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THE IMPORTANCE OF PROBLEM SOLVING AND PROJECT WORK IN TEACHING THE ELECTROMAGNETISM DEPARTMENT BASED ON AN INDIVIDUAL LEARNING TRAJECTORY

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Abstract
The article focuses on the importance of problem solving and project work in teaching the department of Electromagnetism based on an individual learning trajectory, and through this, the development of methodological competence by increasing the cognitive potential of students.

Keywords: Module-credit system, independent learning, methodological competence, scientific research, scientific knowledge methods, mathematical methods, convergent thinking, divergent thinking, branched chain, intellectual consciousness.

ЗНАЧЕНИЕ РЕШЕНИЯ ПРОБЛЕМ И ПРОЕКТНОЙ РАБОТЫ В ПРЕПОДАВАНИИ КАФЕДРЫ ЭЛЕКТРОМАГНЕТИЗМА НА ОСНОВЕ ИНДИВИДУАЛЬНОЙ ТРАЕКТОРИИ ОБУЧЕНИЯ

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Аннотация:
В статье рассматривается важность проблемно-проектной работы в преподавании кафедры электромагнетизма на основе индивидуальной траектории обучения, а через это развитие методической компетентности за счет повышения познавательного потенциала студентов.

Ключевые слова: модульно-кредитная система, самостоятельное обучение, методическая компетентность, научное исследование, методы научного познания, математические методы, конвергентное мышление, дивергентное мышление, разветвленная цепь, интеллектуальное сознание.

Introduction

The importance of physics in the development of modern technology is incomparable. Physical knowledge and methods are an important element of the modern culture of not only society as a whole, but also of each individual, especially if his further professional activity is related to science, technology and production technology. Personal experience gained in the educational

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activities of physics classes, the skills and qualifications acquired by students in the process of studying physics are very important for their formation and development as individuals. In higher pedagogical educational institutions, 180 hours are allocated to the Electromagnetism department of general physics, and 50% of these hours are allocated for independent study according to the module-credit system. We must pay attention to the productive use of these independent study hours in order to effectively organize the individual education of students [1].

Literature analysis and methodology

The content of the component of arousing interest in independent learning topics in the subject of general physics (Electromagnetism) is considered a variable part of the methodological system and is determined by the age-specific characteristics of students. In implementing the methodological system for developing students' methodological competence in practice, the independent learning method (Electricity and Magnetism Educational and Methodological Manual) serves as the main tool [2,3]. In the process of students mastering independent learning topics in the subject of general physics (Electromagnetism), this independent learning is carried out in three stages. Let us briefly describe them. “The first stage of independent learning is “Initial acquaintance” with the subject of general physics (Electromagnetism), in which a reproductive form of teaching is used. Students are introduced to the subject of general physics (Electromagnetism), independent study topics, scientific knowledge methods, research skills and their structure, preparation for individual implementation of independent study topics, analysis and generalization of the collected data, the procedure for writing independent study topics, preparation of presentations of independent study topics, and the criteria for evaluating research work are clarified. Motivations for research work are awakened in students based on conversations and project work on various topics. At the second stage of independent study, the student is prepared to implement independent study topics based on exercises focused on independent study topics. Effective teaching methods are used at this stage. Students are given theoretical knowledge and instructions on the use of mathematical methods and ICT programs and tools in preparation for independent study topics.

Results

The third stage of independent learning is aimed at solving issues such as writing each independent learning topic, preparing its presentation and submitting it. The distribution of hours in independent learning sessions in the “Methodology of preparing students for independent learning topics in general physics (Electromagnetism) based on an individual learning trajectory” is presented in Table 1.

Table 1 90-hour independent study plan on "Methodology of preparing students for independent study topics in general physics (Electromagnetism) based on an individual educational trajectory"

	Topics	Theoretical and practical
	Theoretical exercises	
1.	The interaction of electric charges Coulomb's law.	2 s
2.	Understanding the electric field. Electric field strength.	2 s

