

# Place of ecological knowledge in Biology and Health Education curriculum in the upper secondary level of school education in Bulgaria

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**Abstract.** Profile-oriented education is a set of three or four subjects studied within extended course outlines and with an increased number of hours in the 11<sup>th</sup> and 12<sup>th</sup> grade of the Bulgarian schools. The new programme is valid from the 2020/21 academic year and in May 2022 the first matriculation exams have been held. In the present study, the authors have focused on the analysis of the curriculum and the place of ecology in the specialized training in Biology and Health Education, and have compared the Bulgarian curriculum with other related curricula. Along with the analysis, the study has used surveys and narrative interviews with students and teachers regarding their opinion on the place of ecology in the profile subject Biology and Health Education. The study has shown that no matter how important environmental knowledge is, teachers face significant obstacles teaching ecology in the profile, in terms of insufficient number of teaching hours and positioning of the subject in the course outline.

**Key words:** Biology and ecology, Health Education, knowledge, profile-oriented education

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## Introduction

Enactment of Ordinance 7/11.08.2016 of the Minister of Education and Science introduced profile-oriented training in various subjects in the 11<sup>th</sup> and 12<sup>th</sup> grades of the Bulgarian schools. After introduction of profile-oriented learning, changes in the curricula for these classes are keeping in line with the structur-

ing of curricula in most European countries and with synchronization of education in Bulgaria with the EU requirements. Changes in the Law on Preschool and School Education (promulgated in State Gazette No. 79 of 13.10.2015, amended and supplemented in State Gazette No. 82 of 18.09.2020) have divided the high school education level into two stages. The first stage covers the grades 8-10, the second, which includes

grades 11 and 12, introduces profile-oriented training in subjects chosen by the students, along with the general education subjects. Students who have completed grade 10 get a certificate of completing the first high-school stage of secondary education, which empowers them to continue their studies at the second stage of secondary education and apply for profile-oriented qualification. Students educated according to a school curriculum that provides profile-oriented training complete their secondary education after successfully passing a mandatory state matriculation exam in Bulgarian language and literature and a second mandatory state matriculation exam in some profile subject. Study and examination programmes for the state matriculation exams on the academic content, included in the compulsory school programme at the two stages of secondary education, are outlined by the state educational standard for general education [Art. 137] (1).

The subjects in a specified profile are the same in the 11<sup>th</sup> and 12<sup>th</sup> grade. Each profile subject consists of compulsory and optional modules. A module is a separate unit of the profile-oriented training in the relevant profile subject aimed at upgrading the proficiency acquired in general education, as well as at in-depth proficiency in the specific and/or applied areas. Compulsory modules are studied in the 11<sup>th</sup> grade, in the course of 144 study hours per year, and in the 12<sup>th</sup> grade in 124 hours/year.

Syllabus outline for the compulsory modules is approved by the Minister of Education and Science. A profile comprises three or four subjects studied in extended curricula and at an increased number of hours. Two of these subjects are determined at national level and state matriculation exams are held for them. Biology and ecology, respectively, are studied in two profile compulsory groups:

► **Natural Sciences** profile, with the following mandatory profile subjects:

- a) Biology and Health Education and Chemistry and Environmental Protection;
- b) Chemistry and Environmental protection and Physics and Astronomy.

► **Physical Education and Sports** profile, with the following mandatory profile subjects:

- a) Physical Education and Sports;

b) Biology and Health Education.

The subjects in a specified profile are the same in the 11<sup>th</sup> and 12<sup>th</sup> grade. Under Ordinance No. 7, they should be studied in no less than four teaching hours, and should not exceed eight teaching hours per week.

Profile-oriented learning makes it possible for more schools to specialize in a given field without changing their status. This makes the schools more flexible in offering curricula in different subjects after taking into account the interests of the students, as well as the qualifications of the teaching staff. Introduction of profile-oriented training and amendments to the Law on Preschool and School Education, featured by Ordinance No. 7, provide for recognition of the results achieved by profile-oriented training with specific mandatory and/or optional modules approved by a specified higher educational institution, as credits accumulated in that higher educational institution under the conditions and order specified by the relevant higher school or scientific institute.

