

A Case Study of the Development of a Digital Textbook of "Big Data Analysis and Mining" Based on Competency Maps

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Abstract: The construction of digital textbooks represents an important direction in the digital transformation in vocational education. The study focuses on the development of a digital textbook based on a competence map. Taking the "Big Data Analysis and Mining" course of Intelligent Logistics Technology specialty in the higher vocational as an example, the study explores the construction of a competence map aligned with the course and a path to develop a textbook based on the map. Via research methods of literature review, survey research and comparative analysis, the study first reviews the current research status both domestically and overseas, summarizing the theoretical and practical progress in digital textbook development. Then, based on the professional competencies requirement of the course, it constructs a course competence map, and explores how to design and develop the course textbook. The research holds considerable value in enriching the theoretical achievements and practical experiences of digital textbook development in higher vocational education, as well as in promoting the reform and digital transformation of vocational education textbooks. It will further explore how the digital textbook could facilitate teaching reform.

Keywords: Higher Vocational Education; Digital Textbook; Competency Maps; Big Data Analysis and Mining; Intelligent Logistics Technology Specialty

1. Introduction

1.1 Research Background

Textbook development in vocational education serves as a strategic grip for the high-quality development of vocational education and is one of the "Five Golds" key tasks in the new infrastructure of vocational education. Digital

textbook development represents a new direction and trend in textbook development within the context of the digital transformation of vocational education. As early as September 2020, nine departments including the Ministry of Education, issued the "Action Plan for Improving the Quality and Excellence of Vocational Education (2020-2023)," proposing to "strengthen vocational education textbook development, innovate textbook formats based on the characteristics of vocational school students, and promote scientific, rigorous, easy-to-understand, illustrated, and diverse textbooks in the form of loose-leaf, workbook, and media-integrated formats." In 2021, the General Office of the Ministry of Education issued the "Implementation Plan for Textbook Development in the 14th Five-Year Plan for Vocational Education," proposing to "develop textbooks for integrating job positions, courses, competitions, and certifications," "promote the development of supporting resources and digital textbooks for textbooks, explore the digital transformation of printed textbooks, and create more digital textbooks that can be listened to, viewed, practiced, and interacted with."

At the World Education Conference in 2024, Minister of Education (PRC) Huai Jinpeng proposed to "focus on enriching resource formats and vigorously developing digital textbooks," which is bound to trigger a wave of research on the development of various types of educational digital textbooks. In the field of vocational education, the state has successively issued a series of policies for the development of digital textbooks in higher vocational education that leads to the starting of the construction and research of digital textbooks. Developing digital textbooks which is ought to be interactive, deeply integrate artificial intelligence technology and utilize a variety of media not only meets the requirements for dynamically integrating new technologies, new norms, new processes, and new standards into textbook content but also aligns with the needs of

integrated theoretical and practical teaching. Implementing the relevant documents for high-quality vocational education development and developing digital textbooks tailored to the characteristics of vocational education is more than a popular trend of research in higher education but a challenging issue that should be addressed urgently.

1.2 Definition of the Core Concepts in the Study

1.2.1 Competency map

The "competency map" defined in this study is oriented towards vocational competencies. It extracts from the knowledge, skills, and qualities required for professional courses from the integration of job positions, courses, competitions, and certifications and analyzes the relationships among the three (knowledge, skills, and qualities) and organizes them, presenting them in the form of skill points to form a competency map.

1.2.2 "Big data analysis and mining"

The study takes the "Big Data Analysis and Mining" course as an example to conduct research on the design and development of digital textbooks based on a competency map. According to the Introduction of Higher Vocational Education Majors (2021 edition), the course is a core course for the Intelligent Logistics Technology major in higher vocational colleges, aiming to cultivate students' preliminary abilities in logistics big data integration, analysis, and digital technology application.

2. Research Contents

The study takes the "Big Data Analysis and Mining" course of the Intelligent Logistics Technology major in higher vocational colleges as an example, guided by the integration of job positions, courses, competitions, and certifications. It constructs a competency map aligned with the course from dimensions such as industry demand, job knowledge, and vocational competencies. Based on the competency map's competency levels, textbook content will be designed by dividing the project tasks in the textbook into independent competency learning units. The study explores the path of developing digital textbooks that lead students to learn based on a competency map in a specific field, enriching the theoretical research results and practical exploration experiences of digital

textbook development in vocational education.

3. Review of Research Status Quo

3.1 Domestic Research Status

In the context of the current digital transformation of education, domestic scholars have conducted in-depth research on digital textbooks and proposed many valuable viewpoints.

