

# Bridging Concept and Practice: Development Dilemmas and Breakthroughs in a Loose-Leaf Textbook for Mechanical Drawing

Wei Zheng, Yuan Xia\*, Dan Liu

*School of Intelligent Manufacturing, Chongqing Industry and Trade Polytechnic, Chongqing, China*

*\*Corresponding Author*

**Abstract:** Loose-leaf textbooks are widely promoted in China's vocational education reform, yet they often remain advanced in concept but stalled in practice. This paper reports our two-year effort to bridge that gap. We developed a loose-leaf textbook for Mechanical Drawing at Chongqing Industry and Trade Polytechnic, tracking its design, pilot testing, and revision over 18 months. Drawing on case-study data—including classroom observations, interviews, student feedback, and enterprise input—we propose a “four-dimensional” framework that anchors textbook development around purpose, content, mechanism, and value. Our implementation exposed three recurring problems: industry partners engaged only symbolically; dynamic updates became procedural rituals rather than quality-driven revisions; and student peer-assessments drifted toward subjective judgments. These dilemmas, we argue, stem from misaligned incentives, the absence of quality filters, and a premature transfer of evaluative authority to untrained students. To address them, we piloted three interventions: an interest-responsibility co-binding model for industry collaboration; a minimum viable review workflow to discipline content updates; and a rubric-based, anonymized peer-assessment system. Preliminary results show these strategies reduced content obsolescence from 8–10 months to 3–4 months and improved peer-evaluation consistency (standard deviation dropped from 0.51 to 0.28). Our experience suggests that loose-leaf textbook development, to be genuinely effective, requires not just a new binding format but a systemic rethinking of roles, processes, and evaluation practices.

**Keywords:** Mechanical Drawing; Loose-Leaf Teaching Materials; Integration of Industry

and Education; Teaching Material Construction

## 1. Introduction

In recent years, the state has focused on promoting the construction of vocational education textbooks as a basic project for the construction of a modern vocational education system. The “Notice on Key Tasks to Accelerate the Construction and Reform of the Modern Vocational Education System” issued by the Ministry of Education in 2023 clearly requires the development of new forms of the teaching materials such as loose-leaf and workbook types [1]. The “Opinions on Deepening the Reform of Key Elements of Vocational Education Teaching” issued in 2026 further clarified the underlying logic of the construction of new forms of teaching materials, emphasizing that teaching materials must adapt dynamically to industry needs [2]. The policy direction is clear, but implementation is difficult. Vocational education textbooks have problems such as insufficient ability to educate talents, insufficient educational functions, and low frequency of use [3]. The loose-leaf textbooks developed by many colleges and universities have been reduced to “traditional textbooks bound with loose leaves”, and the form and content of the textbooks have a poor match [4-5]. Core features such as student-centeredness, dynamic updates, and school-enterprise collaboration have not been truly realized. The fundamental reason is that loose-leaf textbooks are not a simple change in the binding form [6-8], but a systematic reconstruction involving content organization logic, teaching implementation paths, and quality assurance systems. If we only stay at the surface level and fail to touch the core logic, it will be difficult to break through the dilemma of “advanced concepts but difficult implementation” [9-10].

The research team chose the “Mechanical Drawing” course as a breakthrough. This course is a core basic course for mechanical majors and has the typical characteristics of “strong standardization, high practicality, and large student diversity”. Different majors place different emphasis on drafting skills. There are significant differences in basic knowledge among students from different sources. The contradictions of the traditional “one size fits all” teaching materials are particularly prominent. It is worth noting that the drawing courses are highly standardized, such as line type, projection relationship, dimension labeling, etc., all have strict national standards. This requires that loose-leaf textbooks must seek a balance between “flexibility” and “normativity.” The development difficulty is significantly higher than that of the ordinary courses, which also makes it more research valuable. The research team started compiling the loose-leaf textbook “Mechanical Drawing” in 2023, and it took a year and a half to complete the first draft and put it into use. This study adopts the design of case study method as the main method and action research method as the supplement. Taking this textbook as an example, the data sources include writing process records, classroom observations, interviews with teachers and students, questionnaires, and corporate surveys. This paper attempts to reveal the core logic of loose-leaf textbook development and analyze typical dilemmas and their causes. And put forward feasible optimization strategies, hoping to provide reference for similar colleges and universities.

