

Research on the Development of Loose-leaf Teaching Materials for Vocational Education Based on the Reforms of Teachers, Textbooks and Teaching Methods - Using the Course of Railway Vehicle Mechanical Device Maintenance as a Case Study

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Abstract: The development of loose-leaf teaching materials through "dual-subject (industry-academia)" collaboration between colleges and enterprises is an urgent issue to be addressed in the process of deepening the reform of "Teachers (faculty), Teaching methods, and Textbooks (teaching materials)" (often referred to as the "Three Education" reform). This article focuses on the background of the "Three Education" reform and takes the course of Railway Vehicle Mechanical Device Maintenance as an example to explore the development of Loose-leaf textbooks for vocational education. The design concepts, structural features, and style specifications of Loose-leaf textbooks are analyzed, and a detailed introduction to the development process and key points of textbooks are provided from the aspects of content organization, construction framework, supporting resource development, and practical application, aiming to provide a reference for the reform of vocational education textbooks.

Keywords: Vocational Education; Loose-Leaf Textbook; "Three Education" Reform; Maintenance of Railway Vehicle Mechanical Devices

1. Introduction

With the continuous deepening of the reform of vocational education, the reform of the "Three Teaching Elements" (teachers, teaching materials, and teaching methods) has become the key to improving the quality of vocational education. As an important carrier of teaching, the reform of textbook is of great significance for promoting the

modernization of vocational education and cultivating high-quality technical and skilled talents^[1]. Loose-leaf (modular and updatable) textbooks, with their flexible modular combinations, innovative content presentation methods, and convenient updating mechanisms, have attracted widespread attention^[2]. This article takes the course of Maintenance of Railway Vehicle Mechanical Devices as an example to explore the development of loose-leaf textbooks based on the reform of the "Three Teaching Elements".

2. The Requirements of the "Three Education" Reform on Teaching Materials

2.1 From the Perspective of Teachers

"The 20 Measures for Vocational Education" emphasizes the integration of industry and education through the "dual-subject (industry-academia)" approach in talent cultivation^[3]. The optimal collaboration model involves high-level professionals from industries, enterprises, and the education sector jointly participating in the development of quality teaching materials and conducting modularized teaching with clear division of labor. Enterprise experts provide real production projects, typical work tasks, and practical cases to promote the spirit of craftsmanship, while vocational college teachers are responsible for designing the content and organizing the units of the teaching materials, ensuring that the content is derived from and yet surpasses enterprise practices, meeting the needs of industrial digital transformation and aligning with the growth patterns of skilled talents^[4].

2.2 From the Perspective of Textbook

Teaching material content should keep pace with the development of the times, promptly incorporating new technologies, new processes, and new standards into teaching criteria and content to achieve dynamic updates^[4]. Meanwhile, teaching materials should highlight the vocational and practical nature of vocational education, focusing on cultivating students' practical abilities and professional qualities, in line with the law of cultivating vocational competence. Keeping teaching material content updated at all times while adhering to the law of cultivating vocational competence is also the purpose of developing loose-leaf (or modular, replaceable-page-style) teaching materials^[5]. However, when updating the content, it is necessary to maintain the systematization and logical coherence of the original teaching materials, without undermining the stability of the content and its organizational structure.

2.3 From the Perspective of Teaching Methods

Textbooks should adapt to the integration of modern information technology with teaching and support blended learning methods that combine online and offline instruction^[6]. By leveraging information-based resources such as virtual simulations, videos, audios, animations, VR (Virtual Reality) technology, etc., abstract knowledge can be transformed into concrete and visual forms. This enhances the immediacy and functionality of the textbooks, thereby meeting the development needs of "Internet Plus Vocational Education."^[7]

3. The Characteristics and Advantages of Loose-Leaf Textbooks

3.1 Characteristics

3.1.1.Flexible Formats

Externally, loose-leaf textbooks (or educational materials) offer diverse structural options, including bound or unbound formats, fully or partially detachable pages, and combinations of physical textbooks paired with digital resources. Learners enjoy the freedom to choose according to their preferences and

needs. Internally, the emphasis lies in adaptable content organization — with a transformative focus on restructuring logical frameworks, reference standards, knowledge points, and their interrelationships, along with innovative methods of sequencing and presentation^[8].