The new profile-oriented programme has been valid from the 2020/21 academic year and in May 2022 the first matriculation exams were held.

## Material and methods

The goal of the present investigation has been to outline the relationship between the importance of environmental knowledge for students and the place of that knowledge expressed in the curriculum changes for profile-oriented training at the upper secondary level in Bulgaria. The authors have traced this relationship in the Biology and Health Education curriculum. Another goal of the investigation has been to analyse how Bulgarian education reflects the needs in ecology education as compared on international scale. To understand the problems and needs of the Bulgarian teachers, who teach the Biology and Health Education profile in terms of ecology, has been the third goal of the present investigation.

In order to fulfil the aims of this study, the Biology curriculum for profile-oriented training in Bulgaria and the IB Diploma Programme (<https://ibo.org>) have been analysed. The IB Diploma Programme is

an international programme with the participation of more than 150 countries/territories and over 5000 IB World Schools worldwide. In Bulgaria, it has been taught since 2003 in a number of private schools and one state school. The present analysis runs along two lines: how relevant is the knowledge of ecology included in the core Bulgarian Biology profile syllabus and Biology IB syllabus, and how ecological knowledge is represented in the optional modules in the two curricula.

Furthermore, surveys and narrative interviews were carried out with Bulgarian teachers regarding their opinion on the place of ecology in the profile subject Biology and Health Education. The survey was run online, in the period April-May 2022. (In May 2022, graduated the first students trained according to the new, here analysed curricula.)

A link to the questionnaire in Bulgarian has been provided to 130 teachers across the country teaching Biology and Health Education in the secondary high school stage. Feedback was received from 56 teachers. Descriptive statistics and frequency analysis of the respondents' opinions were applied.

## Results

In the Bulgarian profile-oriented programme for the upper secondary level of school education, each profile study subject consists of compulsory and optional modules. A module is a separate component of the profile-oriented training in the relevant profile subject, aimed at upgrading the proficiency acquired in general education, and at in-depth proficiency in the specific and/or applied areas. Compulsory modules are studied in the 11<sup>th</sup> grade, within 144 study hours per year, and in the 12<sup>th</sup> grade within 124 hours/year. Compulsory modules form the core of the syllabus and their syllabus outlines are approved by the Minister of Education and Science. In the curriculum for profile-oriented Biology and Health Education approved by the Ministry of Education and Science, environmental knowledge is presented in Module 3 *Biosphere - Structure and Processes*. It is featured in the syllabus by a total of 31 teaching

hours, four of which are dedicated to practical work. This module is taught during the first term of the 12<sup>th</sup> grade. Positioning of the module is explained by the fact that the profile program is structured around the concept of organizational levels of the living matter. Thus, in the 11<sup>th</sup> grade and early in the 12<sup>th</sup> grade, Module 1 *The Cell - Elementary Biological System* and Module 2 *Multicellular Organization of Biological Systems* are taught.

In Module 3 *Ecology and Protection of the Environment*, the curriculum content is centred on four topics:

- population as the basic unit for existence of the species;
- structural organization and dynamics of communities and the biosphere;
- sustainable development strategies, and
- biosphere research methods.

The content of the first topic is based on the structural and functional organization of the population, its dynamics, properties and varieties. Analysis of changes in the populations as a result of anthropogenic activity is also required in the program for this topic. In the second topic, mandatory content elements are the structural and functional organization and dynamics of natural communities, and the productivity and development of ecosystems, with an emphasis on the relationship between ecosystem productivity and demographic explosion of man, and human influence on the ecosystems. This topic also includes knowledge about the biosphere: its homeostasis, existing biomes and biogeochemical cycle. Special attention is paid to sustainable development: definition and grouping of natural resources by specific characteristics, with special emphasis on renewable resources. Particular attention in this topic is focused on conservation biology: importance of biological diversity for sustainability of the biosphere and role of international cooperation in biodiversity conservation and sustainable development (Bogoev & Georgieva 2020).

