

Exploring the Pathways for Digital Textbook Development in Vocational Undergraduate Institutions under the Context of New Quality Productivity

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Abstract: In order to produce new productive forces of quality, the vocational education should have a new kind of worker who is skilled and efficient in the operation, technologically literate and innovative. This paper uses the case study of the textbook Power Battery Manufacturing and Maintenance Technology as an example, which has been developed based on the paradigm of the Core-Chain Dual-Drive and Three-Stage Six-Path, where the problems of the vocational undergraduate textbooks are simply copies of the higher vocational colleges, the development speed of power battery technology is too fast, and the high-voltage, high-risk environment leads to the fact that the textbooks are not able to be updated quickly and there are many risks involved in the practical training process. The logic of building is determined by changing the goal towards the transmission of knowledge and engineering thinking with the content being directed at the life cycle of the entire power batteries and job competence map. The course of development will be as follows: the building of the entire life cycle knowledge graph, using the Core-Chain; reducing the risk of high voltage in the process of the Core-Track (virtual simulation + practice); promoting the skills to be developed through the task chain (Six-path interactive) and developing the new type of laborers based on the data profiling and industry education. In its turn, a four-step progressive system is designed as follows: Core Creation - Core Management - Core Safety - Core Repair and a competency map is created along with different learning paths. The textbook is therefore transformed into a dynamic knowledge base that has been turned into an interactive competence-based navigation tool, which will help to create new-type workers at the field-engineer level, and it will also have a lot of promotional potential towards the introduction of new energy-

related classes.

Keywords: New Quality Productive Forces; Vocational Undergraduate Education; Digital Textbooks; Power Battery; Core-Chain Dual-Drive

1. Introduction

The New Quality Productive Forces require the development of a new kind of skilled worker who is knowledgeable in technology, proficient in operation and able to innovate and the main purpose of vocational undergraduate education is to produce field engineers. Nevertheless, the existing textbooks are predominantly copies of higher vocational education or academic simplifications. In combination with the fast cycle of new energy technologies and high-voltage and high-risk character of power batteries, conventional textbooks are outdated and practical training has great risks. Thus, it was inevitable to restructure teaching through the use of digital-intelligent technologies in digital textbooks [1].

Using the textbook Power Battery Manufacturing and Maintenance Technology as an example, this paper integrates the paradigm of Core-Chain Dual-Drive and Three-Stage Six-Path: the four-stage process of Core-Chain maps the entire life cycle of batteries, the parallel virtual-physical approach of Dual-Track reduces the risk of high-voltage, and the six-step closed-loop of Six-Path leads to competency progression. The construction logic is explained in this paper, the development path of four dimensions, Core-Chain Integration, Dual-Track Empowerment, Six-Path Closed-Loop, and Data Profiling and Industry-Education Integration Dual-Drive are elaborated, and the practical effectiveness is reflected with a view to offering a reference to the development of digital textbooks on similar courses.

2. Construction Logic of Vocational

Undergraduate Digital Textbooks Powered by New Quality Productive Forces.

2.1 Objective Logic: Shifting the Knowledge Transmission to the Development of Engineering Thinking and Innovation Ability

The new Quality Productive Forces are to be changed with the help of the so-called skilled executors, but rather as engineering innovators. The vocational undergraduate study is designed to train field engineers and it will focus on the composite competence of being a good operator, having the knowledge in technology and being an innovator. It also defines that its digital books should not only be the lineal representation of the information, but also the intelligent systems of teaching, which would facilitate the development of the thinking in the field of engineering and innovation [2].

Conventional paper-based textbooks communicate deterministic knowledge in the form of static text and images, which is not easy to represent dynamic development of electrochemical mechanisms, interaction with BMS data stream, and extreme working conditions like thermal runaway that make students fall into the cognitive blind spot of knowing how to repair but not how to build. Digital textbooks on their part, due to the Five Accessibilities (visualizable, audible, practicable, interactive, and searchable) convert abstract principles into 3D animations and incorporate high-voltage operations in virtual simulation environments. This allows students to reach explicitation of tacit knowledge and embodiment of engineering thinking in the process of trial-and-error feedback iteration [3].

Using the digital textbook Power Battery Manufacturing and Maintenance Technology as an example, its purpose has changed to "developing system-level engineering thinking." The textbook has become a "thinking scaffold" through the four-stage process of "Core Creation" (DIY battery to understand mechanisms), "Core Management" (analyzing data streams to build logic), "Core Safety" (aligning with national standard mandatory testing) and "Core Repair" (diagnosing and repairing real work orders) which drives students to make the competency leap from passive acceptance to active construction and then to creative problem-solving exactly answering the deep-rooted needs of New Quality Productive Forces new-type skilled workers.

