

# SCIENTIFIC LITERACY: PROBLEMS OF SCIENCE EDUCATION IN BULGARIAN SCHOOL

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## Abstract

*This article presents the results of a theoretical study, which purpose is to identify opportunities to update the learning process. Subject of study is the formation of scientific literacy among students in Bulgarian schools.*

*Our study has two aspects: scientific literacy in the normative documents regulating the teaching of science in the Bulgarian school; approaches, methods and tools for the formation of scientific literacy. The analysis of normative documents is discussed in relation to scientific knowledge and scientific processes for the formation of scientific literacy among students in secondary schools in Bulgaria.*

*Need for changes in science teaching is discussed in terms of: the choice of approaches, methods and tools for the formation of scientific literacy among students, the creation of appropriate tools, including questions and problems, case studies pertaining to specific situations and require event critical attitude towards the statements and opinions expressed and decisions on important life issues, creating the right environment in which students work together as active learners and that could lead to the development of student's knowledge necessary for life.*

**Key words:** *scientific literacy, chemistry education, biology education.*

## Introduction

To act adequately in today's world, young people, school graduates should be able to understand and process scientific information, to apply scientific knowledge to explain the phenomena surrounding reality. In response, over 90's years of 20-th century stands the idea of objective science teaching in schools is to establish a science literate people. All people, regardless of age, gender, cultural and ethnic environment, require a certain volume of science knowledge and skills to enable them to realize the personal and social aspects. "Understanding the natural sciences and their inherent processes contribute to the development of these skills" (National Science Education Standarts, USA, 1996, p.1). In this respect, the new vision of education brings to the fore the emphasis on development of personal student's skills in the formation of scientific literacy. This is supported by the fact that scientific literacy is a subject of researches (Bybee, 1997, Coll, Taylor, 2009, Holbrook & Rannikmae, 2009, Organization for Economic Cooperation and Development, 2003, 2006 etc.), and is taken as fundamental objective of science education (National Science Education Standarts, USA, 1996).

The term “scientific literacy” appears regularly in discussions on education. This is explained by the fact that their knowledge of science and scientific processes is undeniable role and essential to life as a society and the individual. Everyone faces the need to use scientific information to meet the challenges of everyday life - to take decisions on issues pertaining to life and his responsibilities to the society.

Many of the researches associated with scientific literacy relate to the disclosure content of the concept of “scientific literacy” (Bybee, 1997, Holbrook & Rannikmae, 2009, Organization for Economic Cooperation and Development, 2003, 2006 etc.), other studies describe different teaching approaches which seek to promote reflection on scientific issues (Marks & Eilks, 2009), or are devoted to the study of the level of scientific literacy (Preczewski, 2009, Organization for Economic Cooperation and Development, 2003, 2006).

Based on the analysis of literary sources (Bybee, 1997, Holbrook & Rannikmae, 2009, Organization for Economic Cooperation and Development, 2003, 2006) we found that the focus of “scientific literacy” is designed in a number of knowledge and processes related to the student’s ability to use different sources of information; to express responsible attitude towards the problems of environmental protection; to care for their own health; to recognize the important human life’ and society’ questions that science can answer and learn to work independently and in groups, to determine their motivation and other preferences. ie to know their own mental activity, to have knowledge of the processes inherent in scientific knowledge - observation, description, explanation, prediction of events and phenomena, understanding and interpretation of evidence or statements, acceptance or rejection of the foreign findings. In this sense, scientific literacy is a unity of scientific knowledge and scientific processes that choose between two of its components: the content and procedure.

Knowledge, building a content aspect of scientific literacy, are those scientific knowledge that are important to human life and environmental, natural resources, human health, applicability limits of science and technology. Thus, in certain personal relationships are formed and ready to participate in discussions of social issues and the ability to take important life decisions. The second component of scientific literacy include scientific processes, mental and practical activities relating to the recognition of scientific solutions, scientific explanation of phenomena using scientific evidence to draw conclusions and implications and etc.

To achieve scientific literacy of students are required time and make changes in the theory and practice of teaching. In their base on the one hand a need to reconsider the amount of studying facts, concepts, laws which will make him optimum science knowledge relevant for a long period of time and the other instruction that is designed to support the process of personal constructing the knowledge learned by students.

