II. ПРОБЛЕМИ МЕТОДИКИ НАВЧАННЯ ФІЗИКИ

INTEGRATION OF KNOWLEDGE OF NATURE STUDIES WHILE FORMING COGNITIVE INTEREST TO PHYSICS IN SECONDARY SCHOOLS

Stepan VELYCHKO, Victoria BUZKO

The article deals with formation of pupils' cognitive interest in the process of teaching Physics in Ukrainian schools by means of integration of Nature Studies. Specific examples of forming pupils' cognitive interest for Physics while studying the themes "Nucleus. Nuclear Energy" are analyzed.

Forming pupils' cognitive interest while teaching Physics at comprehensive school is rather actual. The problem of interest in the context of various cognitive-searching activities of students is being increasingly researched nowadays. It allows to bring to light theoretical foundations of this phenomenon, to actively form and develop pupils' interests, bring up their active attitude towards learning process and their own life activity.

Interest, as a complex and meaningful formation for a human being, has various interpretations in psychological pedagogical aspects of its definition. It is considered as:

- selective focus of people's attention (N. F. Dobrynin [5], T. Ribo [12]);
- manifestation of his mental and emotional activity (S. L. Rubinshtein [13]);
- active emotional and cognitive attitude to the world (N. G. Morozova [8; 9]);
- specific attitude of an individual to the object caused by the realization of its vital significance and emotional appeal (A. G. Kovaliov [7]);
- a form of manifestation of cognitive needs, that provides the focus on individual's understanding of activity goals and thus contributes to orientation, familiarization with new facts, reflection of reality in a fuller and deeper way (according to Petrovsky [10]).

One of the drawbacks of organizing the educational process in modern secondary schools in Ukraine while teaching Physics, is the contradiction of the principle of continuity of natural education in Grades 5-6 and 7-9 and we believe the reason of this phenomenon is that the knowledge obtained by pupils during previous years of studying occurs in an isolated form and is not linked by general laws. The task of an educational process is to combine such knowledge in pupils' mind and provide an individual with new knowledge at any time while forming a personal outlook. One of the means of such directions of pedagogical activity is the integration of the knowledge of Nature Studies while teaching Physics in a comprehensive school.

The research of psychologists and pedagogues is directed at examining different aspects of the issue of cognitive interest. The psychological nature of interest is the subject of the research of one group(M. F. Beliayev, L. A. Gordon), scientists of another group consider the interest as a means of learning (G. I. Shchukina, V. B. Bondarevsky) or as a motive (A. N. Leontiev, S. L. Rubinstein).

The questions of pupils' integration of knowledge and interdisciplinary links in particular were highlighted profoundly in the works of well-known pedagogues and methodologists: O. I. Buhayov, S. U. Honcharenko, I. D. Zvereiev, V. R. Ilchenko, O. I. Liashenko, P. I. Samoylenko, A. V. Usova, V. M. Fedorova and others.

Methodological and theoretical problems of knowledge integration were examined in the works of S. U. Honcharenko, I. M. Kozlovska, P. I. Samoilenko, O. V. Sergeyev and others. Organization of the educational process on the basis of integration became the research subject in the scientific works of Y. M. Sobko, V. T. Fomenko, T. D. Yakymovych; the integration of the knowledge in Nature Studies was analyzed in the scientific works of Y. I. Dick, M. T. Martyniuk, V. G. Razumovsky; the principles of interdisciplinary connections and professional orientation training were examined in the works by V. M. Maksimova, V. I. Palamarchuk, V. M. Fedorova and others.

The essence of the integration of training is to combine ideas, scientific theories, concepts, teaching technologies by coordinating the activity of teachers of different Nature Studies disciplines and cognitive and learning activities of students. The idea of integrating content and form of teaching has always interested scientists and educators who worked practically. For instance, S. U. Honcharenko and I. M. Kozlovska offer to implement the integration into the educational process using several ways:

- related elements, concepts or actions are selected among two subjects and an integrated course is developed;
- the knowledge of different subjects is grouped around a particular object (this option can be called modular or profiled);
- being based on really existing objectivity of knowledge, one subject can comprise the elements of knowledge and skills in other subjects that are necessary in general and particular cases (basic academic subject is placed in the center and concentric circles of approximation of different order accrue around it).

