

Construction of New Form Teaching Materials for Mechanical Design Series Courses under the Background of Engineering Education

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How to cite this paper: Ao, H. R., Yan, H., Ding, G., Yang, Q. X., Song, B. Y., & Huang, F. R. (2024). Construction of New Form Teaching Materials for Mechanical Design Series Courses under the Background of Engineering Education. *Open Journal of Social Sciences*, 12, 828-836.

<https://doi.org/10.4236/jss.2024.1211055>

Received: August 5, 2024

Accepted: November 26, 2024

Published: November 29, 2024

Abstract

The construction ideas and measures of new form textbooks of mechanical design courses under the background of engineering education were discussed, and the influence of online and offline hybrid teaching mode and other influencing factors on teaching was explored. On the basis of the original paper textbooks, the new form of teaching materials is digitally matched, and the excellent teaching material content is equipped with modern education technology and means to assist the hybrid mechanical design teaching, which provides a powerful means to improve the quality of teaching and expand students' learning resources.

Keywords

Engineering Education, Mechanical Design Courses, New Form Textbook

1. Introduction

Educational technology is increasingly being used both inside and outside the classroom, and changes in the way knowledge is produced and replicated are influencing the way we perceive. The development of modern information technology has greatly promoted the change of teaching materials, so that teaching materials have changed from a single paper presentation form to a static digital form, and then to a dynamic and interactive digital form.

Some scholars believe that “the cultural shift from books to videos, from text to windows, drives the migration of cognitive activities” (Ren & Wang, 2003). As an important carrier of curriculum teaching, the change of the form of teaching materials will surely promote the reform of curriculum teaching. In the use of paper

textbooks, the revision process needs a long cycle, and the main way should be to revise the textbooks in a timely manner, introduce the content of the textbooks in digital form, and timely introduce the latest research results, theories and innovative contents into the course teaching. Therefore, it is very necessary to study the characteristics, development trend and construction path of new form textbooks in colleges and universities, and it is also one of the important influencing factors to achieve the quality of engineering education and build first-class courses.

American scholars Jia Frydenberg and Gary W. Matkin believe that the new form textbook is an open and dynamic continuum (Frydenberg & Matkin, 2007): on the one hand, this continuum is a textbook of physical form, which is simply digitized and put on the Internet, which can be seen by anyone; on the other hand, there is a super open course that integrates teaching videos, textbooks, learning resources, and assessment links. From static digital textbooks to ultra-open courses, the dynamic and interactive characteristics of teaching materials are gradually obvious, and the more obvious this characteristic is, the higher the requirements for the required infrastructure and the more obstacles are encountered. When the dynamics and interaction are advanced and the obstacles encountered are balanced, the form of the textbook remains temporarily stable. For a long time to come, the new form of teaching materials will be in a dynamic development process in the contest between these two forces.

Some scholars have tried to put forward the concept of new forms of teaching materials and the basic elements they contain. For example, some Swedish scholars believe that the current new form of teaching materials can be called “collaborative digital textbooks”, which is a collaborative, dynamic digital work environment, in which teachers and students can participate in discussions and feedback, test knowledge and monitor results. In addition to knowledge content, teaching materials contain elements such as presentation aids, tools for working with text, communication tools, and teacher tools (Grönlund, Wiklund, & Rickard, 2018). Some scholars believe that “the conceptual model of digital textbooks includes four elements: knowledge content, multimedia and interactivity, textbook presentation format, and open source software” (Pešut, 2018).

In China, with the emergence and vigorous development of new forms of teaching materials in China, some scholars have tried to explore new forms of teaching materials, for example, some scholars have proposed the concept of integrated teaching materials, that is, taking paper teaching materials as the core, relying on online platforms to build course resources, and connecting online courses and classroom teaching through the cloud to build an integrated textbook or three-dimensional teaching material concept of “paper textbooks, online courses, and blended learning” (Zhao, 2018).

