***Корсун Ігор Васильович**, викладач кафедри фізики і методики її викладання Тернопільського національного педагогічного університету імені Володимира Гнатюка, кандидат педагогічних наук.*

THE FORMS OF INTERDISCIPLINARY COMMUNICATIONS IN PHYSICS TEACHING

Science is more than a school subject, or the periodic table, or the properties of waves. It is an approach to the world, a critical way to understand and explore and engage with the world, and then have the capacity to change that world...

Barack Obama, the 44th *president* of the United States

23 March, 2015

Introduction

Many branches of modern science are related closely. Therefore, the school subjects cannot be isolated from each other. According to Casey, "the interdisciplinary approach has become an important and challenging technique in the in the modern curriculum" [1, p. 76]. In this way, the problem of interdisciplinary approach is relevant in current education [2-5]. Interdisciplinary communications provide the didactic conditions and means of deep and comprehensive mastering the basics of science [6]. One of the challenges of the modern teacher – show to student the interdisciplinary communication on concrete examples. This is an extremely important condition for building a quality education system [7]. The aim of our study is a definition of the forms of interdisciplinary communications in physics teaching.

Method

The United States has developed as a global leader, in large part, through the genius and hard work of its scientists, engineers, and innovators. In a world that's becoming increasingly complex, where success is driven not only by what you know, but by what you can do with what you know, it's more important than ever for our youth to be equipped with the knowledge and skills to solve tough problems, gather and evaluate evidence, and make sense of information. These are the types of skills that students learn by studying science, technology, engineering, and math – subjects collectively known as STEM [8].

Holubova [9] has found out that learners can be motivated by various instructional methods based on their own activity. The author proposed to use in teaching of physics the problem based learning, project based learning, team work, inquiry based learning, interdisciplinary approach, experiments – from very simple and low cost experiments to computer based experiments and remote laboratories. According to this approach, we have analyzed the works of Sergeev [10], Dik and Turysheva [11], Kats [12]. It helped to determine the forms of interdisciplinary communications in physics teaching: study of new material, formation of abilities and skills, work on projects.

Study of new material. Learner will be not able to understand the educational material, if will not feel the need to study it. Therefore, it is necessary the formation of learners' situational interest. In this way, Erinosho [13, p. 151] has proposed to use the concrete examples for the learners' motivation in physics. Interdisciplinary communications allow to formulate the problems. For example, the study of the lesson "Thermonuclear reactions" (Physics) begins with the formulation of the problem. The Sun is the energy source on Earth (Astronomy). This energy reaches our planet during radiation. The mass of the Sun is reduced about by 4.2×10^9 kg during 1 s. But the next day, the Sun continues to shine. Why the mass of the Sun is not reduced? Thermonuclear reactions are the energy source on the Sun. Thermonuclear reactions occur in the other stars. Is it possible to create a thermonuclear reaction on Earth? Explosion of the hydrogen bomb is an example of uncontrollable thermonuclear reaction. Now scientists are working on creation a controlled thermonuclear reaction.

Formation of abilities and skills. According to Wang, "what we must do is not only teach students knowledge, but also develop their problem solving skills and lifelong learning skills" [14, p. 1]. Any physics law describes the relationship between certain physics phenomena. Mathematics formulates physics law quantitatively. For example, we consider the task about radiocarbon dating (practical exercises "Tasks on radioactivity"). Nitrogen atoms $^{14}_{7}\mathrm{N}$ are constantly in the Earth's atmosphere (78.082% by volume of dry air). Nitrogen nuclei are transformed into radioactive Carbon nucleus $^{14}_{6}\mathrm{C}$ under the influence of cosmic radiation (Chemistry). Carbon enters into the plants (Biology). The amount of this radioactive isotope decreases gradually when plant dies. Archaeological godsend is made of wood (History). Scientists determine the

radioactivity of Carbon A in archaeological godsend using radiocarbon dating. This value is compared with the radioactivity of Carbon A_0 in the tree, which had just cut down. Learners have determined the age t of archaeological godsend with using the law of radioactivity change ($A = A_0 2^{-\frac{t}{T}}$, where T is half-life of Carbon $^{14}_{6}$C).

Work on projects. Physics is a fundamental science. Therefore, the interdisciplinary communications between physics and other sciences form the scientific outlook of learners. For example, consider the main issues of the project "Discovery of Higgs boson". The Large Hadron Collider (LHC) is the most larger experimental setup in the world. It lies near Geneva, Switzerland, in a tunnel 27 kilometres in circumference and runs underground at a depth of 175 metres. The aim of research is to test the predictions of different theories of particle physics, high-energy physics and other unsolved questions of physics. LHC is an accelerator of charged particles (e.g., protons). Scientists record the process of particle's collision. In 2012, scientists opened a particle similar to the Higgs boson (the only missing link so-called Standard Model, whose existence is predicted half a century ago). Data from collisions have been analyzed with a grid-based computer network infrastructure connecting 140 computing centers in 35 countries (Informatics). The Worldwide LHC Computing Grid is the world's largest computing grid [15].

Conclusion

The value of interdisciplinary communications of physics with other school subjects has been analysed. The general guidelines of improving methods of teaching physics on based interdisciplinary communications have been given. Interdisciplinary communications provide a holistic view of natural phenomena. This contributes to a better assimilation of knowledge by learners, forms the scientific concepts, laws, theories and scientific outlook. Forms of the interdisciplinary communications in physics teaching have been defined. These are study of new material, formation of abilities and skills and work on projects.

Prospects for the results of this research are the study of the interdisciplinary communications between the other STEM disciplines.

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