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International Scientific Conference**INTEGRATION OF SCHOOL SCIENCE DISCIPLINES IN THE  
CONTEXT OF SUBJECT CONCEPTS**Oleg Viktorovich Petunin (a)\*, Valeriy Anatolyevich Ryabov (b)  
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**Abstract**

The article is devoted to the urgent problem of integration of school courses of Physics, Chemistry, and Biology in the light of the requirements of subject concepts. The integration of natural science disciplines is interpreted in the given article as the implementation of methodological, content-based, procedural, methodological, and organizational links between Physics, Chemistry, Biology, Physical Geography, and Ecology within the framework of educational activities at schools to form a complete natural science picture of the world. The problem of integration of school natural science disciplines is actualized by the content of the concepts of teaching individual subjects. Currently, the concepts of teaching academic subjects such as "Astronomy", "Biology", "Physics" and «Chemistry" have already been approved. Among the problems of content-based and methodological nature stated in the concepts, the authors point out the problems of the lack of time and intersubject coordination between the syllabi and textbooks; a high degree of sovereignization of natural science disciplines; difficulties in the competent application of knowledge from other subjects by teachers, etc. Solving these problems can reduce the probability of a subjective approach in determining the subject capacity of educational topics; to focus teachers' and students' attention on the key aspects of academic subjects and to carry out a step-by-step organization of work on establishing intersubject connections, constantly complicating cognitive tasks. In the article, the authors give a rather detailed analysis of implementing intersubject integration, which includes the realization of intersubject relations; conducting integrated lessons, and developing integrated courses.

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*Keywords:* Integration, integration of natural science disciplines, subject concept, intersubject relations, integrated lessons, integrated courses



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## **1. Introduction**

According to Vernadsky (1988): "Human beings living on Earth and the surrounding animate and inanimate nature are united in a certain way, coexisting together according to the general laws of nature" (p. 44). This indicates the material unity of nature and sets us the task of studying it generally.

The core components in the course of nature study and its separate topics at school are realized by subjects referring to the subject area "Natural Science", or the so-called natural science disciplines. Physics, Chemistry, Biology, and Astronomy among them are studied at school. All these sciences study various natural phenomena, processes, and elements. It is obvious that for the complete students' perception of nature to be formed, close integration of all school natural science disciplines is necessary. The problem of integration of school natural science disciplines is currently actualized by the content of the concepts of teaching separate subjects and it turns out to be an important scientific and methodological problem.

## **2. Problem Statement**

The need for a well-rounded consideration of the content integration of school science disciplines in the context of several concepts of teaching subjects made us consider the structure, functions, and content of concepts of teaching subjects, to identify the theoretical foundations, levels, and methods of implementing this process. All this emphasized the need to solve the following problem: what are the legal and general pedagogical foundations for integrating the content of school science disciplines in the context of the provision of the concepts of teaching relevant subjects?

## **3. Research Questions**

The normative-legal and general pedagogical bases of integration of the content of school natural science disciplines in the context of the provision of the concepts of teaching relevant subjects were the subjects of the study. Analysis of the structure, functions, and content of the concepts of teaching the subjects "Astronomy", "Biology", "Physics", and "Chemistry" and identification of general pedagogical bases for integrating the content of school natural science disciplines; creation and implementation in the educational process of regional schools methodological recommendations to ensure the integration of the content of school natural science disciplines in the context of the concepts of teaching relevant subjects were the main tasks of the research.

## **4. Purpose of the Study**

The purpose of this work was to analyze the structure, functions, and content of the concepts of teaching subjects such as "Astronomy", "Biology", "Physics" and "Chemistry" to identify the general pedagogical foundations of integrating the content of school natural science disciplines and to develop methodological recommendations for the implementation of this process.

## 5. Research Methods

The study was conducted based on the methods of analysis of normative documents (concepts of teaching subjects), critical analysis of the theory and practice of integrating the content of natural science disciplines established at school.

## 6. Findings

By integration (from Lat. *integratio* – "connection») is most often meant the process of combining different parts into a whole (Big Russian Encyclopedia, 2008).

Integration in pedagogy is the process of establishing links between the structural components of content within a certain educational system to form a complete picture of the world (Dvoryatkina et al., 2017; Kodzhaspirova & Karapirov, 2005).