The studies of S. P. Velychko [15] prove convincingly that it is important to form and develop scientific and research thinking and make it possible to effectively use it to solve different didactic purposes in physics in secondary school in order to prepare a highly qualified teacher who will be able to implement basic tasks of individually oriented technologies while teaching physics. It is important to integrate mandatory professional psychological and pedagogical disciplines studied at Pedagogical University and to complement them with additional special courses that are of an integrated nature both in content and in their procedural component for a positive solution of this global didactic problem.

Under the circumstances, an integrated approach to special disciplines being created should be combined with: 1) the opportunity to get acquainted with the latest scientific advances in physics, pedagogy and psychology and issues of methods of teaching physics and to solve complex scientific and methodological problems of differentiated instruction at school simultaneously; 2) the intensification of the role of an active individual activity of each student in developing specific guidelines and in the aspect of his personal development as a future specialist; 3) highlighting contemporary problems of physics methods not only at the lectures where the teacher's competence is in no doubt, but mainly during laboratory practical sessions and while carrying out individual tasks, which are based on independent and active cognitive searching activity of students and which simultaneously develop cognitive interest towards the subject under the study and make the teacher an active and effective practitioner; 4) each student's possessing the completed materials and works (like: synopses of the lessons, educational activities, instructions, etc.) that have previously been discussed and evaluated and are allowed to be used during teaching practice and independent activity) [15, p. 289]. The following samples of such specialized disciplines that were introduced in Kirovohrad pedagogical university and are implemented to prepare future teachers of physics for different educational qualifications the following courses can be considered: for the “bachelor” level — “Modern innovative technologies of teaching physics in high school”, for the level of “specialist” — “Using a training laser in teaching the school course of Physics”, for the level of “Master” — “Computer facilities in the educational process while teaching Physics”.

The essence of integration is to obtain a new cognitive outcome that has an advantage because of its heuristic significance of the cognitive value of all integrated components. The following features of integration should be pointed out: 1) the integration is formed as the interaction of isolated elements, that were previously scattered (new conditions that vary in quantity can arouse only due to different elements); 2) the integration is connected with qualitative and quantitative transformations of related items, as a gradual change of separate elements takes place. The elements are included into an increasing quantity of links, the accumulation of these changes leads to changes in the structure, the appearance of new functions of elements, i.e. the nascence of a new integrity; 3) the process of integration has its logical and profound basis (the construction of integration means, first of all, the determination of a common framework for combining scattered elements of knowledge, the search and reasoning the criteria of unity of different sets) [16].

The *objective* of this article is to reveal the potential for integration of knowledge in Nature Studies to form cognitive interest while teaching Physics at school, the main objectives include the possibility to integrate the knowledge in Nature Studies to create and enhance cognitive interest of students by studying the theme “Nucleus. Nuclear energy” (Grade 9).

The term “integration” is derived from Latin integratio — recovery, replenishment, from integer — whole, which means the process and result of interaction of elements (with properties given), that are accompanied by the restoration, establishment, complication and strengthening of significant ties between them on the basis of reasonable cause, resulting in emerging integrated object (system) with qualitatively new properties, which are stored in the structure properties of individual source elements [6, p. 337]. Methodical basis of an integrated approach to learning is development of the knowledge about the surrounding world, establishment of interdisciplinary and intersubject connections while

teaching Physics. Thus, we consider it advisable to call any lesson having its own structure an integrated one, if the knowledge, skills and results of the material analysis that is studied by methods of other Nature Studies disciplines are applied for its conduction. Because of it integrated lessons are also called interdisciplinary. Such basic didactic requirements towards an integrated lesson can be pointed out:

- having a specific educational and cognitive aims that are distinctly formulated;
- arising pupils' interest for establishing links between adjacent fields of science;
- a high activity of students to apply knowledge from other disciplines is provided;
- deepening and expanding the students' outlook;
- the development of skills while studying popular scientific literature, stimulate the students' desire to acquire new knowledge independently.

It is hard to imagine the modern approach to teaching Physics without making interdisciplinary connections. It intensifies the educational process, stimulates students' learning interest, promotes the outlook expanding. In particular, the links between physics, biology and chemistry that are successfully revealed and shown, reinforce the practical orientation of both a school subject and the educational process in general. Thus, integration aims at laying the foundation for students' holistic understanding of nature and society and forming their personal attitude towards the laws of their development [3, p. 26].