Firstly, different perspectives have emerged for the definition of digital textbooks' connotation. Huang believes that digital textbooks are new learning materials that exist in digital form, can be loaded on digital terminals for reading, can update content dynamically, and can record interaction trajectories timely, that emphasizes content dynamic updates, digital terminal loading for use, and the ability to record interaction trajectories [1]. Wang et al. believe that vocational education digital textbooks should use real production projects, typical work tasks, and cases as carriers in terms of content primarily to meet the needs of structured and modular teaching and help students master practical operational skills and problem-solving abilities. Meanwhile, appropriate media should be used to present teaching content as technology serves the content and it's necessary to possess appropriate interactive functions providing personalized learning behavior and data [2].

Secondly, domestic scholars have discussed different strategies for the development of digital textbooks in vocational education. The first strategy is to establish a development mechanism collaboratively, set development goals reasonably, construct textbook content systematically, and arrange the presentation elaborately [3-5]. The second one is to form a digital textbook development community, establish a vocational education digital textbook standard system, build vocational education digital textbook content based on knowledge maps, and optimize supporting platforms for vocational education digital textbooks [6-7]. The third strategy is to build a systematic and complete theoretical system, strengthen industry-education integration, explore practical cases of appropriate theories, and improve the development level of digital textbooks [8].

It can be seen that, at this stage, domestic scholars' theoretical research on digital textbook development mainly focuses on the discussion

of connotations and strategies at the macro level. Research results on the practice of digital textbook development for specific courses at the micro level still need to be enriched.

3.2 Overseas Research Status

To adapt to the global wave of digital transformation, multiple countries have successively embarked on the era of digital textbook development. Japan's digital textbook development started early and can be divided into three stages: foundation laying, pilot implementation, and universalization. In June 2023, Japan's Cabinet approved the fourth "Basic Plan for Education Revitalization" (2023-2027), which states that educational resources will shift from "digitalization" to "optimization" and vigorously promotes the digital transformation of textbooks, school affairs, software, and hardware facilities. In recent years, U.S. states have developed digital textbooks based on actual needs, formed professional teams responsible for digital textbook management, and established management mechanisms. They have designed new teaching methods and developed supporting measures to adapt to the characteristics of digital textbooks, thus forming a relatively systematic action framework for digital textbook development.

Regarding digital textbook development, scholar Deepak Prasad proposed a development system framework that can analyze student academic performance based on digital textbooks. It creates digital textbooks in ePub format, authenticates users, records their operations, stores and analyzes data, and updates and revises digital textbooks for distribution to students [9]. Japanese scholars Shin-nosuke Suzuki et al. proposed a new type of Active-Textbook that utilizes general portable electronic terminals such as smartphones and system application software. By using additional digital information, ordinary textbooks can be transformed into digital textbooks, and various digital resources such as movies, animations, and 3D views can be obtained [10].

Overseas scholars' research findings have varying degrees of reflection on the significance of digital textbook development for educational digital transformation, but there are differing definitions of digital textbooks, particularly in the context of vocational education where research on digital textbook development still needs enrichment.

4. Research Methods

The study employs research methods such as literature review, survey research, and comparative analysis.

4.1 Literature Review

The study collects relevant literature and books to summarize the theoretical research findings on digital textbook development in vocational education. It focuses on analyzing the connotations and strategies of digital textbook development in the context of digital transformation and deepening the reform of the modern vocational education system, laying a solid theoretical foundation for subsequent research in the research.

4.2 Survey Research

The study conducts research through industry surveys, enterprise visits, expert interviews, and other means to investigate the requirements of new technologies, norms, processes, and standards in the fields of big data and artificial intelligence. It also investigates the typical job tasks and technical specifications of positions related to the operation and maintenance of logistics information management systems in the logistics industry, providing a basis for the construction of the course competency map.

4.3 Comparative Analysis

By conducting a comparative analysis of various types of textbooks currently published in the market (such as paper textbooks, loose-leaf textbooks, integrated textbooks, and three-dimensional textbooks), the study compares the differences in textbook format, function, application, and other aspects, as well as the differences in digital textbook development between vocational education and other types of education. The analysis aims to refine the concept of digital textbook development in vocational education and conduct the research more targeted.

5. Research Value

5.1 Theoretical Value

Firstly, it further increases the theoretical research outcomes of digital textbook development in vocational education. The study is guided by policy documents related to the high-quality development of vocational

education. By conducting research on a specific course, it furthers enriching the connotation of digital textbook development in vocational education practically and the research results would be more reliable and targeted to enrich the theoretical research results of high-quality vocational education development.

Secondly, it systematically studies and elucidates the connotation of vocational education digital textbooks developed from competency maps. It promotes the construction of the theoretical system of digital textbook development in vocational education, improves the research path on the development of digital textbooks in vocational education and the "three teaching" reform (teaching teams, teaching methods, and teaching materials) theoretically, and provides systematic theoretical support for the development and construction of digital textbooks in vocational education.

