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Research on Curriculum Reform for the Teaching of Silicate Petrology Based on the 'Two Properties and One Degree' Standard to Establish Multi-Element Coordinated Coupling

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Abstract
Silicate Petrography is a foundational course in the field of inorganic non-metallic materials. Traditional teaching methods for this course often involve a large volume of content, abstract concepts, and complex theories, which can be difficult for students to grasp. Addressing these challenges through a blended online and offline teaching model has become a key objective in the current curriculum reform for Silicate Petrography. In response, the course has been redesigned based on the "Two Properties and One Degree" standard, with a student-centered approach. The course objectives and content modules have been restructured to enhance its "high-level" nature. Diverse and "innovative" teaching elements, along with secondary construction of implementation modules, have been seamlessly integrated. Additionally, a multi-level assessment and evaluation system, referred to as the "challenge" module, has been developed and implemented. These efforts aim to achieve comprehensive goals in knowledge, skills, and personal development. After being implemented in teaching practice, the redesigned course has shown promising results, providing a valuable reference and model for the reform of other engineering courses at our university and across the province.

Key words: Silicate petrography; Two Properties and one degree; Course modules; Multi-element coordinated coupling

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Courses play a critical role in talent cultivation, and the quality of instruction directly impacts the caliber of the professionals produced. Therefore, a key focus in improving talent development lies in applying educational reforms to course design and delivery. In this context, China's Ministry of Education issued the "Notice on Strictly Implementing the Spirit of the National Undergraduate Education Work Conference in the New Era" (Teaching Letter [2018] No. 8), which calls for universities to review and improve course content, eliminating "water courses" and developing "gold courses" to enhance teaching quality (Ministry of Education of the People's Republic of China, 2018). A "gold course" is defined by the principles of the "Two Properties and One Degree," which refer to high-levelness, innovativeness, and degree of challenge (Chen, 2023). "High-levelness" involves the integration of knowledge, skills, and qualities to cultivate students' ability to solve complex problems and engage in higher-order thinking. "Innovativeness" incorporates cutting-edge content, advanced teaching methods, and personalized, research-based learning outcomes. The "challenge degree" relates to increasing the complexity and research-oriented nature of course content. These principles guide the ongoing innovation in higher education (Song, 2021 & Liu, 2023). Silicate Petrography is a core theoretical course for students majoring in inorganic non-metallic materials science, engineering, and related fields. The course primarily covers key concepts in crystallography, mineralogy, crystal optics, and the application of mineral raw materials in ceramics. Its goal is to help students understand the structure and properties of crystals and minerals and the petrographic textures of rocks at various scales. This foundation is essential for advanced research in ceramics and other inorganic non-metallic materials (Sun, 2021). However, traditional teaching approaches for this course often overwhelm students with dense, abstract content and limited instructional time, resulting in reduced engagement and suboptimal outcomes. The concept of modular teaching—initially proposed by Professor Michael in the U.S. has proven to be an effective strategy in addressing these issues. Modularized teaching reorganizes the course structure into distinct learning modules tailored to the needs of the students, optimizing content delivery and facilitating practical, competency-based education. Grounded in Outcome-Based Education (OBE), this approach incorporates new elements such as blended learning, political and ideological education, virtual simulations, and modern information technology. While these new elements can sometimes create conflicts in teaching strategies, modular teaching provides a framework to effectively integrate these components.

Therefore, based on the "Two Properties and One Degree" standard and aligned with national "gold course" construction initiatives, the course team has continuously explored and developed a modular teaching model comprising "course objectives-teaching content-teaching implementation-teaching evaluation-teaching feedback" over multiple years. This approach effectively integrates blended online and offline teaching, political and ideological education, virtual simulation, and information technology, yielding positive results.