Integration of natural science disciplines is viewed in this article as the establishment of methodological, content-based, procedural, methodological, and organizational links between Physics, Chemistry, Biology, Physical Geography, and Ecology in the educational process to form a complete scientific picture of the world (Voronin et al., 2019; Zelenev, 2018).

The problem of integration of school natural science disciplines is currently actualized by the content of the concepts of teaching separate subjects.

A concept (from Lat. *conception* - understanding, system) is a certain way of understanding, interpreting an object, phenomenon, process, or the main point of view on an object or phenomenon (Evyukhov, 2018).

The subject concepts represent a system of opinions based on principles, priorities, goals, objectives, and main directions of development of teaching a particular subject in the Russian Federation; they also describe mechanisms, tools, resources, target indicators, and expected results.

According to the concepts, the goal is stated to improve the system of education and enlightenment in the Russian Federation, its adaptation to the needs of modern society

By the present time, the concepts of teaching the main natural science disciplines have already been approved (approved by the decision of the Board of the Ministry of Education of the Russian Federation No. PK 4-vn of 03.12.2019):

- The concept of teaching the subject "Astronomy" in educational organizations of the Russian Federation implementing basic general education programs (The concept of teaching the subject "Astronomy"..., 2019);

- The concept of teaching the subject "Biology" in educational organizations of the Russian Federation implementing basic general education programs (The concept of teaching the subject "Biology"..., 2019);

- The concept of teaching the subject "Physics" in educational organizations of the Russian Federation implementing basic general education programs (The concept of teaching the subject "Physics"..., 2019);

- The concept of teaching the subject "Chemistry" in educational organizations of the Russian Federation implementing basic general education programs (The concept of teaching the subject "Physics"..., 2019).

Subject concepts perform several functions:

1) updating the content of education (cyclical);

2) preservation of the unified educational space of the country, since according to the Federal State Educational Standard, schools and teachers are responsible for the development of content (syllabus).

The subject concept has a certain logical structure:

1. The meaning of the subject;

2. Problems of teaching the subject, covering content-based and methodological aspects and specifying the requirements for teachers;

3. Main fields of implementation.

Among the content-based and methodological problems stated in the concepts, the authors also notice the problems related to the need to integrate natural science disciplines:

- the lack of time and intersubject coordination between the syllabi and textbooks;

- a high degree of sovereignization of natural science disciplines (inconsistency of terminology, notions and in some cases definitions of concepts; when teaching disciplines, concepts formed during the study of other subjects are often not used, etc.);

- difficulties in the competent application of knowledge from other subjects by teachers (Concepts of teaching subjects, 2019).

Solving these problems can allow teachers:

a) to reduce the probability of a subjective approach in determining the subject capacity of educational topics;

b) to focus on the key aspects of academic subjects;

c) to carry out step-by-step work on establishing intersubject connections, constantly complicating cognitive tasks;

d) to form the cognitive interests of students using various academic subjects;

e) to carry out creative cooperation between teachers and students;

f) to study the most important worldview problems through various subjects, etc. (Petunin, 2010).

In pedagogy and methodology of teaching various subjects, integration is realized at different levels.

1. Intrasubject - integration of concepts, knowledge, and skills within individual academic subjects.

Integration at this level allows systematizing knowledge within a certain discipline, a so-called transition from isolated facts to their system in the process of discovering a new law and clarifying the picture of the world. The integration of this type is aimed at combining the information into large blocks, which ultimately leads to a change in the structure of the content of the discipline. In this sense, the integrated content is more information-intensive and is aimed at forming the ability to think in terms of information-intensive categories.

2. Intersubject - synthesis of facts, concepts, principles, and resorting to two or more disciplines. It is manifested through the use of laws, theories, and methods of one academic discipline in the course of study another one. The systematization of content carried out at this level leads to such a cognitive result

as the formation of a complete picture of the world in the students' minds. Intersubject integration significantly enriches intrasubject integration.

3. Trans-subject – synthesis of components of the core and additional contents of education. This is the highest level of integration (Petunin, 2010).

In this article, we will focus on methods to implement intersubject integration. They include:

- implementation of intersubject relations;
- conducting integrated lessons;
- development of integrated courses.