5.2 Practical Value

Firstly, through exploring the design and development of the "Big Data Analysis and Mining" digital textbook, the study concludes how to develop a digital textbook for vocational education, promotes the reform of vocational education textbook development and the digital transformation of vocational education, and also enriches the practical experience of digital textbook development and "three teaching" reform in relevant majors in transportation colleges.

Secondly, the study meets the cultivating needs of higher vocational students. By representing knowledge and skill points through digital textbooks based on competency maps vividly to align with the learning characteristics of higher vocational students, it stimulates students' learning interest, optimizes the teaching and learning model, further providing strong support for students' sustainable development of high-quality technical and skilled talents.

6. Research Process

6.1 Summarizing Theoretical Findings of Digital Textbooks in Vocational Education

The study conducts research on relevant documents and literature on digital textbook development in vocational education, systematically summarizes the new requirements for digital textbook development in the context of deepening the reform of the modern

vocational education system and educational digital transformation, and analyzes and summarizes the essential elements and development strategies for digital textbook development in vocational education. At the macro level, it is necessary to deepen school-enterprise cooperation, establish a multi-party collaboration mechanism for digital textbook development, and integrate new technologies and processes from industries and enterprises into textbook development to meet the training requirements of high-skilled talents in the new era. From the mid-scope, the content of digital textbooks should be modularly designed from real production projects, typical job tasks, practical cases, and real problems as "prototypes" to design knowledge units or practical projects in textbooks, following the formation logic of technical skills. At the micro level, it should be emphasized on the interactivity of digital textbooks, enriching the digital resources and activity designs of textbooks to meet students' individualized learning needs.

6.2 Constructing the Competency Map for the "Big Data Analysis and Mining" Course

Based on the professional training objective of the course (to develop preliminary capabilities in logistics big data integration, analysis, and digital technology application), and guided by the integration of "job, course, competition, and certification", this study analyzes the requirements of "job, competition, and certification" for professional knowledge, operational skills, problem-solving abilities, and team collaboration abilities. It constructs a three-level competency map based on occupations, positions, and specific domains. The first-level competencies include broad core professional competencies, such as professional knowledge, operational skills, and professional ethics, describing the essential qualities and generic skills within the professional field. The second-level competencies cover the skill requirements of specific positions, including positional operation norms and tool usage. The third-level competencies involve the professional skills required for specific tasks and projects, such as the operational procedures for big data analysis and mining and problem-solving abilities. The study constructs a three-level competency map to accurately describe the skill units corresponding to job projects and tasks, guiding

the design and development of digital textbooks for the course.

6.2.1 First-level competencies

According to the 2025 teaching standards for Intelligent Logistics Technology majors of higher vocational education, the professional orientations of this major include warehouse managers, information and communication system administrators, etc. The main technical fields include logistics management information systems, warehouse equipment control systems, and transportation technology systems. The core course "Big Data Analysis and Mining" bears

the cultivating purposes of the core professional competency of "big data analysis".

6.2.2 Second-level competencies

Based on the national occupational skill standards for warehouse managers, information and communication system administrators, and logistics service planners with high relevance in the logistics industry, the study summarizes the job skills related to the core professional competency of "big data analysis" in two aspects: data statistics and data mining. The specific competency requirements are shown in Table 1.

Table 1. Second-Level Competencies of Competency Map for "Big Data Analysis and Mining"

Number	Second-Level Competency Description
1	Data Analysis Competency: Complete daily data statistics for information and communication systems and communication business support systems; perform statistical analysis on logistics data based on business needs.
2	Data Mining Competency: Capable of preprocessing logistics data; applying data mining techniques for logistics business forecasting, planning, and scheduling; analyzing the value of logistics data and formulating data-driven operational strategies.

6.2.3 Third-level competencies

Third-level competencies are the skill points refined and decomposed from each second-level

competency. The skill point requirements and their correspondence to second-level competencies are shown in Table 2.

Table 2. Third-Level Competencies of the Competency Map for "Big Data Analysis and Mining"

