

Exploration and Practice of “Guiding Interactive” Teaching in Advanced Geochemistry Courses from the Perspective of Constructivist Theory

Lei Liu^{1,2}, Chunming Liu^{1,2,*}, Weijian Zhou^{1,3}

¹Key Laboratory of Metallogenic Prediction of Nonferrous Metals and Geological Environment Monitoring, Ministry of Education in Central South University, Changsha 410083, Hunan Province, China

²School of Geosciences and Info-Physics, Central South University, Changsha 410083, Hunan Province, China

³Hunan Vocational College of Engineering, Changsha 410151, Hunan Province, China

*Corresponding author: Chunming Liu, liuchunming@csu.edu.cn

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Abstract: The construction of geochemical disciplines has brought new vitality to the development of traditional geology. In the new round of “Double First-Class” discipline construction at Central South University, the course of Advanced Geochemistry has effectively stimulated students’ interest in learning and further improved their scientific thinking and research innovation skills through the implementation of “Guiding Interactive” teaching reform measures, which has important theoretical significance and practical value.

Keywords: Geochemistry; Advanced Geochemistry; Teaching reform; Guiding Interactive

Online publication: January 18, 2024

1. Introduction

Geochemistry is a key discipline that studies the chemical composition, elemental and isotopic composition, distribution, migration, and evolution of the Earth, its inner and outer spheres, and various celestial bodies in the solar system, and solves geological and even earth science problems ^[1]. Since the 20th century, with the rapid development of science and technology, Geochemistry has been increasingly applied in multiple professional fields such as Earth Science, Environmental Science, and Ecological Science, and the integration of disciplines and specialties has continued to deepen. As one of the fastest developing majors in the past 20 years and a key focus of many higher education institutions in the field of Geology, the construction of the Geochemistry discipline not only brings new vitality to the development of traditional Geology, but also widely applies its research results to key scientific fields such as resources, energy, ecological environment, new materials, and human health in the new era. It plays an important role in implementing China’s Strategy of Rejuvenating the Country through Science and Technology, Strategy of Resource Security, and Strategy of “Dual Carbon” ^[2].

In October 2015, the State Council of the People’s Republic of China issued the “Overall Plan for

Coordinated Promotion of the Construction of World-Class Universities and Disciplines,” proposing a major national strategic decision to “drive the construction of world-class universities through the construction of first-class disciplines.” At the same time, it clarified the overall goals, specific tasks, and support measures for promoting the construction of “Double First-Class” [3]. In 2017, the implementation measures for the construction of world-class universities and first-class disciplines (“Double First-Class”) were introduced, indicating that China’s higher education will usher in a profound transformation, providing new opportunities and challenges for the cultivation of top-notch innovative talents in universities [4].

The School of Geoscience and Info-Physics at Central South University has three doctoral degree-granting points in primary disciplines: Geological Resources and Geological Engineering, Surveying and Mapping Science and Technology, and Geology. The Earth Science Group composed of these three primary disciplines is a new round of “Double First-Class” construction discipline points at Central South University. Among them, Geology, as one of the earliest advantageous disciplines established by Central South University, is the source and foundation of the non-ferrous metal discipline chain of “Geology, Mining, Beneficiation, Metallurgy, Materials.” At present, the Department of Geology at the School of Earth Science and Information Physics of Central South University covers secondary disciplines such as mineralogy, petrology, mineral deposits, structural geology, geochemistry, paleontology and stratigraphy, and Earth Information Science, with corresponding authorization points for master’s and doctoral degrees. In the context of the new era, the construction of the “Double First-Class” discipline will continue to be guided by national major needs and international geological frontiers. Based on the theoretical and methodological innovation research of metal mineral resource exploration and environmental geology under the background of China’s geological structure, combined with new theories of modern mineralization and structure, it further improves and develops the theoretical system of continental tectonic activation and mineralization, takes into account research on mineral resource exploration and comprehensive utilization, develops the discipline of geodynamics and its material movement epigenetic science, and serves the exploration, development, and utilization of non-ferrous metal resources and environmental protection work [5]. The improvement and updating of the above-mentioned content in the discipline, as well as the innovation of scientific research theory and technology, have put forward higher requirements for geochemical research and curriculum construction.

