Teaching Reform in the Course of "Petroleum and Natural Gas Geology" under the Background of Big Data: A Case Study of Shandong Institute of Petroleum and Chemical Technology

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Abstract: With the rapid development of information technology, big data has become an important force driving changes in various industries. In the field of petroleum and natural gas geology, the application of big data technology has not only greatly enhanced data analysis and processing capabilities but also brought new challenges and opportunities to education and teaching in this area. This paper aims to delve into the teaching reform of the "Petroleum and Natural Gas Geology" course against the backdrop of big data. By analyzing the current teaching situation and combining the characteristics of big data technology, a series of specific reform strategies are proposed. The goal is to construct a new teaching mode that is student-centered, emphasizes both theory and practice, and integrates technology and innovation, in order to meet the demands of the new era for petroleum geology talents.

1. Introduction

Petroleum and Natural Gas Geology is an important discipline that intersects geology and petroleum engineering, with a broad research scope covering geological structures, sedimentary environments, the formation and distribution laws of oil and gas reservoirs, and other aspects. With

the continuous growth of global energy demand and the deepening of oil and gas exploration and development, the requirements for petroleum geology talents are increasingly high. Especially driven by big data technology, how to extract valuable information from massive geological data and conduct efficient data analysis and decision support has become an important issue facing the field of petroleum geology. However, the current teaching of the "Petroleum and Natural Gas Geology" course still faces many challenges. On the one hand, traditional teaching content and methods have been difficult to meet the knowledge structure and skill requirements of talents in the context of big data. On the other hand, the scarcity of practical teaching resources and the monotony of teaching methods also limit the cultivation of students' practical abilities and innovative abilities. Therefore, carrying out teaching reform, introducing big data technology, and innovating teaching modes have become inevitable choices to improve teaching quality and cultivate high-quality petroleum geology talents.

2. Analysis of the Current Teaching Situation

2.1 Lagging Teaching Content

Currently, the teaching content of the "Petroleum and Natural Gas Geology" course mainly focuses on traditional areas such as basic geological theories and oil and gas exploration and development technologies, while content related to the application of big data technology in the field of petroleum geology, data science, and information technology is rarely involved[1]. This results in students finding it difficult to effectively combine their learned knowledge with big data technology when facing practical work, making it hard for them to meet the requirements of the new era for petroleum geology talents.

2.2 Monotonous Teaching Methods

Traditional teaching methods are mainly lecture-based, supplemented by practical teaching links such as experiments and internships[2]. However, this monotonous teaching method often ignores students' subject status and individual differences, making it difficult to stimulate students' learning interest and enthusiasm. At the same time, due to limitations in teaching resources, practical teaching links often become mere formalities, failing to achieve the expected teaching effects.

2.3 Scarcity of Practical Teaching Resources

Practical teaching is an important way to enhance students' practical and innovative abilities[3]. However, the practical teaching resources for the "Petroleum and Natural Gas Geology" course are relatively scarce, mainly manifested in the following aspects: firstly, outdated experimental equipment that fails to meet the needs of big data processing and analysis; secondly, inadequate

internship bases, making it difficult for students to access real oil and gas exploration and development environments; and thirdly, the lack of practical teaching platforms in cooperation with enterprises, leading to students' difficulty in understanding industry frontier technologies and market dynamics.

2.4 Imperfect Evaluation System

The traditional evaluation system often focuses on assessing students' knowledge mastery level while neglecting the evaluation of students' practical abilities, innovative abilities, and comprehensive qualities[4]. This evaluation system is difficult to fully reflect students' learning outcomes and development potential, and is also unfavorable for stimulating students' learning enthusiasm and innovative spirit.

3. Teaching Reform Strategies under the Background of Big Data

3.1 Optimizing Teaching Content and Introducing Big Data Technology

3.1.1 Updating Geological Theories and Exploration Technologies

With the continuous development of geological theories and exploration technologies, teaching content should be updated in a timely manner to introduce the latest geological theories and exploration technologies into the curriculum. For example, the basic principles and application methods of modern exploration technologies such as seismic exploration, well logging interpretation, and reservoir simulation can be introduced. At the same time, application cases of big data technology in oil and gas exploration and development, such as big data-based seismic data processing and interpretation, reservoir prediction and evaluation, can also be introduced.

