

Review Article

APPLICATION OF THE LINEARITY PRINCIPLE IN THE STRUCTURING OF OIL AND GAS CHEMISTRY TEXTBOOK

Olga L. Shepelyuk

Tyumen Industrial University, Russia  
[unitech19@yandex.ru](mailto:unitech19@yandex.ru)

Received: 09.11.2019

Revised: 01.12.2019

Accepted: 30.01.2020

**Abstract.**

In the article, the author raises the issue of developing a manual on the chemistry of oil and gas for students of engineering specialties at the Oil and Gas University. The author presented an analysis of existing textbooks in various disciplines and highlighted their shortcomings, which provided a basis for describing his author's approach to the content of the manual. The presented manual is a combination of theoretical and practical parts of educational material, the selection and structuring of educational information was based on the principle of linearity, namely, a block system of presentation of the material. The proposed structure made it possible to study educational information for students in the form of blocks that are independent of each other, the tasks do not require knowledge of the previous block, which has shown its effectiveness in teaching students of correspondence courses.

**Key words:** chemistry, principle, linearity, block, higher education.

© 2019 by Advance Scientific Research. This is an open-access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>)  
DOI: <http://dx.doi.org/10.31838/jcr.07.02.02>

**INTRODUCTION**

Successful introduction of various innovative forms of education into the educational system of a technical university, in particular distance learning, entails the reconstruction of methodological support, in particular textbooks and teaching aids, since it is necessary to orient educational material to predetermined final professional goals and to develop the complex skills of future engineers in oil industry.

The development of educational and educational literature has received the closest attention throughout the history of education.

Different approaches to the structuring of textbooks are offered by teachers of secondary and higher schools.

Ovchinnikova, E. N. offers structuring of a training manual based on a logical-informational approach to learning (Ovchinnikova, 2008).

Ivanova, O. M. in his practice applies the principles of structuring electronic manuals using Multimedia (Ivanova, 2016).

Orlova, A.P., Zinkova, N.K., & Teterina, V.V. created a textbook based on modular technology (Orlova et al, 2013).

Goloveeva, L. Yu. Offers the design of educational material based on an integrative approach (Goloveeva, 2001; Ibatova, 2017).

Analysis of various textbooks on oil and gas chemistry for students of engineering specialties allows us to conclude that, in general, the structure and content of textbooks, the actual teaching of this discipline has a number of significant drawbacks, namely, a shortage of textbooks on chemistry of oil and gas of a practical nature; poor orientation of educational material to future professional activities.

Based on the shortcomings of teaching aids, we carried out work on the development of the content of the training manual: chemistry of oil and gas laboratory practice for students in the direction of preparation 03.21.01 "oil and gas business"

The choice of this particular discipline was due to the fact that the material of this discipline is widely in demand in cycles of

both general professional and special disciplines. The section contains a lot of concepts, the training and control of which is easily and efficiently implemented within the framework of federal state education 3 ++.

**METHODOLOGY**

In the centre of the development of the manual, we took the principle of linearity and accessibility. In the formation of system knowledge, the selected educational material plays an important role, but also the principle of its presentation, presentation. These principles are closely related to each other and determine the order of study of the material. Consider their effectiveness and action when developing a training manual.

The linear principle of studying material is its sequence, the transition from one block of material to another. Blocks of material content are not interconnected. Thus, students can develop an idea of the subject being studied, consisting of several main sections.

This method is effective, in our opinion, for part-time students, since studying the next block does not require repeating the material of the previous one, in case of skipping classes or unexplored material.

We distributed the training material so that at the beginning of the laboratory work the material was predominantly presented block by block with the simultaneous attraction to each of the blocks of a certain theoretical part of the material from other blocks, followed by an ever closer mixing of the theoretical foundations of the content of the blocks.

The selection of the content of the textbook took place in accordance with the program for the discipline, which reflects the methods of studying the material, organizational forms, teaching aids and the type of assessment of acquired knowledge indicating the hours of study. The curriculum in the discipline "Chemistry of oil and gas" contains the volume of the studied material and indicates the learning algorithm.

Regarding the curriculum in the discipline of oil and gas chemistry at the Tyumen Industrial University, the problem is complicated by the fact that this course is a non-core discipline

taught to first-year students of engineering specialties of universities for only one semester.

Therefore, the development of the content and structure of the training material, taking into account the above conditions, in accordance with the principles of building the program, namely, taking into account the principle of linearity, the block system seems to us effective.

## RESULTS

The most productive construction of a training manual, in which theory and practice are perceived as interacting, mutually reinforcing parts of the discipline.

In the process of laboratory work, students must understand the theoretical material, be able to theoretical knowledge in practice.

At the beginning of the manual, the author outlines the structure of the contents of the manual briefly. The presented manual for laboratory work in the discipline "Chemistry of oil and gas" complies with federal educational standards and the work program for the discipline.