2.2 Content Logic: Consistent with the Full Life Cycle of Power Batteries and Job Competency Map

The emergence of New Quality Productive Forces is the source of a great change in industries, and also an industrial transformation and upgrading. The need to have talents that can work with power batteries is not anymore a matter of single-process workers but of composite technical personnel who are able to diagnose the process of manufacturing, management and so on. In the case of traditional paper books, they are based on the system of disciplinary knowledge which is linearly structured as Fundamentals - Structure - Maintenance and it disconnects the theory of learning and the practice of work as well as does not relate to the whole life cycle of the work, leading to the fact that what was learned is not used.

The discipline barriers should be broken through for the digital textbook of vocational undergraduate, taking the entire life cycle of power batteries as the main line, and converting typical tasks into structured and interactive contents. The digital textbook takes the four-stage progression of "Core Creation-Core Management-Core Safety-Core Repair" as the logic chain of contents, which corresponds accurately to the job competence map of the four major stages "R&D trial production→ system integration→ safety mandatory testing→ operation, maintenance and troubleshooting", reflecting the feature of "teaching adaptability" of vocational digital textbook [4].

In particular, Core Creation is a form of the DIY preparation to learn about the mechanisms and this is the competence of the manufacturing engineer; in Core Management, the BMS data streams are studied by the test engineers; in Core Safety, virtual simulation of working conditions at extreme levels was employed as an element of the safety competency; in Core Repair, actual work orders and fault trees were introduced in order to develop the ability to troubleshoot. The four layer model has been able to make the shift from the paradigm of accumulating knowledge on disciplinary basis to that of job competency map. Every piece of information is fixed with a particular job task and all skills training leads to a certain level of competence, which allows students to finish the process of building the technical system of the whole chain of industries in the development of the learning doing thinking.

This reasoning of content is also in accordance with the demands of New Quality Productive Forces of new type skilled workers and gives the opportunity to vocational undergraduate books to escape the problem of being copies of higher vocational education."

3. Digital Textbooks development in the Core-Chain Dual - Drive and Three - Stage Six - Path model

3.1 Core-Chain to Penetrate Content and Build a Full Life Cycle Knowledge Graph

The main benefit of digital textbooks is to use knowledge graph technology to realize the structured reconstruction and intelligent association of teaching content. Vocational undergraduate digital textbooks should take the four-stage development of "Core Construction-Core Management-Core Safety-Core Maintenance" as the framework to build a full life cycle knowledge graph integrating the three dimensions of "knowledge points-skill points-competency points" to realize accurate mapping with job competencies.

Particularly, Core Creation is a process of the creation of the electrochemical knowledge and assembly skills based on the DIY approach to create the spirit of craftsmanship; the Core Management is an activity that links the communication systems with monitoring operations in terms of BMS data flows to promote the idea of the system thinking; the Core Safety is an activity that determines the extreme conditions of work (nail penetration and thermal runaway) as the critical points of the system, which are connected to the safety standards and mandatory virtual tests to increase the reverence to the standards.

The knowledge graph has been based on the semantic connections and learning behavior information, which can be used to create an AI learning companion in the textbook platform that will automatically detect weak links of students and direct the direction of tiered micro-resources, creating a closed-loop of adaptive learning: Diagnosis - Push - Practice - Re-evaluation [5]. The process of personalization with the knowledge graph and the penetration into the content with the Core-Chain is a new development path that allows the textbook to be transformed into a dynamic competency navigation system instead of a static knowledge base, as it is the way New Quality Productive

Forces have their own internal needs to provide the personalized training and education of the so-called new-type skilled workers.

3.2 Enable the Implementation by "Dual-Track": Mitigating High-Voltage Practical Operation Risk via Virtual Simulation

Power battery systems are high voltage (300-800 V) and they have high-risk conditions like high-voltage power-on/off and thermal runaway. The conventional paper-based textbooks cannot demonstrate dynamic operation processes or safety warnings, whereas physical hands-on training has significant safety risks such as electric shock and fire. Consequently, the pain point of dare not teach, dare not practice has become widespread. In this regard, the textbook proposes a parallel Dual-Track model of virtual simulation rehearsal + physical standardized operation, which is highly integrated with the idea of using virtuality to ensure reality and link virtuality with reality in the structure of the textbook.

The textbook is also provided with a high-voltage simulation module (1:1) in the track of virtual rehearsal. Trial-and-error can be done by students up to hundreds of times. The operation paths are recorded and they will be able to determine compliance on their own. In case of violations, the system shuts down the simulation and warns it instantly [6]. To simulate the process of thermal spread in the extreme working conditions like nail penetration, the textbook uses 3D animations that allow students to develop an idea of what trigger propagation suppression is and transform the textbook into a safety training ground (Huo et al.). In the physical practice course, the textbook has been made so easy to connect between the physical and the virtual via the use of QR codes and AR markers. It is necessary to reach a level of $\geq 90\%$ of virtual compliance before any actual hands-on tasks are unlocked. The platform is also used as part of the data collection where a competency radar chart will be created which makes the transition between experience-based judgment and data-driven diagnosis.

