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STANDARDIZATION OF NATURAL AND SCIENTIFIC EDUCATION IN SECONDARY SCHOOL

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Abstract. The education system in Kyrgyzstan is undergoing a major restructuring under the influence of society's needs and the ongoing ideological and economic changes in the country. This restructuring requires a systems approach in all disciplines, particularly in science education. A systematic approach to the teaching of natural science subjects is clearly traced in the study of natural science theories. The formation of knowledge about the theories and theoretical methods of science consists of the following logical operations: idealization and modeling; analogy; thought experiment; and hypothesis. The study and application of these logical operations also require a systematic approach. As a result of such systematic study of concepts, laws, theories and research methods, students develop ideas about the natural science model of the world. This article examines the implementation of the system-structural and content-activity approaches to the standardization of natural science education in secondary schools.

Keywords: *standard, standardization, system-structural and content-activity approaches to education, the fundamental core of the subject, the content lines of the subject.*

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1. Introduction

Standard can be understood as a sample, or a model, taken as the source for comparison with other similar objects; Normative implies technical document establishing units of quantities, terms and their definitions, requirements for products and production processes, etc. Standard is also a technical document designed to be used as a rule, guideline or definition (What is a standard, 2019; Rubin & Emelyanov, 2005). For example, pedagogical standard is a standard of pedagogical activity that must be mastered in the process of vocational training and professional activity.

Standardization on the other hand, implies the establishment of a scale of uniform norms and requirements for socio-economic and production processes. States can be authorizing standards, known as state standards. The State Standard of Secondary General Education of the Kyrgyz Republic (State Standard, 2014) is the basis for the development of the subject standard, curriculum and the learning teaching materials.

Within the Kyrgyz State Standards, the subject standard is a document regulating the educational results of students, methods for their achievement and measurement within the framework of the subject. Thus, basic curriculum can be understood as a document establishing a list of compulsory subjects, the sequence of their study, the volume and form of the training load.

The teaching-learning materials are commonly understood as a system of teaching aids, containing, along with the textbook, methodological manuals for the teacher, workbooks, sets of didactic materials intended for the students and teachers.

The structure of the subject standard is defined in article 34 of the Kyrgyz Republic Government's Decree:

1. General Provisions.
2. The concept of the subject.
3. Educational results and assessment.
4. The requirement for the organization of the educational process.

In our opinion, the following system of secondary general education in the schools of the Kyrgyz Republic – as depicted in Figure 1 below - should be the methodological basis for constructing subject standards of the natural science educational field. We view such a schema aimed at combining systematic, structural, and substantive - activity approaches to standardization.

