behavior portraits can accurately judge students' learning status, reflect their behavioral performance and learning path

characteristics, and promote students' correct cognition and development of their own learning status [15]. In the learning behavior portraits formed by digital textbooks, students' learning behaviors are classified and labeled through a tag system from three dimensions: personal characteristics, behavioral performance, and environmental factors. With the tags of each student's learning behavior portrait, teachers can also fully grasp students' learning status, thereby better adjusting teaching methods to improve students' learning effects.

Electronic textbooks lack the function of collecting and analyzing students' learning behavior data. In the process of students using electronic textbooks, they only serve as carriers of information and cannot record students' learning behaviors. In the process of students and teachers using electronic textbooks, their understanding of students' learning status and learning effects is often only subjective and perceptual, lacking specific information and data.

3.3. Intelligence

With the continuous development of a new generation of information technologies, digital textbooks have become intelligent teaching tools. By measuring, collecting, analyzing, and reporting students' learning data, digital textbooks can propose optimization plans for each student's learning process with the help of intelligent algorithms. For students, digital textbooks track each student's learning process, conduct full-process vertical evaluations of learning situations and horizontal evaluations of various knowledge point elements, helping students conduct personalized intelligent learning management. For teachers, using intelligent digital textbooks as carriers, aiming at the whole-process behavioral data of teaching, learning, assessment, and evaluation of class students, using in-depth data mining and analysis, and real-time visual intelligent feedback, a data-driven intelligent feedback chain and a teaching optimization and intelligent learning management mechanism based on digital textbooks are formed.

When using electronic textbooks, understanding students' learning situations can only be achieved through traditional tests and examinations, which have high requirements for test methods and question quality, and are time-consuming with poor instantaneity. There are also many accidental factors, making it difficult for teachers and students to effectively manage learning progress and quality.

3.4. Data interaction

A major feature of digital textbooks is the sharing and intercommunication of learning data between students and teachers, as well as among students. In the process of learning using digital textbooks, by recording and analyzing each student's learning behavior portrait, digital textbooks can integrate all students' learning data, analyze common problems existing in students' learning processes, present them visually, and open access permissions to all students and teachers using the digital textbook. For students, when encountering problems in the learning process, they can refer to other students' learning data and, if necessary, discuss with teachers and classmates through digital textbooks, that is, the interactivity of learning data among students. For teachers, by accessing the learning data analyzed and visually processed by digital textbooks, they can grasp the overall learning situation of the whole class and understand each student's learning progress in detail, making it easier to carry out targeted classroom teaching and improve students' mastery of the taught knowledge, that is, the interactivity of learning data between students and teachers.

3.5. Update methods

With the continuous development of scientific research and practical applications, textbooks should also be

continuously updated. Digital textbooks adopt a graph-based knowledge structure, which can easily add new knowledge to the knowledge graph. It is only necessary to design the content of the new knowledge itself and its relationships with existing knowledge to seamlessly connect the new knowledge with the existing knowledge graph and update all associated knowledge points simultaneously. Textbook updates include not only adding new content but also removing outdated content and correcting incorrect content. During use, digital textbooks collect a large amount of students' learning information and teachers' teaching information. With the help of intelligent data analysis and mining technologies, combined with teachers' guided updates, real-time updates keeping pace with the times can be achieved.

Electronic textbooks still belong to traditional publications. When updates are needed, they have to go through long processes such as revision, review, and release. Moreover, due to the lack of feedback data from textbook users, the design and update of electronic textbooks are often difficult to truly meet the needs of users, reducing the learning effects of textbook users.

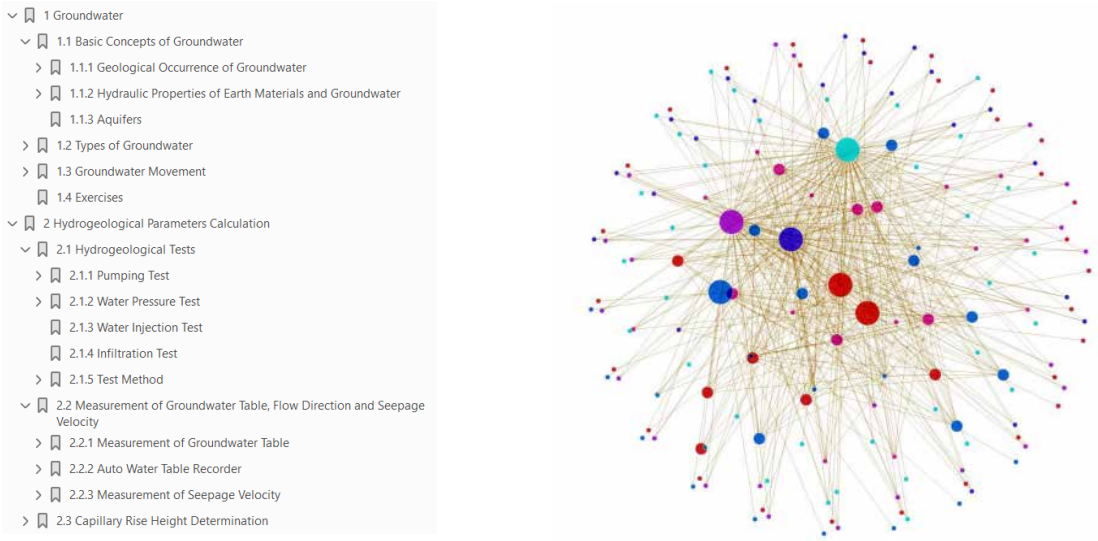
4. Case analysis: Groundwater engineering knowledge micro-unit