Having in mind that the understanding the basic science knowledge and processes give the opportunity for full-bodied and productive live, we are targeting the state outlining the problem of construction of scientific literacy among students in the practice of science education in Bulgarian schools.

Content and procedural components of scientific literacy, outlining its social importance and necessity of a man for a long period of time. In this respect, scientific literacy and student are the main things in learning of natural science, which implies adequate training programs // that are relevant to teaching and learning. In connection with the above we analyzed , National Educational Requirements /standards/, educational programs, presence of factual and theoretical knowledge, taught in the context of real-life and learning when effective methods and tools are used.

The study is focused in two aspects: scientific literacy and regulations governing the teaching of science in the Bulgarian school; approaches, methods and tools for the formation of scientific literacy.

### **Scientific Literacy and Legal Documents on Science Education**

The basic documents, regulating educational process in Bulgaria are the National Educational Requirements /standards/ – National Educational Requirements for educational contents and the curricula. National Educational Requirements describe the expected results from education in chemistry and biology in high school. National Educational Requirements are embedded in curricula, describing the

expected results in separate nuclei. Outlining concrete knowledge, skills and relationships that must be achieved in chemistry and biology training is an essential element of the program, since these results will be measured and evaluated.

Keeping in mind the fundamental role of the normative documents sought opportunities they offer for the formation of scientific literacy among students in secondary school in Bulgaria in relation to scientific knowledge and scientific processes:

*Scientific knowledge.* National Educational Requirements /standards/ on science provide students the opportunity to familiarize themselves with the content of basic scientific facts, concepts such as (item, substance, reaction, cell, organism, energy, etc.) that are specified by the study of individual representatives of chemical, biological objects, physical, chemical, biological phenomena, current theories about the construction of building particles of inanimate and animate nature and scientific laws that aims the understanding of nature. We think that the curricula are overloaded with facts, which were introduced in a sequence very similar to the consistency of academic courses in natural sciences. This affects the teaching of science. Our observations and studies // show that a significant part of students taught knowledge remain “passive”, ie students can not apply them in solving relevant problems and particularly those which involve complex application of science knowledge or tasks similar to real situations.

*Scientific processes.* The processes related to the formation and application of scientific knowledge that can be formed through science education are connected with research practice - planning, testing, measuring using proper instruments, description, explanation, forecasting, processing and analysis of experimental data .

For example, when studying the basic chemical laws and theories, the scientific processes reflected in the National Educational Requirements /standards/ are compared, making conclusion, description, explanation, prediction and etc.

For example the description is used in chemical interactions, structure of atoms of I and II period of the periodic system, the main types of crystal lattices, application of studied substances, including petroleum, schematic circulation of nitrogen and carbon, studied compounds acting as environmental contaminants, construction the functional carboxyl group and others.

The explanation - for the disclosure of the relationship between the chemical nature of the item and properties of substances; properties of substances in their composition and structure; use of substances by their chemical properties; using the circle of carbon and nitrogen in explaining the problems of environment; type chemical processes known as chemical equations; physical phenomena, physiological functions of organs and others.

In predicting the nature and properties of compounds of chemical elements, knowing the chemical nature, properties of substances knowing their chemical bonds and others.

Scientific literacy implies students to apply their scientific knowledge to recognize these real issues of life that can be solved by them and that assist decision-making and expression of views on issues relating to nature and its changes resulting from human activity. Application of scientific knowledge and processes associated with familiarizing students with the biological action of ions, the influence of mineral fertilizers on the plants, the effects of ethyl alcohol on human health, the relationship of derivatives of hydrocarbons medicines to know the basic biological functions of fat and etc., which is presented outside the context of real life situations. In this respect could be desired much more involvement of educational content.

The analysis of the legislation related to the science education in Bulgarian schools, give us reason to make the following conclusion:

Content of National Educational Requirements /standards/ and the curriculum, allowing the formation of scientific literacy among students. At the same time studies show that Bulgarian students are below the average level of scientific literacy (OECD,2006) and (Stefanova§.Minevska, 2009).

The reasons for this, in our opinion are:

- scientific literacy is not clearly defined as a target on science education;
- curricula reflect the consistency of the factual and theoretical knowledge, specific to academic courses. Not focus on basic scientific concepts and directions that are relevant to the formation

of scientific literacy, as is done in some standards and curricula (National Science Education Standards, USA, 1996). This leads to a significant amount of factual knowledge (facts about the substances, processes, etc.) loading content studied by students.