3.1.2.Modularized Content Design

The textbook content is structured into discrete modules, each representing a minimal competency unit (MCU) characterized

by irreducibility (non-decomposability), integrity, independence, and adaptability. These modules are systematically combined following a specific pedagogical logic to align with occupational competency requirements for targeted roles. When updated, individual modules can be revised or replaced without compromising the structural integrity of the overall textbook^[9]. At its core, the "loose-leaf" (modular) textbook design in vocational education mandates that each MCU maintains inherent autonomy and completeness—ensuring that revisions to any module do not disrupt the foundational structure of the textbook^[10]. Meanwhile, the modularization process adheres to a hierarchical arrangement principle rooted in work-process competencies and job-specific skill demands, progressing from basic to advanced, isolated to integrated, and simplistic to complex levels. This design aligns with the developmental trajectory of technical-skills talent and students' cognitive learning patterns, fostering a seamless transition from theory to practice.

3.1.3.Outstanding educational function in cultivating talents

It comprehensively promotes the integration of Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era into teaching materials, fulfills the fundamental task of fostering virtue and cultivating people, constructs a "dual-entity" (school-enterprise or similar collaborative) educational model, and integrates ideological and political education throughout the entire process.

3.1.4.Innovative Integration of Teaching

Methods

Leveraging the synergistic development of modern information technology and online open courses, we advance a hybrid teaching approach that combines both online and offline modalities, embodying the dynamic and adaptable ("lively" in spatial and pedagogical context) essence of teaching materials.

3.2 Advantages

3.2.1. Enhancing the Targeted Nature of Teaching

Teachers can flexibly combine and adjust teaching material modules according to the teaching schedule and students' actual conditions, thereby meeting the learning needs of students at different proficiency levels and from various disciplines.

3.2.2. Enhancing the Timeliness of Teaching Materials

They are capable of promptly reflecting the latest industry trends and technological advancements, ensuring that teaching content is closely aligned with practical engineering applications and preventing the content from becoming outdated.

3.2.3. Promoting Students' Active Learning

By incorporating highly interactive content into teaching materials, such as thought-provoking questions, discussion topics, and project assignments, students are guided to think independently, actively participate in classroom discussions, and engage in hands-on project practices. This approach enhances students' enthusiasm and initiative in learning.

3.2.4. Facilitating Teaching Evaluation

The modular structure of teaching materials enables timely assessment and feedback on students' learning processes and outcomes. This empowers teachers to adapt teaching strategies dynamically, thereby enhancing the overall quality of instruction.

4. Development of Loose-Leaf Teaching Materials for the Course of Railway Vehicle Mechanical Device Maintenance

The development of the loose-leaf teaching materials for the course of Railway Vehicle Mechanical Device Maintenance is oriented toward the vocational competencies required for positions such as railway locomotive driving and maintenance, railway carriage/wagon inspection and operation, and EMU (Electric Multiple Unit) ground-based maintenance and onboard technical support. It systematically extracts representative work tasks, including wheelset inspection, wheelset flaw detection, bearing inspection, axle-box assembly, and wheel-axle pressing, with the quantity of tasks tailored to each module's objectives. These representative work tasks serve as the pedagogical carriers, adopting a student-centered approach and leveraging school-enterprise "dual-entity" collaboration to co-develop modularized loose-leaf resources aligned with authentic work processes. By integrating cutting-edge information technologies, the project aims to create an innovative teaching resource that meets the evolving demands of the railway industry in the new era. The development workflow for these loose-leaf materials is illustrated in Figure 1.