In this manual for laboratory work, seven laboratory works are presented, which include the theoretical part, a laboratory experiment, examples of solving problems on the topic under consideration, and questions for self-monitoring of test tasks. Training forms general professional competencies:

- the student is able to solve problems related to professional activities, using methods of modeling, mathematical analysis, natural science and general engineering knowledge;
- the student is able to take measurements, process and present experimental data.

Laboratory work is designed in such a way that students can work in small groups, with individual samples of oil and petroleum products.

After conducting the presented laboratory work, the student should receive the necessary knowledge about:

- physico-chemical properties of hydrocarbons, chemical reagents;
- methods of laboratory studies of hydrocarbons;
- requirements of regulatory documents;
- properties, mechanisms and conditions for the formation of oil emulsions;
- safety measures;

as well as necessary skills:

- carry out diagnostics of oil-water emulsions;
- perform laboratory tests;
- work with laboratory equipment and instruments;
- make reports, perform calculations, present the results in Microsoft Excel.

After completing the laboratory work, the student must submit a report that includes the completed experimental part of the laboratory work, including the setup, calculations for the experiment, completed tables, graphs (if necessary, built in Microsoft Excel), conclusions, and resolved issues for self-monitoring.

The work performed is evaluated in accordance with the number of points presented in the rating, depending on the work in the laboratory and the design of the report.

The following are general safety instructions.

when working in a chemical laboratory, fire safety rules. It should be noted the importance of recommendations for working with literature, since it is recommended to study the course according to the textbooks presented in the list of references. Studying the material, one should carefully consider the theoretical foundations of the topic under consideration, carefully analyze the definitions and formulas, considering the units of measurement of each quantity. When studying theoretical material, one should use the lecture notes, textbooks, methodological literature, carefully consider the basic concepts, specific terminology, and the mathematical dependence of the parameters on external factors. Incomprehensible questions should be outlined and the teacher will contact them.

Much attention in the material under consideration should be given to graphical dependencies, graphs and diagrams, linear and nonlinear changes in the parameters under consideration, this will allow one to well absorb the material. The topics should be considered sequentially, as they are presented in the work program for the discipline.

In preparation for laboratory classes, the student should answer questions for self-control, focusing on the lecture notes and the theoretical part outlined in the methodological manual. To complete written homework, students need to carefully read the appropriate section of the textbook and work through similar tasks considered by the teacher in lecture classes. Highlight issues that could not be resolved. In the notebook for laboratory work, outline the procedure for performing laboratory work, prepare tables for filling out according to the results of the experiment.

In the framework of the linear principle of structuring the manual, we offer the following procedure for structuring the content in the block, within the framework of one laboratory work:

1. purpose of work;
2. theoretical part;
3. experimental part;
4. task;
5. equipment;
6. progress of work;
7. questions for self-control.

In total, the manual contains 7 laboratory works.

Laboratory work No. 1 Determination of water content in oil

Laboratory work No. 2 Determination of oil density

Lab 3 Oil Viscosity

Laboratory work No. 4 Determination of the fractional composition of oil and oil products

Laboratory work No. 5 Determination of chloride ions in oil and industrial wastewater

Laboratory work No. 6 Determination of oil content in water by photoelectrocolorimetric method

Laboratory work No. 7 Determination of physicochemical properties of fuels.

The content of laboratory work is developed on the basis of the content elements of the discipline "Chemistry of oil and gas" for first-year student

**Table 1 The content of sections and topics of discipline**

Nº n/n	Section Name disciplines	The content of the discipline section in didactic units
1	Chemical and elemental composition of oil	- oil origin theory - elemental composition of oil - hydrocarbon hydrocarbon classes - physicochemical properties of hydrocarbon oil - heteroatomic compounds of oil
2	Physico-chemical properties of oil and oil products	- physicochemical properties of oil and oil products - fractional composition of oil - oil classification
3	Oil Dispersed Systems	- VAT classification - oil emulsions - SAV - oil preparation
4	Natural combustible gases	- classification of natural combustible gases - physiochemical properties - processing and commercial products
5	Oil refining	- fuel oil refining option - non-fuel oil refining option - methods for the separation of oil components and physico-chemical analysis

We give an example of Laboratory work No. 6

#### DETERMINATION OF OIL CONTENT IN WATER BY PHOTOELECTROCOLORIMETRIC METHOD.

Objective: to determine the concentration of oil in water (mg / l), using one of the types of physicochemical analysis "OST 39-133-81 Water for flooding oil reservoirs. Determination of oil content in field wastewater. " As a result of laboratory work, students should have an idea of the Photoelectrocolorimetric Method, its application in order to determine the oil content in water.

The following is the theoretical part, which is devoted to the description of this method, a filter for obtaining a ray of light of the visible region of a certain wavelength through which the light flux passes, extraction - a method for extracting a substance from a solution, etc.