- The advance importance is given to the knowledge. In the curriculum is not set enough the application of scientific processes that are important for the formation of scientific literacy.

### Approaches, Methods and Tools for Building Scientific Literacy

The formation of scientific literacy involves changes in science teaching. Teachers create an environment in which their students work together as active learners; reveal the place and role of scientific knowledge and processes in everyday human conditions and create an appropriate environment that leads to the development of students 'active' knowledge necessary for life. Diversity of needs of students, their personal experiences, and the environment in which they live and learn, require wide support from teachers, providing excellent opportunities for all students to learn fruitful and require learning to correspond to familiar situations in life.

We think that in training in natural sciences still dominate "receiving of knowledge", which proved ineffective approach in teaching process. Use of interactive teaching methods and modern information technology is limited.

Our observations in the practice of teaching natural science, discussions with teachers and students show that most teachers do not understand the meaning of the term "scientific literacy". Many of them connect it with scientific awareness and competence. In the pages of the Bulgarian magazine there are very few publications devoted to scientific literacy. This explains insufficient awareness of teachers for science literacy, which is targeted to be formed.

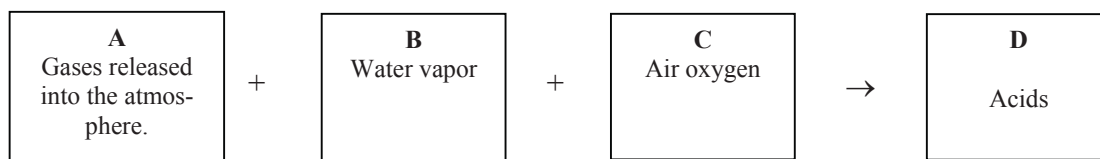
Undoubtedly, the proper choice of approaches, methods and tools will support the formation of scientific literacy among students as essential is the use of appropriate tools, including questions and problems, case studies pertaining to specific situations and require demonstration of a critical approach to expressed statements and opinions and making decisions on important life issues.

We suggest the following example for a task which requires analysis of information and interpretation of evidence from the world around us for formation of scientific findings.

#### *Acid rains*

*The presence of chemicals, dangerous to human health and the environment, in the atmosphere, in large quantities and for a long period of time, is causing air pollution. For industrialized countries, this is due to carbon dioxide, sulfur oxides and nitrogen oxides emissions resulting from human activities (transport, industry, power generation, etc.). Released oxides can stay in the atmosphere for days and be carried over long distances. As fresh air circulates above ground, it sweeps dust and pollutants. Sulfur oxides and nitrogen oxides mix with these pollutants and interact with their components (oxygen, nitrogen, water vapor) or with one another. Thus, new pollutants are obtained, acids, that fall on the ground in the form of acid rain. When they fall on the ground, they alter the chemical composition of soil and water.*

*In general, the reactions that occur in the formation of acid rain, can be represented as follows:*



1. Give examples of substances which may be entered in box **A** and box **D**.
2. Identify possible sources of substances in box **A**.
3. What adverse effects are likely to have the substances in box **D**?
4. Suggest measures to reduce acid rains.

In training, based on fundamental principles of the constructivist approach in which the personal experience of the students in their interaction with the outside world plays a leading role in the absorption and transformation of new information we see possibility of organizing teaching and learning supporting the formation of scientific literacy (Brooks & Brooks, 1999, De Berg, K. 2006).

## Conclusion

Scientific literacy is not set as a goal of teaching natural science, so it remains away and misunderstood from teachers.

National Educational Requirements /standards/ and curricula reflect the consistency of the factual and theoretical knowledge, specific to academic courses.

In terms of scientific knowledge is not sufficiently emphasized on basic concepts of scientific literacy in a context close to real live and daily life of students.

Insufficiently well supported is the application of important for scientific literacy processes such as interpretation of scientific evidence, findings, identify issues, statement in need of research and etc.

Teachers do not pay enough attention to establishing the conditions and proper environment that allows students to actively apply their knowledge, using appropriate scientific processes in the performance of complex tasks.

The formation of scientific literacy is not a process of purposeful work in the process of teaching and learning.

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