

# Research on Dynamic Update Mechanism of Digital Teaching Materials for Aircraft Maintenance Major — A Discussion Based on the SECI Model

Min Wang, Lijie Wu

Shanghai Technical Institute of Electronics Information, Shanghai 201500, China

**Copyright:** © 2026 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

**Abstract:** The issue of sustainable updating after the completion of digital teaching material construction in vocational education has not been systematically addressed. Taking the aircraft maintenance major as an example, this paper reveals three types of blockages hindering the update of digital teaching materials, namely delayed regulatory channels, failed standardized coordination and solidified cultural cognition. The SECI model is expanded from one-off knowledge production to a spiral sustainable updating framework, and a four-stage micro-update mechanism of Trigger — Production — Review — Application is initially constructed. The study holds that under specific conditions, the micro-update mechanism may be more feasible than large-scale full revision. Empowering frontline teachers can turn teaching material updating into a natural extension of daily teaching, which provides theoretical reference for transforming digital teaching materials from a construction-oriented paradigm to an update-oriented paradigm.

**Keywords:** Vocational education; Digital teaching materials; Dynamic update; Aircraft maintenance; SECI model

**Online publication:** September 17, 2026

## 1. Introduction

The construction of digital teaching materials is an important initiative to advance the digital transformation of vocational education and improve the cultivation quality of skilled talents<sup>[1]</sup>. The Outline for the Construction of an Education Power (2024–2035) proposes to gradually establish a standard system covering the development, application, and administration of vocational digital teaching materials, indicating that the development of such materials has shifted from quantity expansion to quality upgrading.

At present, many scholars have carried out research on vocational digital teaching materials. Li Yuanbo revealed institutional dilemmas including imperfect regulatory guarantees, insufficient standardized support and shallow cultural recognition in the construction of digital teaching materials<sup>[2]</sup>. Xu Ye pointed out deficiencies such as inadequate overall planning, lack of uniform standards and absent knowledge graphs in the

development of digital teaching materials. Li Wen et al. stated that digital teaching material platforms should integrate teaching administration and data service functions, and visualize students' mastery of knowledge points to provide teachers with a comprehensive overview of learning performance<sup>[3]</sup>. Hong Guofen further put forward three intelligent update modes for vocational digital textbooks: update based on learner and teacher data, update based on user feedback, and content update driven by industrial technological progress<sup>[4]</sup>. The above studies offer multi-dimensional perspectives on how to construct digital teaching materials, yet they pay insufficient attention to sustainable updating after completion. Existing literature either focuses on one-off development procedures or discusses the potential of technological empowerment<sup>[5]</sup>, while few studies explore mechanical issues such as who triggers updates, what standards to follow, which procedures to go through, and what constraints exist. If digital textbooks are only developed without continuous updating, their digital advantages will be reduced to static multimedia resources, essentially retaining the logic of printed textbooks whose content is fixed once published.

Based on the above background, this paper focuses on the dynamic update mechanism of vocational digital teaching materials, takes the aircraft maintenance major as a research case, adopts knowledge management theory and institutional analysis tools, and mainly discusses three questions: What structural dilemmas hinder the updating of digital teaching materials for vocational majors? How to construct the theoretical logic and framework of dynamic updating? How to design practical implementation paths? This research intends to shift the research paradigm of digital teaching materials from construction to sustainable updating, and provide theoretical support for maintaining the long-term vitality of digital textbooks for technology-intensive majors.

## **2. Practical dilemmas: Three blockages restricting the update of digital teaching materials for aircraft maintenance major**

The construction of vocational digital teaching materials is trapped in three institutional blockages at the regulatory, normative and cultural-cognitive levels. For aircraft maintenance majors, these dilemmas are embodied as delayed update channels, formalized multi-party coordination and reliance on traditional teaching habits, forming a chained barrier of "institution — action — cognition".

### **2.1. Regulatory blockage: Insufficient institutional support and delayed update channels**

Regulatory elements refer to institutional provisions and legal constraints that set rigid boundaries for organizational behaviors. At present, the development of vocational digital teaching materials lacks a systematic policy framework, with lagging textbook review procedures and copyright administration rules, resulting in three mismatches: the timeliness of civil aviation regulation revisions vs. the long textbook review cycle, corporate technical confidentiality requirements vs. the open sharing of teaching resources, and schools' independent update authority vs. unified quality supervision.