Studies have shown that the new form of teaching materials provides students with rich learning resources, brings unprecedented convenience to students’ learning, enables students to obtain a new learning experience, and improves learning efficiency. For example, a scholar in the United States investigated

teachers and students on the use of new form textbooks in the teaching of a college course, and believed that “the richness of the content of the new form of textbooks allows it to replace traditional textbooks, and the use of new form textbooks is conducive to improving students’ academic performance” (Hilton, 2019).

In view of the common problems existing in the traditional engineering textbooks of colleges and universities, as a carrier for implementing curriculum standards and embodying the spirit of teaching reform, how to make up for the shortcomings of engineering application knowledge and practical ability training requires in-depth exploration and practice by textbook compilers in the construction of teaching materials. In the face of the requirements of engineering education reform, how to closely combine mechanical design course teaching with engineering education, combine the teaching advantages of schools with the technical advantages of Internet enterprises, and realize the docking and complementarity of online and offline resources, is a difficult task.

2. The Necessity of Building New Form Teaching Materials for Mechanical Design Series

The development of new forms of teaching materials in colleges and universities will be closely linked to online open courses, and they will coexist and promote each other. Since 2019, the first-class curriculum construction plan implemented by the Ministry of Education has focused on creating a number of high-order, innovative and challenging offline, online, online-offline hybrid, virtual simulation and social practice high-quality courses. Although the types of curriculum construction are different, the requirements for content are the same, all require course content to keep pace with the times, dynamically update the knowledge system according to the frontier dynamics of disciplines and social development needs, meet the curriculum goals, the selection of teaching materials meets the regulations of the Ministry of Education and school textbook selection, teaching resources are rich and diverse, and the content of teaching materials should reflect ideology, science and times. Even for the construction of offline first-class courses, on the basis of paper teaching materials and teachers’ teaching, it is necessary to appropriately expand online teaching resources to help students keep abreast of the latest subject knowledge and expand their knowledge. All these put forward requirements for the construction of new forms of teaching materials.

The development of online open courses has reconstructed the relationship and ecological chain between the series of mechanical design courses and new form teaching materials. At this stage, courses such as mechanical design and curriculum design have taken the open curriculum as the starting point and developed new forms of teaching materials, and the open course has become the source and starting point for the selection of teaching materials. With the continuous advancement of online open courses, the form of teaching materials must keep pace with the pace of course form change, and the formulation of curriculum standards, the preparation and presentation of teaching materials and the construction of

courses are integrated, so as to provide high-quality content guarantee for the reform of curriculum teaching.

3. Measures for the Construction of New Forms of Teaching Materials

3.1. Course Objectives

In formulating the course objectives of mechanical design, mechanical design course design, mechanical design foundation and other courses, it is required to put forward specific construction goals from the perspective of improving students' knowledge, ability and quality. At the same time, the course objectives should form a supporting relationship with the specific requirements of the students' graduation requirements indicator points, as shown in **Table 1**.

Table 1. The correspondence between course objectives and graduation requirement indicator points.

Course knowledge unit	Table Column Head		
	Indicators Corresponding to the Course	Graduation Index Points Required by Indicators	Corresponding Course Objectives
Based on the actual research and testing of engineering projects, the student learner can independently analyze the demand characteristics of mechanical systems and parts, write the design scheme and typical parts design report required for specific projects through typical parts design. The students' ability to solve engineering problems can be assessed through group discussions, peer evaluation and teacher comments.	Engineering knowledge	Engineering thinking; Engineering application capabilities	Case studies and research; Panel discussion; Comprehensive exams
	Design/develop solutions	Engineering ethics; Engineering systems concept	Assignment; Case study
	Research	Engineering and technical methods; Craftsmanship spirit	Online Discussion