This Dual-Track progressive logic does not only protect the safety bottom line, but also guarantees the efficiency of skill training, and is a direct answer to the competency needs of New Quality Productive Forces of new-type skilled workers who are operationally proficient and safety-conscious [7].

3.3 Competence Cultivation on “Six-Path” Closed-Loop: Promoting Skill Progression through Interactive Chains of Tasks

The essence of the New Quality Productive Forces in new-type skilled workers is not only to be proficient in operation but more importantly, it should be able to innovate that is, have a comprehensive ability to actively detect problems and creatively solve them in complicated engineering situations. Unless vocational undergraduate digital textbooks are still at the level of digitization of resources as a static process, students cannot easily trigger their endogenous motivation and higher-order thinking [8]. In this respect, the textbook hardens the six-step approach of guide, create, analyze, simulate, practice, innovate into an interactive chain of tasks. It is motivated by tiered checkpoints + real work orders, which builds a step-by-step skill development path, which facilitates the conversion of the classroom into a knowledge transmission field to a competency generator.

Guide and Create are the introductory tasks that entail stimulating interest and building perceptual cognition. The topic is introduced in the digital textbook through new energy vehicle recall events, which introduce fault phenomena and corporate recall announcements using interactive case modules embedded into it, leading students to learn with authentic questions like Why did this happen? And how can it be avoided. Next, the textbook gives the task of DIY preparation of aqueous manganese batteries. The textbook provides direct access to micro-videos, 3D animations, and step-by-step instructions for the analysis of electrochemical mechanisms at the micro level. This design shatters the linear pattern of theory first, practice later of the traditional textbook allowing students to comprehend principles by doing hands-on work, filling the cognitive blind spot of knowing how to repair but not how to build.

Simulate and Analyze are the higher-order operations, in which the logic is developed and standards are respected. In the textbook, it will be introduced as a platform of sharing cases of technicians, where the mind maps of faults will be embedded into the pages by industry experts. The students can open nodes and follow the path of the development of the fault and learn the logic of the reasoning behind the front-line troubleshooting. At the same time, the book relates to the virtual simulation system, with the students having to pass through simulations on

working conditions that are extreme, including nail penetration and thermal runaway tests, according to the GB38031 mandatory standard. It will also document the history of operation and its compliance automatically; individuals who do not adhere to the set standard would not be able to access the next content. This is an interactive model of case analysis + virtual compulsory testing, which internalizes the corporate problem-solving process and national regulations in a form of compulsory learning process, which contributes greatly to the improvement of the diagnostic process and knowledge of the standards [9].

Practice and Innovate relate to the high-level tasks, which are aimed at transferring skills and practicing innovatively. The textbook creates a four-stage training module of Analyze - Practice - Apply - Show: students initially analyze common fault cases (Analyze), then engage in layered troubleshooting exercises on virtual simulations and physical equipment (Practice), next transfer what they have learned to the overall diagnosis and treatment activities of actual corporate PACK work orders (Apply) and finally share their ideas of troubleshooting and optimization solutions through the platform Work Display Area (Show). Another intelligent push mechanism established by the textbook is an apply by analogy one: as soon as the system realizes that a student constantly commits errors in a specific type of faults (e.g., disconnection of high-voltage interlocks), it will automatically suggest variant tasks and extended resources. In the case of outstanding students, the textbook provides an opportunity to engage in horizontal research projects, which connect with the current research projects of the teacher (e.g., battery echelon utilization optimization), directing students to jump out of the passive completion of learning tasks into active participation in technical research and thus achieve the growth of innovative skilled workers as anticipated by New Quality Productive Forces.

The digital textbook turns the teaching model into an operable, traceable and evaluable interactive chain of tasks through the closed loop of “Guide – Create – Analyze – Simulate – Practice – Innovate”. The students accomplish the competence jump from “cognition” to “skill” to “innovation” by completing a series of tasks with increasing difficulty.

4. Content Structure and Competency Map of

Digital Textbooks

4.1 General Framework and Module Design of the Textbook

The online textbook is based on the four-stage process of Core Creation - Core Management - Core Safety - Core Repair as a vertical, which is the core of the life cycle of power batteries, and the horizontal aspect of the dual-track (virtual simulation + physical practice) and six-step tasks (Guide - Create - Analyze - Simulate - Practice - Innovate), in which they are combined to create three-dimensional architecture. The textbook does not follow the linear order of disciplines but uses the work tasks that are common to all units and arranges them into differentiated interactive resources.

