Practical Reform of the Civil Engineering Surveying Course under the Integrated Perspective of 'Zhuo Si Chuang'

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Abstract: *As the demand for high-quality technical talents in the field of civil engineering continues to rise, the traditional teaching model of civil engineering surveying courses can no longer meet the requirements of modern engineering education. To adapt to the new trends in educational development, this course centers around the fundamental task of fostering virtues and cultivating students' abilities. It addresses issues such as the insufficient integration of ideological and political education in the curriculum, students' practical abilities not meeting market demands, outdated and fragmented course content systems, and the lack of diverse assessment methods. Based on the course's strong practical nature, the course continuously reforms in aspects such as content reconstruction, innovative teaching methods, creation of teaching environments, and evaluation, through a practice-based education approach. This has led to the development of a collaborative education model that integrates "value guidance - knowledge transmission - practice-driven" professional education, ideological and political education, and innovation and entrepreneurship education. The model forms a new innovative practice approach of "One Core, Two Wings, Four Platforms," with the core being moral education, and the goal of cultivating ability literacy and entrepreneurial awareness. Four platforms have been carefully built: the integration of theory and practice platform, the ideological and political education platform, the digital intelligence resource platform, and the second classroom platform. These efforts have yielded significant educational innovations, achieving the dual goals of improving students' abilities and enhancing their innovation and entrepreneurship awareness.*

Keywords: *Civil engineering surveying, ideological and political education, innovation and entrepreneurship education, "Zhuo Si Chuang" integrated model*

Introduction

The ability to cultivate a large number of versatile talents with a spirit of craftsmanship, a sense of mission, and an awareness of innovation and entrepreneurship is crucial for the transformation and upgrading of China’s manufacturing industry in the "new normal." It is also essential for local universities to survive and develop, as well as to enhance students' overall quality and employability. President Xi Jinping, in his speech at the 19th National Congress of the Communist Party, proposed the construction of a workforce of knowledge-based, skilled, and innovative laborers, advocating for the spirit of model workers and craftsmanship, and promoting a societal atmosphere that honors labor and strives for excellence. Meanwhile, the employment of graduates from civil engineering programs at local colleges primarily targets production sectors. Industry demands have consistently focused on students' loyalty to enterprises, work ethic, and strong practical engineering abilities. Especially in recent years, with the cyclical downturn of the civil engineering and construction industries, civil engineering graduates face significant employment pressure. This demands that school education pay more attention to cultivating students’ comprehensive abilities. Under the new circumstances of accelerating the formation of new types of productive forces, the demand for cultivating innovative, interdisciplinary talents has made the introduction of the "Zhuo Si Chuang Integrated" educational philosophy in ideological and political curriculum reform an inevitable outcome. This approach integrates knowledge transmission, value guidance, and innovation and entrepreneurship awareness development, aiming to strengthen students' moral character and innovative entrepreneurial capabilities.

1. Current Status and Issues of "Civil Engineering Surveying"

"Civil Engineering Surveying" is an essential foundational course in the civil engineering program, integrating theory and practice with strong professional and practical features. Engineering surveying has always been a crucial skill in civil engineering construction. However, in teaching practice, the course faces the following issues:

Firstly, there is insufficient integration of ideological and political education and innovation and entrepreneurship education. The course does not emphasize value shaping and the cultivation of innovation awareness enough, and as a result, it fails to foster high-quality, application-oriented talents with both innovation and entrepreneurship spirit and moral and professional integrity.

Secondly, there is an overemphasis on theory and insufficient focus on practice, which makes it difficult for students to meet market demands with their practical skills, causing graduates to struggle in adapting to work quickly[1].

Thirdly, the separation of theory and practice in terms of time and space leads to an inability to practice immediately after learning, or to integrate learning with practice. The teaching content is disconnected from the rapidly evolving surveying technology and fails to keep up with the times.

2. Course Reform Approach

To address the above issues, the course team has developed a collaborative education model that integrates professional education, ideological and political education, and innovation and entrepreneurship education, focusing on the cultivation of students' abilities and entrepreneurial awareness. Guided by this concept, the course construction approach is as follows:

First, strengthen the integration of ideological and political education to cultivate students' patriotism and the spirit of craftsmanship. It ensures that every class naturally incorporates elements of ideological education without being forced, thus nurturing good moral character.