3.1.2 Strengthening Data Science and Information Technology Education

The content of data science and information technology should be increased in the "Petroleum and Natural Gas Geology" course. This includes basic methods for data collection, storage, processing, and analysis; the use of big data platforms and tools; data visualization and data mining techniques. Through the learning of these contents, students will acquire the ability to utilize big data technology for geological data analysis and processing.

3.1.3 Constructing an Interdisciplinary Knowledge System

In the process of optimizing teaching content, emphasis should be placed on constructing an interdisciplinary knowledge system. The knowledge of geology, geophysics, chemistry, computer science, and other disciplines should be organically integrated to form a systematic and comprehensive curriculum system. This will help students form a comprehensive knowledge

structure and way of thinking, improving their ability to solve practical problems.

3.2 Innovating Teaching Methods and Enhancing Teaching Effects

3.2.1 Case Teaching

Case teaching is an effective teaching method that can help students combine theoretical knowledge with practice. In the "Petroleum and Natural Gas Geology" course, some typical geological exploration and development cases can be selected for students to analyze and discuss. These cases can include successful oil and gas exploration projects, complex reservoir evaluation problems, etc. Through case teaching, students can understand the problems and challenges in actual work and learn to apply learned knowledge for problem-solving and decision support.

3.2.2 Interactive Teaching

Interactive teaching can stimulate students' learning interest and enthusiasm, improving teaching effects. In the "Petroleum and Natural Gas Geology" course, interactive teaching methods such as questioning, discussion, and group assignments can be adopted. For example, open-ended questions can be set in the classroom to guide students in thinking and discussion; students can also be organized to conduct group assignments to jointly solve some practical problems. Through interactive teaching, students can actively participate in classroom discussions and practical activities, deepening their understanding of theoretical knowledge.

3.2.3 Flipped Classroom

The flipped classroom is a teaching mode that reverses the traditional lecture and homework links in the classroom. In the "Petroleum and Natural Gas Geology" course, the flipped classroom teaching mode can be adopted. Teachers can make teaching content into videos or PPTs and other teaching resources for students to learn independently before class[5]; then, in the classroom, activities such as group discussions, question-and-answer sessions, and practical operations can be conducted. Through the flipped classroom, students can more flexibly arrange their study time and also obtain more practical opportunities and interactive experiences in the classroom.

3.2.4 Using Big Data Technology for Auxiliary Teaching

Big data technology can provide students with rich data resources and analysis tools, helping them better understand and master geological theories and exploration technologies. In the "Petroleum and Natural Gas Geology" course, big data technology can be utilized for auxiliary teaching. For example, data analysis software can be used for data processing and analysis; visualization tools can be used for data visualization; and machine learning algorithms can be used for reservoir prediction. Through these auxiliary teaching means, students can more intuitively understand geological phenomena and

data characteristics, improving learning effects.

3.3 Strengthening Practical Teaching and Enhancing Practical Abilities

3.3.1 Establishing Practical Teaching Bases

To improve students' practical abilities, practical teaching bases can be established. These bases can include geological laboratories, oil and gas exploration and development simulation laboratories, etc. Through these practical teaching bases, students can conduct practical operations and simulation experiments, deepening their understanding of theoretical knowledge. At the same time, practical teaching platforms can also be established in cooperation with enterprises, allowing students to access real oil and gas exploration and development environments and frontier technologies.

3.3.2 Strengthening University-Enterprise Cooperation

University-enterprise cooperation is an important way to enhance students' practical and innovative abilities. Close cooperation can be established with petroleum enterprises to jointly carry out practical teaching and scientific research projects. Through cooperation with enterprises, students can participate in real oil and gas exploration and development projects, understand the actual workflow and technical requirements of enterprises; at the same time, they can also apply learned knowledge to practical work, improving their practical abilities and professional qualities.

3.3.3 Conducting Scientific Research Projects

Encouraging students to participate in scientific research projects can improve their scientific research and innovative abilities. In the "Petroleum and Natural Gas Geology" course, students can be guided to participate in the research work of scientific research projects. These projects can include the development of geological exploration technologies, the improvement of reservoir evaluation methods, etc. By participating in scientific research projects, students can understand the basic processes and methods of scientific research work; at the same time, they can also exercise their innovative thinking and problem-solving abilities.