Restricted by long production cycles and mandatory post-completion review procedures, digital textbooks cannot be revised at will. Such institutional constraints offset the real-time advantage of digital platforms: partial revisions still require the full set of review formalities, just like printed textbooks. Meanwhile, the construction of digital teaching materials involves multiple conflicts between public welfare and commercial value, private data space and public resource sharing, whereas current institutions fail to clarify teachers' legitimate authority and liability in content updating. Even if teachers are willing to revise textbooks, they lack

institutional authorization to carry out relevant work. A deeper problem lies in the fact that post-completion maintenance is often limited to formal version archiving rather than continuous content iteration. Taking the technical data update of C919 aircraft as an example, even if updated technical documents are available, textbooks fall behind teaching practice by nearly two semesters because the review cycle is counted by semesters and partial revisions require full formalities. Teachers can only supplement new knowledge verbally, making the dynamic update function of digital platforms practically idle <sup>[6]</sup>.

Imperfect textbook governance systems hinder the high-quality development of digital teaching materials. The current governance mechanism operates at a low level without specialized, systematic regulations. For aircraft maintenance textbooks, the quality inspection, supervision and accountability system remains incomplete, with no clear provisions on review standards, responsible subjects and time limits for updated content. Teachers' revision activities exist in an institutional vacuum.

## **2.2. Normative blockage: Formalized multi-party coordination and overburdened teachers**

Normative elements include shared values and behavioral standards to coordinate interest relations among multiple stakeholders. The updating of aircraft maintenance digital textbooks involves four parties: college teachers, enterprise technicians, publishing institutions and civil aviation administrative departments, whose value orientations diverge greatly. Enterprises prioritize technical confidentiality and commercial interests, colleges focus on teaching applicability, and publishers pursue economic benefits, failing to form a stable consensus. When empowering digital textbooks with knowledge graphs, the integration of heterogeneous resources is often ignored, leading to an information cocoon effect. Tacit maintenance experience mastered by enterprise technicians cannot be effectively converted into structured digital textbook content under current compilation modes, and multi-party coordination is merely a superficial content migration dominated by college teachers.

Furthermore, teachers bear heavy responsibilities yet lack corresponding authorization. Intelligent platforms monopolize data to form closed learning loops, depriving disciplinary experts of substantial control over core links such as student behavior data and knowledge updating. Teachers become passive recipients of platform data instead of active drivers of the update cycle. The compilation of intelligent digital textbooks requires authors to master three-dimensional curriculum design, integrating text and digital resources, which creates a tension with teachers' real workload. Traditional printed textbook compilation mainly demands writing ability, while intelligent digital textbooks require closer connections between text and fragmented digital resources. This imposes an extra heavy burden on aircraft maintenance teachers who already have heavy teaching schedules <sup>[7]</sup>.

## **2.3. Cultural-cognitive blockage: Weak recognition of digital textbooks and cognitive risks**

Cultural-cognitive elements represent shared meaning frameworks and legitimate identities that shape members' understanding of behaviors. In aircraft maintenance teaching, teachers are accustomed to using a single textbook plus years of lecture notes and lack the willingness to utilize the dynamic update function of digital platforms. Students tend to outsource their cognition to digital resources, over-relying on preset interactive paths and weakening their ability to read original maintenance manuals and retrieve regulatory clauses — core competencies required by the CCAR-66 License Examination. In addition, Generative Artificial Intelligence (GAI) may weaken students' thinking ability and mislead their cognition when applied

in digital textbooks. Complex information output, redundant interactive designs and highly simulated virtual scenes embedded in GAI-powered digital textbooks increase students' cognitive load instead of supporting in-depth knowledge processing and meaning construction <sup>[8]</sup>.

Teachers have observed typical cases in practical training: students can complete troubleshooting tasks with a pass rate over 90% by following preset flowcharts in digital textbooks. However, when teachers set atypical hydraulic intermittent pressure fluctuation faults in assessments (requiring comprehensive analysis of interactions among multiple subsystems), most students immediately try to find matching procedures in digital textbooks instead of conducting independent analysis based on Aircraft Maintenance Manual (AMM) logical frameworks. Around 60% of students spend excessive time on this link, and some even give up troubleshooting without matching textbook content. This phenomenon indicates that the convenience of preset paths improves learning efficiency for standard scenarios yet erodes students' independent judgment when confronting complex atypical problems. Informal interviews with five teachers of the same major show that four are used to fixed textbooks and lecture notes, rarely utilizing the update function of digital platforms.

The three blockages mentioned above do not exist in isolation but form a vicious cycle: delayed regulatory channels make normative coordination unworkable, formalized coordination reinforces the belief that updating is useless at the cognitive level, and finally the dynamic update function of digital textbooks is suspended due to imperfect mechanisms <sup>[9]</sup>.