Specific examples of the integration of natural knowledge to create and enhance students' cognitive interest for Physics while studying the theme “Nucleus. Nuclear energy” (Grade 9) are represented by Table 1.

Table 1

The list of interdisciplinary connections that are used in teaching physics:

Grade, chapter	*Subject*	*Contents*
Grade 9. Nucleus. Nuclear Energy	Primary school	Grade 3. Bodies, substances, particles
	Nature Studies	Grade 5. Bodies and substances, surrounding a person
	Biology	Grade 10. Cytoplasm and its components Grade 11. Hypotheses of life arising on earth
	Chemistry	Grade 8. The Nucleus Structure: nucleus and electronic shell. The composition of atomic nuclei (protons and neutrons). Proton number. Nucleon number. Isotopes (stable and radioactive)
	Geography	Grade 8. Major climatic factors: solar radiation, atmospheric circulation.
	Physics	Grade 7. Substance Structure.

It is appropriate to use historical information about the scientists who made a significant contribution to the development of an appropriate direction while teaching this topic: E. Rutherford, J. Thomson, Maria Sklodowska-Curie, Pierre Curie, N. Bohr and others. It is worth considering the issues of biological effects on the theme “Ionizing radiation effects”. Biochemical changes can occur both in a few seconds, and in several decades after the exposure and become an immediate cause of cell death or the changes in it, which can lead to a serious and complicated disease. Radiation influences the heredity intensively and affects the genes in the chromosomes in particular. In most cases, the effect is adverse.

The exposure of living organisms can have some benefit as well. For example, the cells that multiply rapidly in malignant tumors are quite sensitive to radiation. The inhibition of cancer by γ-rays of radioactive drugs that are more effective for this purpose than X-rays is based on it.

Students consider it to be interesting that scientists themselves have only recently realized that radon is the most significant of all the natural sources of radiation. It is an invisible, tasteless and odorless heavy gas, which is 7.5 times heavier than the air. According to the United Nations estimates radon and its products of radioactive decay generate approximately 3/4 doses of radiation received by the population from terrestrial sources of radiation. A person receives the bulk of the radiation dose from radon while being in the rooms that are not ventilated. Then it is advisable to analyze the diagram concerning the influence of a room ventilation on the contents of radon in it (Fig. 1).

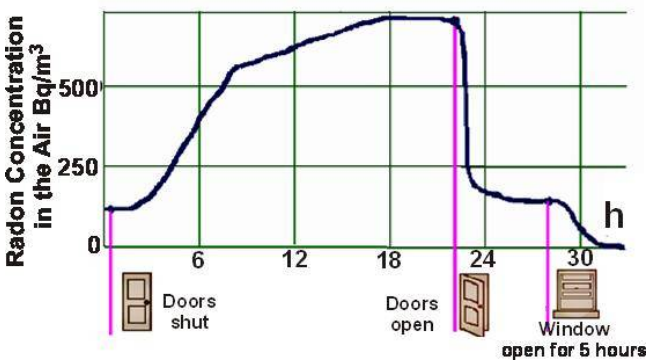

Fig. 1. *The influence of airing the room on the contents of radon in the air of a bedsitter in a single-family house*

It is useful to show the diagram at the Physics lesson, which is conducted as a conference. It should be noted that the pupils were previously offered to do an individual or group research or mini-projects. The results of pupils' independent research can be integrally presented as diagrams, that are illustrated in Figure 2 and 3.

Doing home laboratory assignments in Physics as a means of developing pupils' cognitive interest, forms the flexible and critical thinking, observation, increases the interest for Physics and is rather effective didactic method.

The research of natural radioactivity of food [2, p. 73], is the example of the task whose didactic objective is to experimentally measure the radioactivity of the mostly wide-spread items of food. Such a research develops pupils' cognitive interest for Physics and forms independence while carrying research work out.