## **2. A Four-Dimensional Framework for Loose-Leaf Textbook Development**

Building a loose-leaf textbook isn't just about collecting experience here and there. We needed a systematic framework to guide every decision—from page layout to task sequencing. Based on the review of the theory of the vocational education textbooks and the development practice of the research team at Chongqing Industry and Trade Polytechnic. This article constructs a “four-dimensional core logic” of the concept, content, mechanism and value of loose-leaf textbooks. The core of the concept answers “why to do it” and constitutes the starting point of value. The core of content answers “what to do” and constitutes the entity

carrier. The core of mechanism answers “how to do it” and constitutes operational guarantee; The core of value answers “for whom”. At the beginning of the development of teaching materials, the team used this four-dimensional design as a blueprint. Subsequent practical exploration will present the specific form of teaching materials according to these four dimensions. Dilemma analysis will diagnose the deviations in implementation of each dimension. The optimization strategy proposes correction plans for deviations in each dimension. The above content is the methodological logic of this study.

In terms of concepts and content, the teaching materials have achieved a dual shift from standard standardized instruction to differential adaptation, and from subject logic to job logic. In view of the diversity of students and the characteristics of students who are good at hands-on practice, the teaching materials adopt a modular split and layered design strategy. Students entering high school generally start with the two-dimensional sketching module. Students entering vocational high schools can directly enter the three-dimensional modeling and drawing conversion module to implement teaching students in accordance with their aptitude. In terms of content organization, the textbook turns to job logic and subdivides the six core projects into 22 specific tasks, such as converting the cross-section drawing method into selecting appropriate cross-section drawings based on the processing technology of shaft parts. Dynamic adaptation of knowledge transfer and industrial needs is achieved.

In terms of mechanism and value dimensions, the team continuously activates the vitality of teaching materials through school-enterprise collaboration and dynamic iteration. In response to the chronic problem of lagging content solidification in traditional textbooks, the team has established a dual-element collaborative mechanism between schools and enterprises. The dual-element collaborative mechanism between schools and enterprises is composed of a community of “dual-qualified” teachers, enterprise engineers and industry experts. The company regularly provides front-line production cases and process standards, and teachers turn them into teaching tasks. An updated closed loop of “feedback from production frontline - adjustment of teaching material content - classroom implementation”

was formed. Relying on the physical characteristics of loose-leaf binding, textbooks can be supplemented and replaced with single pages, ensuring that content and industrial technology resonate at the same frequency. Following the principles of progressive task complexity and complete skill coverage, a design strategy of standardization in the front and flexibility in the back was adopted between flexibility and standardization. National standards are presented uniformly in the front part, and subsequent tasks focus on flexible application and comprehensive innovation. This laid a methodological foundation for subsequent practical exploration.

### **3. Practical Development and Implementation: A Case Study**

#### **3.1 Case Overview and Analysis of Diverse Programmatic Needs**

This study takes the loose-leaf textbook “Mechanical Drawing” officially published by the team in the Machinery Industry Press in June 2024 as the core case [11]. As a mature teaching achievement that has been published for nearly two years, this textbook provides a solid practical carrier for this research. This textbook uses six major projects and 22 tasks as the basic framework. It uses loose-leaf binding and supporting task worksheets to realize the teaching function of learning and practicing through independent exploration, cooperative research, and mutual review and evaluation. The School of Intelligent Manufacturing of Chongqing Industry and Trade Polytechnic offers multiple majors such as mechanical design and manufacturing, CNC technology, and mechatronics. There are significant differences in the demand for drawing skills among various majors. The mechanical design and manufacturing major focuses on design expression and specification, emphasizing the in-depth drawing of parts and the design logic of assembly drawings. The CNC major focuses on the interpretation of machining-oriented drawings and the correspondence between tolerances and machining accuracy. The mechatronics major focuses on the collaborative expression of mechatronics integration and the assembly coordination of mechanical and electrical components. The traditional teaching material model with unified content is difficult to adapt to the above-mentioned differentiated