The first module, Core Creation is based on the creation of perception in electrochemistry and its own DIY process, and 3D animation. Module 2, the Core Management will be used to enhance systems thinking through the use of interactive data panels as well as virtual calibration. In the third module, Core Safety, the extreme working conditions like the penetration of nails are changed into a safe practice that can be tried and tested with the help of virtual mandatory testing. Module 4: Core Repair: This module is a combination of AR disassembly, fault trees and work orders of corporate companies which results in an exponential increase in the diagnosis and repair of faults.

The four modules will be in the following order: cognitive base, logic building, safety bottom line, and full - scale use. The task chain for each module is "knowledge input → virtual simulation → physical practice → innovation expansion". It changes the textbook from a set of static information into an action - based, skill - developing learning system that links up with the job competency map of the whole industry.

4.2 Job Competency Map and Learning Path Mapping

In case the content structure of the digital textbook is still at the level of division into modules, it is hard to respond to the main question of what students will be able to do after taking the course. In this regard, anchoring the competency needs of New Quality Productive Forces on new-type skilled workers who are proficient in operation, knowledgeable in technology and capable of innovation, the textbook exactly outlines the four-step process of Core Creation -

Core Management -Core Safety -Core Repair to the standard job positions within the whole industry chain of power batteries. It builds a trinity job competency map of typical work tasks knowledge points / skill points / competency points forms of digital resources and uses knowledge graph technology to plan differentiated learning paths of students with different foundations as illustrated in Table 1 [10].

According to the job competency chart, the textbook is designed in a way that the knowledge map and the learning behavior of the students will be used as a basis in designing the differentiated learning strategies for those who have various backgrounds. The system advises the full-link standard path of Core Creation, then Core Management, then Core Safety, then Core Repair in case of the students with no foundation or they are switching to another major. In the case of electrical and electronic engineering where there is some background of the student, the system enables them to bypass the step of core creation and directly proceed to the step of core management and the stream of data analysis of BMS and it also provides dynamic support on weak areas by providing pre-tests. To the best students with extra energy, the system can provide more work orders and the horizontal research project portals in the module of the Core Repair, which would lead them to the higher order objective of becoming an innovative person. Such individualized teaching process of the knowledge graph navigation + data diagnosis + path deviation has transformed the digital textbook into a really smart carrier, which could be easily adjusted to the principle of teaching students according to their ability in New Quality Productive Forces [11].

5. Conclusion

Under the impetus of New Quality Productive Forces, vocational undergraduate digital textbooks should be transformed to the development of engineering thinking and innovation capability and accurately fit into the job competency map. Using Power Battery Manufacturing and Maintenance Technology as an example, this paper suggests a four-dimensional path of Core-Chain Integration - Dual-Track Empowerment - Six-Path Closed-Loop - Data Profiling and Industry-Education Integration Dual-Drive, and builds a four-stage progression model of Core Creation-Core

Management-Core Safety-Core Repair. Its essence is: "Core-Chain" infiltrating the main line with a full life cycle knowledge graph; "Dual-Track" reducing high-voltage risks by parallelizing virtual simulation and physical practice; "Six-Path" pushing skill progression through interactive task chains; and "Data" personalization by competency radar charts. Therefore, the textbook jumps out of a static state knowledge base to the dynamic competency

navigation system, which is a feasible and applicable solution of how new-type skilled workers can be trained in operation, technical skills, and innovation. In the future, it will be possible to shift the paradigm to the courses like intelligent manufacturing and new energy based on the AIGC and resource library of the municipal industry-education consortiums, providing a replicable model of digitalization of vocational education.

Table 1. Mapping between Job Competency Map and Learning Paths in the Power Battery Digital Textbook

Stage Module	Corresponding position	Typical Tasks	Knowledge Points	Skill Points	Competency Points	Forms of digital resources
Cognitive Foundation (Core Creation)	Battery Manufacturing Engineer	Cell trial production and assembly debug	Electrochemical basics; properties of electrode materials	Making aqueous manganese batteries by hand; parameter testing	artisan spirit; inquiry consciousness	3D micro animations; interactive experiment manuals.
Logic Construction (Core Management)	BMS Test Engineer	data calibration; protocol analysis	CAN communication protocol; SOC/SOH algorithms	Interactive data panel manipulation; strategy debugging	systems thinking; data sensitivity	Virtual calibration jobs; dynamic curve tools
Core Safety (Safety Bottom Line)	Vehicle Safety Engineer	mandatory standard implementation; risk assessment	GB38031 mandatory testing standards; thermal runaway propagation	Virtual mandatory testing operation; compliance judgement	Veneration of standards; safety baseline awareness	3D virtual mandatory testing module; thermal runaway simulation

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