Curriculum and Teaching Methodology (2024)
Clausius Scientific Press, Canada
DOI: 10.23977/curtm.2024.070113
ISSN 2616-2261 Vol. 7 Num. 1

# *The Application of Digital Technology in Online and Offline Blended Teaching of Mechanical Principles Course*

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***Keywords:*** Digital technology, Mechanical principles, Blended teaching, Mechanical engineering

***Abstract:*** With the rapid development of information technology, the application of digital technology in the field of education has become increasingly widespread. This study takes the "Mechanical Principles" course as a background and explores the application of digital technology in the online and offline blended teaching of this course. The study aims to explore effective methods for improving student learning outcomes and teaching quality by establishing online teaching resource repository, digital teaching materials and online virtual laboratory, as well as establishing assessment and feedback mechanisms. It is hoped to provide in-depth theoretical support and practical experience for the application of digital technology in the "Mechanical Principles" course, and also serve as a valuable reference for the broader implementation of digital technology in mechanical engineering courses.

## 1. Introduction

"Mechanical Principles" is a core foundational course for the major of Mechanical Design, Manufacturing, and Automation, typically offered in the second semester of the sophomore year. Serving as a pivotal linkage between theoretical and specialized coursework, mechanical principles distinguishes itself from courses such as physics and mechanics by its closer alignment with practical engineering applications. The course primarily addresses common issues within the mechanical domain and delves into the performance characteristics and design methodologies of commonly used mechanisms [1, 2]. However, despite its close relevance to tangible engineering problems, this course is characterized by a wealth of theoretical knowledge. Students often grapple with challenges in flexibly applying theoretical concepts to real-world engineering scenarios. Mechanism diagrams in traditional textbooks are typically simplified and static, making direct correlations with actual machinery difficult. Consequently, students encounter certain challenges in comprehending and mastering the practical applications of the course's key concepts [3, 4].

Traditional teaching methods in mechanical principles primarily employs the instructional approach of imparting theoretical knowledge, relying on static textbook illustrations. This instructional paradigm, to a certain extent, constrains students' comprehension of actual mechanical motion and principles. Students typically encounter simplified schematic diagrams only in textbooks, making it challenging for them to authentically perceive the dynamic characteristics of mechanical motion. Besides, traditional classrooms often prioritize the derivation of theoretical formulas and the elucidation of concepts, lacking practical application and hands-on exercises. This deficiency leads to students having a limited understanding of abstract concepts in mechanical principles. This instructional model exhibits a disconnection between knowledge and practical application, influencing students' in-depth learning and application capabilities in mechanical principles [5, 6].

With the rise of blended learning models integrating both online and offline components, the imperative for reforming traditional teaching methods has necessitated the integration of digital technology. The introduction of digital technology holds the promise of bringing about transformative possibilities for the teaching of mechanical principles [7, 8]. Through interactive and dynamic teaching methods, it is anticipated that digital technology will enhance students' understanding and application of mechanical principles. This paper aims to explore the application of digital technology in the teaching of mechanical principles, with the goal of improving both teaching effectiveness for educators and the overall learning experience for students.

## 2. Construction and Integration of Digital Resources

### 2.1. Online Resource Repository

The online resource repository serves as a diversified learning platform, playing a crucial role in the "Mechanical Principles" course, particularly in the context of the blended learning model that combines both online and offline components. As illustrated in Figure 1, the content of the online resource repository is rich and diverse, encompassing elements such as video lectures, case analyses, electronic textbooks, academic papers, online quizzes and assignments, and discussion forums. Through this platform, students not only delve into theoretical knowledge in the classroom but also engage in pre-class preparation and post-class consolidation using the online resource repository. Moreover, students have the flexibility to access learning materials anytime, anywhere, overcoming constraints imposed by traditional classrooms and fixed study hours.