3.2. Textbook Structure System Planning

Engineering textbooks should focus on the new connotation of engineering ability, take engineering ability training as the core, and introduce students into the engineering field to guide them to establish engineering concepts, understand engineering and form preliminary engineering ability, which is not only the basic requirement for the engineering education ability of professional teachers, but also the basic task that the construction of professional teaching materials should undertake. It is generally believed that engineering ability can be divided into three levels, from low to high: engineering cognitive ability, engineering application ability and engineering research ability. The undergraduate stage is mainly to cultivate

engineering cognitive ability and engineering application ability, and the post-graduate stage mainly cultivates engineering research ability. In the construction of the basic series of textbooks of mechanical design, it is necessary to expand students' systematic understanding of engineering knowledge through the construction of professional knowledge system; It is also necessary to use the case resources of engineering projects to technical problems, analyze problems and propose solutions to solve problems; It is also necessary to cultivate students' preliminary engineering quality through various testing links in teaching design, and fully reflect the engineering application, cultivate students' ability to understand engineering and that is, the practicality of engineering professional textbooks. **Figure 1** shows the design of the framework of textbooks. The construction of the textbook can be found in **Figure 2**.

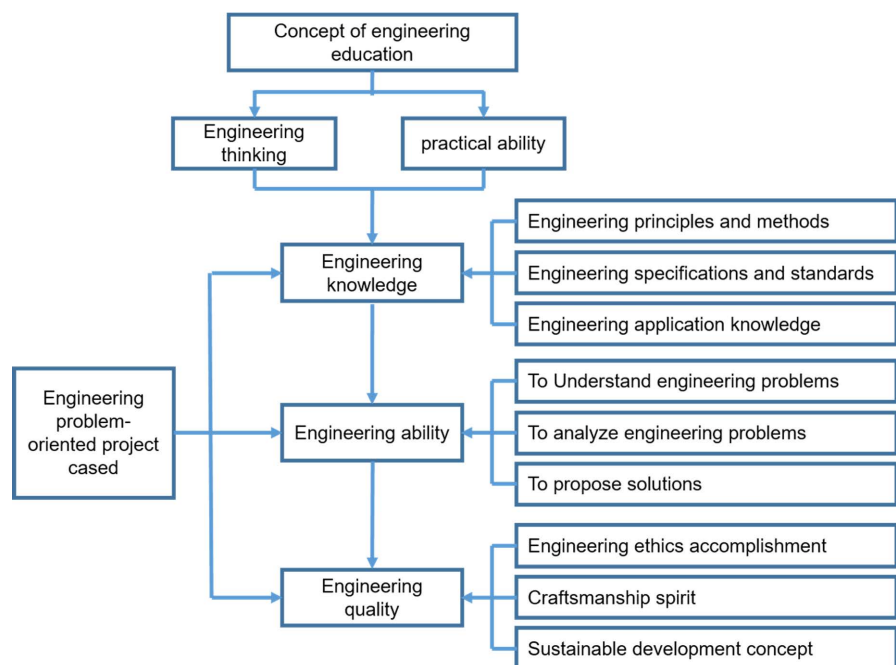


Figure 1. The approach to the textbook construction.

Compared with the traditional mechanical design series of textbooks, the new form textbooks focus on a center, that is, the design and effective use of general parts and components in general mechanical equipment, from the inside to the outside, from the user's demand for mechanical systems, to control and other auxiliary systems, and then to the intelligent and information-based integrated platform of the entire system, and finally through the operation management system to achieve safe, economical, energy-saving and efficient operation of equipment. By reconstructing the knowledge system of the textbook, the intrinsic connection of the chapters of the textbook is closer and the professionalism and systematization, completeness and effectiveness of the knowledge points of the textbook are better integrated. **Figure 3** shows the resources for the new form textbooks for mechanical design courses.