2. Curriculum construction

The Geochemistry course is based on courses such as structural geology, mineralogy, petrology, and university chemistry, and covers knowledge of the Earth’s chemical composition, trace element geochemistry, isotope geochemistry, and more. Advanced Geochemistry, as a fundamental course, is included in the graduate training program of the Department of Resource Exploration at the college. Taking the master’s degree course Advanced Geochemistry as an example, this course provides a new supplement for basic geochemistry and is intended for undergraduates of earth sciences.

Geochemistry mainly deals with chemical compositions, chemical processes, and chemical evolution for Earth and some celestial bodies. This course mainly attempts to instruct undergraduates on how to trace sources and geological processes by means of trace elements, rare earth elements, and isotopes, and how to precisely determine the timing of various geological bodies and reconstruct their evolution history. Based on the traditional introduction of basic theory, this course will emphasize the latest research progress on geochemistry, including new theories, research focus, and new studying methods. The total course hours are 32, and the key and difficult points lie in the basic theories and research progress of trace element geochemistry and isotope

geochemistry. Among them, the designated class hours for trace elements are 4 teaching hours and 2 discussion hours. The isotope section mainly focuses on geological chronology knowledge, namely the processing and interpretation design of radioactive isotope data, with 6 teaching hours. The course content, assessment methods, and other information are presented in **Table 1**.

Table 1. Course schedule of Advanced Geochemistry

Total hours (32)	Content	Assessment content and assessment ratio	
Lecture hours (24)	1. Elements in the solar system	Process score (50%):	
Discussion hours (4)	2. Geochemical kinetics	Attendance (20%)	Final-examination (50%):
Experimental hours (4)	3. Trace element geochemistry	Homework (20%)	Course paper
Internship hours (0)	4. Geochronology	Experiments (10%)	
	5. Stable isotope tracing technology		
	6. Fluid action geochemistry		

3. Problem and analysis

Geochemistry is a compulsory or elective course widely offered in geological-related majors in various universities. It has strong theoretical content that may be boring, and low student learning enthusiasm^[6]. The course teaching primarily focuses on teachers teaching basic theories in the classroom, and students passively accept key knowledge points, often struggling to understand geochemical theory. The main objective of this course is to apply the knowledge of geochemistry to enhance scientific literacy while addressing the research topic. Compared to undergraduate studies, Advanced Geochemistry, as a graduate course, has a higher level of content, more detailed practical application, and increased difficulty in understanding and applying it to research projects. The continuous development of science and technology, the application of new technologies and methods, and the addition of cutting-edge research results have also brought new challenges to teachers and students in effectively teaching and learning this course. In the current context of the “Double First-Class” construction in schools, the traditional input-based teaching method based mainly on lectures is no longer conducive to graduate students’ understanding of geochemistry and the application of research topics. This puts forward new requirements for the improvement of the teaching mode and methods of the Advanced Geochemistry course.

Fully understanding the learning and teaching perspectives of constructivist theory, implementing the student-centered approach in teaching activities, and leveraging the “leading and assisting” role of teachers provide a clear direction for the reform of teaching models and methods in the course of Advanced Geochemistry. As the main body of receiving and constructing a geochemical knowledge system, graduate students need to rely on existing knowledge systems, namely undergraduate course knowledge and self-learning related knowledge, and on the other hand, they require active guidance from teaching teachers^[7]. Therefore, in the process of teaching reform of Advanced Geochemistry, teachers should fully respect and leverage the role of students as the main body in learning, create teaching models (situations) that can stimulate students to reconstruct knowledge, establish interactive links (collaborations) between teachers and students, promote the exchange of information and ideas (conversations), and consciously guide students to engage in exploratory thinking activities. These approaches stimulate and enhance students’ interest in learning, promote the improvement of self-learning and innovation abilities, and ultimately achieve the construction of students’ curriculum knowledge systems and the cultivation of their application abilities.

