Curriculum and Teaching Methodology (2024)
Clausius Scientific Press, Canada

DOI: 10.23977/curtm.2024.070913
ISSN 2616-2261 Vol. 7 Num. 9

Teaching Reform of Oil and Gas Geology in Resource Exploration Engineering: A Case Study of Shandong Institute of Petroleum and Chemical Technology

Yuzuo Liu[a], Jiao Wang[b,*], Jie Chen[c]

College of Petroleum Engineering, Shandong Institute of Petroleum and Chemical Technology, Dongying City, China
[a]2540639420@qq.com, [b]896221370@qq.com, [c]93680706@qq.com
[*]Corresponding author

Keywords: Undergraduate education, Teaching reform, Resource exploration engineering, Oil and gas geology

Abstract: Taking the teaching reform of oil and gas geology course of resource exploration engineering major in Shandong University of Petroleum and Chemical Technology as an example, this paper analyzes the key problems existing in the traditional teaching mode, such as the disconnection between theory and practice, the old teaching content, the single teaching method, and the insufficient cultivation of students' practical ability. In order to solve these problems, a series of creative and forward-looking reform initiatives are discussed, including the construction of a teaching system that combines theory and practice, the introduction of the latest scientific research results and industry dynamics, the adoption of diversified teaching methods and assessment mechanisms, and the strengthening of university-enterprise cooperation and the construction of internship and training bases. These reforms aim to stimulate students' interest in learning and improve their comprehensive quality and practical ability. This will provide the industry with more high-quality professionals with innovative spirit, practical ability and international vision.

1. Introduction

The importance of oil and gas geology as a core course in resource exploration engineering is self-evident. It not only provides students with the basic theoretical framework about the formation, distribution law and exploration and development of oil and natural gas, but also serves as a bridge connecting the theory of geology and the practice of petroleum industry[1]. Mastering the knowledge of this course is crucial for cultivating future professionals who can search for and effectively develop oil and gas resources in complex geological environments.

At present, the course of oil and gas geology faces a series of challenges in teaching. The traditional teaching mode often focuses on the teaching of theoretical knowledge, but neglects the close integration of theory and practice, which makes it difficult for students to apply what they have learned in practical problem solving. At the same time, the teaching content is lagging behind, failing to reflect the latest scientific research results and industry trends in a timely manner, which limits the

expansion of students' horizons. The homogenization of teaching methods, such as over-reliance on lectures and lack of interaction, will reduce students' interest and enthusiasm in learning. In addition, the insufficient cultivation of students' practical ability and the lack of sufficient opportunities for internships and practical training make them incompetent when facing the complex and changing tasks of oil and gas exploration. Together, these problems constitute the key obstacles in the current teaching of oil and gas geology.

Therefore, it is imperative to carry out teaching reform for the course of Oil and Gas Geology. This paper will take Shandong Institute of Petroleum and Chemical Technology as an example, and carry out teaching from the methods of building a teaching system combining theory and practice, introducing the latest scientific research achievements and industry dynamics, adopting diversified teaching methods and assessment mechanisms, strengthening school-enterprise cooperation and internship and training base construction, and so on. It aims to cultivate high-quality professionals with innovative spirit, practical ability and international vision, and contribute to the sustainable development of Chinese energy industry.

2. Basic Course Content

Oil and Gas Geology is a compulsory course for third-year students majoring in Resource Exploration Engineering. The textbook we use is "Petroleum and Natural Gas Geology and Exploration" (Third Edition), co-authored by Youlu Jiang, Ming Cha, and others[2]. This course consists of 64 class hours, including 54 class hours of lecture courses and 10 class hours of laboratory courses. This course mainly explains the basic principles and distribution laws of generation, transportation and aggregation of oil and natural gas in the earth's crust, methods and techniques of oil and gas exploration, oil and gas exploration procedures and basic knowledge of oil and gas exploration management. Students are required to systematically master the basic theories of oil and gas generation, transportation and aggregation. On this basis, they can carry out oil and gas geological research and oil and gas resource evaluation. Through the study of this course, students can independently analyze and solve practical problems in oil and gas geological exploration. This will lay a solid professional theoretical foundation for engaging in oil and gas geological research and exploration practice after graduation.

