Implementing the case study method in a process of teaching oil engineers

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Abstract. The article describes the features of teaching and compiling cases suitable for students of "Oil and Gas Engineering" specialty. It is noted that such comprehensive classes provide students with the necessary connections between all the disciplines studied in the curriculum and allow you to quickly find, process, analyze and use professionally relevant information from various sources, to form a broader view of solving oil and gas complex problems. Fulfillment of such tasks allows not only to consolidate students' knowledge, but also motivates them to self-development and also strengthens interest in future work.

1. Introduction
Starting from the first year, students studying the specialty "Oil and Gas Engineering" get acquainted with subjects that gradually form hydrocarbon production specialists from them.

In the process of studying the subject "History of the development of the oil and gas business" on the first year, students get acquainted with their chosen profile, reveal the resource potential of the Russian Federation, learn about the main provinces and fields.

From the beginning of the second year, students begin to study the discipline "Fundamentals of Oil and Gas Business". Here, students have the opportunity to see the full cycle of work with hydrocarbon raw materials, from the exploration to the processing.

Further, during the course "Petrophysics" and "Physics of the oil and gas reservoir", future specialists get acquainted with the properties and behavior of the reservoirs and the fluids.

In the third year, there is a complete immersion in the specialty, and students learn almost all the main disciplines. They study the features of hydrocarbon filtration in a porous medium, methods of well drilling, repair and operation and features of field development.

In the final course, the main subjects are methods for increasing oil recovery and hydrodynamic modeling. For the successful construction of hydrodynamic models, the knowledge gained during all previous years of training is necessary.

Recalling the previous material, it becomes clear that students have knowledge and understanding of the processes occurring in a porous medium. But all of these "building blocks" of knowledge do not form an overall picture in which each individual element is logically connected with all the others. For the formation of these connections, logical patterns and transitions of competencies obtained in some disciplines into mandatory elements of others, complex tasks are needed that facilitate the application of all accumulated knowledge [1]. Based on the foregoing, the case method is the best option.
2. Features of case method

Case study learning is learning from a specific situation or case. Usually a case consists of real facts and contains an ambiguous problem. Harvard Law School (1870) became the founder of the application of case-studies in the educational process, and such a system has been used for teaching business since 1920. As a rule, the basis of the case is the situation that occurred in a particular company [2,3]. If necessary, the business situation is aggravated, and the problem provoking a discussion is laid in it. To make a case closer to reality, it is usually prepared in close collaboration with company representatives: case authors discuss the problem with top managers, conduct interviews with employees, collect data from different departments. The content of the case is supplemented by data from open sources: reports of consulting companies, market research, information for investors, statistics. Thus, in the training of specialists in economic, legal and even medical fields, this approach has long established itself as successful, interesting and, moreover, necessary [3].

This method is gaining more and more popularity due to its undeniable advantages. Firstly, this method has a pronounced practical orientation. Students can apply the acquired knowledge to solve a specialized, non-standard problem and assess the level of their knowledge and competencies. Secondly, the case trains specific skills, those skills that may be necessary in the real working process. Thirdly, it is an interactive format that allows you to communicate in a group, identify leadership qualities, and also contributes to better assimilation of the material due to emotional involvement in the process. And, in conclusion, this training format involves active work with different sources of information, analysis of a large amount of data [4,5]. The complexity of the case solution is that standard cases do not have the correct answer, there can be several effective solutions. In addition, a limited amount of time is allotted for the solution, which simulates real practical situations and allows participants to be more actively and intensively involved in the process. The teacher in the process of such a group work can not only assess the level of knowledge of the participants of the working groups, but also form a positive attitude of the students to the knowledge gained, motivate students to future work in the specialty.

By complexity, volume and duration, the cases can be like classic Harvard cases (20-25 pages), which involve working in a team for several days. There are thematic ones, with preliminary preparation (3-5 pages of information) and Executive cases (1-2 pages), when participants get acquainted with the case directly at the event (lesson) [6]. In the framework of training and knowledge testing at the university, the Executive-case becomes optimal. Traditional for business, when preparing engineering students, this approach is used much less often. For example, the training of oil students, the main problem becomes the complexity of the task, which can be completed in a short time.