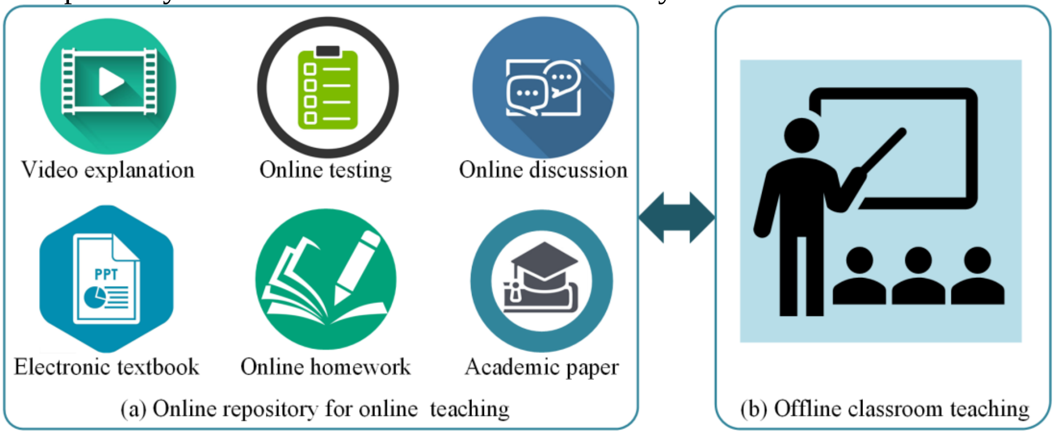



Figure 1: Online and offline blended teaching of "Mechanical Principles" course.

Simultaneously, instructors can focus more on practical exercises and addressing student queries during offline classes, fully leveraging the advantages of face-to-face teaching. This blended learning model empowers students to enhance their understanding of mechanical principles comprehensively within a more interactive and practical learning environment. In the current challenging landscape for traditional teaching methods, the online resource repository provides students with more autonomous and diverse learning resources, fostering innovation and deepening the teaching of mechanical principles.

### 2.2. Digital Teaching Materials

The innovation of digital teaching materials injects new vitality into the instruction of mechanical principles. Utilizing digital means, animations and QR codes are incorporated into traditional textbooks. By scanning the QR codes with a mobile device, abstract diagrams of mechanical movements are presented in the form of animations and simulated simulations. This approach transforms the abstract theories of mechanical principles into vivid imagery, enabling students to understand the motion and operational principles of common mechanisms in a more in-depth and intuitive manner.

Traditional static paper-based materials struggle to depict the dynamic characteristics of mechanisms, whereas digital teaching materials address this limitation through visual and interactive means. Students find it easier to comprehend and retain complex knowledge of mechanical principles through watching animations and simulations. This interactive learning approach helps students transcend the constraints of traditional teaching, stimulates their interest in learning, enhances their in-depth understanding of complex theories, and establishes a bridge between theory and practical application.

Figure 2 presents some examples of schematic diagrams of mechanisms along with the application of demonstration animation QR codes. By scanning the QR codes with a mobile phone, animated demonstrations can be accessed, rendering the schematic diagrams of mechanical principles more vivid and practically applicable. This aids students in gaining a better understanding of the motion and operational principles of common mechanisms.

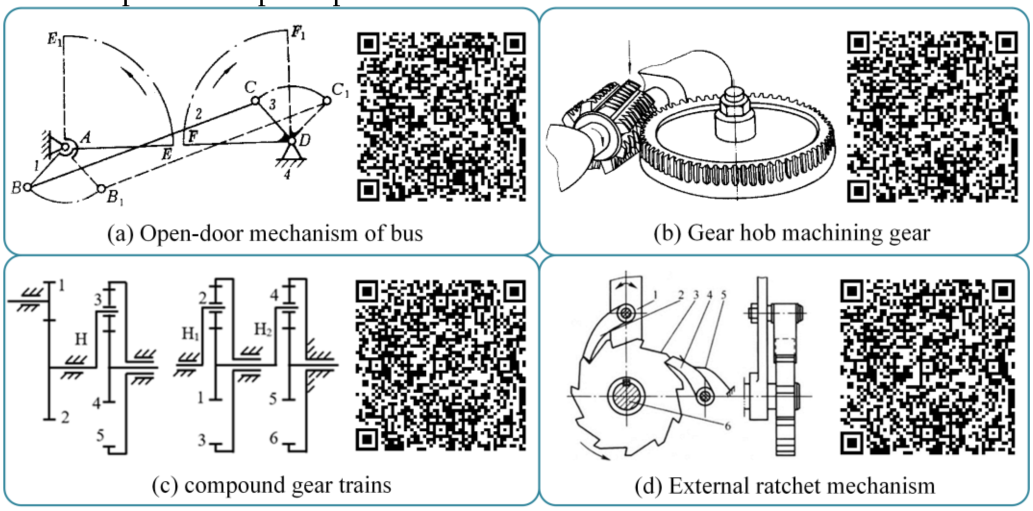



Figure 2: Application of schematic diagrams and demonstration animation QR codes.