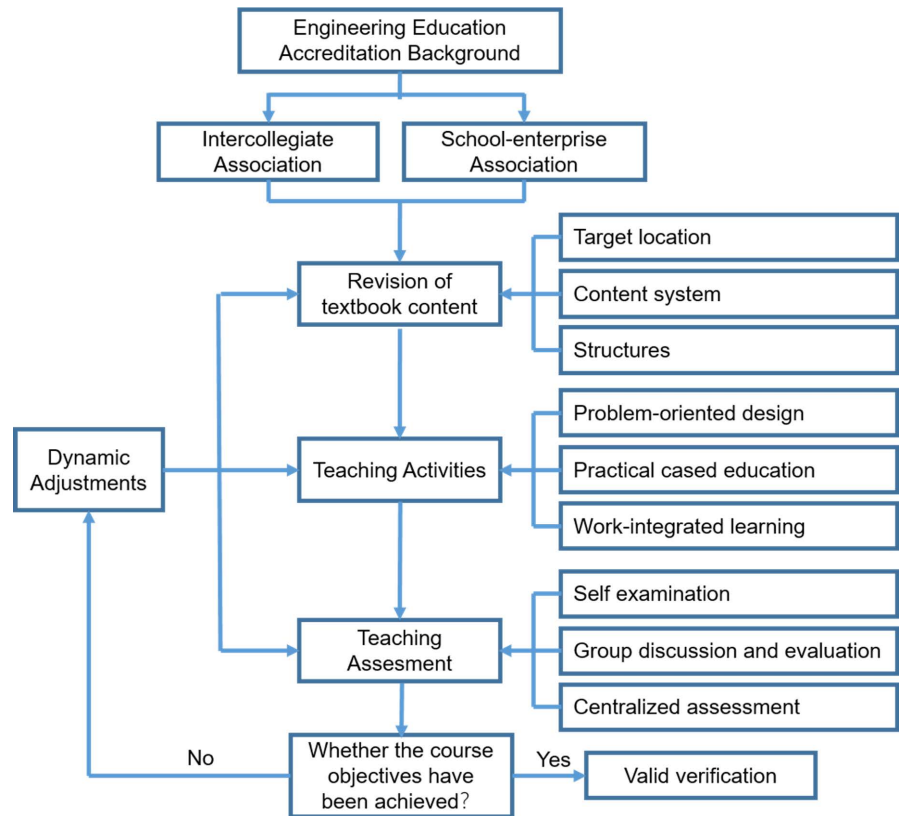


Figure 2. Engineering practical framework design.

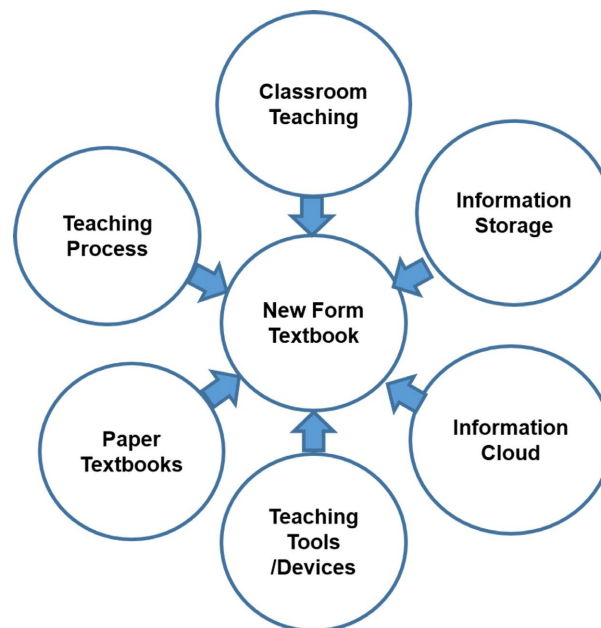


Figure 3. Resources for the new form textbooks.

3.3. Selection of Engineering Cases

The selected cases correspond to multiple knowledge points. From the perspective of problem orientation, each case includes the following elements: 1) project

overview, so that students can understand the overall picture of the project to which the project belongs, including the project site and engineering problem description, that is, the actual occurrence of various phenomena and problem descriptions in the operation of the mechanical system; 2) Diagnose and determine problems, including qualitative and quantitative analysis of problems; 3) Propose solutions and methods, and be able to propose solutions to problems and organize discussions; 4) Predict and evaluate the implementation effect of the operation plan, and pay attention to whether the problem is solved and whether the effect can be achieved; 5) Conduct case summary and analysis, put forward common problems, and refine relevant professional principles or theories. Since case materials are online resources, they are convenient for open sharing. Real-time updates, so it is possible to upgrade teaching materials from static to dynamic, from 2D to multidimensional.