3. Learning process

At the end of the 4th year of education, students were offered to solve a case. The case includes several areas of knowledge, such as: oil and gas geology, petrophysics, physics of oil and gas reservoir, well drilling, well operation, oil and gas field development, equipment and technologies for enhanced oil recovery methods, hydrocarbon field gathering and treatment, hydrocarbon transportation, oil and gas industry economics. As part of the case study, students worked in teams. They acted as the head of a vertically integrated oil and gas company (VINK), which has several fields in its assets.

The oilfields are located in the different parts of Russia: in the Timan-Pechora oil and gas province, in the Volga-Ural province and in the Lena-Tunguska province in Eastern Siberia (figure 1).
Participants needed to determine which asset is the most promising to invest in, i.e. to conclude about the possibility (impossibility) of a profitable development of each. For the object that, in their opinion, is suitable for development in the current conditions, it is necessary to highlight operational facilities, justify the development system, and propose a production method. Substantiate ways of processing products and identify markets. The complexity of the task is that all objects have their undeniable advantages and disadvantages. The proposed deposits varied greatly in structure (figure 2-4) and in reserves. But in this case, smaller reserves were not a repulsive factor, just as the largest reserves did not become the undisputed leader.

**Figure 1.** The location of oilfields in the territory of the Russian Federation.

**Figure 2.** Object № 1, located in the Timan-Pechora oil and gas province.

**Figure 3.** Object № 2, located in the Volga-Ural oil and gas province.

**Figure 4.** Object № 3, located in the Lena-Tunguska oil and gas province.
But, among other things, the fluid properties varied greatly (table 1), the geological and physical conditions of occurrence of productive reservoirs, and the complexity of entering the project. Even reservoir rocks are different in each case, these are both carbonates and sandstones. This allows you to test work skills in fundamentally different conditions, and will create difficulties when choosing a system for enhancing oil recovery. The third field, among other things, was supplemented by a large gas deposit. All objects had only one thing in common – all oils were characterized by higher viscosity, which created difficulties in determining the technology of production and transportation.

**Table 1.** The main geological and physical characteristics of the deposits and the properties of the fluids.

| Reservoir | Field 1 | Field 2 | Field 3 |
|-----------|---------|---------|---------|
| Density, kg/m³ | 930 | 880 | 830 |
| Viscosity, mPa·sec | 140 | 45 | 30 |
| Content (sulfur), % | 1.96 | 3.61 | 0.82 |
| Content (paraffine), % | 4.13 | 3.75 | 2.35 |
| Content (gum), % | 13.09 | 32.94 | 15.58 |
| Content (asphalt), % | 7.03 | 10.89 | 2.24 |
| Content (V), % | 0.048 | 0.019 | 0.002 |
| Content (Ni), % | 0.031 | 0.009 | 0.003 |
| Content (He), % | – | – | 2.5 |
| T (reservoir), °C | 17 | 25 | 44 |
| P (reservoir), MPa | 11 | 15 | 14 |

But from the initial data it is seen that the higher than average oil viscosity is also different, for example, for field 1, the viscosity is very high (140 mPa·sec), while at the third field it is higher than average (30 mPa·sec).

To help justify the choice of the field, links were made to resources containing information on existing Russian refineries and gas processing facilities, as well as pipelines routes. To determine the markets, oil and gas price forecasts were proposed for the domestic market, as well as for the markets of Europe and Asia (figure 5) [7].

**Figure 5.** Forecast of oil prices in the Asian, European and domestic markets.

4. Results
As a result of working on projects, students had to quickly collect, process and analyze a large amount of information, as well as apply all their knowledge gained in previous years of study. Students note
that after working on such a case assignment, the significance of information, which until then seemed
to be inapplicable, became more apparent. In addition, the participants realized how interesting the
solution of the problems of the oil and gas industry can be, which entailed an increase in the desire for
future employment in the specialty and self-development in the professional sphere.

All participants note that the solution of case-studies in comparison with the traditional practical
work and seminars allows one to more efficiently assimilate and apply the acquired knowledge, as
well as forms a positive attitude towards future knowledge among graduates and motivates them to
work in their specialty. All this, in turn, improves the quality of university graduates and raises the
university status in the eyes of partner companies and future employers.

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