### **3. Theoretical logic: Knowledge management framework for dynamic updating**

The three blockages prove that the updating dilemma of digital textbooks is not merely an institutional issue but a problem of obstructed knowledge circulation. To break the chained barrier of institutions, behaviors and cognition, updating must be transformed from static institutional arrangements to dynamic knowledge management processes. The SECI model of knowledge management provides an analytical tool for this transformation.

#### **3.1. SECI model: Theoretical tool from one-time production to sustainable updating**

The SECI model proposed by Ikujiro Nonaka illustrates four conversion modes between tacit and explicit organizational knowledge: Socialization (S) realizes experience sharing from tacit to tacit knowledge; Externalization (E) encodes tacit knowledge into explicit conceptual forms; Combination (C) systematically integrates fragmented explicit knowledge; Internalization (I) generates practical capabilities by absorbing explicit knowledge. The traditional SECI model assumes one-off knowledge completion after four conversion cycles. Nevertheless, the aircraft maintenance major features stable core knowledge and demand for partial targeted updates, so the model needs to be expanded into a spiral sustainable iteration system. Each round of teaching feedback triggers a new knowledge conversion cycle, forming a closed loop of "Update — Application — Feedback — Re-update". Digital textbooks are no longer static carriers of knowledge transmission but dynamic platforms hosting cyclic SECI operations. Within this framework, knowledge is not a static object waiting to be delivered in textbooks, but dynamically generated through continuous interactions among teachers, enterprises, technical platforms and students <sup>[10]</sup>.

#### **3.2. SECI spiral for the update of aircraft maintenance digital textbooks**

(1) Cycle 1: Socialization (S) — Enterprise Experience Integrated into Teaching

New fault modes, aircraft maintenance procedures and new process technologies exist first as tacit experience held by enterprise technicians. Higher vocational teachers initially acquire such tacit knowledge through corporate internships, technical exchanges and work order research. The core bottleneck of this stage lies in enterprises' insufficient motivation to share tacit knowledge due to technical confidentiality and commercial concerns, plus conflicts between teachers' corporate practice schedules and teaching tasks that make socialization superficial. Therefore, digital textbooks should expand applicable scenarios and realize seamless docking with other educational platforms for data sharing.

(2) Cycle 2: Externalization (E) — Encoding Tacit Experience into Explicit Knowledge

Teachers convert acquired tacit experience into explicit textbook content. Generative Artificial Intelligence serves as auxiliary support in this stage: teachers input fault descriptions and troubleshooting ideas, and GAI generates standardized case texts, draws flowcharts and matches regulatory clauses. The quality of externalization depends on teachers' understanding of enterprise experience and the accuracy of AI assistance. Vocational digital textbooks should explore efficient methodologies of resource generation based on generative AI, and guide teachers to interact with large models to produce teaching resources.

(3) Cycle 3: Combination (C) — Systematic Integration of Multi-Source Knowledge

Fragmented explicit knowledge generated in externalization is integrated into the existing textbook system to form updated knowledge networks. Knowledge graph technology establishes internal connections among fragmented educational data, realizing seamless integration of cross-disciplinary, cross-school and multi-teacher teaching resources. For aircraft maintenance textbooks, the combination relies on knowledge graphs to build a three-dimensional correlation network of “regulations — aircraft models — work cards — cases”, ensuring linkage calibration of associated knowledge points after partial updates.

(4) Cycle 4: Internalization (I) — Teaching Practice and Effect Feedback

Students conduct practical training with updated textbooks. Indicators such as troubleshooting success rate and license exam pass rate are taken as standards to test update effectiveness. Learning data are collected in real time throughout students' learning via three channels: learning journals, digital equipment and virtual scenarios, with feedback embedded in the internalization link to form a closed loop of “student training performance — system automatic diagnosis — targeted teacher intervention — directional textbook updating”. Students' doubts and confusion in use drive a new round of the socialization cycle.

### 3.3. Core implications of the theoretical framework

The four stages operate cyclically under the guarantee of regulatory, normative and cultural-cognitive institutions. Based on this spiral structure, the theoretical framework for dynamic updating of aircraft maintenance digital textbooks can be summarized as trigger conditions (regulatory revisions/aircraft model iterations / new processes/teaching feedback) → Socialization (teachers acquire tacit enterprise experience) → Externalization (GAI-assisted encoding of tacit experience into explicit knowledge) → Combination (multi-source knowledge integrated via knowledge graphs) → Internalization (training feedback testing update effectiveness) → new trigger (identification of knowledge gaps, cyclic iteration), with full-process institutional safeguards at three levels.