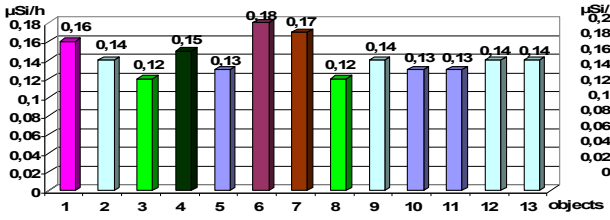

Fig. 2. Measuring the equivalent doses of γ-radiation on the school premises (1 - 8 — classrooms, 9 — Physical Laboratory, 10 — the Principal's Office, 11 — Methodical study, 12 —Teachers'Room, 13 — Assembly Hall

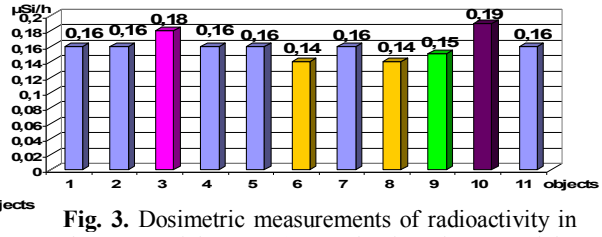

Fig. 3. Dosimetric measurements of radioactivity in the centre of the town (1 — school yard, 2 — Velyka Perspektyvna Street (Part I), 3 — Velyka Perspektyvna Street (near the surface), 4 — Kirov Square, 5 — Kirov Square (near the surface), 6 — Shevchenko Street, 7 — Bohdan Khmelnytsky Square, 8 — over the Ingul River, 9 — on the banking (Part I), 10 —on the banking (Part II), 11 — Velyka Perspektyvna Street (Part II)

Besides important theoretical questions, it is reasonable to reveal the notion of radiation background, radiation of substances that enter the human body through food, natural radioactivity. At the same time, it is appropriate to reveal the possible effects of radioactivity on a man. Therefore, the ability to explore food's radioactivity is an important aspect of life.

Besides important theoretical questions, it is reasonable to reveal the notion of radiation background, radiation of substances that enter the human body through food, natural radioactivity. At the same time, it is appropriate to reveal the possible effects of radioactivity on a man. Therefore, the ability to explore food's radioactivity is an important aspect of life.

The equipment and materials used in the experiment mentioned consist of a dosimeter, buckwheat, instant coffee, milk and other products. To write the results of the experiment into Table2.

Table 2

The results of the study of natural radiation of products

№	*Names of product items*	*Background Activity* A_{back}	*Activity Measurement* A_{meas}	*Product Activity* $A=K(A_{meas}-A_{back})$		*Natural specific radioactivity (table meaning)*	
				Bq/kg	*Ki/kg*	*Bq/kg*	*Ki/kg*
				$K_2=20$	$K_1=8\cdot10^{-9}$		
1	Buckwheat					60-70	$(1,6\text{-}1,9)\cdot10^{-9}$
2	Instant Coffee					900	$2,4\cdot10^{-8}$
3	Milk					30-60	$(0,8\text{-}1,6)\cdot10^{-9}$
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Special attention should be paid, in our opinion, to solving integrated and interdisciplinary problems while implementing the integrated approach. Such training problems in physics with interdisciplinary content are a source, means and a necessary condition for pupils' interest. If a student has solid knowledge and skills in the field of Physics, this ability to solve applied problems significantly activates his cognitive activity [4, p. 267].

The revision and generalization of the material learned previously, the solution of non-standard creative tasks that require creative thinking are other examples of the integration of knowledge in the natural sciences. The following sums can serve as the examples of such tasks while teaching physics in comprehensive schools.

1. To give examples that characterize the quantity and sizes of atoms and molecules:

a) There are $2 \cdot 10^{22}$ drops of water in the Black Sea. There is an equal number of molecules in one water drop.

b) A pin head contains more than 10^{19} atoms of iron. If these atoms are distributed by one in a row on the way from the Earth to the Sun (150 million km), then there will be half a million atoms on every millimeter of the way [1, p. 151].

2. The average capacity of an exposure dose of radiation in an X-ray room is $6{,}45 \cdot 10^{-12} \frac{Kl}{kg \cdot s}$. A doctor spends 5 hours a day in this office. What is his dose of radiation in six weekdays? [11, p. 147]

3. Isotope phosphorus-32 is widely used in biology and medicine. Thus, using the method of tracer atoms, the processes of assimilation of nutrients from fertilizer by plants and metabolism in the body are learnt, the growth of plants' root system is examined. The therapy of blood diseases is done in medicine. The half-life of phosphorus is 14 days, it is a β-radioactive isotope. The maximum radiation energy equals to 1.71 MeV. Define the chemical element whose nucleus is formed as a result of the following reaction (${}^{31}_{5}P \rightarrow {}^{31}_{16}S + {}^{0}_{-1}e$) [14, c. 239].