needs. To resolve this contradiction, we turned to modular design. Instead of one uniform textbook, we built a pool of 22 independent task modules that each major could cherry-pick. Different majors can choose key modules from 22 tasks to organize teaching according to their own needs.

#### **3.2 Modular Design and Dynamic Content Iteration**

In terms of content organization, the six core items of the developed loose-leaf textbook follow a progressive logic from simple to complex. Project 1: Drawing of plane graphics lays the foundation for drawing ability. Project 2 combines three-dimensional views to cultivate spatial imagination and projection analysis abilities. Project 3 machine parts expression methods Master the expression skills such as cross-section and cross-section. Project 4: Standard parts and commonly used parts, familiar with standard drawing methods of threads, gears, etc. The parts drawings of Project 5 and the assembly drawings of Project 6 comprehensively use the aforementioned skills to complete the drawing of complete engineering drawings. In terms of content iteration, the team established a “dual-channel feedback” mechanism. In-school channels include classroom observations, which mainly record task nodes where students encounter difficulties, student questionnaires, and teaching reflection logs. Off-campus channels include company visits, mainly to collect new industry requirements for graphics talents. Return visits by graduates are used to verify the matching between the teaching material content and actual work and to track industry standards. Based on this, the team carries out micro-updates every semester and makes systematic adjustments every year to ensure that the teaching material content always resonates with industry needs.

#### **3.3 Pedagogical and Technological Integration**

The loose-leaf textbook is designed with three functional modules in the physical form: task worksheet, knowledge connection, and evaluation module. The closed-loop teaching model of independent preview, classroom exploration, and extended practice is supported by three major modules. Before class, students use task worksheets to conduct independent

previews, clarify learning goals and make preliminary attempts. Group cooperative learning is used in the classroom, with teachers providing on-site guidance and students completing mutual evaluations and presentations between groups. Practical tasks are assigned after class to consolidate and transfer skills. At the same time, relying on the municipal-level demonstration virtual simulation training base, typical mechanical parts are disassembled into interactive three-dimensional models. Students enter the virtual scene through VR equipment and draw drawings according to the annotation specifications in the loose-leaf textbook. Taking the parts surveying and mapping task as an example, the teaching implementation is divided into three stages: observing the three-dimensional structure and measuring key dimensions in the virtual scene, completing the drawing annotation according to the teaching material specifications, and comparing and verifying the drawn drawings with the actual parts. This combination of virtual and real methods effectively solves the difficulty of cultivating spatial imagination ability and significantly improves students' learning effects.

### **3.4 Multi-Stakeholder Evaluation Framework**

The loose-leaf textbook establishes a multi-subject evaluation system that combines process and results. Set evaluation nodes after each project task is completed. The evaluation content covers three dimensions: drawing standardization, task completion, and collaboration participation. The main body of evaluation includes four categories: student self-evaluation, intra-group peer evaluation, inter-group peer evaluation, and teacher evaluation. Students' self-evaluation conducts self-checking based on the evaluation standards in the teaching materials, intra-group mutual evaluation focuses on detailed feedback of the collaboration process, and inter-group mutual evaluation conducts horizontal comparisons. Teacher evaluation is a comprehensive evaluation from a professional perspective. The four categories of results are combined according to weights to form a comprehensive evaluation of students. This design transforms evaluation from a one-time assessment at the end of the semester to dynamic feedback throughout the entire learning process. This

provides a practical basis for subsequent dilemma analysis and strategy optimization.