Let us start studying intersubject integration with intersubject connections. As our experience shows, intersubject relations function at several levels:

- content-based (factual, conceptual, theoretical);
- operational (speech development, working with information, etc.);
- methodical (purposeful use of certain teaching methods: reproductive, searching, creative, etc.);
- organizational (episodic, systematic, continuity in the work to ensure intersubject connections).

Observations and our pedagogical experience have shown that the most effective methods and techniques for implementing intersubject connections are: heuristic conversation; conversations of a generalizing plan; excursions; visual teaching techniques; independent work; verbal drawing in a class; expressive reading of landscape descriptions; solving problems on a local history basis.

Next, we will focus attention on the second method of implementing intersubject integration - an integrated lesson. It is conducted in several circumstances:

- if there is a duplication of the same information in different syllabi;
- the desire to save time on studying the topic by taking the developed content from a concurrent discipline;
- study of inter-scientific and generalized categories, laws, principles covering different aspects of human life;
- identification of contradictions in the description and interpretation of the same phenomena, events, facts in different sciences;
- demonstration of a wider field of manifestation of the phenomenon under study, which goes beyond the scope of the subject under study, etc.

As teaching experience shows, an integrated lesson has several possibilities. Conducting integrated lessons contributes to:

- implementation of the most important principle of didactics - the principle of systematic learning;
- increasing the level of students' knowledge of the subject;
- development of students' thinking (ability to abstract, ability to highlight the main thing, draw analogies, analyze, compare, generalize);
- development of a systemic worldview, etc.

There are usually two types of integrated lessons in school teaching practice.

1) intersubject lesson – the material being studied is illustrated with information from other disciplines. For example, in the course of biology taught to the 10th graders, when studying topics related

to biologically important organic substances, it is obligatory to rely on the knowledge of Chemistry about the structure and properties of these compounds.

2) binary lesson - the topic is considered from different points of view using two or more subjects. The peculiarity of such a lesson is that the presentation of the information on one subject is continued in another. For example, in the same biology course taught to the 10th graders, when studying the topic "Water and its biological role", it is necessary to conduct a lesson together with Physics, Chemistry and Biology teachers, because without understanding the features of the structure of the water molecule and its unique properties, it is impossible to understand the biological functions performed by this amazing liquid.

Let us focus attention on the third and last method of integration – the development of integrated courses.

Firstly, we are talking about courses that are implemented within the framework of regular class activities. For example, it is "Natural Science" taught to 10-11 graders studying the subjects within the humanities and socio-economic profile at the basic level.

This course provides the study of theoretical and applied foundations of Physics, Chemistry, and General Biology. It reflects the tasks humanity is currently facing, the solution of which is aimed at the development of a well-rounded competent personality, the preservation of the environment, and human health. The number of hours in each class is 105 (3 hours per week) (Collection of normative documents..., 2008).

Additionally, an educational and methodical complex under the guidance of I. Y. Aleksashina was developed to support, the course, which included a textbook and didactic material for the teacher. Currently, an approximate program in Natural Science has been developed and adapted based on the FSES SGE.

The introduction of the course Natural Science will help eliminate excessive multi-subject content by integrating academic disciplines. The main problem that hinders the introduction of this course to mass school is the lack of teachers who are ready to work at the level of philosophical generalizations of Natural Science.

Secondly, it is necessary to recall the courses of extracurricular activities, elective courses of an integrated nature. Examples of such courses are Biochemistry; Biophysics; Chemical Physics; Physical Chemistry, Environmental Protection; Nature Management, etc.

Lastly, the problems of implementing intersubject integration should be mentioned. They include:

- of time and intersubject coordination between the programs and textbooks;
- a high degree of sovereignization of natural science disciplines leading to the inconsistency of terminology, notions, and in some cases definitions of concepts; when teaching disciplines, concepts formed during the study of other subjects are often not used, etc.;
- difficulties that teachers experience while applying knowledge from other subject areas..

## 7. Conclusion

As observations and our pedagogical experience show, the following method could be used to solve the problems of integration of natural science disciplines:

- development of intersubject elective courses, integrated extracurricular activities;
- ecologization of subjects of the subject area " Natural Science»;

- providing a further in-depth study of the subjects of the subject area "Natural Science" at school;
- conducting intersubject workshops on various problems of natural science;
- teachers' professional training and organizing PC courses on additional integrated professional programs.

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