Second, emphasize the development of students' abilities, particularly their capacity to solve practical engineering problems. The course will incorporate more school-enterprise cooperative teaching, project-based, and case-based teaching methods.

Third, focus on the integration of the latest surveying technologies, big data, digital twins, AI artificial intelligence, and other advanced technologies to enhance the course's high-level and innovative aspects, thereby strengthening students' innovation awareness.

Based on this approach, the course has carefully built "Four Platforms": the integration of theory and practice platform, the ideological and political education platform, the digital intelligence resources platform, and the quality development platform. These platforms create a comprehensive, multi-dimensional, and all-weather student cultivation system that integrates theory and practice, in-class and out-of-class, online and offline, and on-campus and off-campus learning, ensuring holistic and continuous student development.

3. Course Reform Measures

3.1 Platform One: Building an Integration of Theory and Practice Platform to Achieve a Unified Space-Time Structure for Theoretical and Practical Teaching

3.1.1 Reconstruction of Course Content

The teaching content of "Civil Engineering Surveying" is organized according to the construction process of engineering projects. It adheres to a problem-oriented approach, employing a student-centered, heuristic project-based teaching method, with the goal of cultivating students' practical engineering surveying abilities. The course gradually develops students' overall engineering thinking, ensuring the integration of knowledge and practice. For example, starting from the familiar process of house construction, students are gradually introduced to the full construction process of an engineering project, leading to the core content of engineering surveying (i.e., the teaching material). The focus is on identifying the engineering surveying tasks involved in the project and understanding how to carry them out (Problem). This approach encourages students to learn and explore with real-world engineering problems, enhancing their focus and initiative in learning.

The teaching content is restructured based on the tasks of engineering projects, transforming the course content into projects, which helps students grasp the overall framework of the course knowledge. The complete construction project serves as the main teaching framework, blurring the lines between theoretical and practical teaching. The traditional 11-chapter content is reorganized into five main projects: preliminary knowledge, control surveying, digital mapping (and engineering applications), construction surveying, and deformation surveying.

Regarding the training projects, the surveying tasks are centered on topographic map surveying and construction setting-out in the context of an engineering project. The surveying work for a construction project is broken down into several sub-projects that are interconnected. For example, sub-projects such as the use of total stations and leveling route surveying focus on mastering instrument operation and field calculations, which support tasks like traverse surveying. Control data for digital mapping comes directly from the results of the previous sub-project's planar control survey (traverse survey). The setting-out data for construction layout comes from the topographic design generated in the digital mapping process, with control data derived from traverse survey results. This interconnected structure ensures that the various surveying tasks form a cohesive whole. At the end of the semester, a comprehensive practice session through engineering surveying internships is conducted to consolidate and strengthen students' practical surveying abilities[2].

3.1.2 "Teach-Learn-Practice" Integrated Teaching Method

The course "Civil Engineering Surveying" involves a substantial amount of practical content, including instrument operation, software usage, and data computation and processing. These all require timely and appropriate training to ensure effective teaching. Therefore, conditions for student practice should be created as much as possible during the teaching process. To this end, the "Teach-Learn-Practice" integrated teaching method is creatively adopted.

Teaching spaces are moved from classrooms to laboratories and practical base sites for on-site instruction. Daily teaching is organized in groups, with students sitting around tables by group, which facilitates mutual learning and discussion among team members.

When explaining the operation of instruments or software, each group is provided with instruments or computers for students to learn and practice. During software instruction, students use their own computers for synchronized practice, with random students being selected to explain the operation process. The instructor then analyzes and corrects common issues in a timely manner. The teaching space serves both as a laboratory and a mini practical base.

For some more difficult training tasks, excellent students are selected for pre-training the day before, enabling them to master the key points of the training project. During the actual training, these students guide others in their group, enhancing the training outcomes through a "point-line-surface" peer mentoring approach.

To improve the effectiveness of classroom teaching, especially for more theoretical content, the teaching content and process are reasonably arranged. Appropriate time is allocated for instrument practice, software operation, or in-class competitions. For instance, when explaining the use of leveling instruments or total stations, a 5-minute break is arranged for a competition on tasks like leveling instrument placement or total station centering and leveling. Outstanding performers are awarded points for their usual performance, which both energizes the teaching atmosphere and stimulates student interest.

