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BIOLOGY CONTENTS IN CURRICULA OF COMPULSORY EDUCATION IN SERBIA, FINLAND AND ENGLAND

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Abstract – At this moment in time, which is marked by extremely negative human influences on the environment, and when a sustainable development of nature is needed, school has a significant role in developing students' knowledge, skills and attitudes towards natural sciences. In European countries, students gain biological knowledge during primary school either through integrated or specific subjects. This paper contains the results of a comparative analysis of the biological content in teaching programs and curricula in three European countries – Serbia, Finland and England. In Serbia, biological contents are included in two integrated subjects (*The World Around Us* and *Nature and Society*) during the first cycle of compulsory education, while during the second cycle they are included in a separate subject – biology – and are linearly arranged. Throughout compulsory education in Finland and England, biological contents are concentrically arranged and are realized through the students' research work in their surroundings in several school subjects.

Key words: compulsory education; biological contents; Serbia; Finland; England

INTRODUCTION

The present economic as well as general situation in the Republic of Serbia, together with changes occurring in its environment "… point to the need for a very reasoned, organized and quality educational system; this is one of the key conditions for the development of a society based on knowledge, which will ensure a higher employment rate" (Serbian Government, 2012). The tendency to interconnect the educational systems of European countries was strengthened by adopting the "European Dimension of Education" resolution in 1991, when the process of compulsory education was expanded by a segment of European education. Serbia, as a country on the road to European integration, is changing and modernizing its educational system in order to join the trends of European education. The changes within the educational system in primary and secondary schools are conducted by the relevant Ministry.

A new primary school curriculum was gradually introduced, grade by grade from the first to eighth grade, from the 2003/2004 academic year to the 2010/2011 academic year. Only in schools where changes have been realized is their full significance noticeable, since the achievements of the projected changes are best seen through teaching practice. The strategy of these changes as well as their realization should follow European educational trends. At

the same time, together with the development and transformation of contemporary Serbian schools into schools of the future, it is also important to preserve the identity and specifics of our country and our schools (Potkonjak, 2009).

The economical and social changes in the European Union require young people to gain a wide range of knowledge in order to prosper in the globalized economy and ever-changing societies (Commission of the European Communities, 2008). Eight key competences to be acquired during compulsory schooling are defined by the European Union. Native language, mathematics and sciences, as basic skills, are listed in the majority of European countries (European Commission, 2012). Particular importance is given to the quality of students' knowledge of natural sciences, part of which is biology. The development of natural sciences contributes to the discovery of new facts which can contribute to solving numerous everyday problems (Miljanović, 2003). The knowledge, skills and attitudes that students gain and develop through studying biology are necessary for their general education.

Studies related to the comparative analysis of the biology curricula in Serbia and other countries are very rare. Miljanović and Grujičić (2003) compared the biology curricula of Serbia and the Republic of Srpska, Miljanović and Milivojević (2005) analyzed biology curricula in Serbia, Hungary, Croatia, Germany and United States (North Carolina), while Džamić-Šepa (2009) compared that of Serbia, Croatia and Slovenia.

This paper analyzes the biological content in the teaching programs and curricula within compulsory education in three European countries – Serbia, Finland and England. Finland is the leading European country on the international PISA testing of student achievements in scientific literacy (OECD, 2010), while the success of English students is above the European average (Department for Education, 2011). The results of Serbian students on international PISA testing so far are much lower compared to other European countries (Hebib and Spasenović, 2011).

The aim of this research was a comparative analysis of the presence, arrangement and structure of the biological content in teaching programs and curricula within the compulsory education systems of Serbia, Finland and England in order to identify similarities and differences between them. This analysis may provide possible directions for changing the current biology curriculum in primary schools in Serbia with the aim of improving biological education in compulsory education.

The research is of theoretical-empirical character and has been realized by the application of descriptive method and the method of theoretical analysis.

RESULTS AND DISCUSSION

In this paper, we analyzed and compared strategic documents in the field of education, legal acts, teaching programs and curricula of the subjects that include biological contents within the compulsory education in Serbia, Finland and England, and drew conclusions about their mutual similarities and differences.

The structure of compulsory education in Serbia, Finland and England

In the Republic of Serbia, compulsory education lasts for nine years. All preschoolers pass through compulsory preparation for the first grade of primary school that lasts for 6 months; primary school lasts for eight years and is arranged in two cycles. The first cycle covers the period from the first to fourth grades, where teaching is realized by the class teachers. In the second cycle, covering the period between the fifth and eighth grades, separate subjects are taught by teachers of the relevant scientific disciplines.

In Finland, preschool education is voluntary and free for all children, and it involves about 95% of children. Children start primary schooling at seven. Compulsory education lasts for nine years and is divided into two levels. The first level covers the period from the first to the sixth grade, where teaching is realized by class teachers. The second level of compul-

Table 1. Subjects with biology contents in compulsory education in Serbia (overview of topics per grade)

