

Deep Exploration of Teaching Reform in "Petroleum and Natural Gas Geology Curriculum Design" Oriented by National Oil and Gas Geology Competition-A Case Study of Shandong University of Petroleum and Chemical Technology

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Abstract: The National Oil and Gas Geology Competition, as a pivotal platform for evaluating students' professional practical capabilities and innovative thinking, offers clear guidance for advancing teaching reforms in university-level oil and gas geology courses. This study takes the "Petroleum and Natural Gas Geology Curriculum Design" at Shandong University of Petroleum and Chemical Technology as a case example to analyse prevailing issues in current curriculum design, including disconnection between teaching content and industry demands, misalignment of practical training with competition standards, and over-reliance on singular evaluation metrics. Aligning with competition requirements for competencies in data integration, map compilation, comprehensive analysis, and teamwork, this research proposes a reform strategy of "promoting teaching and learning through competition." Key measures include reconstructing curriculum content to mirror competition modules, innovating scenario-based teaching models, strengthening competition-empowered practice, and implementing multidimensional evaluation systems. The aim is to cultivate high-caliber applied oil and gas geology talents capable of meeting industrial development needs.

1. Introduction

"Petroleum and Natural Gas Geology Curriculum Design" serves as a core bridge between theoretical instruction and engineering practice for Resource Exploration Engineering majors, aiming to enhance students' ability to solve complex geological problems using petroleum geology theories through integrated research training^[1]. In recent years, with the institutionalization of national-level competitions (e.g., the "National Oil and Gas Geology Competition"), their multidimensional assessment framework-integrating skill testing, knowledge evaluation, and academic exchange-has

emerged as a critical benchmark for evaluating university talent cultivation quality^[2]. However, traditional curriculum design faces challenges such as outdated content relative to technological advancements, disconnection from competition requirements, and insufficient emphasis on innovative thinking, hindering students' ability to meet competition demands for full-process competencies in data integration, map compilation, comprehensive analysis, and result presentation^[3].

To address these gaps, Shandong University of Petroleum and Chemical Technology has spearheaded systematic reforms in its curriculum design, guided by the National Oil and Gas Geology Competition. By integrating competition-based training, simulating real contest scenarios, and optimizing evaluation mechanisms, the university has achieved deep alignment between curriculum teaching, industrial needs, and competition standards, providing a practical pathway for nurturing applied oil and gas geology professionals.

2. Analysis of Current Teaching Challenges

Based on teaching practices at Shandong University of Petroleum and Chemical Technology and nationwide surveys of peer institutions, the following critical issues persist in current curriculum design:

2.1 Misalignment between Teaching Content and Competition Requirements

Traditional curriculum content focuses heavily on theoretical validation (e.g., basic training in source rock evaluation and trap analysis) but lacks competition-emphasized practical skills such as comprehensive multi-source data application and hydrocarbon accumulation simulation under complex geological settings. For instance, competition skill tests require students to complete structural mapping and migration pathway simulation within strict time limits, whereas existing curriculum design imposes minimal standards for map precision, data accuracy, and visualization-leaving students ill-prepared for high-intensity, high-stakes competition environments.

2.2 Monotonous Practical Training and Lack of Competition Simulation

Curriculum design typically adopts a "teacher topic assignment-student independent completion" model, neglecting training in core competition competencies such as teamwork and time-bound problem-solving. According to guidelines for the 8th National Oil and Gas Geology Competition, integrated skill groups must complete geological data interpretation, processing, accumulation model mapping, and on-site defense within 3 months. In contrast, traditional curriculum design spans only 1 week without team-based task division, resulting in weak collaborative awareness and poor time management skills for extended projects.

2.3 Result-Oriented Evaluation Overlooking Process Competencies

Current evaluation systems prioritize final reports and map quality (accounting for >70% of scores) but inadequately assess process capabilities such as data analysis, logical reasoning, and innovative thinking. Competition evaluations, however, emphasize multidimensional criteria including scheme rationality, data processing innovation, and result presentation clarity-rendering traditional systems incapable of reflecting students' holistic literacy.

2.4 Inadequate Faculty Experience in Competition Guidance

While most instructors possess strong theoretical backgrounds, they lack expertise in competition question design, evaluation, and practical coaching, limiting their ability to integrate competition standards and strategies into daily teaching. This deficiency reduces the effectiveness of students' competition preparation.