## **4. Implementation Dilemmas and Causal Analysis**

### **4.1 Development Dilemma: Symbolic Engagement in School-Enterprise Collaboration**

Although the team established a school-enterprise collaboration mechanism at the beginning of the textbook compilation. In actual operations, enterprise participation often remains on the surface of "cooperating to complete the project." Although the company's engineers provided some production drawings as teaching material cases, there is a significant lag in the updates of these cases. About 30% of the process standards used in the 2025-2026 school year still fail to reflect the latest corporate practices in a timely manner. The underlying reason lies in the structural mismatch between the roles of schools and enterprises. For institutions, teaching materials are the core carrier of teaching activities. For corporate engineers, teaching material development is an additional task that is not directly related to their core performance indicators. Incentives such as authorship rights and project sharing provided by colleges and universities are still "extracorporeal circulation" for corporate promotion and salary systems. This institutional gap in the evaluation system has caused corporate participation to fall into a "suspended" state, with willingness to cooperate remaining verbal and substantive investment difficult to sustain.

### **4.2 Implementation Dilemma: Procedural Formalism in Dynamic Iteration**

In dynamic iterative practices, teams encounter the risk of ritualization. For example, there is an update cycle but no content filtering standards; there are update actions but no quality benchmarks; there are update records but no traceability mechanism. Although the team has carried out micro-updates every semester and systematic adjustments every year on time, the quality of the new content is uneven. For example, during the revision of a "section drawing method" task, the team added new cases from enterprises. However, due to the lack of the clear review standards, there was a problem in the case that the dimensions did not

comply with the latest national standards, which was not discovered until after it was used in the classroom. The reason is that the high-frequency updating characteristics of loose-leaf textbooks make these nodes loose or missing. The core issue of the vacancy in the system is that “who will review, what will be reviewed, and how to review” is not clear, leaving the team in a dilemma between update efficiency and review quality.

### **4.3 Evaluation Dilemma: Criteria Subjectivity in Multi-Stakeholder Assessment**

The multi-subject evaluation system encountered an unexpected dilemma during its implementation: the spread of “non-professionalism” in students' mutual evaluation. During the observation in the practice class, it was found that some students' evaluation criteria slipped from “whether the line type meets the national standards” to “I think the painting is pretty good-looking.” Taking a mutual evaluation of the “Combined Volume View Drawing” task as an example, a drawing submitted by a student had an obvious error in the projection relationship. However, in the mutual evaluation within the group, none of the three students identified the problem, and instead gave a positive evaluation of “the drawing is quite neat.” It is difficult for students who lack training to accurately identify professional errors. Instead, they are more likely to focus on non-core visual features such as the “neatness” and “symmetry” of drawings. The underlying contradiction lies in the temporal incongruence between the decentralization of evaluative authority and the cultivation of evaluative competence. Students are granted evaluative authority before they have acquired the corresponding professional judgment skills. When professional errors go unrecognized, not only is assessment fairness compromised, but there is also a potential risk of gradually eroding students' respect for drawing standards.

## **5. Breakthrough Strategies and Practical Pathways**

### **5.1 Optimizing Collaboration: an Interest-Responsibility Dual-Alignment Model**

To address symbolic engagement in school-enterprise collaboration, we shifted from a

school-initiated cooperation approach to a mechanism based on dual-alignment of interests and responsibilities. For interest alignment, we upgraded our collaboration with local mechanical manufacturing enterprises from simple authorship acknowledgment to technology source certification. For responsibility alignment, we signed a textbook update responsibility agreement specifying that enterprises' core obligation is to confirm the timeliness of enterprise-related cases on a quarterly basis. This transforms enterprise participation from actively providing new cases to passively confirming existing ones, significantly lowering the threshold for engineer involvement. The depth of collaboration has gradually shifted from one-time material provision to continuous co-construction and sharing.