Additionally, to further improve the efficiency of practical training, virtual simulation training is incorporated. This course leverages university mapping competitions, effectively utilizing competition software resources and the college's simulation training platform. Before students begin learning the instruments, they familiarize themselves with the virtual operation steps of the instruments. This not only enhances their familiarity with the instruments but also exposes them to the latest surveying technologies, such as unmanned aerial surveying, radar surveying, and GIS (Geographic Information System) technologies.

3.1.3 Establishment of a Virtual Simulation Training Platform

To further enhance the efficiency of practical training, this course relies on university-level surveying competitions, effectively utilizing competition software resources and the college's simulation training platform to conduct virtual simulation-based training. Before learning to use the instruments, students first familiarize themselves with the virtual operation steps, which not only improves their familiarity with the instruments but also exposes them to the latest surveying

technologies, such as unmanned aerial photogrammetry, radar surveying technology, and GIS (Geographic Information Systems) technology.

3.2 Platform Two: Ideological and Political Education Platform, Adding Warmth to the Course

Based on the course characteristics and the spirit of craftsmanship, this platform integrates national sentiment, national confidence, the concept of rule of law, scientific spirit, and professional ethics, strengthening the ideological and political education of the course. A total of 19 ideological and political elements have been carefully developed to ensure that 2-3 instances of ideological education are integrated into every class. The course subtly nurtures students through real events and vivid characters, such as the national survey team's Mount Everest elevation measurement, the BeiDou Satellite Navigation System, and the "Fuxing" high-speed rail. Through interactive teaching, students come to understand the strength and challenges of national development and feel the spirit of craftsmanship and the perseverance of the nation's infrastructure heroes. This process helps students gradually move from sensory understanding to the level of values and ideals, thus achieving the goal of ideological education[3].

3.3 Platform Three: Digital Intelligence Resources Platform, Adding Depth to the Course

The course team, based on the development of a provincial-level first-class course, has recorded 37 online videos totaling 353 minutes of content on the Wisdom Tree network platform. A question bank has also been developed and has been running online for six semesters. Through the establishment of this online resource platform, students complete related online resource learning before engaging with the teaching content, which significantly reduces the time spent on theoretical explanations. This allows more time to be devoted to flipped teaching, practical training, and group discussions.

Furthermore, to enhance the course's high-level and innovative aspects, a modern intelligent surveying technology library has been established and interconnected with course content in the form of a knowledge map, allowing students to revisit and reflect on the material.

Using the advantages of platforms such as Rain Classroom and Wisdom Tree, as well as virtual simulation teaching resources, the course, centered on the provincial-level first-class "Civil Engineering Surveying" course, constructs an information-based classroom tailored to the university's context and the course's characteristics. Through a "self-driven + externally sourced" approach, the course integrates digital mapping virtual simulation training projects, fourth-level leveling, drone surveying, laser radar surveying, and other virtual simulation training programs, with the support of enterprises, to enhance the information-based classroom. This approach breaks through the limitations of offline classroom time and space, expanding the boundaries of information-based teaching[4].

3.4 Platform Four: Second Classroom Platform, Keeping the Course Engaging After Class

By utilizing modern information technology and internal and external resources, a multidimensional teaching environment, centered on the first classroom (main classroom) and supported by task-based classrooms, club classrooms, and competition classrooms, is created. This effectively addresses the challenges of limited class hours, abundant content, insufficient teaching focus, and the constraints of time and space.

3.4.1 Open Task Classroom

The Civil Engineering Surveying Laboratory is opened for extracurricular tasks, establishing a task-based classroom. The course adopts an open training approach, with class representatives organizing students to practice, achieving the goals of previewing and reinforcing operational proficiency. Students are encouraged to take the initiative, with daily training organized and managed by classes or groups, enhancing their self-organization and management skills. Extracurricular tasks are released in group formats, with practical tasks such as earthwork volume calculation, settlement observation, and green area measurement. These tasks typically serve as extra credit.

3.4.2 Support for Club Classrooms

The development of engineering surveying associations related to the course is supported, establishing club classrooms. The association plays a pivotal role in assisting classroom teaching, with a structure where third-year students are the core, second-year students are the backbone, and first-year students are members. The association regularly holds activities or training sessions, with senior

students teaching basic knowledge, instrument operation, and simple calculations, thereby fostering a stronger professional learning atmosphere and enriching students' extracurricular cultural lives. This also lays a good foundation for future learning in the course.