3. Competition-Oriented Teaching Reform Strategies

To address these challenges, Shandong University of Petroleum and Chemical Technology has implemented reforms across four dimensions-content, pedagogy, practice, and evaluation-benchmarked against national competition standards:

3.1 Reconstructing Curriculum Content to Align with Competition Module

Using National Oil and Gas Geology Competition skill test questions as blueprints, the curriculum project library has been restructured to cover core competition modules: source rock hydrocarbon generation potential evaluation, hydrocarbon migration pathway simulation, trap comprehensive assessment, and accumulation model mapping. For example, based on the competition question "Hydrocarbon Accumulation Conditions in the Dongying Sag," a curriculum task was designed requiring students to analyze geological data (drilling records, seismic profiles, geochemical indices) and produce six key maps (e.g., source rock evaluation, reservoir property analysis, hydrocarbon distribution prediction) alongside a research report-simulating the full competition workflow of data-mapping-reporting.

To meet competition demands for big data analysis and 3D modeling, the curriculum incorporates geological data visualization and GIS application training. Students are required to use software (e.g., Surfer, CorelDRAW) for map compilation, enhancing achievement standardization and aesthetics to match competition-quality requirements.

3.2 Innovating Scenario-Based Teaching Models

Curriculum design is divided into individual tasks (e.g., single-well histogram plotting) and team projects (e.g., "Evaluation of Hydrocarbon Potential in a Rift Basin"). Teams of 3–5 students are assigned roles (data collation, analysis, mapping, reporting) and complete tasks within a 1-week deadline, fostering collaboration and time management.

An intramural preliminary contest is held mid-semester, simulating competition conditions: 8-hour time-limited tasks (e.g., reservoir type identification, trap effectiveness evaluation) assess rapid theory application. A final result defense invitation industry experts (e.g., geological engineers from Shengli Oilfield) as judges, adopting competition standards (10-minute PPT presentation + 5-minute Q&A) to enhance presentation skills.

3.3 Building a "Course-Competition Integration" Practice Platform

Leveraging the university's "Oil and Gas Geology Exploration Lab," competition-designated software (Petrel, Landmark) and databases (e.g., Shengli Oilfield, Bohai Bay Basin) are deployed. Virtual simulation experiments enable students to practice on-site defense scenarios.

A competitive coaching team reviews experience. (e.g., National Oil and Gas Geology Competition question designers) and industry engineers (e.g., Jiangnan Oilfield Exploration Institute experts) provides regular workshops on mapping standards and report writing, guiding students in

competitions like the "National College Students Resource Exploration Skills Contest."

3.4 Implementing Multidimensional Competency-Oriented Evaluation

A three-tiered evaluation system (process assessment: 30%, result assessment: 40%, competition performance: 30%) aligns with competition criteria. Process assessment includes teamwork and software proficiency; result assessment emphasizes map accuracy and report innovation; competition performance incorporates intramural and national contest results. This system shifts focus from "exam-oriented learning" to "competency development."

4. Reform Implementation Cases

In 2025, the university launched curriculum reforms with the following measures:

Replaced single-work-area analysis with comparative studies of typical competition cases (e.g., Dongying Sag, Songliao Basin) to enhance comprehensive analysis capabilities.

Hosted the first "Intramural Oil and Gas Geology Skills Competition," where contest tasks were simulated to select teams for the 9th National Competition.

Increased the weighting of "competition performance" to 30% for the 2023 Resource Exploration Engineering cohort, leading to improved report quality and map standardization.

5. Reform Reflections

Teacher development needs: Some teachers lack professional knowledge in emerging competitive technologies such as 3D geological modeling. The plan includes seconded teachers to participate in the competition evaluation expert group and jointly developing a mentorship training program led by the enterprise.

Resource Expansion: Insufficient software licenses hinder full participation; initiatives include applying for provincial virtual simulation projects and building a cloud-based competition training platform.

6. Conclusion

Competition-oriented reforms in "Petroleum and Natural Gas Geology Curriculum Design" have effectively bridged the gap between traditional teaching and industrial needs through content-competition alignment, scenario simulation, and competency-focused evaluation. Shandong University of Petroleum and Chemical Technology's experience demonstrates improved student competition performance, practical abilities, teamwork, and industrial adaptability-offering replicable models for applied talent cultivation. Future efforts will deepen "course-competition integration," synchronize teaching resources with industrial technologies, and supply high-quality talent for the petroleum sector's high-quality development.

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