The following takes the groundwater engineering knowledge micro-unit at Tongji University as an example to illustrate the differences between digital textbooks and electronic textbooks proposed in this paper. Groundwater Engineering is a core professional compulsory course for the major of Geological Resources and Geological Engineering at Tongji University, undertaking the core teaching task of the water research line in the integrated soil-water-rock three-line professional research system. The existing textbooks for Groundwater Engineering are "Groundwater Engineering (Second Edition)" and "Groundwater Engineering Second Edition" edited by Tang Yiqun, Zhou Jie, etc., both of which have complete electronic versions. However, groundwater is "invisible and intangible" with a wide range of impacts. Existing textbooks can only describe and analyze it through text and pictures, making it difficult for students to fully grasp the laws of groundwater movement. At the same time, the Groundwater Engineering course is based on engineering construction and is a practice-oriented course, which also requires textbooks to fully help students understand practical engineering and guide them to apply the learned knowledge to practice. Therefore, there is an urgent need for the development and construction of digital textbooks for Groundwater Engineering. Currently, the teaching team of the Groundwater Engineering course is actively carrying out the construction of digital textbooks, striving to construct a practical engineering-based teaching environment for students through digital textbooks, and the design concept fully reflects the differences between digital textbooks and electronic textbooks.

In terms of the content covered by textbooks, the content form of existing electronic textbooks is only text data and charts, while digital textbooks include various rich forms such as case videos, interactive virtual experiments, and VR internships on the basis of electronic textbooks.

In terms of knowledge structure, as shown in **Figure 1**, the existing electronic textbooks for Groundwater Engineering adopt the same traditional chapter-based structure as text-based textbooks to ensure consistency, while the digital textbook under construction is designed with a graph-based knowledge structure. It not only provides sufficient learning materials for each knowledge point but also clarifies the relationships between various knowledge points, establishing a clear knowledge framework of the Groundwater Engineering course for students. The graph-based knowledge structure also facilitates the update of new knowledge; it only needs to add the content of the knowledge point itself and the connections with related knowledge, which has extremely high expandability. However, when updating knowledge, electronic textbooks are prone to the separation of

new knowledge points from the overall knowledge system due to the lack of effective representation of the connections between knowledge points.



a. Chapter-based knowledge structure of electronic textbooks b. Graph-based knowledge structure of digital textbooks

Figure 1. Differences in knowledge structure between electronic textbooks and digital textbooks.

The digital textbook for Groundwater Engineering will collect and analyze students' learning behavior data, construct students' personal learning portraits, and present the analysis results in a visual form. The system provides data query permissions for teachers and students, supporting student communication and teacher management. As shown in **Figure 2**, after the textbook analyzes students' in-class and after-class learning behavior data, a visual learning portrait with classification labels is generated. Based on this, the system can intelligently regulate the learning process, and teachers can also adjust teaching and update textbook content according to the portrait data, thereby improving learning effects and textbook quality.

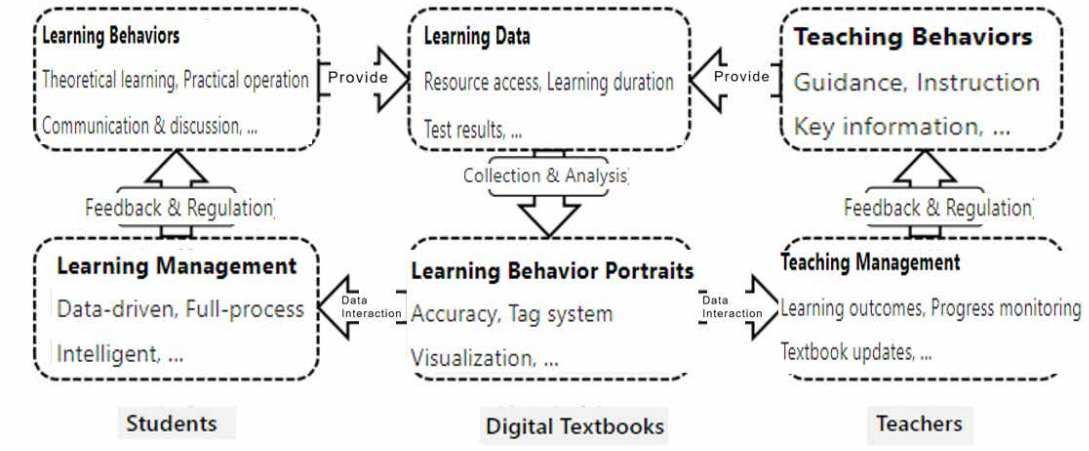


Figure 2. Usage mode of the digital textbook for groundwater engineering.

5. Conclusions

Digital textbooks are the key to the digital transformation of education. The fundamental difference between them and electronic textbooks is that the latter only provide static content, while digital textbooks, in addition to providing multimedia resources, can collect and analyze learning data, featuring personalization, interactivity, and intelligence. Integrating multimedia resources, learning evaluation, progress management, and data interaction, digital textbooks adopt a graph-based knowledge structure, realize the whole-process intelligent management and visual analysis through learning behavior portraits, thereby improving learning effects and supporting continuous optimization and updates based on data.

Taking the Groundwater Engineering course at Tongji University as an example, digital textbooks can construct virtual scenes of groundwater movement, helping students intuitively understand abstract laws and making up for the lack of practical perception in traditional electronic textbooks. Therefore, the construction of digital textbooks for Groundwater Engineering is of great significance. For similar engineering courses with complex knowledge systems, strong practicality, and rapid updates, it is necessary to actively integrate a new generation of information technologies in the future to build open and shared digital textbooks, making them an intelligent educational link connecting theory and practice.

Disclosure statement

The authors declare no conflict of interest.

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