1. CONSTRUCTION OF A COURSE MODULE WITH DIVERSE SYNERGISTIC COUPLING EFFECTS BASED ON THE 'TWO PROPERTIES AND ONE DEGREE' STANDARD FOR SILICATE PETROGRAPHY

Under the perspective of gold courses, there is a need to focus on the organic integration of knowledge, abilities, and qualities, innovate in course content, teaching formats, and knowledge systems, and enhance the challenge degree of the course. Although preliminary teaching efforts have incorporated OBE (Outcome-Based Education) teaching, political and ideological education, blended learning, and virtual simulations, these have been introduced as isolated elements. When multiple new elements are simultaneously integrated, they inevitably lead to conflicts and imbalances in the course's ability cultivation. Therefore, utilizing modularized teaching to alleviate these imbalances and achieve a diverse synergistic coupling effect (where $1+1 > 2$), aiming to promote the enhancement of students' higher-order abilities and the comprehensive development of quality education, becomes essential for the reform of silicate petrography.

1.1 Restructuring Course Objectives and Teaching Modules to Enhance the High-Level Nature of the Course from the Perspective of Gold Courses

The content of Silicate Petrography is both extensive and abstract, covering a wide range of challenging concepts. To deliver this material effectively within limited instructional hours, it is essential to optimize and modularize the knowledge structure, focusing on key concepts and difficult topics. Integrating the latest scientific research on crystals and minerals can elevate the course's high-level nature. In alignment with national standards for "gold course" development, and aiming to enhance students' advanced abilities and comprehensive development, we have redefined the course objectives, focusing on knowledge, skills, and qualities. This approach strives to integrate knowledge transmission, the outcome-based education (OBE) teaching framework, and quality development through course-based political and ideological education. The key elements of this initiative are:

(1) Restructuring Course Objectives, the course objectives are the foundation of each teaching phase and must evolve from basic to advanced cognitive levels. By adopting a "student-centered" model and incorporating ideological education, the course objectives are designed to progress from basic cognitive functions (e.g., memory, understanding, application) to more complex ones (e.g., analysis, evaluation, creation). These objectives encompass the following levels:

Knowledge level: Students should master the basic theories of crystallography, mineralogy, and crystal optics.

Skill level: Students should be able to apply mineralogical theories to analyze ceramic formulations and evaluate the impact of raw material choices on ceramic production processes.

Quality level: By embedding the Jingdezhen ceramic artisan spirit, the course aims to foster a "craftsman spirit" and rigorous scientific attitude, as well as instill values of integrity and innovation.

(2) Optimizing Course Content and streamlining and aligning course content with other courses in the major is key to improving efficiency and relevance. The primary textbook《Ceramic Mineral Raw Materials and

Petrographic Analysis》 by Professor Liu Shuxing, covers crystallography, mineralogy, petrology, and petrographic analysis. To avoid redundancy, the crystallography section will be simplified, while mineralogy will focus on minerals pertinent to ceramics, such as their properties, identification, and applications. The petrology section will give a brief overview of natural rocks, and the petrographic analysis will delve deeply into crystal optics and microscopy techniques, omitting oil immersion methods. This streamlined approach ensures students focus on the most relevant and critical content for their field.

(3) Building a Modular Knowledge System instead of following the traditional chapter sequence, the course is organized into knowledge modules based on the course objectives and student needs. The modules include: Basic theories of crystallography and crystal optics, Basic theories of mineralogy, and Knowledge application and extension. Instructors are encouraged to move beyond relying solely on experience and to integrate practical, cutting-edge research into their teaching. For instance, when discussing the microstructure of ceramics, students can be guided to understand how ceramics' unique properties arise from their microstructure (e.g., glass phase, mullite crystals, residual quartz). This method helps link theory with practice, deepening student engagement and understanding. Additionally, introducing students to modern applications, such as the liquid-phase method for preparing γ-Ce_2S_3 as a non-toxic red pigment or the gas-phase method for producing environmentally friendly alumina powder coatings, connects traditional knowledge to contemporary research and innovation (Wang, 2021). By connecting theoretical content to real-world applications, students develop a more practical, nuanced understanding of the subject matter. To align with the national standard for "gold course" development, our course team has continuously refined a modular teaching model over several years. This model integrates blended online and offline learning with ideological education, virtual simulations, and IT infrastructure. The resulting improvements in teaching practice demonstrate the effectiveness of this approach and offer valuable insights for broader curricular reforms.