3. Problems in teaching oil and gas geology courses

3.1. Disconnection between theory and practice

The disconnection between theory and practice is a significant problem in the teaching of oil and gas geology course. The course itself is highly dependent on field exploration and data analysis, but many teaching activities are still limited to theoretical lectures in the classroom. Although students are able to grasp the principles of geology and the basic theories of oil and gas exploration, they often feel overwhelmed when faced with practical tasks such as analysis of actual geological formations and identification of oil and gas reservoirs. This disconnect not only limits students' ability to apply theoretical knowledge to solve practical problems, but also reduces their interest in the course content.

3.2. Outdated teaching content

With the progress of science and technology and the continuous updating of exploration technology, new theories and new technologies in the field of oil and gas geology are emerging. However, part of the teaching content fails to keep up with this pace, and still focuses on traditional geological theories and exploration methods. This leads to a gap between what students learn and the

current industry dynamics, thus making it difficult for students to meet the needs of the future job market.

3.3. Single teaching method

Oil and gas geology, as the science of exploring the oil and gas resources inside the earth, the problem of single teaching method is particularly prominent in the current course teaching. The traditional didactic teaching, although it can systematically teach the knowledge framework, but this way due to the lack of sufficient interactivity and interest, it is difficult to maintain the attention and interest of students for a long time, and ultimately make the students sick of learning.

Geology is a discipline that relies heavily on spatial imagination, logical reasoning and comprehensive analysis, so purely didactic teaching methods are often difficult for students to accept. Geological phenomena are complex and changeable, and the exploration and development of oil and gas resources require a high level of innovative thinking and practical ability. However, traditional didactic teaching often favors the transmission of knowledge and neglects the cultivation and stimulation of students' thinking ability, which ultimately prevents students from actively exploring the mysteries of geological phenomena.

At present, the traditional didactic teaching is often difficult to provide enough visual materials and dynamic demonstrations, which makes it difficult for students to understand complex geological formations, depositional processes, etc., and ultimately reduces the degree of students' cognition.

Therefore, the homogenization of teaching methods not only affects the teaching effect of oil and gas geology courses, but also restricts the degree of cultivation of students' comprehensive quality and innovation ability.

3.4. Inadequate development of students' practical skills

Oil and gas geology, as a science that studies the distribution, formation, exploration and development of oil and gas resources within the earth, is extremely practical. This requires students not only to have a deep theoretical foundation, but also to have the ability to transform knowledge into practical operation. However, in the existing education system, the teaching of this discipline tends to favor the transmission of theoretical knowledge, while neglecting the systematic cultivation of students' practical ability. Ultimately, the lack of practical ability of students restricts the development of talents and industry.

Specifically, although the content of the course covers theoretical knowledge such as geological tectonics analysis, sedimentary basin analysis, reservoir formation mechanism, etc., there is a lack of sufficient practical sessions to support the deepening and application of these theoretical knowledge. As a bridge between theory and practice, laboratory practice should allow students to improve their data analysis and report writing ability through simulation experiments and analysis of geological samples. However, due to insufficient experimental equipment, high cost of reagents and consumables, limited laboratory space, and lack of professional instructors, laboratory practice is often a formality. Ultimately, it is difficult to ensure that every student can get enough opportunities and guidance in laboratory classes.

Similarly, field internships are essential for improving students' skills in field observation, geological survey, sampling and analysis. However, the organization of field internships often faces many challenges, such as the selection of internship sites, the arrangement of transportation and accommodation, the consideration of safety issues, and the limited teaching resources. All of these uncertainties, to a certain extent, make the time, scale and quality of internships much less favorable. As a result, it is often difficult to achieve the expected teaching effect of field internships, which leads to students not being able to fully experience the diversity of geological phenomena and not being

able to deepen their understanding and application of theoretical knowledge in practice.