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3.	Work done in an electrostatic field. Potential difference.	2 s
4.	Conditions for the equilibrium of charges in conductors. The relationship between potential difference and field strength.	4 s
5.	Conductors in an electric field.	2 s
6.	Capacitance. Capacitance of simple capacitors.	2 s
7.	Connection of capacitors. Charged capacitor energy.	2 s
8.	Compound capacitors.	2 s
9.	Ohm's law. Electrical resistance.	2 s
10.	Work and power of a direct current.	2 s
11.	Joule-Lenz's law.	2 s
12.	Networked circuits. Kirchhoff's laws.	2 s
13.	Work and power of an electric current.	2 s
14.	Law of conservation of energy for an electric field.	2 s
15.	Magnetic interaction of currents. Magnetic induction.	2 s
16.	Magnetic field strength. Magnetic field lines.	2 s
17.	Current-carrying conductor in a magnetic field. Ampere force.	4 s
18.	Magnetic field of a moving charge. Lorentz force	2 s
19.	Lenz's rule.	2 s
20.	The basic law of electromagnetic induction.	2 s
21.	Self-induction. Magnetic susceptibility of matter.	2 s
22.	Electromagnets. Magnetic flux linkage.	2 s
23.	Alternating current generators.	2 s
24.	Two-phase current. Three-phase current.	4 s
25.	Transformers and their networks.	2 s
26.	Maxwell's equations.	4 s
27.	Temperature dependence of saturation current.	2 s
28.	Secondary electron emission.	2 s
29.	Ionization of gases. Movement of ions in gases.	2 s
30.	Independent and non-independent gas charges.	2 s
31.	Movement of charged particles in a uniform electric field.	2 s
32.	Faraday's laws of electrolysis.	2 s
33.	Electrolytic dissociation. Movement of ions in electrolytes.	2 s
34.	Electrode potential. Batteries.	2 s
35.	Resistance in an alternating current circuit.	2 s
36.	Capacitor in an alternating current circuit.	2 s
37.	Inductive coil in an alternating current circuit.	2 s
38.	Resistance, capacitor and inductive coil in an alternating current circuit.	4 s
39.	Generation of a free electromagnetic wave.	2 s
40.	Energy of electromagnetic waves.	2 s
	Total:	**90 s**

In most cases, during the training process, we give students ready-made explanations of physical laws and mathematical expressions. The student thinks based on the algorithms he mastered during the training process (thinks convergently). By giving a student who can think convergently, the ability to think divergently is formed in them by sequentially giving creative tasks [3,4]. The psychological and pedagogical conditions that affect the formation of divergent thinking depend on its objective and subjective aspects. In this case, its objective aspects are:

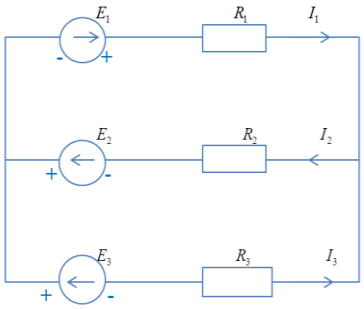
a) these are conditions related to the professor-teacher: in the teaching process, he (professor-teacher) clearly sets the goal, engages in a sincere and friendly relationship with the student, and arouses in him the motivation to strive for the goal.

b) conditions related to the formation of learning abilities: the presence of educational literature (as well as additional literature, scientific journals, reference books), and an Internet system in the educational institution.

Subjective, i.e. aspects related to the student's personality: the student's ability to work on himself, think independently, gain self-confidence, develop interest in himself to achieve the goal, achievements, and desire to demonstrate the knowledge gained in front of the professor-teacher.

In the process of preparing for independent study topics in the subject of General Physics (Electromagnetism), we will consider the development of convergent and divergent thinking skills in students. In this case, it is possible to systematically encourage students to solve questions and problems on each topic individually for independent study topics, and determine the level of development of their thinking skills. For this, first of all, they are recommended to solve several questions or problems that can be solved by several methods. In order to practically test the level of development of the student's thinking skills, the process of completing the recommended problem assignment (or project work) is observed. As an example, students are given a network of chains. Given the following problem related to Kirchhoff's laws.

Problem 1. Source voltages of an electric circuit *E1 =15 V, E2= 25 V, E3=20 V* resistances *R1=30 Om, R2=15 Om, R3=20 Om* equal. Determine the network currents based on the superposition method.