The experimental part involves an algorithm for performing work. Equipment:

1. KFK - 3;
2. separatory funnel;
3. standard solutions of oil in hexane;
4. control solutions;

5. hexane;
6. measuring dishes.

#### Working process

1. Prepare a series of standard solutions.
2. The oil content in 1 ml of standard solution should be respectively 0.1; 0.2; 0.4; 0.6; 0.8; 1 mg / ml.
3. Pour 20 ml of control solution and 20 ml of hexane into the separatory funnel. Shake the separatory funnel and attach it to the tripod.
4. Separate in two glasses, the aqueous layer and the hexane layer.
5. Determine the optical density of the control solutions. To do this, pour hexane into one cuvette (i.e., a pure solvent, in relation to which we will determine the optical density), pour the first standard solution into the second cuvette. In accordance with the order of work on CPK, determine the optical density of the solution. Similarly determine the optical density of the remaining solutions. Fill in table 2:

**Table 2 Optical Density Results**

C, mg/ml	0,1	0,2	0,4	0,6	0,8	1	Result

1. Determine the optical density of the control solution - C1 and C2, enter the data in table 2.

2. Build a calibration graph, and from it calculate the concentration of oil in water.

3. Using the formula, calculate the concentration of oil in

$$C = \frac{C_1 \cdot V_1 \cdot 1000}{V_2}$$

water, mg/l.

where C1 is the oil content in 1 ml of extract (according to the calibration graph based on the optical density of the extract), mg.

V1 is the volume of extract obtained by extraction of a water sample taken for analysis, ml.

V2 is the volume of water taken for analysis.

The order of work at KFK-3

Turn on the device by pressing the Network button and warm it up for 30 minutes.

1. Press the Start button - the G symbol appears on the digital display, its corresponding value and the value of the wavelength.
2. Set the Wavelength knob to the minimum wavelength (520 nm).
3. Place the cuvettes with hexane and the test solution in the cell compartment. Place the cuvette with hexane in the far compartment of the cuvette holder, and with the solution in the near. Using a handle, install a cuvette with hexane in the light beam.
4. Close the lid of the cell compartment. Press the G key. The G symbol will be displayed on the lower digital display.

5. Press the E key. The E symbol will be displayed to the left of the flashing comma and its value to the right, which should lie in the range  $0.00 + 0.002$ . If this is not the case, press the G, E keys again, observing a short pause.
6. Open the lid of the cuvette compartment and press the Zero key, close the lid, press the E key.
7. Using a handle, install the cuvette with the test solution into the light beam. The reading on the digital display to the right of the flashing point corresponds to the optical density of the solution at a given wavelength.

**Questions for self-control.**

1. What light absorption depends on.
2. The law of the Bouguer-Lambert-Beer.
3. What is called optical density.
4. How to choose a filter on KFK.
5. How are the cuvettes installed in the cuvette holder?
6. Why is a calibration chart built and how is it used to determine the concentration of the control solution.
7. The order of work at KFK.
8. What is extraction.
9. What solvents can be used to extract oil from the aqueous layer?

**CONCLUSION**

Thus, the approach we presented in the form of blocks on the basis of the principle of linearity to the development of teaching aids in the chemistry of oil and gas helps to streamline and actualize the content of didactic units according to the curriculum, a clear selection of the amount of knowledge, and allows you to streamline and systematize the educational process in this discipline, increase the quality of assimilation of educational information and to form the professional competencies of the future engineer.

The principle of linearity makes it possible to present educational material in the form of a single printed material. The student does not need to work with other literature, since all information is contained directly in the block.

**REFERENCES**

1. Ovchinnikova, E. N. (2008). Structuring the manual based on the logical and informational approach to learning (Doctoral dissertation, -SPb: SPbAPPO. - 2008).
2. Ivanova, O.M. (2016). Structuring an e-book using Multimedia. In ACTUAL PROBLEMS OF VOCATIONAL EDUCATION: GOALS, OBJECTIVES AND PROSPECTS FOR DEVELOPMENT (pp. 22-27).
3. Orlova, A. P., Zinkova, N. K., & Teterina, V. V. (2013). Modern approaches to the construction of the textbook "History of Pedagogy" based on modular technology.
4. Goloveeva, L. Yu. (2001). Construction of educational material based on an integrative approach. Bulletin of Barnaul State Pedagogical University, (1), 17-24. Ibatova, A. Z., Vdovichenko, L. V., Mukhutdinov, R. H., Rodionova, A. E., & Potanina, A. V. (2017). Updating and development of educational process methodological equipment in technical university. *Man in India*, 97(10), 227-232.
5. Ibatova, A. Z., & Ivanova, N. L. (2018). A professionally oriented approach to teaching engineering students: From theory to practice. *International Journal of Mechanical Engineering and Technology*, 9(4), 977-982.
6. IBATOVA, A. Z. (2017). The methodology for english textbooks organizing in higher educational establishments. *Revista ESPACIOS*, 38(45).