### **5.2 Optimizing Content Management: A Minimum Viable Review Workflow**

To counter procedural formalism in dynamic iteration, we designed a minimum viable review (MVR) mechanism. Two specific measures were evaluated. First, a removal justification form is required when removing or replacing loose-leaf pages, specifying reasons for outdated or unsuitable content, thereby preventing arbitrary changes. Second, an amendment log is compiled at the end of each semester, signed by both school and enterprise representatives, and archived to create a complete audit trail. This minimal trace management system forces update behavior to shift from performing an action to providing documented justification. Operationally, this mechanism reduced the average content timeliness lag from 8–10 months to 3–4 months, while maintaining basic quality control. Although it increases teachers' documentation workload, standardized templates have kept the operational cost within an acceptable range.

### **5.3 Optimizing Evaluation Tools: Rubric-Guided and Anonymized Assessment**

In response to the dilemma of “standard subjectification deviation” in multi-subject evaluation, two types of evaluation tools, “standardized + anonymized”, were developed. In terms of standardization, a drawing error grading evaluation card has been developed, which divides common drawing errors into three levels according to “severity” and

“difficulty of identification”: Level A errors, such as missing views and closed dimension chains, are “must deduct points” (-5 points/place), Level B errors, such as inconsistent section line directions and irregular fonts, are “point deduction items based on frequency” (-2 points/place), and level C errors, such as fine-tuning the labeling position, are “suggested items” (-1 point/place). The core logic of this design is to transform “professional judgment” into “pattern recognition”, which significantly lowers students' cognitive threshold. Taking the “Combined Volume View Drawing” task as an example, it was difficult for students to determine what problem the “projection relationship error” belongs to before. Now, they only need to look at the evaluation card to determine that it is an A-level error and deduct the corresponding points. Judging from the teaching feedback, the introduction of this evaluation tool combination has reduced the intra-group standard deviation of the mutual evaluation results of Class 3 of 2025 Mechanical Design and Manufacturing from 0.51 to 0.28, and the consistency of evaluation has been significantly improved. In terms of anonymity, the team has perfected the “blind review envelope system”. Each group of drawings is submitted anonymously and distributed randomly, and can be implemented without relying on any electronic system.

## 6. Conclusion and Outlook

This study takes the “Mechanical Drawing” loose-leaf textbook developed by the team as an example, and systematically examines the entire process of the loose-leaf textbook from concept to implementation. At the practical level, the developed loose-leaf teaching materials have achieved the transformation from “standard standardized instruction” to “differential adaptation” through modular project design, dual-channel feedback iteration, three-loop closed-loop teaching model, deep integration of virtual and real, and multi-subject evaluation system.

Yet, implementation also revealed three typical dilemmas: symbolic engagement in collaboration, procedural formalism in iteration, and criteria subjectivity in assessment—stemming respectively from institutional gaps, the absence of quality assurance mechanisms, and misalignments in evaluative competence. In response, we proposed and validated an

interest-responsibility dual-alignment model for collaboration, a minimum viable review (MVR) workflow for content management, and rubric-guided anonymized assessment tools. Preliminary practice data confirm the feasibility of these strategies. Theoretically, this study builds upon systems theory to construct a four-dimensional analytical framework for loose-leaf textbook development, and it conceptualizes “symbolic engagement,” “procedural formalism,” and “criteria subjectivity” as distinct analytical categories, thereby enriching the theoretical vocabulary for vocational education textbook research. Practically, our exploration demonstrates the viability of an agile and iterative development approach. Rather than waiting for all conditions to mature, development should begin with the most urgent courses, the most willing enterprise partners, and the most flexible teams. School-enterprise collaboration requires institutionalized interest-responsibility alignment; multi-stakeholder assessment must be equipped with scaffolding tools; and loose-leaf textbook development is, in essence, a systemic transformation involving role redefinition, process reengineering, and technological adaptation.

At the same time, this single-case study may be context-bound. The tracking period for strategy effectiveness is relatively short, and we lack a strictly controlled experimental comparison with classes using traditional textbooks. Future research could conduct multi-case comparisons, extend the tracking period, and explore pathways for the digital upgrade of loose-leaf textbooks to further validate and extend our findings.

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