The educational aims in this Module are:

- to enhance knowledge about the composition, structure and processes in the biosphere, methods for its research and for application of knowledge about the biosphere for the development of biological, economic and social sciences and practices;

- to form concepts relating to the biosphere organization of matter on a structural and functional basis;
- to form a system of cognitive, value-oriented and practical skills as part of the key proficiencies in the field of science.

The objectives in Module 3 are aimed at the formation of:

- key proficiencies in the natural sciences (use of knowledge about the composition, structure and dynamics of the levels of organization of the biosphere; authentication of connections and relationships in Nature: discussion of human activities based on scientific facts, knowledge of the major characteristics of scientific research and awareness of the relationship between them);
- learning skills (study of information from different sources, discussion of problems, critical thinking, teamwork, planning activities, and formulation of solutions);
- skills in support of sustainable development (critical attitude and awareness, interpretation of specific situations as consequences for the natural environment, awareness of the importance of sustainable development for the future of humanity);
- healthy lifestyle skills (knowledge on health and disease prevention, decision-making related to personal and public health).

Besides the four core topics, elective topics are also part of preparation of the profile. Topics for the elective modules are defined by the teachers and they prepare the syllabi for them. The syllabi are approved by the Principal of the school. The main goal of the elective modules is to further expand the knowledge obtained in the compulsory modules. Content of the elective topics is not included in the matriculation exams.

The International Baccalaureate (IB) Diploma Programme is designed to equip students with the basic academic skills needed for university study, further education and their chosen profession. Students are required to study six subjects and a curriculum core concurrently over two years in the 11<sup>th</sup> and 12<sup>th</sup> grade. These subjects are classified in six groups. Biology is in Group 4: *Science*, along with chemistry, physics, computer science, design technology, environmental

systems and societies, and sports, exercise and health science. To acquire an IB Diploma, the students have to study three subjects at standard level (preparation for general education) and three at higher level. An analogue of the Bulgarian profile-oriented training is the higher level in the IB Programme. Within the structure of the IB Higher-Level Biology Programme, in addition to the six mandatory modules at the standard level, another five modules are studied. The higher level is required when applying for universities with biological and medical specialties. The minimum number of hours for the two-year study course in biology at the standard level is 95 hours, and 60 more for the advanced level. Normally, depending on the curriculum of the school, students are taught more than the minimum hours proposed by the IB Diploma Programme. In addition to these hours, the IB Programme provides also hours for practical activity: 40 for the standard level and 60 for the advanced level. In these classes, laboratory and field experiments should be held on each of the topics in the syllabus.

An analysis of the biological training in the IB Programme has shown that within the six compulsory modules at the standard level (compulsory for the general education and profile degree) ecological knowledge is included in Module 4: *Ecology*. The syllabus outline of this Module covers four main topics: 1. Biological species, biocenoses and ecosystems; 2. Flow of energy; 3. Carbon cycle; 4. Climate changes. In the first chapter, problems of the definition of species, nature of populations, nutritional relationships between organisms, biocoenoses, ecosystems and their stability, and circulation of substances in ecosystems are discussed. The second topic is entirely devoted to the sources of energy for ecosystems, types of energy and their conversion from one form to another, loss of energy during its transition from one nutritional level to the next, and ways of researching and presenting energy transitions in the food chains. The topic related to the carbon cycle deals with carbon fixation by the green plants during photosynthesis, behavior of CO<sub>2</sub> in aquatic environment, absorption of CO<sub>2</sub> by autotrophs from the atmosphere and water and its release during cellular respiration. Here, special attention is paid to methanogenesis and formation of peat

bogs, fossilization of organic matter and burning of biomass as a source of CO<sub>2</sub>, and formation of calcareous sediments of biological origin. The fourth topic, Climate change, studies greenhouse gases and the mechanism of greenhouse effect, as well as its impact resulting from anthropogenic activity on the Earth's climate changes (Allot & Mindorff 2014).

