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A Study on the Implementation Path of the Blended Teaching Model in Geological Hazards Investigation and Evaluation

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Abstract: Geological Hazards Investigation and Evaluation is the core course of Environmental Geological Engineering, aiming to cultivate skilled talents with solid theoretical knowledge and excellent practical skills. At present, the course faces several issues, including a teaching environment disconnected from real-world work scenarios, course content that deviates from job-related tasks, a lack of digital teaching resources, and reliance on a single teaching method, leading to students' poor feedback from employers. Based on the concept of outcome-based education, the course team of Geological Hazards Investigation and Evaluation establishes a "five-step double-rotation" blended teaching model with the help of a Small Private Online Course platform. The program is designed to improve the teaching environment and expand the digitalized teaching resources in order to improve students' learning motivation, enhance learning effectiveness, and cultivate skillful talents who meet employers' satisfaction.

Keywords: Outcome-based education concept; Geological Hazards Investigation and Evaluation; Teaching mode; Blended teaching and learning

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1. Introduction

Outcomes-based education (OBE) was first proposed by Spady, a famous American education scholar, in 1981. It is a new education model oriented to students' learning outcomes and is the core of professional accreditation of engineering education [1,2]. Blended teaching combines traditional and online methods, emphasizing a student-centered approach to achieve optimal teaching outcomes. The OBE concept applies results-oriented reverse design to the teaching process, encouraging students to take initiative in their learning and exploration, while focusing on their needs and interests. This approach aligns with the "student-centered" principle of the blended teaching model [3].

2. The current situation and problems in teaching Geological Hazards Investigation and Evaluation

Geological Hazards Investigation and Evaluation is a content-rich course that covers a wide range of abstract knowledge points. In the traditional offline teaching mode, which primarily relies on lectures, there are several challenges, including limited teaching hours that hinder the development of students' practical skills, a disconnect between teaching and practice, varying levels of student understanding, and a lack of classroom interaction. These issues result in poor teaching outcomes and prevent the course from efficiently achieving its expected goals.

Through a summary of the teaching process, four key insufficiencies in students' skills and common issues were identified. In terms of knowledge and foundational skills, students often lack clarity in the basic geological survey process and are not sharp enough in identifying field geological phenomena. Regarding understanding and practical skills, some students are not sufficiently standardized in their use of geological instruments when determining the production status of rock layers, and their geological sketches and field records also lack standardization.

3. Design of a blended teaching model for the course Geological Hazards Investigation and Evaluation based on the OBE concept

3.1. General idea

The teaching policy of "results-oriented, reverse design, forward implementation" is to reverse design the course objectives, determine the course content based on the job tasks, and then implement the teaching content positively through the online and offline blended teaching mode relying on the Small Private Online Course (SPOC) platform and various information technology tools [4-7]. In the process of teaching implementation, teachers should first adopt a results-oriented reverse design approach to the content, making timely adjustments to their roles and mindset. They should shift from being the "controller" of the classroom to becoming a "guide" in the learning process. Secondly, in the teaching process, we should integrate the network quality resources, make full use of modern information technology means, highlight the central position of students, and realize the most ideal teaching effect. In addition, teachers should establish a timely and effective feedback mechanism to track student progress. By utilizing online platforms, educational technology tools, and access to student learning data, teachers can reflect on their teaching and address issues promptly. This ensures that the teaching model continually adapts to the evolving educational environment and student needs. Personalized tutoring should also be implemented to stimulate students' enthusiasm for learning and ultimately achieve the goal of talent cultivation.

3.2. Setting teaching objectives with vocational competence as the outcome

Based on the vocational skill requirements for the role of geological disaster investigator and following the professional standards set by the Ministry of Education, the course integrates professional training and curriculum standards with the skills required for certification. It fully implements the OBE concept, emphasizing "vocational skill as a result-oriented, student-centered, continuous improvement" while incorporating labor education. The teaching objectives, focused on "accurate investigation and research-based judgment," are outlined in **Table 1**. Analyzing the learning context and teaching experience, it is anticipated that identifying and characterizing the structure of landslide geological formations will be the key teaching focus, while evaluating landslide risk will present the greatest challenge.

Table 1. Overall objectives for the Geological Hazards Investigation and Evaluation course

Course objectives	Content
Quality objectives	(1) To firmly establish the concept of "people first, life first"; (2) To carry forward the geological spirit of hard work, simplicity, and pragmatism, and actively practice the concept of green development; (3) To cultivate students with a rigorous and realistic scientific attitude and style, innovation and truth-seeking spirit; (4) To build a solid foundation in systems science theory and geology.
Knowledge objectives	(1) To master the structural characterization of rock and solid bodies in disaster bodies; (2) To clarify the purpose and significance of Geological Hazards Investigation and Evaluation; (3) To understand the principles of investigation, evaluation, prevention, and treatment; (4) To increase familiarity with norms, national standards, and technical methods such as field investigations in industries related to geologic hazards; (5) To master the application of space-air-ground satellite remote sensing technology in geological disasters.
Competency objectives	(1) To discriminate between disaster geological technical bodies and types according to the norms and national standards of the geological hazards-related industries; (2) To apply new technological methods such as space-air-ground for the field and structural characterization of geological outcrops; (3) To apply 3S technology and early warning platforms for risk assessment and monitoring and early warning of geologic hazards.