3.4. Analysis of Major Factors

- Carefully prepare the paper part of the textbook. As the basic skeleton of information bearing in the new form of teaching materials, the paper part of the textbook should focus on expounding the basic theory, basic knowledge and basic laws, and its content is relatively concise but complete and systematic to ensure that the focus and main line are clear. In the content corresponding to the paper textbook, the type and content of the digital resource are marked with eye-catching icons and serial numbers, and it is best to be accompanied by a QR code of the corresponding URL, which is conducive to readers using mobile terminals (such as mobile phones or tablets) to quickly reach online knowledge points, and guide users to digital courses for corresponding deep and extended learning.
- Fully integrate the existing digital teaching resources of online open courses such as high-quality resource sharing courses and MOOCs. In October 2011, the Ministry of Education launched the construction of national excellent open courses, including high-quality video open courses and high-quality resource sharing courses. The MOOC mobile terminal of Chinese universities has been downloaded and installed 89,621,400 times, and the number of open courses taught on the platform is 60,200. These rich digital teaching resources have gradually formed a system. These online courses can also build new forms of teaching materials, which is conducive to the combination of online and offline resources, so that teaching materials can adapt to the new trend of hybrid teaching that combines online and offline.
- Pay attention to readers' opinions on the construction of digital teaching resources. Digital courses can be equipped with videos, animations, pictures, and even various programs, greatly expanding the types of materials available in the development of teaching materials. Teachers and students are the primary users of digital teaching resources, and they are also the real demanders of digital teaching resources. Therefore, timely collect their feedback on the

construction of digital teaching resources, and optimize the form and construction method of digital resources.

- Develop an APP that supports a variety of smart terminals. There are more advantages for readers to browse digital content through APP, for example, it is conducive to intellectual property protection, convenient for readers to take notes on digital content, reduce irrelevant operations in the learning process and improve learning concentration. However, in the APP development process, multiple versions should be developed according to the application platform (such as iOS, Android, PC), and the differences of each handheld intelligent terminal under the same application platform, such as computing rate, screen resolution, etc., should be considered to ensure maximum compatibility.
- Optimize digital resource content. In the process of developing and constructing the digital resource content of new forms of teaching materials, it is necessary to break the original thinking pattern and optimize and update or supplement it according to the new teaching needs. Digital resources are not simple carrier moving after scanning and processing paper textbooks, but need to jump out of the traditional textbook writing mode and strengthen interactive content. For example, in the process of digital resource construction, many abstract and complex mechanical parts interaction processes can be vividly presented in the form of animations, charts, scenario simulations, virtual simulations, etc. through a simple, concise and clear style, helping readers better understand the phenomenon of institutional motion and its laws from multiple levels and perspectives, thereby reducing the difficulty of course learning and stimulating students' enthusiasm for learning. In addition to paying attention to the quality of individual components, digital resource construction should also handle the connection between components and components, and attach importance to the assembly of components. For example, build a knowledge graph, set up fast search, and quickly jump between related knowledge points.

4. Summary

In the context of the deep integration of information technology and education and teaching, it is necessary to fully understand the basic status and role of teaching materials in curriculum construction, and take the construction of new forms of teaching materials as a breakthrough point to promote teaching reform and the construction of first-class undergraduate courses. In order to effectively play the advantages and positive role of new form teaching materials, teachers and students need to change the mindset when using single paper teaching materials, improve information literacy and ability, and actively explore the thinking mode under new form teaching materials. It is necessary to improve the standards and mechanisms for editing, using and evaluating new forms of teaching materials; It is necessary to attach importance to the empirical research of new form teaching materials, handle the relationship between knowledge dynamics and stability, extract theory from practice and serve the construction of new form teaching

materials, so as to continuously launch high-level course teaching materials, open up a new situation in the construction of course teaching materials, and lay a solid foundation for the construction of first-class undergraduate courses in colleges and universities.

Acknowledgements

This work is supported by Heilongjiang educational reform program (Project number: SJGY20210255) and Ministry of Industry and Information Technology teacher teaching development research project (Project number: G7JFKTY202305).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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