Solution:

The current flowing through the column branches in the superposition method is equal to the algebraic sum of the branch currents flowing under the separate influence of each E.U.K.:

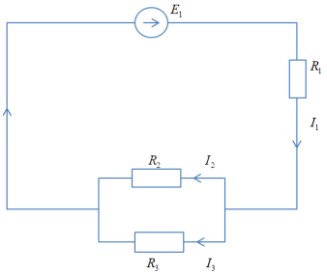
$$I_1 = I_1^{'} + I_1^{"} + I_1^{"}$$

$$I_2 = I_2^{'} + I_2^{"} + I_2^{"}$$

$$I_3 = I_3^{'} + I_3^{"} + I_3^{"}$$

To determine these currents, we divide the given circuit into simple equivalent circuits consisting of one E.U.K.

a) $E_1 = 15V$, $E_2 = E_3 = 0$ network currents for the situation $I_1^{'}$, $I_2^{'}$, $I_3^{'}$ we define:



$$I_1^{'} = \frac{E_1}{R_u} = \frac{E_1}{R_1 + \frac{R_2 R_3}{R_2 + R_3}} = \frac{15}{30 + \frac{15*20}{15+20}} = \frac{525}{1350} = \frac{7}{18} A \quad I_2^{'} \text{ and } I_3^{'} \text{ We derive the following}$$

formulas to derive the current strengths. According to Om's law $I_2^{'}$ current power $I_2^{'} = \frac{U_2}{R_2}$ determined by the formula. In Parallel connected conductors $U_2 = U_3$ and $U_2 = E - U_1$ considering.

$$I_2^{'} = \frac{E - U_1}{R_2} = \frac{E - I_1^{'} R_1}{R_2} = \frac{\frac{I_1^{'}\left(R_1 R_2 + R_1 R_3 + R_2 R_3\right)}{R_2 + R_3} - I_1^{'} R_1}{R_2} =$$

$$= \frac{\frac{I_1^{'} R_1 R_2 + I_1^{'} R_1 R_3 + I_1^{'} R_2 R_3 - I_1^{'} R_1 R_2 - I_1^{'} R_1 R_3}{R_2 + R_3}}{R_2} = I_1^{'} \frac{R_3}{R_2 + R_3}$$

$$I_2^{'} = I_1^{'} \frac{R_3}{R_2 + R_3}$$

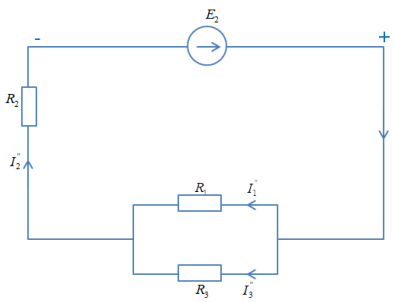
$$I_3^{'} = I_1^{'} \frac{R_2}{R_2 + R_3}$$

comes from. Now $I_2^{'}$ and $I_3^{'}$ we calculate the numerical value of the.

$$I_2^{'} = I_1^{'} \frac{R_3}{R_2 + R_3} = \frac{7}{18} \frac{20}{15+20} = \frac{2}{9} A$$

$$I_3^{'} = I_1^{'} \frac{R_2}{R_2 + R_3} = \frac{7}{18} \frac{15}{15+20} = \frac{1}{6} A$$

b) $E_2 = 25V$, $E_1 = E_3 = 0$ network currents for the situation $I_1^{''}$, $I_2^{''}$, $I_3^{''}$ we define:



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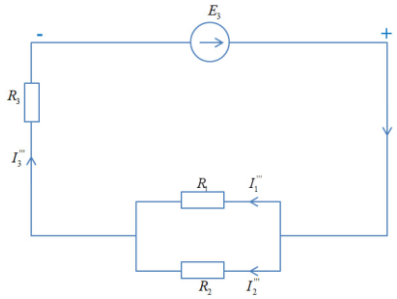
$$I_2^{''} = \frac{E_2}{R_u} = \frac{E_2}{R_2 + \frac{R_1 R_3}{R_1 + R_3}} = \frac{25}{15 + \frac{30*20}{30+20}} = \frac{1250}{1350} = \frac{25}{27} A$$

$$I_1^{''} = I_2^{''} \frac{R_3}{R_1 + R_3} = \frac{25}{27} \frac{20}{30+20} = \frac{10}{27} A$$

$$I_3^{''} = I_2^{''} \frac{R_1}{R_1 + R_3} = \frac{25}{27} \frac{15}{30+20} = \frac{15}{54} A$$