1.2 Efficient Integration of Diverse "Innovative" Teaching Elements and Secondary Construction of Teaching Implementation Modules

The course emphasizes a student-centered approach to ensure the "high-level" nature of its teaching objectives and the scientific and practical feasibility of its implementation modules. To achieve this, modern information technologies should be fully utilized, prioritizing the innovativeness, diversity, and interactivity of teaching methods. Building a diversified teaching model to enhance the "innovativeness" of the Silicate Petrography course means making substantive progress in reforming and innovating course content and teaching methods. The ultimate goal is to achieve near-perfect attendance and engagement ("attendance rate" and "attention rate"), fully engaging students and motivating them to learn independently. The following strategies are employed to meet these objectives:

(1) Blending Online and Offline Teaching to Innovate Instruction and Spark Student Interest in Autonomous Learning. Since 2020, the course team has developed a blended learning model for Silicate Petrography on the Chaoxing Learning platform. Short instructional videos (15 - 30 minutes each) covering key concepts and theories were created and organized according to the course content. Students are required to watch these videos before class and complete quizzes, noting any unclear points or questions for discussion during offline sessions. In offline classes, instructors revisit these topics, helping students solidify their understanding and fill knowledge gaps. To foster continuous engagement, the platform's interactive features, such as discussion boards and chat rooms, are used to maintain a dynamic exchange between teachers and students, ensuring timely feedback.

(2) Virtual Simulation Experiments and Course-Based Political and Ideological Education for Increased Engagement. In the section on layer silicate minerals, virtual simulation experiments are used to engage students by allowing them to observe and analyze the formation process of clay minerals. This interactive approach adds an element of fun, making the learning process more engaging. Additionally, the course incorporates political and ideological education by exploring the moral and educational significance of the material. This approach ensures the integration of "knowledge transmission," "value guidance," and "ability enhancement" throughout the learning process. For example, in the lesson on "tectosilicate minerals," the use of feldspar in domestic ceramics and construction is tied to the course's theoretical content, encouraging students to tackle real-world "bottleneck" issues in material science through technological innovation. Students are tasked with reviewing relevant literature and applying Marxist theoretical perspectives, as well as Xi Jinping Thought, to their problem-solving. They summarize their insights into short papers, which are reviewed by the instructor, who provides feedback, ensuring active participation and meaningful engagement with political and ideological content.

(3) Innovating Teaching Formats to Stimulate Exploration and Enhance Participation. To encourage deeper learning and exploration, the course adopts a student-centered approach where learners take on the role of both designers and facilitators of their education. Teaching methods such as case studies, flipped classrooms, and experiential learning are employed to expand the depth and scope of class discussions. Ample

discussion topics and supporting literature are prepared to ensure that students are able to actively engage with the content. For example, when teaching macroscopic symmetry and crystal orientation, students are invited to the front of the class to analyze crystal models and demonstrate their orientation, which enhances their independent thinking and problem-solving skills while also boosting confidence in public speaking. Similarly, during lessons on mineral morphology, images or physical specimens are used to prompt group discussions, after which students present their findings. Teachers then provide feedback, reinforcing learning outcomes and fostering greater involvement.