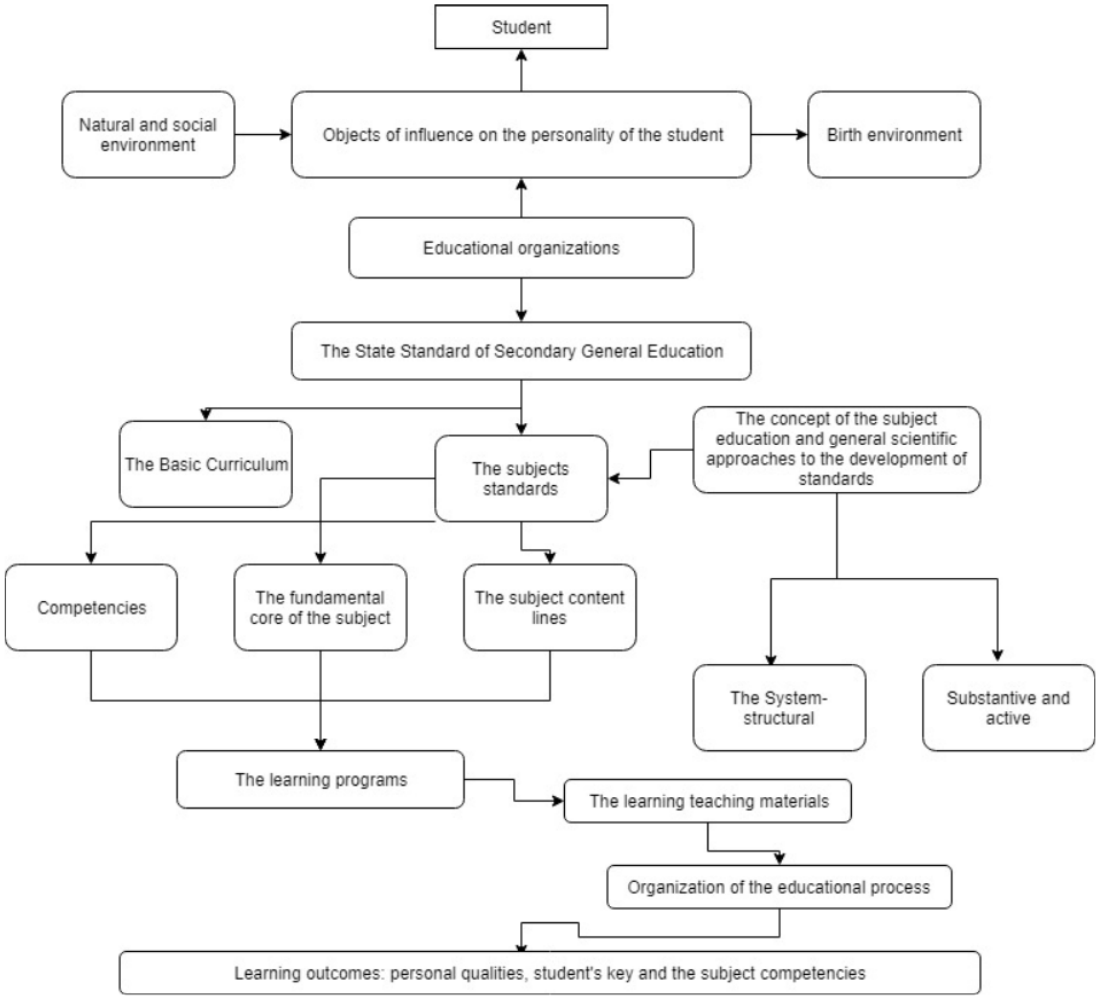

Fig. 1. Model for creating a subject standard

The main component of this system is the student - a healthy, proactive, active and creatively developed personality - the future foundation of the country.

The natural and social environments, as well as educational organizations, influence the formation and development of the student. In their activities, educational organizations, in particular the school, are guided by the State educational standard of secondary general education, on the basis of which a basic curriculum and subject standards are developed.

Central to the development of subject standards is the definition of subject competencies and their relationship with elements of basic competencies. These in turn, are developed on the basis of the foundational core of the subject matters, and their content domains.

The fundamental core of the subject can be conceived as consisting of three interconnected and complementary elements (Mambetakunov, 2015). Fundamental scientific knowledge, Universal educational actions, and the system for evaluating the results. We elaborate each of these below:

1. Fundamental scientific knowledge has a methodological and system-forming nature.

Based on the logical genetic analysis, a group of authoritative didactic scientists determined and scientifically substantiated the structural elements of the system of knowledge in natural science (Fig. 2).

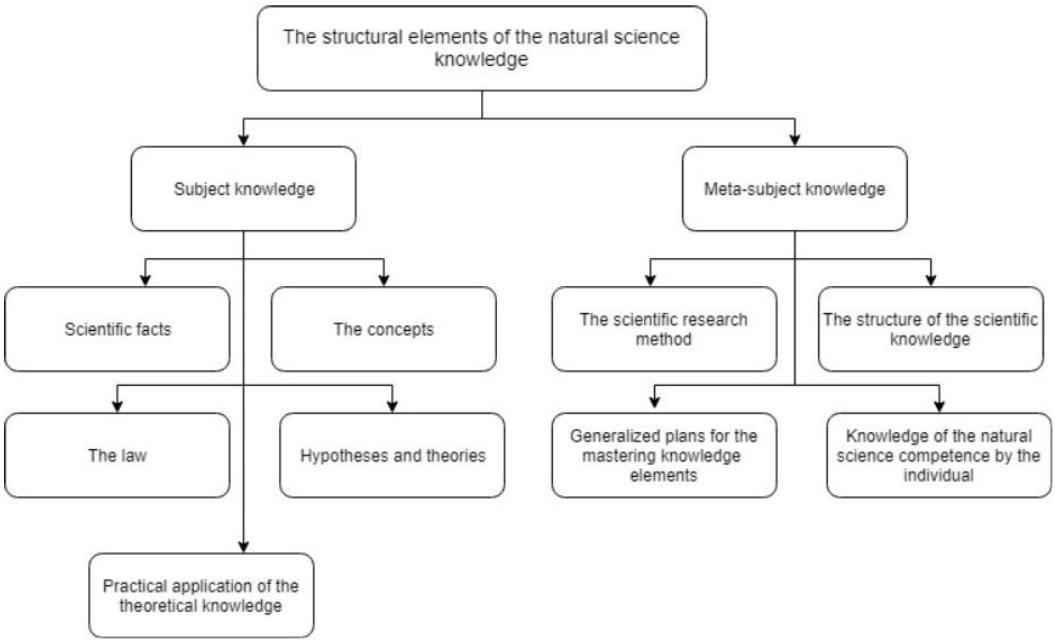

Fig. 2. Structural elements of the system of natural science knowledge

As a result of studying some of the structural elements of this system, students formulate a natural science picture of the world, including a physical, biological, chemical, astronomical, geographical and geological picture of the world. The composition of this phenomenon includes not only substantial, but also personal, technological components of a person that characterize their competencies.