These problems lead to the lack of practical ability and analytical skills in facing the actual problems after mastering the theory of oil and gas geology. At the same time, the disconnection between theory and practice further hinders students' career development.

4. Course teaching reform content

4.1. Building a teaching system that combines theory and practice

4.1.1. Optimization of the curriculum and practical links

In order to solve the problem of disconnection between theory and practice in the teaching of oil and gas geology courses, the first task of teaching reform is clearly to build a teaching system that closely integrates theory and practice. The constructors of this teaching system first start from the curriculum, they ensure that students can fully participate in the practical aspects while mastering the necessary theoretical knowledge, so as to realize the deep integration of theory and practice.

It is a prerequisite to retain the necessary theoretical lecture sessions in the curriculum[3]. At the same time, the proportion of practical sessions such as laboratory training and field trips is substantially increased. This includes laboratory simulation experiments, such as analysis of geological samples and simulation of oil and gas reservoirs. Simulation experiments allow students to experience the process of geological exploration and development. Field trips allow students to go into nature, observe geological phenomena, collect geological data, and deepen their understanding of geological theory.

4.1.2. Establishment of “problem-based” learning programs

In order to enhance students' practical and innovative abilities, the teaching system should establish “problem-oriented” learning projects. These projects encourage students to conduct research on specific geological problems (e.g., formation of oil and gas reservoirs, evolution of geological structures). Students develop problem-solving skills by reviewing data, designing experiments and analyzing results. The projects also encourage teamwork and communication to stimulate innovative thinking[4]. Upon completion of the project, students present and provide feedback on their results, such as writing a report and oral defense, to enhance academic expression and critical thinking skills.

4.2. Introducing the latest scientific research results and industry trends

4.2.1. Update the teaching content

In order to maintain the cutting-edge and practicality of the oil and gas geology course, the teaching reform emphasizes the introduction of the latest scientific research results and industry trends, which includes regularly inviting experts and scholars in the industry to share the challenges in actual exploration and development, the latest exploration technologies, reservoir evaluation methods and environmental protection strategies. These lectures not only provide students with valuable practical experience and cutting-edge knowledge, but also stimulate their interest in geology research[5]. At the same time, the instructors can also incorporate the latest research results into the teaching materials and lesson plans in a timely manner to ensure that the students' knowledge is kept up-to-date with the current trends in the industry.

4.2.2. Establishment of the “Small Research Project” project

We can also set up a “small research project” program to provide students with more practical opportunities. These projects can come from teachers' research projects, or students can design their own research programs. By participating in these projects, students can experience geology research by taking part in the whole process from choosing a topic, designing an experimental plan, collecting data, analyzing the results to writing a thesis. The “Small Research Project” not only cultivates students' scientific research quality and innovation ability, but also enables them to have a deeper understanding of the new theories and technologies of geology.

4.3. Adopt diversified teaching methods and assessment mechanisms.

4.3.1. Diversified teaching methods

Teaching reform should be actively acted against the problem of homogenization of teaching methods in oil and gas geology courses. We should introduce diversified teaching methods. First of all, case teaching is an effective method. Case teaching can make students better understand the application of theoretical knowledge in practice by selecting real exploration cases for analysis. Secondly, group discussion is also a good way. Group discussion and role-playing can promote communication and cooperation among students, thus stimulating their collision of ideas and enhancing their problem-solving ability. In addition, project-based learning and flipped classroom are also teaching modes worth trying. Project-based learning encourages students to conduct in-depth research on specific topics and complete project tasks through teamwork, so as to cultivate their practical ability and innovative thinking. Flipped classroom is a brand new teaching mode. Flipped classroom subverts the traditional teaching process. It allows students to learn theoretical knowledge independently through videos and reading materials before class, while class time is mainly used for discussion, Q&A and practical operation. Therefore, the flipped classroom model can improve the teaching efficiency of teachers and the learning depth of students.