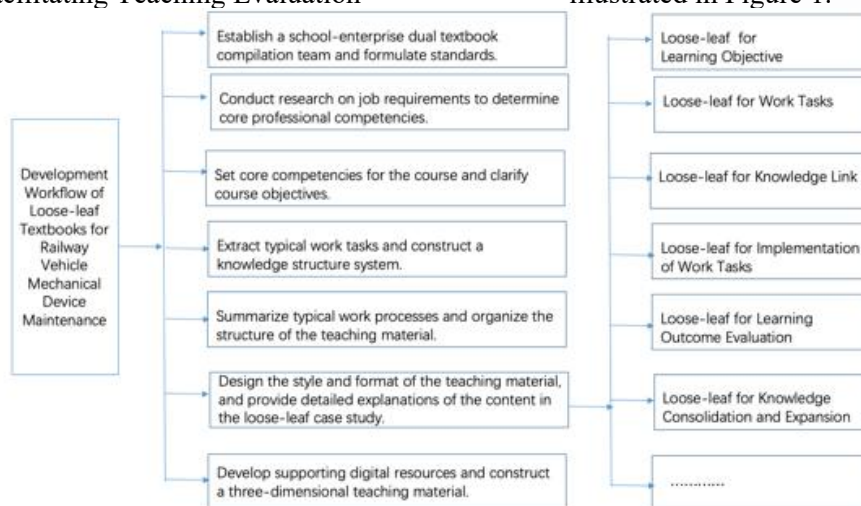


Figure 1. Development Workflow of the Loose-leaf Textbook

4.1 Establish a Team for Teaching Material Development/Compilation

Establish a teaching material development team which comprises subject-matter experts, frontline educators, and skilled industrial practitioners. The team collaboratively reviews the curriculum planning guidelines and standards formulated by educational administrative authorities, ensuring alignment across professional program design, curriculum structure, content delivery, pedagogical implementation, and textbook compilation/organization. Industrial team members, including technical virtuosos and master craftspeople, leverage their extensive field experience to primarily select representative work tasks during the textbook development process. They integrate the industry's "Three New" trends (new technologies, new processes, new norms) into the curriculum, embed occupational ethics, and define specific requirements to nurture students' healthy worldviews, values, and professional ethos. Meanwhile, vocational education institutions take charge of content design and pedagogical sequencing, bridging industrial work tasks with theoretical knowledge frameworks. This ensures the textbooks adhere to the didactic principles of vocational education and align with students' cognitive and psychosocial developmental trajectories.

4.2 Organize the Structure of Textbook and Develop Its Content

4.2.1. Set course objectives, define project-based tasks, and structure teaching content in alignment with the cultivation of vocational competencies.

Conduct field research on the practical demands of maintenance positions for mechanical systems in railway rolling stock. Align course objectives with the cultivation of vocational competencies, integrating professional talent development goals, students' cognitive levels, and learning aptitudes. Systematically consolidate modularized loose-leaf textbook content based on job competency requirements, design project-based tasks, and restructure pedagogical content. For instance, when addressing maintenance tasks for spring and

damping assemblies, develop curricular modules covering foundational knowledge of springs, steel coil springs, rubber springs, friction dampers, and other components. These modules shall provide detailed explanations of each component's functional roles, classification criteria, technical characteristics, failure modes, and maintenance protocols.

4.2.2. Summarize typical work processes and structure the textbook framework accordingly

During the research process, we summarized the typical work scenarios encountered by job role incumbents in their work processes. These scenarios were then arranged in a sequence from simple to complex and from easy to difficult, transforming them into learning-oriented work scenarios. This approach was used to construct the structural hierarchy of a loose-leaf textbook, with each learning scenario forming the macrostructure of the textbook. Based on the real work processes at enterprise positions, we have summarized typical work processes that are suitable for organizing teaching and learning between teachers and students, forming the mesostructure of the textbook. The specific cases within the typical work processes reflect various work task segments, which constitute the microstructure of the textbook.

4.2.3. Design the style and format of the loose-leaf textbook, and elaborate on the content of each modular section

A modular approach is adopted for compiling the textbook, with each module encompassing sections such as learning objectives, knowledge maps, task scenarios, task implementation, learning outcome evaluation, and knowledge consolidation and expansion.