1.3 Building and Implementing a Multi-Level Assessment and Evaluation Module to Increase the "Challenge Degree"

To enhance the "challenge degree" of the course, it is essential to establish a comprehensive, humanized, and multi-level assessment and evaluation module. Moving away from a model where a single exam determines a student's entire grade, this new system emphasizes process-oriented assessments that keep students engaged throughout the course and make classes more dynamic. The implementation of both quantitative and qualitative evaluation modules will focus on assessing students' abilities and qualities. This method evaluates not only learning outcomes but also the emotional and attitudinal aspects displayed during the learning process. Ultimately, it aims to create a scientific, objective, and fair evaluation system (Sun, 2022). The quantitative assessment module for the Silicate Petrography course includes both regular assessments and final examinations. The proportion of regular (process-oriented) assessments has increased from 20% to 50%. Online learning evaluations (10%): these focus on the time spent watching video lectures and the completion of post-video self-assessment questions. Classroom performance (8%): This evaluates students based on their participation and accuracy during class discussions and question-answer sessions. Specialized research projects (20%): These projects assess students' deeper engagement with the course material through focused research efforts. Meanwhile, the proportion of the final examination score has been reduced from 80% to 50%. The final exam questions are designed to align with different course objectives, assessing both fundamental knowledge and the application of theoretical principles to practical problems. This allows for a comprehensive evaluation of students' understanding and their ability to apply the theoretical knowledge they've gained. The qualitative evaluation module includes course surveys and focus group discussions, providing a broader, more objective evaluation of students' learning outcomes and development of skills and qualities. This module emphasizes the entire learning process, tracking progress in both academic abilities and personal growth. The evaluation system ensures reliability, validity, and differentiation by scientifically setting evaluation criteria, scoring methods, and weighting factors. This approach guarantees a fair and balanced evaluation of students' overall performance, reflecting both their academic achievements and personal development.

2. IMPLEMENTATION OF A MULTI-SYNERGISTIC COUPLING EFFECT COURSE MODULE BASED ON THE "TWO PROPERTIES AND ONE DEGREE" STANDARD FOR SILICATE PETROGRAPHY – USING "CHAPTER 1, SECTION 4: CRYSTAL ORIENTATION" AS AN EXAMPLE

In line with the "Two Properties and One Degree" standard, we construct a three-tier progressive blended teaching model of "pre-class online - in-class offline - post-class consolidation" that follows the principles of "strong foundation, emphasis on application" and "student-centered learning." Students are randomly divided into groups of 4 to 6, with each group discussing and selecting a different crystal model or mineral as their group name. The course is implemented in three phases: pre-class online learning, in-class offline engagement, and post-class consolidation. The online phases emphasize autonomous learning and collaborative discussions to spark students' curiosity and deepen their exploration of knowledge.

Pre-Class Online (Knowledge Module): Utilizing the Chaoxing Learning Platform, online teaching activities are hosted on the Chaoxing Learning platform, with pre-recorded videos, PowerPoint presentations, and quizzes uploaded by the instructor. These quizzes consist of multiple-choice and true/false questions and are designed to assess students' grasp of fundamental knowledge. Three days before the class, a learning task list is released to guide students through their pre-class studies. Students complete their autonomous learning by watching the videos and taking quizzes. Teachers monitor students' completion and understanding of the material through the platform's analytics tools. For example, for the 2022 cohort (Class 3 and Class 4) in the Inorganic Non-Metallic Materials specialty, teachers tracked students' video engagement and quiz performance before class. The 22.4-minute video for this section was viewed 154 times, with most students completing the section quizzes. Only one student failed to watch the video on time, while another student watched the video nearly five times, indicating different levels of engagement. Based on quiz results, approximately 68.5% of students answered all questions correctly, while 18.5% answered half correctly, and 13% scored zero points. This data guided the teacher's in-class focus on explaining key principles such as crystal axis selection and the establishment of triaxial and quadriaxial orientations, using examples from cubes and octahedrons.

In-Class Offline (Knowledge + Ideological + Extension Module): Utilizing smart classroom technology, Offline teaching activities are conducted in a smart classroom environment, which includes in-class quizzes, group discussions, and key concept elaboration sessions. The first task during class is to address any questions that arose during the online phase. Group leaders summarize their group's pre-class learning experiences, and the teacher then reviews the key points and clarifies difficult concepts.

Guided questions and case studies are used to engage students in discussions that deepen their understanding of course content while integrating political and ideological education to enhance their overall quality of learning. The ideological elements aim to simplify complex topics and provide broader contextual understanding. For example, in the discussion on crystal orientation, students are introduced to the concepts of crystal axes, axis angles, unit axes, and crystal constants, as well as the principles of triaxial and quadriaxial orientations. The political component asks students to reflect on why certain crystal systems (e.g., triclinic or hexagonal) use quadriaxial orientations.