4.3.2. Diversified assessment mechanisms

Teaching reform requires the establishment of a diversified assessment mechanism to comprehensively evaluate students' learning outcomes. Traditional examination results are part of the assessment, but in addition to this, attention should be paid to the comprehensive quality of students. Students' practical ability is an important part of the assessment. Students' innovative thinking is also part of the assessment. Also, students' performance in teamwork should be included in the assessment. To assess these abilities, assignments can be used to test students' mastery of theoretical knowledge and their ability to apply it. Reports are also a form of assessment that can provide further insight into students' application of knowledge. Project presentations can visualize students' practical achievements and innovative thinking. Oral defense can practice students' expression and communication skills. By adopting these diversified assessment methods, teachers can have a more comprehensive understanding of students' learning and provide targeted guidance for their future career development.

4.4. Strengthening school-enterprise cooperation and internship training base construction

The teaching reform of oil and gas geology courses should strengthen the cooperation between schools and enterprises and the construction of internship and training bases in order to improve the practical ability and professionalism of students. Schools should establish long-term cooperative relationships with petroleum enterprises, geological exploration units and so on. These units will

jointly develop internship training programs. These programs provide students with real professional environment and practice opportunities. At the same time, the school should strengthen the construction of on-campus internship and training bases. Bases such as geology simulation laboratories and oil and gas reservoir simulation centers will be built on campus. These bases will be equipped with advanced experimental equipment and software. These equipments and software can simulate the real exploration and development process. Students will be able to get in touch with the cutting-edge technology and equipment of the industry on campus. Through university-enterprise cooperation and the construction of internship and training bases, students can better understand the industry dynamics. Students' practical ability will also be enhanced. This will lay a solid foundation for students' future career development.

5. Conclusions

In the teaching reform of Oil and Gas Geology of Resource Exploration Engineering, we deeply realize the limitations of traditional teaching mode and the necessity of reform. We solve the problems in the traditional teaching mode by building a teaching system combining theory and practice, introducing the latest scientific research results and industry trends, adopting diversified teaching methods and assessment mechanisms, strengthening school-enterprise cooperation and the construction of internship and training bases, etc., so as to stimulate the students' interest in learning, and enhance their practical ability and innovative thinking.

As a highly comprehensive and practical discipline, the implementation of the teaching reform of Petroleum and Natural Gas Geology not only implies a comprehensive reshaping of the knowledge structure of students, but also represents an in-depth enhancement of their comprehensive quality. We firmly believe that through this series of reform measures, we will be able to cultivate more resource exploration engineering professionals with solid theoretical foundations, excellent practical skills and innovative thinking ability, thus injecting more intellectual power and contribution to the national resource exploration and development cause.

Acknowledgements

This research was funded by Jiao Wang's project "Upgrading and Practice of Applied Talent Training System for Resource Exploration Engineering under the Background of Industrial Upgrading" (2024 Petroleum Higher Education Research Project).

References

[1] Dudley, J.S., and Doram, T. (1999) Oil sands geologists in an industry-school partnership: a resource and teaching opportunity. Geoscience Canada.
[2] Jiang, YL, Cha, M., and Liu, H. (2024) Petroleum and Natural Gas Geology and Exploration. Petroleum Industry Press, Beijing.
[3] Fyrenius, A., Bergdahl, B., and Sil én, C. (2005) Lectures in problem-based learning-Why, when and how? An example of interactive lecturing that stimulates meaningful learning. Medical teacher, 27(1), 61-65.
[4] Geissler, G.L., Edison, S.W., & Wayland, J.P. (2012) Improving Students' Critical Thinking, Creativity, and Communication Skills. Journal of Instructional Pedagogies, 8.
[5] Macdonald, R.H., Manduca, C.A., Mogk, D.W., and Tewksbury, B.J. (2004) On the Cutting Edge: Improving learning by enhancing teaching in the geosciences. Invention and impact: Building excellence in undergraduate science, technology, engineering, and mathematics (STEM) education.