In addition to the topics included in the core biology curriculum, choosing one elective module is mandatory for both levels. The minimum hours provided for this elective module are 15 for the standard level and 25 for the advanced level, within the framework of a two-year course of education. Students can choose from the four modules offered by the IB Programme: Neurobiology and Behaviour, Biotechnology and Bioinformatics, Ecology and Environmental Protection, Human Physiology.

A comparison of the teaching hours for ecology and environmental protection shows the following results. In Module 4: *Ecology*, the mandatory minimum number of hours is 12, plus four hours for practical classes. If students choose the optional module *Ecology and Environmental Protection*, 15 extra hours are added for the standard, plus 25 hours for the advanced level (it corresponds to the Bulgarian profile-oriented teaching). The hours for practical lessons in the *Ecology* Module are four at the standard level, and six in the optional module, 10 hours altogether. Thus, for the two-year course, the hours total 31 for the standard and 41 for the high level, and with the optional Module *Ecology* this makes 47 hours. So, in IB Biology, the higher-level students are taught 10 more hours ecology and environmental protection, and if they choose the optional topic *Ecology and Environmental Protection*, they will have another eight extra hours. Mention deserves the fact that this is the minimum number of hours and, like in the Bulgarian programme, extra hours could be added at the school's decision.

One significant difference between the Bulgarian profile teaching programme and the IB Diploma Programme is that in the IB Programme, due to the importance of topics related to ecology and the international nature of the programme, another subject called Environmental Systems and Societies has been

included in the group of natural sciences. Environmental Systems and Societies is an interdisciplinary subject, which brings together scientific study of the ecological systems and holistic understanding of human impacts on these systems. Taking this course, the students will have ample opportunities to develop skills in reflection, critical thinking, empathy and problem-solving, and will understand opinion-making that would lead to action taking. Teaching hours for this subject total 120, plus 30 hours for practical classes, or 150 teaching hours altogether. In the syllabus, eight main topics are mandatory: Topic 1: Foundations of environmental systems and societies (16 teaching hours); Topic 2: Ecosystems and ecology (25 hours); Topic 3: Biodiversity and conservation (13 hours); Topic 4: Water and aquatic food production systems and societies (15 hours); Topic 5: Soil systems and terrestrial food production systems and societies (12 hours); Topic 6: Atmospheric systems and societies (10 hours); Topic 7: Climate change and energy production (13 hours); Topic 8: Human systems and resource use (16 hours). Allocation of subjects with a predominantly environmental focus in the IB Programme shows how important environmental education is to the international community of secondary education teachers ([https://: ibo.org](https://ibo.org)).

Along with the analysis, the study has used survey and narrative interviews with teachers regarding their opinion about the place of ecology in the profile subject Biology and Health Education.

The survey helped investigate the teachers' assessment of the place of ecology in the profile-oriented training of Biology and Health Education. Questions in the survey have followed the 5-point Likert scale, except for one, which was a multiple-answer type of a question. The survey was conducted in the period June-July 2022 and was carried out among 56 teachers of Biology and Health Education at the second high-school level. Most respondents - 44 teachers, accounting for 78.5% - had many years of professional experience (more than 46 years). Half of them taught in profile-oriented classes with extended foreign language study, and 21 teachers (accounting for 37.5%) taught in nature and mathematics profile-training schools (Table 1). It has been noted that in the foreign

languages profile schools, it was common practice to take Biology and Health Education as the third profile subject.