### 2.3. Online Virtual Laboratory

The introduction of an online virtual laboratory aims to create a more practice-oriented learning environment for students. Utilizing virtual reality technology, an online virtual laboratory platform is established. Figure 3 shows the online virtual laboratory of Bell DataInfromation Platform and two case demonstrations of virtual experimental machines. Within this platform, students can analyse, test, and assemble typical experimental cases in simulated engineering scenarios. This innovation not only enhances the convenience of experiments and reduces the waste of laboratory resources but also allows students to conduct experiments more freely without constraints of time and location. This practical learning approach facilitates the integration of theoretical knowledge with real-world applications, deepening the understanding of mechanical principles.

Engaging in actual operations through the online virtual laboratory enables students to better develop practical skills, preparing them to effectively tackle future challenges in the field of mechanics. Therefore, the introduction of an online virtual laboratory not only provides students with a more engaging and flexible learning method but also creates additional opportunities for practical learning of mechanical principles. This initiative encourages students to immerse themselves more deeply in their disciplinary studies, fosters their ability to apply knowledge in practical contexts, and establishes a solid foundation for their future career development in the field of mechanics.

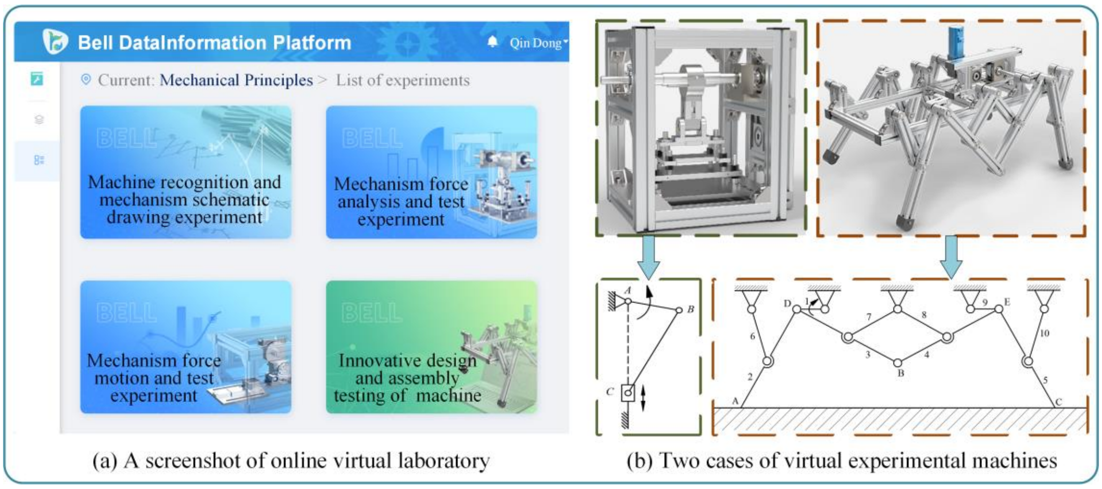



Figure 3: Online virtual laboratory and its case demonstrations.

## 3. Interactive Learning Advancements

### 3.1. Online Discussion Forum

The online discussion forum, as a crucial component of interactive learning, effectively addresses the limitations of traditional classroom constraints, injecting new vitality into the learning atmosphere of the "Mechanical Principles" course. Through online discussions, students can freely express questions, viewpoints, or profound understandings of mechanical principles. They engage in real-time interaction with teachers and classmates, assisting students in developing analytical skills, extracting key information, and forming systematic problem-solving approaches. In practice, instructors can set specific topics for discussion, guiding students to focus on cutting-edge issues or practical application cases in the field of mechanical principles. By sharing their insights, students are encouraged to generate more innovative thinking.

