IMPROVEMENT OF THE TEACHING OF TOPICS ON SEMICONDUCTORS BASED ON AN INNOVATIVE APPROACH AS A PROBLEM.

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Abstract: This article presents information about the problems encountered in teaching topics related to semiconductors, which are included in the science of "Electricity and Magnetism" of higher education, and their solutions. Here are ways to improve and develop semiconductor topics' content, teaching methods, and appropriate teaching technologies. As a result, the educational process's effectiveness can be further increased.

Keywords: semiconductor substance, types of semiconductor substances, semiconductor diode, semiconductor transistor, "FSMU" method, "Venn diagram" method, "T-chart" method, "Case study" method, "SWOT analysis" method and "Cluster method".

When semiconductor materials, devices, and devices made on their basis are widely used, emphasis is placed on the teaching of semiconductor physics in all educational systems. In particular, time is devoted to topics related to the physics of semiconductors in the physics curriculum [2] of secondary schools, academic lyceums, and "Electricity and magnetism" [1] of higher education. As part of the conducted research, when analyzing the curricula introduced in "Electricity and Magnetism" of secondary schools, academic lyceums and higher education, it was found that the topics related to semiconductors in these programs are almost the same, and this can be seen in the example of the following table:

Table 1.

Topics on semiconductors	General Secondary Education (Class 10)	Academic Lyceum (2nd year)	Higher Education (“Electricity and Magnetism”)
Semiconductors	+	+	+
The electric current in semiconductors	+	+	+
Pure and compound semiconductors	+	+	+
Acceptor and	-	-	+

donor zones			
Semiconductor diode	+	+	+
Concept of transistor	+	+	+
Integrated circuit	+	+	+
Study of the volt-ampere characteristic of a semiconductor diode (laboratory work)	+	+	+

The above-mentioned topics on semiconductors are covered in the educational literature introduced to education for the 10th grade of secondary school and the physics subject of academic lyceums and the subject of "Electricity and Magnetism" of higher education as follows:

It is stated that semiconductors occupy the range of metals and dielectrics in terms of electrical conductivity, that the electrical conductivity of semiconductors depends on external influences and that this property is used in making various devices in electronics, that the electrical conductivity of metals and semiconductors depends on temperature. Pictures illustrating the decrease in the electrical conductivity of metals and the increase in the electrical conductivity of semiconductors when metals and semiconductors are heated serve to complement this topic. Also, this topic gives brief information about the semiconductor material silicon, its use, and the role of semiconductors in modern technology [3, 4, 5, 6, 7].

The formation of pure and mixed conductivity is explained in the topic "Electrical conductivity of semiconductors". In this case, the mechanism of formation of electron and hole conductivity in pure semiconductors is given as an example of silicon. Mechanisms of the formation of donor and acceptor compounds by introducing elements of groups V and III of the periodic table into pure germanium and silicon have been described [3, 4, 5, 6, 7].

The topic "Semiconductor devices and their applications" provides information about the processes that occur in the contact region when the formation of the *p-n-* transition is connected to an electric field forward and backwards. The pictures depicting the formation of *p-n-* transition, the change of

the contact area when it is connected to an external electric circuit and the formation of direct and reverse current will help the students to learn the above information easily.

Information on how to obtain a semiconductor diode with a single *p-n*-junction, its function and conditional symbol, the structural structure of a transistor, the principle of operation, its application and its advantages are given. This topic first describes a transistor and briefly states that it has two electron-hole junctions. The fact that each transistor consists of three parts, their names and the fact that they have three terminals that allow connecting the transistor to an electric circuit is given by pictures representing the structure of *p-n-p* and *n-p-n* transistors. From the picture, which shows the electrical circuit of an *p-n-p* transistor, two batteries and a resistor, it can be seen that the first battery is connected to the emitter-base and the second battery is connected to the base and collector. The generation of emitter and collector currents as a result of this connection of batteries and the function of the resistance connected to the circuit is explained. At the same time, this topic contains brief information about the elements of integrated microcircuits and their use [3, 4, 5, 6, 7].

The following conclusion can be drawn from the analysis of the above-mentioned high school and academic lyceums' physics, "Electricity and Magnetism" study programs and educational literature: It was found that there is almost no difference in the level of coverage of the topics of semiconductors presented in the study programs in the textbooks and educational literature. This means that the task of taking into account the scientific and technical innovations that are increasing year by year in the teaching of semiconductor topics in "Electricity and Magnetism" of higher education has not yet been solved.

If we look deeper into the content aspect of the continuing education system, yesterday's secondary school and academic lyceum graduates are today's talented students of higher education and tomorrow's highly qualified specialists with scientific potential. An urgent task for our republic is to provide students of higher education with science-based knowledge that can regularly express scientific and technical innovations in order to raise and rejuvenate the scientific potential. Achieving consistent teaching of topics related to semiconductor physics is an urgent task for professors and teachers of higher education, as it develops rapidly every year, scientific innovations are immediately put into practice, and students become users of its results.

In order to introduce the innovations of any subject into the educational process, they must first be redeveloped from a didactic point of view (system of logical tables), after which the resources become educational material.

In order to improve and develop the content and teaching methods of semiconductor topics and develop appropriate teaching technologies, as a result, the following should be implemented in order to further increase the effectiveness of the educational process:

1) to enrich the content of topics related to semiconductors (with concepts related to the types and production of semiconductor materials, types of semiconductor devices and their use);
2) improvement of its experimental basis through frontal laboratory work (Study of transistors (laboratory work));
3) providing information about the research works of scientists conducting research in this field (results obtained during the research and their significance) for those interested in the physics of semiconductors;

use of interactive methods ("FSMU" method, "Venn diagram" method, "T-scheme" method, "Case study" method, "SWOT analysis" method and "Cluster" method) to improve methods of teaching topics about semiconductors.

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