3.4.3 Encouragement of Competition Classrooms

Competition classrooms are established through various levels of professional and academic competitions, forming a multi-tier competition system spanning “club-school-province-national” levels. Relying on university-level surveying skill competitions and other skill competitions, competition classrooms are developed for instrument operation courses. Discipline-based competitions are interwoven with knowledge learning and skill improvement; professional associations serve as platforms for organizing student participation in academic competitions. A spiral, progressive learning chain is proposed, based on discipline competitions, establishing professional associations, feeding back into theoretical teaching, and supporting practical teaching. This approach enhances students' practical abilities while stimulating their self-management, autonomous learning, and creativity[5].

3.4.4 Expansion of Practical Project Classrooms

Practical project classrooms are expanded based on faculty research or service projects. Students with surplus academic capacity and interest are invited to join, gaining engineering surveying practical experience through real-world engineering projects. Students participate in tasks such as settlement observation, foundation pit monitoring, and rural land rights surveys, significantly improving their engineering practice experience. This approach bridges the gap between theoretical knowledge and real-world applications, truly achieving learning through practice.

4. Reform Outcomes

4.1 Strong Professional Abilities and High Comprehensive Qualities of Students

Through the integration of practical course-based ideological and political education, the ideological elements subtly permeate the teaching process, effectively enhancing students' sense of national honor, pride, self-confidence, and their scientific and rigorous spirit. Students' core professional abilities have been significantly strengthened, as they are now proficient in using common professional software and instruments to solve general complex engineering problems, laying a solid foundation for their future learning and employment. Through both in-class and extracurricular interactions, students' core non-professional qualities, such as teamwork and perseverance, have been cultivated and enhanced. For most students, their core professional skills in engineering surveying have greatly supported their internship practices during the seventh semester, fostering confidence in their work and promoting more opportunities for practical experience[6].

4.2 Positive Classroom Atmosphere and High Learning Motivation

Through activities such as open laboratories, club activities, and academic competitions in the second classroom, the "classroom+" initiative has achieved positive results. The extracurricular learning atmosphere among students has become increasingly strong, which has beneficially promoted teaching in the main classroom. The Engineering Surveying Association recruits nearly 100 new members each year. With the support of various association activities, students' enthusiasm for participating in competitions has risen, and they have achieved good results in measurement competitions at different levels. Around 150 students participate in the university-level surveying competition each year. In the past three years, significant progress has been made in the National College Students' Surveying Discipline Innovation, Entrepreneurship, and Smart Competition, particularly in the unmanned aerial vehicle (UAV) surveying virtual simulation competition.

Conclusion

Through the integration of "Professional, Ideological, and Innovative" perspectives in the reform of the Civil Engineering Surveying course, multiple platforms such as integration of theory and practice, ideological education, digital resources, and second classrooms have been built. This has promoted the dual integration of theory and practice, as well as ideology and profession. The reform has not only enhanced students' professional abilities and comprehensive qualities but also stimulated their interest in learning and the classroom atmosphere. In the future, the course reform will continue to deepen the

integration with new technologies, optimize teaching methods, strengthen innovative practices, and promote the continuous development of the Civil Engineering Surveying course in the context of intelligence and digitalization.

Fund Projects

2022 Hunan University of Technology Teaching and Research Reform Project, "Research on the Information-based Construction of 'Civil Engineering Surveying' Course Based on Virtual Simulation Training Technology," Project No. jy202227

2023 Annual General Topic of Hunan Province Education Science "14th Five-Year Plan": "Teaching Application Research of Concrete Structure Course Based on Knowledge Graph" (XJK23CGD038)

2024 Hunan University of Technology Teaching and Research Reform Project: "Deepening Reform and Practice of Concrete Structure Design Principles Course Teaching under the Perspective of Ideological and Political Education in Curriculum"

2024 Annual Teaching Reform Research Project for Ordinary Undergraduate Colleges in Hunan Province: "Exploration and Practice of the Talent Cultivation Model for Civil Engineering in Applied Universities under the Perspective of Multidisciplinary Integration," Project No. 202401001589

2023 Annual Teaching Reform Research Project for Ordinary Higher Education Institutions in Hunan Province: "School-Enterprise Collaborative Innovation and Practice for New Engineering Talent Cultivation—A Case Study of 'Bridge Inspection and Strengthening Technology' Course" (HNJG-20231308)

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