**Table 1.** Sociodemographic characteristics of the sample (N= 56)

Variables	n	% of the sample
<b>Age</b>		
25-35 years	3	5,4
36-45 years	9	16,1
46-55 years	16	30,3
56-65 years	28	48,2
<b>Type of school profile</b>		
Profile-oriented classes with advanced foreign language learning	28	50
Science and mathematics profile	21	37,5
Other	7	12,5
<b>Sex</b>		
Male	4	7,1
Female	52	92,9
<b>Total</b>	<b>56</b>	<b>100</b>

After finalization of the first graduating class, which marks the completion of the second high-school level with teaching of the new biological education knowledge, most of the surveyed teachers (46 accounting for 82.2%) think that the hours in the four modules of the profile-training program in Biology and Health Education are not distributed optimally. Only 16% of the teachers find their distribution in the modules optimal (four teachers accounting for 7.1% think it is optimal, and five teachers accounting for 8.9 think it is nearly optimal). One of the respondents was undecided (Fig. 1).

Mention deserves the teachers' opinion to what an extent the amount of material taught in the four modules corresponds to the distribution of hours for each of them, according to the curriculum.

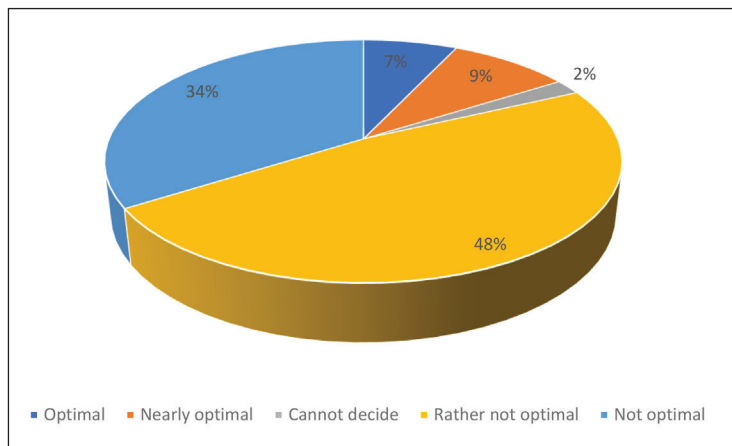
Most of the surveyed teachers (12 accounting for 37.5%) think that the volume of the taught material does not correspond properly to the distribution of hours for each of them, according to the curriculum. About 32.1% of the respondents have found that compliance poor.

The number of respondents with polar opinion is almost the same: five teachers accounting for 9% think that there is full compliance, and six teachers accounting for 10.7% think that there is no compliance. The number of respondents (as compared to the earlier question) hesitating to give a specific answer is striking (Fig. 2).

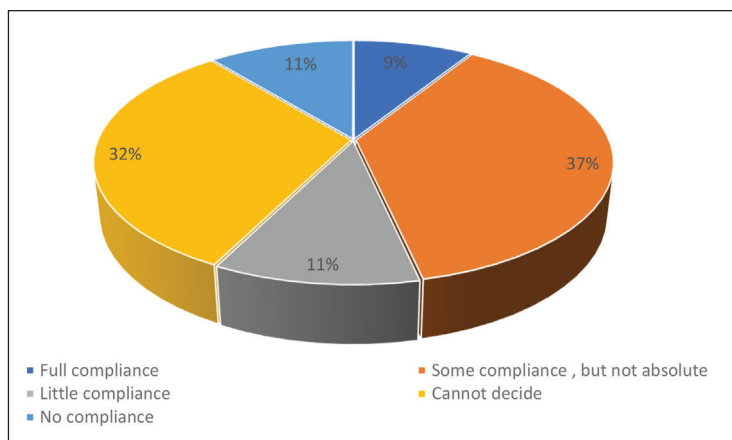
After finalization of the first graduating class, marking the completion of the second high-school level and teaching of the environmental profile in the curriculum, most of the surveyed teachers (21 accounting for 37.5%) think that the number of hours allocated to the study of Module 3: *Ecology and Protection of the Environment* is rather insufficient, while 13 respondents (accounting for 23.2%) assess the statutory hours as insufficient (Fig. 3). Only 16.1% of the teachers find the hours allocated to Module 3 sufficient, and 19.6% think that the hours are nearly sufficient. Two of the respondents cannot decide.