The learning objectives module is a subdivision of the overall course learning objectives, primarily including knowledge objectives, ability objectives, and quality objectives. It is also a written representation of vocational abilities in terms of vocational knowledge, vocational skills, and vocational literacy, enabling learners to understand from the outset the vocational abilities they need to achieve when performing specific typical work tasks.

The knowledge map module helps students organize the knowledge structure. It is a

collection of theoretical knowledge required for job-related vocational abilities in the textbook, focusing on practicality and sufficiency. It also includes some ideological and political cases reflecting the fine traditional Chinese culture and the spirit of craftsmanship, which can be presented through information technology means, making them intuitive and easy to understand.

The task scenario module elaborates on the work background, conditions, and requirements of each work task, guiding students to think and enabling them to choose different work tasks according to the changing demands of the job position, thereby fulfilling the execution of vocational abilities.

The task implementation module mainly presents enterprise work cases in accordance with the actual work process. Teachers provide clear operational examples to guide students in simulated operations, and students record the operation process and results in the loose-leaf textbook. Multiple guiding questions are set during the work process to achieve "learning by doing and thinking while learning," ensuring that learning objectives and theoretical knowledge are implemented in vocational activities, and organically integrating vocational literacy. This is presented through informational resource loose-leaf pages to cultivate virtue and educate people.

The learning outcome evaluation module, on the one hand, allows students to self-assess their learning outcomes and record problems, insights, etc. in "loose-leaf" notes. On the other hand, it includes multiple evaluators in the form of tables with weighted evaluation items to grasp students' learning effects.

The knowledge consolidation and expansion module not only helps students sort out and summarize the knowledge points required to complete the task but also pays attention to new technologies, processes, and specifications in the field of railway vehicle mechanical device maintenance. These should be promptly incorporated into the textbook content. For example, with the continuous development of vehicle technology and the emergence of new types of springs and damping devices, the textbook

should promptly update relevant knowledge and maintenance methods.

4.2.4. Develop supporting digital resources and construct three-dimensional textbooks

Three-dimensional textbooks refer to a structured collection of supporting teaching publications that integrate with information technology, based on paper textbooks, and encompass multi-media, multi-form, multi-purpose, and multi-level teaching resources and services. The paper textbooks organize knowledge, skills, and literacy through typical work tasks that reflect the abilities required for enterprise positions, following a certain logical structure. Digital resources, based on the organizational logic and usage scenarios provided by the paper textbooks, create supplementary materials around specific themes. With the help of information technology, these resources enrich the paper textbooks through external links to images, videos, animations, and other forms, all of which also possess educational value. The development of digital resources makes it convenient and intuitive to "recreate scenarios," promotes blended learning, and meets the personalized learning needs of learners.

4.3 Practical Application and Feedback

Teaching Application: The developed loose-leaf textbook is applied to the teaching of the course "Railway Vehicle Mechanical Device Maintenance." Project-driven teaching, group cooperative learning, and online-offline blended teaching methods are adopted to actively engage students in the learning process.

Effectiveness Feedback: The application effectiveness of the textbook is evaluated through students' performance in academic achievements, practical operational skills, professional competence, as well as feedback from both teachers and students. Based on the evaluation results, the textbook is further revised and improved.

5. Conclusion

The development of loose-leaf textbooks in vocational education, aligned with the "Three Teaching Reforms" (reform of teachers, teaching materials, and teaching methods), represents a crucial direction for textbook innovation in vocational education.

Taking the course "Railway Vehicle Mechanical Device Maintenance" as an example, the loose-leaf textbook developed through measures such as forming a school-enterprise "dual-unit" authoring team, modularizing textbook content, innovating the textbook's structure and format, and developing supporting resources, has enhanced the textbook's relevance, timeliness, and practicality. This approach promotes active learning and personalized development among students. Future textbook development should focus on practical application, continuously optimizing content and teaching methods to provide robust support for vocational education in cultivating high-quality technical and skilled talents.

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