Within this framework, teachers shift from passive textbook revisers to drivers of the SECI spiral. They lead experience acquisition in socialization, knowledge encoding in externalization, systematic integration in combination, and trigger new cycles through internalization feedback.

## 4. Conclusion and prospect

This paper addresses the research gap concerning the continuous updating of digital teaching materials for vocational education after their development, takes the aircraft maintenance major as the research field, and preliminarily constructs a theoretical framework and practical mechanism for teacher-driven micro-updates. The main conclusions are as follows:

- (1) This study expands the SECI knowledge management model from one-off production to spiral continuous updating, reconstructing updating as an ongoing mechanism running through the entire knowledge lifecycle. It provides a theoretical reference for shifting research on digital teaching materials from a development paradigm to an updating paradigm.
- (2) The research argues that the stable core knowledge and demand for targeted partial updates of the aircraft maintenance major make the micro-update mechanism more feasible than large-scale revisions under specific circumstances. The four-stage “trigger – production – review – application” mechanism designed in this paper focuses on precise partial revisions. It not only avoids the resource waste caused by full textbook rewrites but also creates institutionalized channels for frequent, safety-critical modifications, transforming teachers from mere textbook users into drivers of updates.
- (3) By empowering teachers, the micro-update mechanism has the potential to make updating a natural extension of daily teaching work. The four-stage mechanism decentralizes update authority to frontline teaching staff, enabling teachers to initiate timely updates based on regulatory changes, aircraft model iterations and teaching feedback, thereby forming an endogenous cycle of “teaching – feedback – updating”. This transformation aligns with the knowledge characteristics requiring targeted partial updates in aircraft maintenance, and offers a reference for sustaining the long-term viability of digital teaching materials in other technical and skill-based majors.

The limitations of this paper also point out directions for future research: First, the effectiveness of the mechanism remains to be empirically verified. Follow-up research can collect data such as update frequency, teaching outcomes and license examination pass rates through institutional pilot programs to quantify the actual impact of the micro-update mechanism on the quality of aircraft maintenance talent training. Second, the technical boundaries of Generative AI (GAI)-assisted updating require further exploration; real-world testing and calibration are still needed to improve knowledge accuracy and alignment with regulatory standards, preventing the infiltration of hallucination risks into teaching scenarios. Third, this research only adopts aircraft maintenance as a single case study, so the cross-major transferability of the mechanism requires further investigation in subsequent work.

## Funding

General Project of Shanghai Educational Science Research, “Research on the Development and Application of Digital Teaching Materials for Vocational Education in the Digital Intelligent Era” (Project No.: C2026022)

## Disclosure statement

The author declares no conflict of interest.

## References

- [1] Xu Y, 2024, Research on Connotation, Problems and Paths of Vocational Digital Teaching Material Construction. *Chinese Vocational and Technical Education*, 2024(20): 12–18.
- [2] Li Y, Chen P, 2026, Institutional Dilemmas and Solutions for Vocational Digital Textbook Construction — From the Perspective of Sociological Institutionalism. *Education and Vocation*, (6): 94–103.
- [3] Li W, Zeng B, Zhao X, 2025, Remolding and Innovation of Vocational Digital Textbooks in the Digital Intelligent Era. *Education and Vocation*, 2025(6): 72–78.
- [4] Hong G, 2024, Exploration and Practice of Vocational Digital Textbook Construction. *Chinese Vocational and Technical Education*, 2024(23): 10–18.
- [5] Yu H, 2025, Where Is the Innovation Path of Digital Textbooks. *China Education Science*, 8(5): 76–89.
- [6] Xu Y, 2024, Analysis on the Construction and Application of Vocational Digital Teaching Materials. *Chinese Vocational and Technical Education*, 2024(17): 16–26.
- [7] Li Z, 2024, Connotation, Functions and Construction Strategies of Vocational Digital Textbooks. *Chinese Vocational and Technical Education*, 2024(20): 3–11.
- [8] Zhang Y, Yu H, 2023, Value Implication and Construction Logic of High-Quality Development of Digital Textbooks. *Educational Science Research*, 39(6): 52–58.
- [9] Guo L, Li J, 2024, Empowerment of Digital Textbooks via Knowledge Graphs: Motivations, Barriers and Implementation Paths. *Curriculum, Teaching Material and Method*, 44(11): 37–43.
- [10] Xu T, Sun F, 2025, Practical Forms, Practical Challenges and Promotion Paths of Digital Textbook Construction in Higher Education in Intelligent Era. *Open Education Research*, 31(4): 109–115.

### **Publisher's note**

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.