Simultaneously, teachers can promptly identify students' issues, provide targeted guidance, and strengthen interaction between teachers and students. Furthermore, the online discussion forum offers students a space for autonomous learning, allowing them to participate in discussions anytime, anywhere without being restricted by time and location. This more flexible and open mode of academic exchange effectively expands the dimensions of disciplinary discussions, providing students with greater possibilities for academic development.

## 3.2. Online Homework System

The introduction of the online assignment system aims to enhance students' efficiency in homework learning and assist them in promptly assessing their understanding of mechanical principles. Firstly, students submit assignments through the online platform, and upon grading by the instructor, the system provides immediate feedback, allowing students to promptly gauge their learning progress and adjust their study strategies accordingly. Secondly, instructors can obtain clear data analysis of students' learning status through the system, enabling more targeted adjustments to teaching content and enhancing the specificity and effectiveness of instruction.

Moreover, the online assignment system is no longer constrained by time and location, breaking free from reliance on paper or manual completion. Students can submit post-class assignments at any time, flexibly managing their study time and gradually cultivating habits of independent learning. Through the online assignment system, a closer interaction is established between students and teachers, providing a more convenient means for course instruction and management. Compared to traditional assignments, the application of the online assignment system not only improves teaching efficiency but also offers students a more convenient and efficient learning experience, making interactive learning more practically impactful.