Group discussions are then organized to further explore the topic, linking theory with real-world applications, such as the varying physical properties of quartz crystals based on their cut faces and the use of crystal orientation in cutting-edge technologies. Following this, a mini quiz is administered to gauge student comprehension.

Post-Class Consolidation (Knowledge + Extension Module): Post-Class Exercises and Periodic Thematic Research. The post-class consolidation phase consists of assignments and thematic research tasks. Teachers assign tests, homework, and discussion prompts online to solidify students' understanding of the in-class material. Students collaborate in groups on thematic research (which includes a literature review) to delve deeper into course topics. Additionally, teachers gather feedback and track student progress through regular online and offline surveys. To ensure the integration and continuous engagement between the online and offline phases, the teacher answers students' questions and provides assignment feedback via the Chaoxing Learning platform. This system allows for a seamless learning experience, where students can revisit content and clarify any uncertainties as they move between the three phases of learning.

3. CONCLUSION

The construction of university courses based on the "Two Properties and One Degree" standard exemplifies high-level positioning, innovative growth, and the addressing of key educational challenges. This approach has become a critical criterion for universities to establish effective teaching models and create high-quality courses. In the case of the silicate petrography course, years of exploration have resulted in a modular teaching model that aligns course objectives, teaching content, implementation strategies, evaluations, and feedback. This model incorporates blended online-offline teaching, ideological and political education, virtual simulations, and a variety of teaching methods, significantly improving both teaching outcomes and student satisfaction. The course content is comprehensive, with the teaching process emphasizing foundational knowledge, innovation, and relevance. This focus enhances students' learning abilities and elevates the teaching quality of instructors. On the one hand, it lays a solid theoretical foundation in crystallography and mineralogy, which supports students in studying other courses within the field. It also provides essential theoretical backing for future work in the processing of inorganic non-metallic materials. The course's use of diverse learning methods promotes student engagement, fostering creativity, and encouraging the development of higher-order thinking and comprehensive quality education. On the other hand, the course construction significantly improves the teaching and professional capabilities of the instructional team. It enriches the internal structure of the course, optimizes the teaching environment, enhances the integration of teaching and research, and raises the overall teaching proficiency of the instructors involved. By harmonizing innovation with traditional educational values, this model of course construction offers a pathway to creating more dynamic, interactive, and effective university-level education.

REFERENCES

Cheng, X. D. (2023). The "Golden Course" construction model for innovation and entrepreneurship curricula. *Chuangxin Chuangye Jiaoyu*, *14*(04), 113-119.

Liu, C. X., Wang, H. L., Dong, C. F., et al. (2023). Exploration and practice of student-centered professional elective "Gold Course": colloid and interface chemistry. *Chinese Journal of Chemical Education*, *44*(20), 36-43.

Ministry of Education of the People's Republic of China. (2018). *Notice on Implementing the Spirit of the Conference on Undergraduate Education in Universities and Colleges for a New Era.* [EB/OL]. 08. 27.

Song, Z. M., Liu, R. H. (2021). An operational analysis of "two-nature and one-extent" in curriculum teaching. *Theory and Practice of Education*, *41*(12), 48-51.

Sun, Y., Li, K., Liu, S. X. et al. (2022). Cultivation and exploration of international vision capabilities in industry-focused universities under the context of engineering accreditation. *Science & Technololgy Vision*, (02), 44-46.

Sun, Y., Li, X. Y., Xie, Z. P., et al. (2021). Curriculum Reform in Silicate Petrography Course Based on OBE System. *China Light Industry Education.* (06), 89-91.

Wang, L. J., Yang, X. F., & Yang, Y. D. (2021). Study on the Influence of Flux Chemical Composition on Mechanical of Ceramic Plate. *Ceramics*, (03), 18-23.