Second-Level Competency		Third-Level Competency	
No.	Second-Level Competency Description	No.	Third-Level Competency Description
1	Data Analysis Competency: Complete daily data statistics for information and communication systems and communication business support systems; perform statistical analysis on logistics data based on business needs.	1.1	Able to complete descriptive statistics, including: 1. Measures of position: mean, mode, median, percentiles;
		1.2	2. Measures of dispersion: variance, standard deviation, coefficient of variation, range, standard error;
		1.3	3. Measures of distribution shape: skewness, kurtosis;
		1.4	Able to draw data distribution charts, including: 1. Line charts
		1.5	2. Pie charts
2	Data Mining Competency: Capable of preprocessing logistics data; applying data mining techniques for logistics business forecasting, planning, and scheduling; analyzing the value of logistics data and formulating data-driven operational strategies.	2.1	Able to perform logistics data preprocessing operations, including: 1. Data cleaning
		2.2	2. Data integration
		2.3	3. Data transformation
		2.4	4. Data reduction
		2.5	5. Data discretization
		2.6	Able to apply corresponding data mining algorithms to complete logistics data analysis or prediction, including: 1. Classification prediction
		2.7	2. Regression prediction
		2.8	3. Clustering analysis
		2.9	4. Association rule mining

6.3 Design of "Big Data Analysis and Mining" Course Textbook Content

Through industry research, enterprise visits, expert interviews, and other methods, we have gained a deep understanding of the development

trends, technological innovations, and standards in key areas such as smart logistics, big data, and artificial intelligence. Based on this, typical work tasks for positions related to the operation and maintenance of logistics information management systems in logistics industry

enterprises have been identified. With a problem-oriented and project-based approach, teaching project scenarios and modular teaching content have been designed for the digital textbook based on the competency map, as shown in Table 3.

Table 3. Digital Textbook Content Design for "Big Data Analysis and Mining" Based on the Competency Map

Project	Project Description	Task
Project 1: Warehouse Picking Data Analysis	Designed as a teaching project based on the data analysis workflow of warehouse pickers in the context of warehouse picking.	Task 1: Measurement of position for warehousing data
		Task 2: Measurement of dispersion for warehousing data
		Task 3: Measurement of distribution shape for warehousing data
		Task 4: Visual analysis of warehousing data
Project 2: "Double 11" Themed Data Mining Practice	Designed with the "Double 11" shopping festival as the project background and the data mining workflow as the main thread for designing teaching tasks. Each task includes theoretical and practical teaching content.	Task 1: Data collection
		Task 2: Data preprocessing
		Task 3: Data mining
		Task 4: Data mining evaluation

6.4 Exploration on the Development Path of the Digital Textbook for the "Big Data Analysis and Mining" Course

A digital textbook is supposed to possess new characteristics such as vocational relevance, integration, multimedia, and interactivity. Besides content compilation, research is conducted on the application of new generation information technologies in the textbook development process to create interactive courseware and educational resources. In addition to media forms such as text, images, animations, audio, and video, other media resources such as human-computer interaction interfaces and activity designs, and virtual simulation training resources are developed to enhance the granularity and flexibility of digital textbook resources. The adaptation caters to the diversified and personalized learning needs of students would foster their interest in learning, skill development, and quality improvement, and achieves the educational goals of digital textbooks.

7. Conclusion

The study has made innovative progress in the following three aspects:

7.1 Focus on the Digital Textbook Construction for the "Big Data Analysis and Mining" Course in Intelligent Logistics Technology of Higher Vocational Education

With the development and proliferation of new

information technologies such as big data and artificial intelligence, technological upgrades will be triggered across various industries. The intelligent upgrade of the logistics sector demands high-quality technical talents with both logistics expertise and data analysis and mining capabilities. Given the current situation of students in the Intelligent Logistics Technology program having a relatively weak foundation in computer programming, it is essential to develop course textbooks that cater to their academic background and fulfill the skill requirements for data analysis and mining. The study conducts specialized research on the digital textbook construction for the "Big Data Analysis and Mining" course in Intelligent Logistics Technology of higher vocational education, aiming to align the research more closely with the new technologies, requirements, and standards of the logistics industry's digital and intelligent transformation. The alignment would effectively promote the cultivation of comprehensive abilities and qualities in Intelligent Logistics Technology professionals, making the research highly targeted.

7.2 Guiding Digital Textbook Construction Based on Competency Map

A three-level competency map is constructed with the integration of job positions, courses, competitions, and certifications as the guide. The map clarifies the course's competency training objectives at different levels, laying the foundation for the modular content design of the

digital textbook. It allows for more targeted design of project and task content in the textbook according to different competency requirements. The approach accommodates the personalized learning needs of students at various competency levels, enhancing the feasibility and practicality of the study.

7.3 Analysis Based on Industry Research and Literature Review for More Reliable Research Outcomes

The study comprehensively employs research methods such as visits and surveys, literature research, and comparative analysis. The data and theoretical basis relied upon are authentic and reliable, making the research on digital textbook construction more operable and practically significant. The aim is to propose innovative strategic suggestions for digital textbook construction of higher vocational education to promote the digital transformation of vocational education textbook development.

In subsequent research, an empirical study should be conducted on the teaching effectiveness of this digital textbook in actual implementation, and the content and resources of the textbook will be further optimized based on the research findings.

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