3.3. Designing teaching content based on the "post, course, competition, certification, and research"

Based on the concepts of setting classes by post (geological hazards investigator), leading classes by competition (geological hazards investigation vocational skills competition), testing classes by certificate (geological hazards investigation vocational qualification certificate), and educating students by classes (geological-craftsmen), we constructed a comprehensive educating mode of "post, course, competition, certificate, research." The teaching content is restructured according to the typical types of geological hazards. Four types of teaching projects are organized based on the proportion of geological hazards: landslides, collapses, mudslides, and ground deformations, with the focus adjusted according to their frequency and significance. In the teaching task, instruments like high-definition microscopes, computed tomography scanning, and cloud platforms are introduced to realize the visualization of investigation and monitoring results, and through the integration of space-air-ground monitoring technology, high-precision monitoring of geological hazards can be realized as accurate early warning. The spirit of geological craftsmanship of "hard work, pragmatism, innovation, and scientific solidity" is carried out throughout the teaching and students' professionalism is firmly established.

3.4. Implementation of the "five-step double-rotation" blended approach to teaching and learning

The workflow is used as a framework for the educational process, encompassing data collection, field surveys, on-site mapping, disaster research and judgment, and result acceptance. This "five-step" approach aligns with the real-world responsibilities of geological hazard investigators. The course includes pre-course trials, online platform-based independent learning, and contextual skill benchmarking. It emphasizes hands-on experience through demonstrations, skill practice, and real-world applications. After class, students engage in social practice to deepen their understanding and expand their skills. The implementation of the blended teaching mode of Geological Hazards Investigation and Evaluation takes landslide geological hazards as an example, and the specific process is as follows.

3.4.1. Trial learning and experimentation before class

Based on students' learning characteristics, the class is divided into six groups. The core focus is "intelligent investigation and evaluation of 1:10,000 geological hazards." Using landslide geological hazards as an example, the teacher will provide supporting learning resources and practical training tasks through the SPOC teaching platform. Students will access these resources online, and gather basic information such as topographic maps of Dahuaping Village, geological structures, and hydrological conditions. They will also consult the technical specifications for 1:10,000 geological hazard investigation and risk assessment, review the task list, and gain a detailed understanding of the teaching content. Students will analyze the stability and sensitivity of landslides and, if necessary, conduct offline site investigations. Teachers will summarize questions and adjust strategies accordingly.

3.4.2. Hands-on learning and practicing in the class

(1) Reconnaissance: Determining the scope of disaster investigation. (a) Identifying hidden danger points: Students will circle potential danger points and determine their scope by analyzing changes in basic geological data and remote sensing images. They will assess the degree of hazard and develop an awareness of disaster prevention and mitigation. (b) Problem introduction: Students will engage in scene connections, simulation exercises, practical activities, group discussions, independent design, and intelligent scoring. They will align their work with vocational skills competition assessment requirements, elaborating on the geological, hydrological, and meteorological conditions related to landslide hazards. This approach ensures mastery of the core elements of the hidden hazard points.

(2) Annotation: Identifying the structural characteristics of the disaster. (a) Simulation practice and roving guidance: Students will use the simulation platform to familiarize themselves with the entire process. They will enhance their proficiency in annotation through interactive methods such as games, group discussions, and personalized guidance. (b) Experimental operation: Following the simulation process, students will complete the landslide geological technical structure characterization. If the initial test results are not satisfactory, students will practice repeatedly to become more familiar with the process. This iterative approach helps them advance through the levels and address key teaching points.

(3) Study and determine: Refining the ability to judge the stability of disasters. Students will organize their data and accurately study and determine the results of annotation according to relevant technical standards and specifications. The data will be submitted to the provincial platform for monitoring and early warning of natural disasters, where it will be automatically audited by the platform. This approach focuses on achieving results and overcoming teaching difficulties.

(4) Acceptance: Testing students' ability to perform the job. Students will organize their results, and the teacher will establish three-dimensional assessment indicators covering knowledge, skills, and literacy. Utilizing an assessment system in the classroom for scientific evaluation will help enhance students' ability to learn independently.

3.4.3. Flexible learning and practicing after class

After class, students can continue learning and practicing with the help of an online teaching platform. Teachers can introduce cutting-edge knowledge related to geological hazards and invite students to participate in the provincial "1:10,000 Geological Hazards Investigation and Risk Assessment" project and competition. Using their experience from investigating landslide hazards in Dahuaping Village, students can engage in practical projects and competitions tailored to their individual backgrounds. This approach stimulates students' interest in learning and enhances their ability to address real-world geological hazards. The after-class project experience can assist students who are progressing slowly and facilitate their development. Students with additional capacity can choose to participate in innovation and entrepreneurship competitions or engage in rural revitalization and geological hazards science popularization projects, thereby meeting their needs for independent, diverse, and personalized learning.

4. Multi-dimensional assessment and evaluation system

Based on the online learning records of students on the SPOC platform, teachers establish learning evaluation scales for different stages—pre-course, in-course, and post-course. They set score weights and value-added evaluation indexes to assess students' knowledge, skills, and attitudes, leading to their overall grades. Additionally, an electronic archive is created to track each student's growth in the Geological Hazards Investigation and Evaluation course. Teachers use the results from "practice, competition, and creation" assessments during and after the course to reflect on their teaching. They provide feedback on whether students have improved in knowledge, skills, and literacy and use this feedback to refine the teaching of the Geological Hazards Investigation and Assessment course in subsequent stages. This ensures that the teaching mode continuously adapts to the evolving educational environment and student needs.

5. Conclusion

The implementation of the blended teaching mode reform of the Geological Hazards Investigation and Evaluation course has effectively solved the problem of the disconnect between the teaching content, teaching links, and the actual needs of enterprises. It has improved students' practical skills to solve the practical problems of environmental geological engineering, and cultivated talents better adapted to the changes in the industry and the objective requirements of the demand for jobs.

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