An option compensating for the insufficient number of hours in Module 3 is an optional environmental module. In addition to the mandatory modules in profile-oriented training, study of optional modules is planned, and their content and number are determined by the school, where they are to be taught. Curricula for optional modules are approved by the school Principal. The names of the optional modules may be the same or different from those of the required modules. When the names are the same, the content for study cannot be repeated as in the compulsory modules. The idea of optional modules is to upgrade the knowledge obtained in the compulsory modules. Elective modules are novel in the curricula of biology and health, as is the organization of their inclusion into the school curricula. Selection of a relevant topic in the optional module, which will be maximum useful for the students is a challenge for the teachers (Necheva & Krumova 2021).

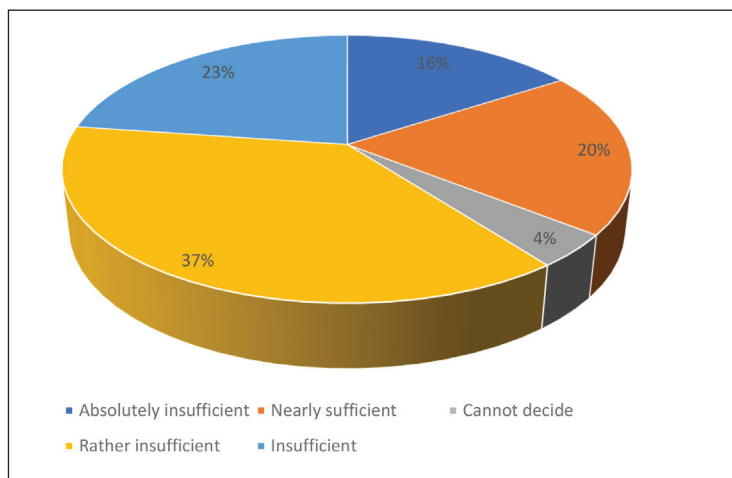
Next question in the survey (the multiple-answer selection type of question) checks on the teachers' motivation in formulating a topic for an optional module related to the content of Module 3 (Fig. 4). The strongest motivator proved to be an opportunity for support by a higher school or scientific institute (selected by 48 teachers accounting for 85.7%). Second



**Fig.1.** Distribution of hours in the four modules in the profile-training programme for Biology and Health Education (teachers' opinion).



**Fig.2.** Correspondence between the amount of material taught in the relevant modules and the distribution of hours proposed for that in the curriculum.



**Fig. 3.** Sufficiency of the hours allocated to the study of Module 3: Ecology and Environmental Protection.

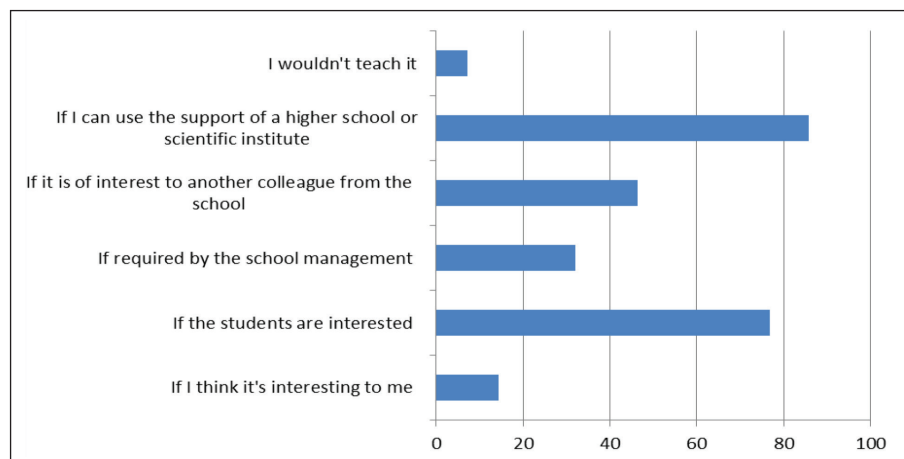
came the interest of students (chosen by 43 teachers accounting for 76.8%), and third was the interest of another school colleague (chosen by 26 teachers accounting for 46.4%). A requirement of the school management that the optional module topic should relate to the content of Module 3 seems to motivate 18 respondents accounting for 32.1%. Personal interest has been leading in eight respondents accounting for 14.3%. Mention deserves the fact that only four respondents have said that they rather would not teach environmental knowledge, skills and proficiency in an optional module.