4. Solving crossword-puzzles as a means of raising interest for Physics is presented in Fig. 4.

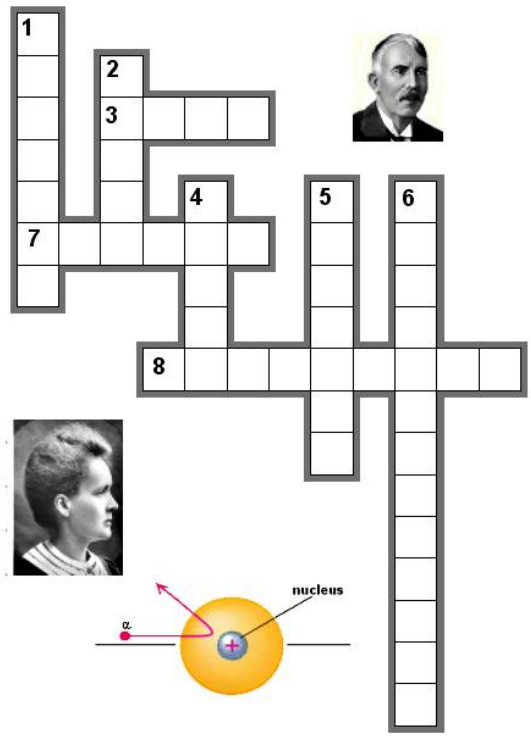

Fig. 4. Nuclear Physics

Horizontally:

2. A French Physicist who was one of the founders of the doctrine of radioactivity.

4. An uncontrolled conversion of unstable isotopes into other isotopes, which are accompanied by the emission of elementary particles.

7. The name of the woman who is one of the founders of the radioactivity doctrine and who discovered the influence of radiation on a living cell. She was the first to use radiation in medicine.

Vertically:

1. A chemical element thar was discovered in 1789, it was obtained in a pure form only in 1841 (the metal of a grey-steel colour).

3. A part of an atom that has a positive charge.

4. The English physicist who offered a nuclear model of an atom.

5. The tiniest particle of a chemical element that consists of a nucleus and electrons.

6. A positively charged particle of a nucleus.

Conclusion. So, the integration of knowledge in Nature Studies gives an opportunity to notably activate the cognitive activity of pupils in secondary school and develop pupils' interest for Physics. At the same time the fact that the integration of fundamental and special knowledge in Nature Studies promotes: the formation of generalized and systemized knowledge, skills and competences in different school subjects and corresponding fields of sciences; formation of pupils' general learning skills and competences; the deeper and more long - lasting acquisition of general scientific notions; removal of the repetition and

economizing time, keeping the principle of continuity during the first concentrum of teaching Physics in secondary school, is very important.

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МЕТОДИЧНІ ОСОБЛИВОСТІ ВИКОРИСТАННЯ НАВЧАЛЬНИХ БЛОКІВ З ЕНЕРГОЗБЕРЕЖЕННЯ У ПРОЦЕСІ ВИВЧЕННЯ ФІЗИКИ

Андрій АНДРЄЄВ

У статті розглядається проблема вивчення фізичних основ енергозберігаючих технологій у процесі навчання фізики. Для здійснення цієї теоретичної підготовки запропоновано метод проблемних ситуацій з енергозбереження. Розглянуто структуру і наведено приклади навчальних блоків, які складають основу даного методу.

The problem of studying the physical principles of energy saving technologies in physics course is considered in the article. The method of problem situations on energy conservation is proposed for such theoretical training. The structure and examples of teaching units, which are the basis of this method, is described.

Проблема вивчення фізичних основ енергозберігаючих технологій. Успішне формування в учнів компетентності у сфері енергозбереження можливе лише за умови наявності в них відповідних знань, що стосуються теоретичних основ енергозберігаючих технологій. У сучасних підручниках та посібниках з фізики вже з'являються деякі відомості щодо останніх досягнень науки і техніки у галузі альтернативної енергетики, економії енергетичних ресурсів та раціонального природокористування. Однак, окрім вивчення учнями навчального матеріалу, поданого у готовому вигляді, потрібно ще й залучати їх до активної діяльності, зокрема, до безпосереднього розв'язування ними навчальних проблем, пов'язаних з енергозбереженням та енергоефективністю. Лише за таких умов можна сподіватися на підвищення рівня *усвідомленого* засвоєння матеріалу.