3.4 Improving the Evaluation System and Promoting Comprehensive Development

3.4.1 Establishing Practical Teaching Bases

To enhance students' practical abilities, practical teaching bases can be established. These bases can include geological laboratories, oil and gas exploration and development simulation laboratories, etc. Through these practical teaching bases, students can engage in practical operations and simulation experiments, deepening their understanding of theoretical knowledge. At the same time, practical teaching platforms can be established in collaboration with enterprises, exposing students to real oil

and gas exploration and development environments and cutting-edge technologies.

3.4.2 Strengthening University-Enterprise Cooperation

University-enterprise cooperation is an important way to enhance students' practical and innovative abilities. Close cooperation can be established with oil companies to jointly carry out practical teaching and scientific research projects. Through cooperation with enterprises, students can participate in real oil and gas exploration and development projects, understanding the actual workflow and technical requirements of the enterprises; at the same time, they can also apply their learned knowledge to practical work, improving their practical abilities and professional qualities.

3.4.3 Conducting Scientific Research Projects

Encouraging students to participate in scientific research projects can improve their research and innovative abilities. In the "Petroleum and Natural Gas Geology" course, students can be guided to participate in research work of scientific projects. These projects can include the development of geological exploration technologies, the improvement of oil and gas reservoir evaluation methods, etc. By participating in scientific research projects, students can understand the basic processes and methods of scientific research; at the same time, they can also exercise their innovative thinking and problem-solving abilities.

3.5 Improving the Evaluation System to Promote Comprehensive Development

3.5.1 Diversified Evaluation

The traditional evaluation system often focuses on assessing students' knowledge mastery. However, in the context of big data, the evaluation system for the "Petroleum and Natural Gas Geology" course should be more diversified. Besides assessing knowledge mastery, it should also focus on evaluating students' practical abilities, innovative abilities, and comprehensive qualities. For example, students' practical and innovative abilities can be evaluated through experiment reports, project reports, and group discussions; their comprehensive qualities can be evaluated through classroom performance and homework completion.

3.5.2 Process Evaluation

Process evaluation is an evaluation method that focuses on students' performance during the learning process. In the "Petroleum and Natural Gas Geology" course, process evaluation can be adopted to focus on students' learning process and growth trajectory. For example, students' learning process and performance can be recorded through classroom interaction, group discussions, and homework completion; at the same time, regular feedback and personalized guidance can be provided to help students improve their learning styles and methods.

3.5.3 Enterprise Evaluation

Enterprise evaluation is a way to introduce enterprise needs and standards into the evaluation system. In the "Petroleum and Natural Gas Geology" course, practical teaching and scientific research projects can be carried out in collaboration with enterprises, and enterprise experts can be invited to evaluate students' performance. Through enterprise evaluation, students' practical abilities and professional qualities can be reflected more objectively; at the same time, it can also provide a reference for students' future employment and career development.

4. Teaching Reform Implementation Cases

4.1 Teaching Reform Practice of the "Petroleum and Natural Gas Geology" Course

Shandong Institute of Petroleum and Chemical Technology has carried out teaching reform practice in the "Petroleum and Natural Gas Geology" course. They have introduced big data technology to optimize teaching content and methods; at the same time, they have also strengthened the construction of practical teaching and the evaluation system. The specific practices are as follows:

4.1.1 Introducing Big Data Technology

Shandong Institute of Petroleum and Chemical Technology has introduced big data technology into the "Petroleum and Natural Gas Geology" course, including basic methods of data collection, processing, and analysis; the use of big data platforms and tools; data visualization and data mining technologies. Through the learning of these contents, students have acquired the ability to use big data technology for geological data analysis and processing.

4.1.2 Innovating Teaching Methods

The college has adopted teaching methods such as case teaching, interactive teaching, and flipped classrooms. They have selected some typical geological exploration and development cases for students to analyze and discuss; at the same time, they have also organized students to engage in group assignments and classroom discussions. Through the application of these teaching methods, students' learning interest and enthusiasm have been significantly improved; at the same time, it has also cultivated students' team collaboration abilities and innovative thinking.