Teachers have identified the following specific difficulties faced when teaching Module 3:

- Two terms of studying Module 3, rather than one (compactness)
- No aids with extra resources for the teachers and students
- No support from higher schools and scientific institutes (specialists support)
- Lack of motivation among students
- The online studies (due to COVID-19)

The current problems of ecology and environmental protection, which in the teachers' opinion should be emphasized, while teaching Module 3 in the profile-oriented training of Biology and Health Education, are:

- improving the carbon balance; carbon neutrality;
- circulation of materials and methods for processing and recycling;
- simple and multi-component materials used in everyday life;
- "circular economy", "green economy", "blue economy";
- good practices in the initiatives (international and local) dealing with waste, which bring financial and social benefits to society;
- waste-free technologies; principles for different treatment;
- major principles of waste management: prevention, "Polluter pays", foresight, proximity.



**Fig. 4.** Instances in which the teachers would suggest an optional module related to the content of Module 3 (multiple-answer selection type of question).

## Discussion

Thus, the study of biology at the IB higher level, which corresponds to the profile-oriented learning in Bulgarian education, requires a greater number of hours, at least 16. A comparison with the curricula has shown that both, in terms of educational content and approximate number of hours, the Bulgarian the and international programs are quite close with regard to the general education training. An elective module in ecology would ensure extra knowledge for students with special interests along these lines. However, there are differences in the positioning of the ecology study in time, as well as in the number and significance of practical classes. In the Bulgarian programme, ecology is studied in the first term of the 12<sup>th</sup> grade and this is determined by the Ministry of Education and Science. In the IB Programme, the study of modules is not fixed within the span of the two years and the teacher could change the order of their studying. Thus, the *Ecology* module could be taught in the months of May and June, when conditions are better for the field experiments. Another significant difference is that the practical classes in the curriculum of the IB Diploma Programme are recorded and submitted by the teacher in an electronic version at the examination centre, which excludes missing the practical work. In the IB Programme, practical classes are subject to special evaluation: the so-called in-

ternal assessment. To receive a grade on this component, the students, after completing the required practical hours, must conduct their own research on a topic of their choice and describe it in a 6-12 page paper. Very often, students choose environmental topics for their internal assessment, because of the opportunity to go out into Nature and collect enough interesting material for their research. The third difference between the two studied educational programmes is the

subject Environmental Systems and Societies present in the IB curriculum and offered to those students who are not greatly involved in natural sciences but wish to acquire skills that will help them to assess human impact on the environment.

Based on the teachers' opinion from the present research, the authors have found that despite the importance of environmental knowledge, it is featured in the Bulgarian programme of profile-oriented training with an insufficient number of hours. Connection between schools and universities and scientific institutes is lacking. Moreover, in the teachers' opinion, the fixed position of the Module 3 lessons makes teaching ecology in the profile difficult.

Ecology can be studied further in the elective modules, but owing to a number of circumstances, teachers avoid teaching ecology in these modules. The reason for such lack of interest in the ecology-oriented elective modules is their placement in the curriculum, and lack of sufficient resources for methodological support of the teachers.

A better connection between secondary schools and higher and scientific institutes is required. Then environmental education will take its rightful place in the education of young people, prompted by the specific needs of society for creation and maintenance of sustainable and renewable natural systems.



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