4. Exploration and practice

The construction of a “Guiding Interactive” teaching model under constructivist theory is an innovative attempt at establishing a teaching model from the perspective of constructivist theory. By improving teaching methods, strengthening teaching concepts, clarifying learning objectives, guiding learning ideas, and utilizing modern teaching methods, interactive learning situations are created. In the practice of the Advanced Geochemistry course, taking the content of “Radioisotope Data Processing and Interpretation” as an example, it is mainly reflected in the following aspects.

4.1. Innovation and practice of teaching content

- (1) Distinguishing between primary and secondary, as well as key and difficult points in teaching content, with a focus on explaining the knowledge related to Rb-Sr, Sm-Nd, Re-Os, and U-Th-Pb dating and tracing, which are widely used in current research. “Cramming education” is avoided.
- (2) After completing the basic theoretical knowledge learning, a “Geochemical Laboratory Operation” section is set up, explaining the basic process of experimental testing, and selecting different testing methods corresponding to the basic principles to establish and deepen students’ understanding of textbook knowledge and improve their interest in learning.
- (3) Using multimedia technology to record the key content of the course and send it to students for preview before class is beneficial for students, as they can bring their questions to the class, better enter the learning state, and deepen their understanding of relevant knowledge.

4.2. Exploration and practice of teaching methods

- (1) Theoretical teaching is integrated with practical teaching, and practical research and application cases in the field of geology are incorporated into the teaching process in the classroom. A team teaching approach is adopted, combined with practical applications such as classroom exercises, homework, and experimental courses, fully leveraging the expertise of teachers, while effectively improving students’ innovation ability and hands-on analysis and practical skills.
- (2) Adopting a “problem-guided” teaching method, students are guided to actively think and explore problem-solving solutions by constantly raising scientific questions during the teaching process.
- (3) Using the “summary feedback” teaching evaluation method, with the practical projects of course chapters as the content unit and each group as the organizational unit, the written project reports and oral reports are checked. The student’s knowledge mastery and skills application are evaluated promptly. Reflective summaries are carried out on teaching effectiveness.

4.3. Transformation and practice of classroom role

The traditional teaching mode is optimized, which is mainly manifested in the transformation of the status of teachers and students during the teaching process. In “Guiding Interactive” education, teachers are no longer the leaders of teaching, but only the leaders in organization and process. Students act as the main body of the classroom to actively think and practice, while teachers serve as the participants, guiding students to learn independently. While achieving high-quality teaching results, they also implement the goals of curriculum reform and construction.

4.4. Creating interactive learning scenarios through modern teaching methods

In actual teaching, modern teaching equipment such as smart classrooms and geochemical laboratories are

utilized to create interactive learning scenarios between teachers and students, enabling students to actively participate in learning. Through their own exploration and learning, they can complete the teaching tasks assigned by the teacher, and ultimately achieve a teaching model that is teacher-led and student-centered in a true sense, greatly cultivating students' innovative abilities.

5. Conclusion

Geochemistry is an emerging discipline and an interdisciplinary field that combines geology and chemistry. It has shown strong vitality after nearly half a century of development. Today, geochemistry, with its unique research ideas and technical method system, has played a huge role in various fields such as basic geology, exploration and mineral exploration, environmental protection, endemic disease control, land resource management, and cultivation of famous and high-quality agricultural products. It has made outstanding contributions to the sustainable development of the national economy and the livability of human society. As an important course for graduate students in our department, Advanced Geochemistry has been implemented in the new round of "Double First-Class" discipline construction at Central South University. Through the implementation of "Guiding Interactive" teaching reform measures, research results have been timely introduced in the teaching process, effectively stimulating students' interest in learning, further enhancing their scientific thinking and research innovation skills, and reflecting important theoretical significance and practical value.

Funding

This article is the research result of the Education and Teaching Reform Research Project (No. 2022JGB038) of Central South University and supported by the Scientific Research Fund of Hunan Provincial Education Department (No. 23B0953).

Disclosure statement

The authors declare no conflict of interest.

Author contributions

L.L. conceived the idea of the study, and wrote the paper with W.Z., while C.L. analyzed the problem and submitted the paper.

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