2. Universal educational actions are generalized methods of actions that open up a wide orientation of students in various subject areas. These include: personality universal learning activities; indicative actions; summarized action plans; specific ways of mastering educational material and their practical applications; technological actions; communication actions, etc.

The program for the development of universal educational actions is based on the provisions of a meaningful and active approach that integrates the achievements of psychological and pedagogical science and practice, including the competence educational paradigm.

3. The system for evaluating the results of the development of educational programs: the use of both personalized and non-personalized assessment procedures; use, along with the internal assessment of the teacher and the school, a system of external assessments; both external and internal assessment should be based on a criteria basis; the formation of control and evaluation activities of students (such as skills of reflection, self-analysis, self-control, self-assessment).

To achieve this goal, it is necessary to set requirements in a subject-activity form that includes only actions or activities that can be recorded, measured and evaluated.

The content areas of the subject are the basic ideas and concepts around which all the teaching materials of the subject and technological approaches to the formation of competencies are generalized.

As an example, we present the content areas of subjects of the natural science cycle: (Table 1).

Table 1. Content areas of subjects of the natural science cycle.

Natural sciences	Nature and natural phenomena. Human. The relationship of the human with nature. How do we know the world around us? We live on planet Earth.
Physics	Methods of scientific knowledge of physics. Matter, its types and properties. Movement and interaction. Energy. The technology of applying physical knowledge.
Chemistry	Methods of scientific knowledge. Substance. Chemical reactions. Technology of knowledge application.
Biology	An organism is a biological system. The diversity of the organic world and evolution. Human and his environment.

Competence is the integrated ability of a person to independently apply various elements of knowledge and methods of activity in a certain situation - educational, personal and professional.

Competence is considered as a system consisting of two structural elements: key competencies (informational, socio-communicative, self-organization and problem solving) and subject competencies.

Academic competencies are skills that have broad transfer properties that students can apply knowledge to solve a wide range of problems not only within the framework of one subject, but also tasks in other related subjects. The formation of generalized competencies is based on the theory of activity, as cognitive, practical, research, organizational, self-control and evaluation. They are common to all subjects.

Meta-subject competencies are knowledge of subject knowledge and skills, as well as methods of scientific knowledge of the subject matter. When considering the most general case of a cognitive situation, its main task can be formulated as follows: based on the goals of the subject and the means at his disposal, given the psychological and pedagogical conditions, find a sequence of actions that would lead to the achievement of goals. Examples of this competence are “generalized plans” for mastering the structural elements of a system of natural science knowledge. They are called generalized because they are suitable for studying a wide class of objects, i.e.

natural facts, phenomena, quantities, instruments, laws, theories, research methods, applied issues, etc.

Subject competencies in the natural science educational field can include: understanding and using methods of scientific knowledge; explanation of natural phenomena based on natural laws and theories; their use in different life situations; assessment of acquired knowledge and skills. Or they can be interpreted as: recognition and posing of scientific questions, scientific explanation of phenomena, and use of scientific evidence.

The following describes the distribution of educational material by content areas and grade levels, and educational results that are formulated according to key competencies as well as subject competencies.

For the successful formation of key and subject competencies in schoolchildren, the implementation of cross-subject or interdisciplinary communications in the educational process is important. Hereafter, we will use the term intersubject communication to denote these kinds of exchanges.

Interdisciplinary communications in didactics are considered as didactic conditions for improving the entire learning process and all its functions. With a meaningful and active approach to the implementation of inter-subject communications, materials of related subjects are more strictly coordinated; the scientific and applied levels of learned materials are increased; and didactic units of knowledge are enlarged. All of this results in students developing strong and systemic knowledge and generalized academic skills; which in turn affect the formation of their key and subject competencies.

Given the specific features of the content of science in school, we consider it appropriate to classify intersubject communications as shown in table 2.

Table 2. Intersubject communications

Basis of classification	Types of Intersubject communications	Types of communications
Time to study the educational material	Chronological	Prior Related Subsequent (prospective)
The structure of the training material	Content-informational	At the level of facts Concept level At the law level At the Theory Level At the level of applied issues At the level of using research methods of natural sciences
Ways to master competencies	Active	Reproductive Search (productive) Creative

To concretize this element of the standard, the following matrix is proposed (Table 2), which reveals the cross-cutting thematic lines of the content of subjects of the natural science educational field.

Sections and themes of the subject. Physics. 7th Grade	Related Items Materials			
	Natural Science	Physiography	Biology	Chemistry
1. What are the physics studies?				

Further, the requirements for the resource support of the educational process and the creation of a motivating learning environment are described, with the main strategies, forms and criteria for assessing student achievement also determined.

Thus, we conclude that the implementation of system-structural and content-activity approaches to standardizing science education in secondary schools should be carried out in programs and textbooks of science subjects. Moreover, all textbooks should contain a single interconnected chain of links. The continuity and logical sequence of the content must be strictly observed not only within each textbook, but also between textbooks.

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