Exploring Blended Learning in Civil Engineering Courses

——A Case Study of the "Fundamentals of Civil Engineering" Course

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Abstract. Based on the unique characteristics of civil engineering courses and the learning styles of contemporary college students, this study explores teaching models and methods for blended online-offline instruction in the Fundamentals of Engineering course. Adopting a student-centered, outcomes-based approach, it establishes a new, integrated teaching philosophy that combines knowledge acquisition, skill development, and personal growth. Utilizing online teaching platforms and taking the Fundamentals of Engineering course as an example, this study incorporates specific engineering case studies and integrates the concept of ideological and political education into the curriculum. By addressing teaching philosophy, instructional methods, and assessment approaches, it reshapes pedagogical concepts, reorganizes knowledge modules, optimizes instructional design, and reforms the assessment and evaluation system. This approach aims to achieve full student participation, comprehensive process management, and all-around improvement, thereby cultivating versatile talents capable of adapting to local, applied, and international contexts.

Keywords: Civil Engineering; Foundation Engineering; Specialized Courses; Online and Offline; Blended Learning

1 Introduction

Education is a social activity aimed at nurturing individuals, encompassing all-round development in moral, intellectual, and physical education. Teaching specifically refers to the interactive process in which teachers impart knowledge and students acquire it [1]. Teaching is merely one of the key means of achieving educational objectives, while the teacher's instruction and the student's learning are crucial components of the teaching process; the two mutually reinforce and influence one another. The ultimate goal of teaching is to transform knowledge into competence. By integrating ideological and political elements into the curriculum, we aim to achieve dual enhancement of competence and character, thereby enabling students to effectively solve specific problems in

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practical production and daily life [2-4]. Therefore, in conducting teaching activities, how to properly manage the relationship between teaching and learning is a matter worthy of reflection and research, particularly in the context of rapid technological development in the current new era.

In today's era of rapid technological advancement, blended learning-which combines online and offline approaches-can effectively address the challenge that traditional classroom instruction faces in cultivating talent for the future. driven by rapid technological advancements and the influx of massive amounts of information, students' learning habits and characteristics are quietly evolving. There is a shift from traditional, centralized classroom learning toward contemporary, fragmented, self-directed learning. The trend toward personalized learning is becoming increasingly prominent, and the diversification of learning formats is growing ever more pronounced. To this end, teachers must continuously update their teaching philosophies, methods, and assessment approaches, effectively utilize online resources, and incorporate smart technology. By designing lessons appropriately in advance based on the needs of each teaching unit, students can gain a preliminary grasp of key concepts through online micro-lessons and overcome difficult obstacles, thereby freeing up more time for in-person classroom instruction.

2 The Challenges of Traditional Teaching

Traditional teaching has largely relied on a teacher, in which teachers take the lead while students remain largely passive. However, in accordance with the design requirements and standards set by professional and engineering education accreditation bodies, foundational engineering courses, professional foundation courses, and specialized courses must account for at least 30% of total credits. The allocation of class hours must reflect the cultivation of students' ability to apply mathematics and natural sciences within their discipline, as well as their capacity for system design and implementation [5-8] Consequently, the credit allocations for many courses-including core major courses-are currently being adjusted, resulting in a significant reduction in class hours.

Engineering construction has led to increasing interdisciplinary overlap, integration, and convergence across various fields. Consequently, undergraduate programs have set higher standards for students' practical skills, collaborative abilities, and craftsmanship. Breaking away from traditional practical teaching methods and developing a scientific and effective curriculum is an essential requirement for adapting to the demands of the new era [9-12]. With the evolution of the times and advances in technology, the nature of education is undergoing subtle yet significant changes. Students' ability to embrace new concepts, technologies, and innovations is evolving in step with the times. How to adapt to current technological and societal developments-shifting from a teacher-centered approach to a student-centered one-and how to cultivate students' independent learning and engineering practice skills have become urgent issues requiring deep reflection by educators today [13-15].

3 Course Objectives

3.1 Course Objectives

The course objectives are designed to better support the program's educational goals, implement the talent development plan, fulfill the curriculum requirements, and provide society with a large number of professional, well-rounded professionals. The specific course objectives are as follows:

First, knowledge objectives: Understand the development of foundation engineering; master the types and scope of application of foundation engineering; become familiar with the basic theories, design principles, and design content of foundation design; and become familiar with and master code requirements.

Second, Competency Development Objectives: Following the acquisition of knowledge, students will develop the ability to evaluate the merits and demerits of foundation design schemes and to analyze foundation-related incidents and issues.

Third, Ideological and Political Education Objectives: Through the study of foundation design and the cultivation of related skills, combined with the analysis of classic domestic and international foundation engineering case studies [16], students will clearly recognize that every stage of engineering practice must strictly adhere to code requirements. thereby fostering an awareness of engineering safety, the course fundamentally helps students form a correct worldview, outlook on life, and values.