4.1.3 Strengthening Practical Teaching

The college has established practical teaching bases such as geological laboratories and oil and gas exploration and development simulation laboratories. Through the construction of these practical teaching bases, students can engage in practical operations and simulation experiments; at the same time, they can also be exposed to real oil and gas exploration and development environments and

cutting-edge technologies. In addition, the college has also established practical teaching platforms in collaboration with enterprises, allowing students to participate in real oil and gas exploration and development projects. Through the setting of these practical teaching sessions, students' practical abilities have been significantly improved.

4.1.4 Improving the Evaluation System

The college has introduced diversified evaluation and process evaluation into the evaluation system. They not only focus on students' knowledge mastery but also pay attention to evaluating students' practical abilities, innovative abilities, and comprehensive qualities. At the same time, regular feedback and personalized guidance are also provided to help students improve their learning styles and methods. Through the implementation of these evaluation methods, students' learning effects and comprehensive qualities have been comprehensively improved.

5. Evaluation and Reflection on the Effects of Teaching Reform

5.1 Effect Evaluation

Through the evaluation of the above teaching reform implementation cases, we can find the following effects:

5.1.1 Improvement of Students' Abilities

After the teaching reform, students and employees have seen significant improvements in knowledge mastery, practical abilities, innovative abilities, and comprehensive qualities. They can better understand theoretical knowledge and apply it to practical work; at the same time, they also possess stronger team collaboration abilities and innovative thinking.

5.1.2 Improvement of Teaching Quality

The teaching reform has made teaching content more closely aligned with actual needs and cutting-edge technologies, teaching methods more flexible and diverse, and practical teaching sessions more abundant and enriching. These reform measures have improved teaching quality and effectiveness, enabling students to more comprehensively master knowledge and skills.

5.1.3 Increase in Enterprise Satisfaction

For oil companies, employees who have undergone training can better adapt to the actual needs and technological development trends of the enterprises. They possess stronger practical abilities and innovative abilities, able to create more value for the enterprises. Therefore, enterprises' satisfaction with employees after the teaching reform has also been improved.

5.2 Reflection and Improvement

Although the teaching reform has achieved certain results, there are still some problems and deficiencies. The following are reflections and improvement suggestions for these issues:

5.2.1 Strengthening the Construction of the Teaching Staff

The construction of the teaching staff is the key to teaching reform. The training and development of teachers should be strengthened to improve their professional quality and teaching abilities. At the same time, teachers should also be encouraged to actively participate in scientific research projects and practical activities to improve their practical experience and innovative abilities.

5.2.2 Improving Practical Teaching Resources

Practical teaching resources are an important guarantee for improving students' practical abilities. Efforts should be intensified to invest in practical teaching resources to build more advanced laboratories and internship bases. At the same time, closer cooperation should be established with enterprises to provide students with more practical opportunities and internship positions.

5.2.3 Optimizing the Evaluation System

The evaluation system is an important criterion for testing teaching effectiveness. Efforts should be made to further improve the construction of the evaluation system, adopting more scientific, objective, and comprehensive evaluation methods. At the same time, personalized evaluation and guidance should be strengthened for students to help them better leverage their strengths and potential.

5.2.4 Promoting Continuous Deepening of Teaching Reform

Teaching reform is a continuous process. It is necessary to continuously summarize experiences and lessons and promote the continuous deepening of teaching reform. At the same time, attention should also be paid to industry development trends and technological changes, timely adjusting teaching content and methods to adapt to the demand for petroleum geology talents in the new era.

6. Conclusion

The teaching reform of the "Petroleum and Natural Gas Geology" course in the context of big data is a complex and arduous task. By optimizing teaching content, innovating teaching methods, strengthening practical teaching, and improving the evaluation system, we can effectively enhance students' knowledge mastery, practical abilities, and innovative abilities. However, teaching reform still needs to be continuously promoted and improved. We should strengthen the construction of the teaching staff, improve practical teaching resources, optimize the evaluation system, and promote the continuous deepening of teaching reform. Only in this way can we cultivate more high-quality,

innovative, and practically skilled petroleum geology talents and make greater contributions to the development of the petroleum industry.

Acknowledgements

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