# 4. Establishment of Assessment and Feedback Mechanism

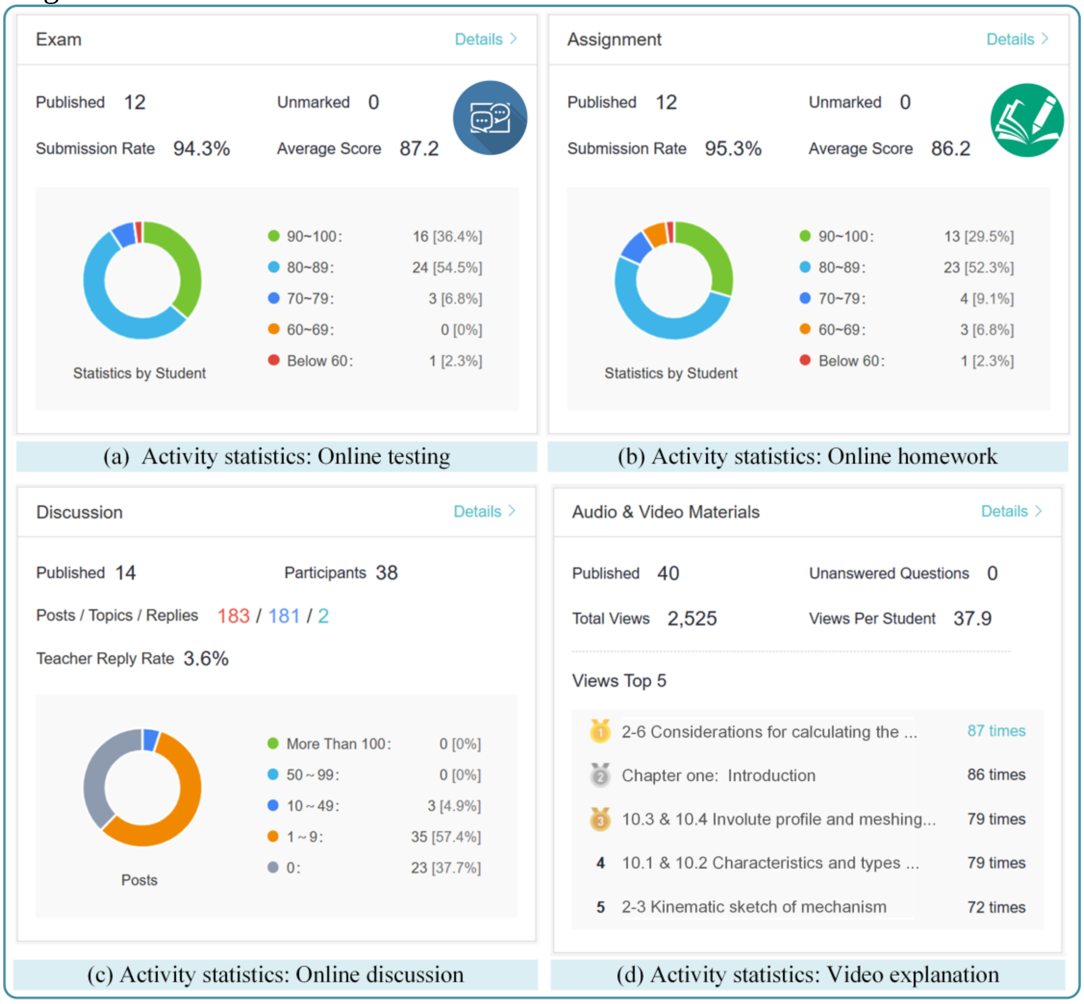
## 4.1. Online Testing

The introduction of online testing is a crucial measure to deepen the assessment of student learning. Through online testing, instructors can rapidly and efficiently gather information about students' learning progress, identifying potential issues in a timely manner. This immediate feedback mechanism assists instructors in gaining a more comprehensive understanding of each student's mastery of specific knowledge points. By analysing the test results, instructors can formulate personalized learning plans and provide targeted assistance to address weak areas in students' understanding of mechanical principles.

The design of online test questions can cover various aspects of the "Mechanical Principles" course, including fundamental theoretical knowledge and practical application skills. Flexible question formats, such as multiple-choice questions, fill-in-the-blank questions, and practical case analyses, allow for a comprehensive assessment of students' disciplinary literacy. Additionally, online tests can incorporate timed features to enhance the sense of urgency and encourage students to complete tasks more attentively. This online testing mechanism establishes a closer connection between educators and students, providing an effective means to enhance the teaching quality of the "Mechanical Principles" course. Through careful design and scientific application of online testing, it aids students in making significant progress in the field of mechanical principles.

## 4.2. Data Analysis

The introduction of data analysis aims to comprehensively understand students' learning processes and provide decision support for instructional improvement. By collecting students' learning data, such as attendance, online discussions, online resource utilization, tests, assignments, etc. (as shown in Figure 4), instructors can obtain key information about students' academic performance, depth of subject understanding, and learning habits on the online teaching platform. In the process of data analysis, various statistical methods and machine learning algorithms can be applied to delve into students' learning patterns and trends. By analysing students' performance on specific knowledge points, bottlenecks in course understanding can be identified, providing a basis for precise guidance.



(a) Activity statistics: Online testing
(b) Activity statistics: Online homework
(c) Activity statistics: Online discussion
(d) Activity statistics: Video explanation

Figure 4: Online activity statistics for the "Mechanical Principles" course.

Simultaneously, real-time monitoring of students' learning progress enables timely identification of problems and difficulties, allowing instructors to respond quickly, adjust teaching plans, and ensure that each student receives effective academic guidance. Data analysis not only contributes to the improvement of teaching quality but also provides a scientific basis for personalized teaching and precise guidance. By better utilizing and analysing students' learning data through technological means, instructors can more effectively achieve personalized educational goals in blended online and offline teaching, providing stronger support for students' academic improvement and comprehensive competence development.

## 5. Conclusions

The widespread application of digital technology has provided new ideas and tools for the teaching of "Mechanical Principles" course. Through blended online and offline teaching, tools such as digital resource repositories and virtual laboratories enrich students' learning experiences, enhancing the effectiveness of teaching. The introduction of digital textbooks, through visual and interactive means, addresses the shortcomings of traditional textbooks in illustrating dynamic characteristics of mechanisms, providing an effective way for students to gain a deeper understanding of mechanical principles. The development of online discussion forums and online assignment systems promotes interactive learning among students, fostering problem-solving skills and improving academic efficiency. Innovations in assessment and feedback mechanisms, especially the application of online testing and data analysis, provide instructors with a more accurate understanding of student learning conditions, making teaching more personalized and efficient.

Guided by digital technology, the reform of "Mechanical Principles" course not only aligns with current trends but also establishes a new model for improving the quality of academic education. This study offers valuable references and experiences to promote the integration of digital technology in mechanical engineering courses.

## Acknowledgements

The authors acknowledge the financial support provided by Shanghai University Young Teacher Training Subsidy Program (Grant No. 10-22-304-811).

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