c) $E_3 = 20V$, $E_1 = E_2 = 0$ network currents for the situation $I_1^{'''}$, $I_2^{'''}$, $I_3^{'''}$ we define:



$$I_3^{'''} = \frac{E_3}{R_u} = \frac{E_3}{R_3 + \frac{R_1 R_2}{R_1 + R_2}} = \frac{20}{20 + \frac{30*15}{30+15}} = \frac{900}{1350} = \frac{2}{3} A$$

$$I_1^{'''} = I_3^{'''} \frac{R_2}{R_1 + R_2} = \frac{2}{3} \frac{15}{30+15} = \frac{2}{9} A$$

$$I_2^{'''} = I_3^{'''} \frac{R_1}{R_1 + R_2} = \frac{2}{3} \frac{30}{30+15} = \frac{4}{9} A$$

Now, taking into account the direction and sign of the currents, we determine the actual network currents:

$$I_1 = I_1^{'} + I_2^{''} + I_3^{'''} = \frac{7}{18} + \frac{10}{27} + \frac{2}{9} = \frac{53}{54} A$$

$$I_2 = I_2^{'} + I_2^{''} + I_2^{'''} = \frac{2}{9} + \frac{25}{27} + \frac{4}{9} = \frac{43}{27} A$$

$$I_3 = I_3^{'} + I_3^{''} + I_3^{'''} = \frac{1}{6} + \frac{15}{54} + \frac{2}{3} = \frac{13}{18} A$$

The solution to the problem given by the student is analyzed by the professor-teacher and, based on the results, the student's level of thinking is assessed as convergent or divergent. In the process of developing students' convergent and divergent thinking, their intellectual abilities also develop. The ability to think convergently is considered the initial stage in the development of intellectual abilities in a person [5,6,10].

Discussion

Problem-based learning is considered important in activating students' individual thinking through independent learning topics. After a student is familiar with the most important knowledge related to an independent learning topic, they are given a series of tasks on this topic, developing their thinking skills (Figure 1).

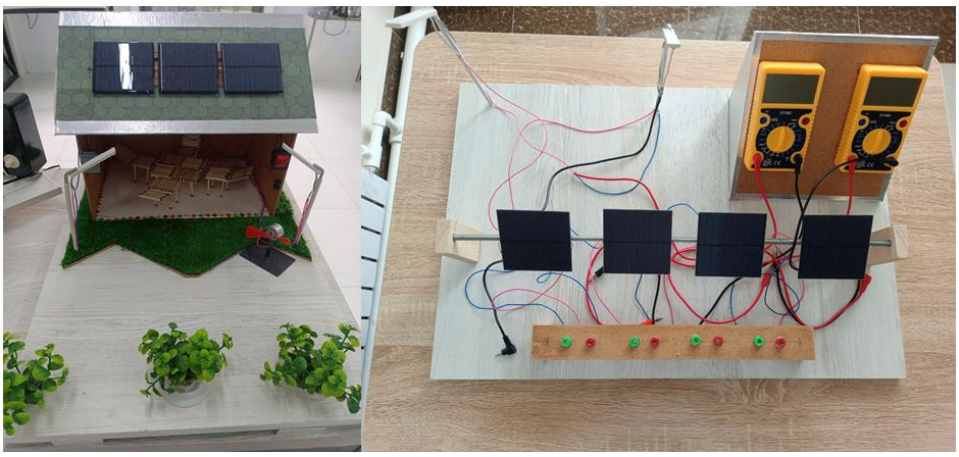


Figure 1. Student project work on the topic of independent learning

The importance of the tasks given in the development of students' methodological competence, in preparing for independent learning topics based on an individual educational trajectory, is very great. Tasks of a creative nature, that is, tasks that allow for individual finding of new ways of solving the problem, can also be considered as tasks that develop students' methodological competence. Such tasks have a positive effect on the development of students' thinking skills. In selecting creative tasks that help develop thinking skills, educational and popular literature was used [7,8,9].

Conclusion

One of the important tasks is to arouse students' interest in carrying out project work on independent educational topics in general physics (electromagnetism) based on an individual educational trajectory. In addition, following the principle of moving from simple to complex in the development of students' educational and creative activities, finding reliable solutions to tasks, checking their correctness, and effectively using educational and laboratory equipment are important factors in increasing the effectiveness of physics education.

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