3.2 The Relationship Between Course Objectives and Graduation Requirements

Professional competencies are broken down into multiple sub-objectives,which support both professional competency requirements and graduation requirements effectively. Table 1 shows how the broken-down course objectives correspond to and support professional competencies and graduation requirements:

Table 1. Table Showing the Relationship Between Course Objectives and Graduation Requirements

Course Objectives	Key indicators for graduation requirements	Supporting Rationale	Evaluation Method
Objective 1: Master the basic types and structural requirements of common foundations; become familiar with the design elements and construction key points of common foundations; and be able to clearly assess and evaluate the merits and short-	1.3 Possess expertise in civil engineering and demonstrate strong comprehensive analytical skills when addressing complex problems.	By comparing the types, characteristics, and design principles of various shallow foundation systems, and through basic explanations and instructional videos, this section analyzes how their scope of application, characteristics, and calculation approaches differ. These con-	Final exams, notes, formative assessments, review reports

comings of general foundation designs.		cepts are all instrumental in developing the ability to conduct comprehensive analyses of complex engineering projects.	
Objective 2: Possess the ability to organize and manage the construction process of foundation engineering, and be able to evaluate and analyze the design and selection of basic foundation types.	2.1 Be able to apply basic analytical methods, such as principles of mathematics and structural mechanics, to solve complex engineering problems in the field of civil engineering.	By expanding on the fundamental principles of structural design and presenting case studies, this course explains the advantages and disadvantages of different design solutions and the differences in their calculation processes. It analyzes the safety and economic aspects of various design options and provides a reasonable evaluation and analysis of these solutions.	Final exams, notes, and formative assessments
Objective 3: Be able to conduct economic analyses of foundation engineering designs for common buildings and effectively organize and manage the construction process.	2.3 Be able to effectively communicate complex civil engineering issues using drawings, tables, and written text.	Drawing on the *Code for Design of Building Foundations* and the *Code for Design of Pile Foundations*, and building upon existing knowledge of mechanics, this course integrates relevant provisions from codes and regulations into the formulas and structural details of foundation design, ultimately presenting the results in text and graphics in accordance with professional drafting standards.	Final exams, notes, and formative assessments
Objective 4: Upon achieving the aforementioned objectives, students will possess comprehensive skills in the design, calculation, and evaluation of foundation types, and will be able to propose design or optimization solutions for complex foundation engineering projects and analyze the strengths and weaknesses of each solution.	3.4. Be able to use appropriate design language to present the results and evaluate their limitations.	It builds a knowledge base for the subsequent design of foundations for high-rise complex buildings. Supplemented with practical examples of pile foundation design, the course cultivates students' ability to effectively communicate through text and diagrams.	Final exams, notes, and formative assessments

4 Design of Blended Learning: Online and Offline Combination

4.1 Blended Learning: Online and Offline Combination

The teaching process is a spatial system comprising three phases: pre-class, in-class, and post-class, each of which is an indispensable part of the process. Therefore, teachers must carefully design each phase based on the teaching content and the students, and make real-time adjustments according to the actual circumstances during the teaching process. The availability of course resources is an indispensable prerequisite for the development and implementation of blended learning. A large volume of on-site video footage helps students understand construction techniques that are difficult to grasp and relatively abstract in the slides. For video materials that are limited by time, location, or construction techniques, Flash animations can be created to help students digest and understand the content.

4.2 Design Approach for Blended Learning

(1) Modular Breakdown

Course content is consolidated or streamlined by removing duplicates and overlapping material from other courses. The core content is divided into three sections: foundational theory, comprehensive application, and innovative extension. Foundational theory is delivered through online self-study, while comprehensive application is conducted in-person. Classroom time is utilized for project-driven learning, and innovative extension is delivered through a combination of online open-source projects and in-person Q&A sessions.

(2) Synchronized Online and Offline Learning

Instructors fully adapt to changes in student learning styles by utilizing the Super Star Learning Pass platform. This platform integrates pre-class push notifications, real-time quizzes, multi-screen interaction, Q&A live chat, and student learning data analysis via mobile devices. It seamlessly integrates with PowerPoint-a tool widely used by instructors-reducing the teaching workload. Instructors can insert lecture notes, videos, exercises, and even voice recordings at any time, allowing students to watch and listen simultaneously. Based on the learning characteristics of contemporary college students, the course fully leverages the advantages of the internet to attract and stimulate student interest in the course, gradually shifting their learning from passive to self-driven, thereby enhancing the effectiveness of independent learning. It integrates pre-class (where teachers use Xue xi Tong to push chapter content and requirements to guide students in previewing; students independently set their own pace for mastery, use Xue xi Tong to self-assess progress, and resolve doubts through online discussions, while simultaneously building a knowledge base for in-class discussions and interactions), in-class (where students enter the classroom with questions and use Xue xi Tong to provide feedback to teachers; teachers use Xue xi Tong to identify students' difficulties and focus their explanations, utilizing features such as online student selection for questions, online quick-response scoring, online polls and quizzes, and other features to practice applying knowledge through inquiry-based learning. Teachers and students

continuously interact via Learning Pass for guidance and feedback, achieving efficient teaching) and post-class (teachers use Learning Pass to continuously publish resources, learning tasks, and Q&A guidance; students can access these resources and feedback anytime, anywhere via Learning Pass to deepen their application of knowledge and pursue personalized expansion; Additionally, teachers can monitor and supervise students' learning progress in real time via the backend. By organically integrating these elements and unifying teaching and learning, we achieve a truly student-centered educational goal. This enables students to master foundational theoretical knowledge while, through active participation and hands-on experience, effectively enhancing their practical application skills and comprehensive analytical abilities. The blended online-offline course structure is illustrated in Figure 1:

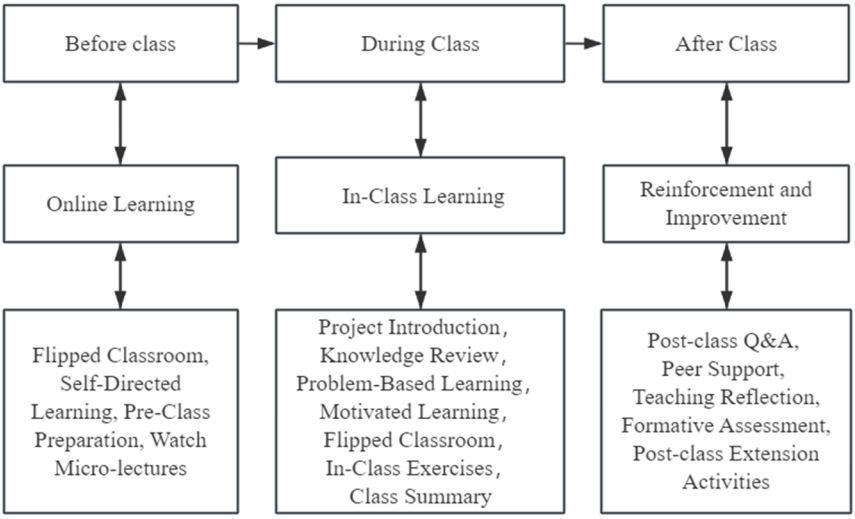

Fig. 1. Schematic Diagram of Blended Learning

(3) Instructional Management and Assessment

The management of blended courses involves, on the one hand, effectively monitoring and promptly following up on students' online learning, and on the other hand, effectively overseeing in-person learning-particularly student engagement and active participation in classroom instruction. For online learning, course materials and requirements are released in advance for each session. Students are given a set deadline to complete the online content, and instructors provide one-on-one follow-up and guidance based on backend statistics.

Assessment for blended courses, particularly for online learning, can be structured into several components: participation (discussions and online quizzes, etc.), learning progress (number of sessions and duration), and online assessments. Instructors can grade students' learning based on backend statistics and analysis. Offline assessment consists of class notes, process-based assessment, and exams, with class notes accounting for 10%, process-based assessment for 40%, and exams for 50%. Students' final

grades are determined by a combination of online and offline assessment scores, with online assessments accounting for 20%-30% and offline assessments for 70%-80%. Additionally, students who fail either the online or offline assessments will automatically receive a failing grade for the course. This policy is designed to encourage students' initiative and enthusiasm in both online and offline learning, transforming their approach from passive to active and fostering good independent study habits.

5 Conclusion

Blended learning courses have subtly transitioned students from traditional classrooms into modern halls of learning, where they can effortlessly absorb knowledge while fully exercising their abilities. This approach maximizes students' curiosity, initiative, and autonomy. Before class, the pedagogical philosophy shifts from being confined to the classroom, moving away from a "teach-first, learn-later" model toward a "learn-first, teach-later" approach where instruction is tailored to student learning. Students engage in online learning before class based on their individual needs and abilities. Teachers use feedback from pre-class preparation data to provide personalized guidance and design targeted, customized classroom instruction. This approach not only realizes student-centered teaching, motivating students' enthusiasm and autonomy, but also transforms students from passive learners into active, self-motivated learners-shifting their focus from merely acquiring knowledge to applying it to solve problems. During class, teachers can leverage information technology to fully engage students and monitor each student's understanding in real time. Teachers and students collaborate to explore solutions and complete learning tasks, maximizing the use of class time. After class, students use the learning platform to communicate effectively with teachers based on their pre-class and in-class progress, seeking timely answers and clarifications. This bridges the gap between teachers and students and fosters a closer relationship. Finally, based on learning data analysis, teachers can obtain a real-time, objective, and comprehensive reflection of the current teaching situation. By leveraging this data to promptly adjust teaching strategies, they create an efficient, modern classroom characterized by full student participation and comprehensive process management. This fully integrates technology into contemporary education, drives continuous educational innovation, and enhances teaching standards and quality, thereby truly achieving the goal of cultivating versatile talents who are adaptable to local needs, application-oriented, and internationally minded.

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