The World Around Us *grade I - 72 lessons*	***The World Around Us*** *grade II - 72 lessons*
I and the others (9 lessons) Animate and inanimate nature (47 lessons) Animate nature (15 lessons) Inanimate – water, air, soil (16 lessons) The connection of animate and inanimate nature (10 lessons) The orientation in space and time (10 lessons) The culture of living (11 lessons)	Animate and inanimate nature (27 lessons) Animate nature (12 lessons) Inanimate nature (11 Lessons) The connection of animate and inanimate nature (4 lessons) Where humans live (15 lessons) Human activity (18 lessons) Movement in space and time(12 lessons)
Nature and Society *grade III - 72 lessons*	***Nature and Society*** *grade IV - 72 lessons*
Nature – Human – Society My homeland Inanimate nature - The connection of animate and inanimate nature Movement in space and time Our heritage Materials and their use Human activity	My homeland – part of the world Encounter with nature Flora and Fauna in Serbia A human as a part of nature The exploration of natural phenomena Work, energy, production and consumption Retrospective look at the past
Biology *grade V - 72 lessons*	***Biology*** *grade VI - 72 lessons*
Introduction (6 lessons) The characteristics of living creatures and the diversity of wildlife (12 lessons) Flora – plant structure and life processes (31 lessons) The diversity of plants, significance and protection (17 lessons) Fungi (6 lessons)	Introduction (3 lessons) Protozoans (9 lessons) Fauna (48 lessons) Endangered species and animal protection (6 lessons) Introduction to evolution of living world (6 lessons)
Biology *grade VII – 72 lessons*	***Biology*** *grade VIII – 72 lessons*
The origin and development of human species (4 lessons) T he structure of human body (59 lessons) Reproductive health (9 lessons)	Introduction Ecology and environment The threat, protection and improvement of the ecosystem – environment Global consequences of environment contamination Environment and sustainable development The environment, health and culture of living

sory education, lower secondary education, covers grades VII, VIII and IX, and each subject is taught by a different teacher.

In England, since 2004, public preschool education is available to all children who start their school in the September after their fifth birthday. Compulsory education lasts for eleven years and is divided into four key phases. Primary education is divided into two levels: Key Stage 1 (KS1) for children from 5 to 7 years old (grades I and II) and Key Stage 2 (KS2) which covers the grades III, IV, V and VI. In these two levels, the teaching is mainly realized by class teachers and in some rare situations by subject teachers. Compulsory secondary education is also divided into two key stages, Key Stage 3 (KS3), which covers the grades VII, VIII and IX, and Key Stage 4 (KS4), which takes place in the grades X and XI.

Subjects with biological content within compulsory education in Serbia, Finland and England

An overview of subjects with biological contents in compulsory education in Serbia, together with topics

to be realized per grade, are shown in Table 1. Within the teaching program of compulsory education in Serbia, biological contents are included into the integrated subjects *The World Around Us* (grades I and II of primary school) and *Nature and Society* (grades III and IV of primary school) at the rate of two lessons per week. Biology is introduced as a separate subject in grade V and is taught until grade VIII, at the rate of two lessons per week. Biological contents are also present within the optional subject *Nature Keepers*, which is taught from grade I to VI of primary school, at the rate of one lesson per week (Sl. gl. RS, 2005).

Curricula of all these subjects include goals and objectives, subject contents, program form and education standards. Education standards for the subject of *Nature and Society* are shown for the final part of the first cycle of compulsory education, while for the subject of *Biology*, they are shown for final part of total compulsory education.

The subjects *The World Around Us* in grades I and II and *Nature and Society* in grades III and IV, are of mainly ecological content. In grade I, students start the study of the flora and fauna of different habitats from their environment, in grades II and III they study terrestrial, aquatic and cultivated environmental communities, while in IV they study endangered and protected plant and animal species living in Serbia. During all four grades, and through these biological contents, students learn about the basic life processes in biology, as well as the external structure of plants and animals, but they do not learn about the functioning of particular organs. The basics of systematics are studied through the representation of diversity of plants and animals from the environment, as well as through the introduction to the flora and fauna of Serbia. Anthropological content is very rare at this level of education. The current curriculum gives more attention to external features of the human body and gender differences, and it does not include the basic functions of particular organs or organ systems in the human body. The curriculum also does not include content on human health preservation and the prevention of common diseases. Previous curricula of the subject *Nature Study* in grade IV of primary school had more anthropological content.

The contents of the subject *Biology*, taught from grade V to VIII, are arranged linearly and each grade is dedicated to one biological discipline: botany in grade V, zoology in grade VI, anthropology in VII, and ecology and environment protection in grade VIII. The *Biology* curriculum for grade V includes the realization of 15 practical lessons, which is very significant for achieving curriculum objectives since "their realization contributes to the quality of students' knowledge, and also has other positive effects – it contributes to their positive attitude towards nature and its values" (Miljanović, 2008). In the *Biology* curriculum for grade VI, the range of contents related to anatomy and animal organ system physiology is reduced, while the correlation between organisms and their environment is emphasized. The curriculum for this grade also includes evolution content on an informative level, whereas in teaching the contents of some of the animal groups, the "evolutionary approach is used" (Miljanović, 2008). The *Biology* curriculum for grade VII includes anthropological content with emphases on health preservation and personal hygiene. According to this curriculum, 11 practical lessons are planned "that could be realized during school lessons or at home, and which is very significant for achieving curriculum objectives and fulfilling the tasks of this subject and in this grade" (Miljanović, 2008). The biology contents for grade VIII are related to ecology and environment protection. This curriculum includes several activities and projects. Through these contents "…the active approach of students to the protection of their immediate environment" is achieved (Sl. gl. RS, 2010). The research of Miljanović (2003) showed that the realization of practical lessons in ecology, which were part of the previous curriculum for grade VII, had a positive effect on both the quantity and quality of students' knowledge.

The overview of subjects and topics with biological content within the compulsory education systems of Finland and England is shown in Table 2.

Table 2. Subjects with biological contents in compulsory education in Finland and England (overview of topics per grade)

Republic of Finland	England
Environment and Natural Studies *grades I - IV – 342 lessons*	***Science*** *grades I and II (Key Stage 1)*
Organisms and living environments One's immediate environment and home region, and the world as a human living environment Natural phenomena Substances around us The individual and health Safety	Life processes Humans and other animals Green plants Variation and classification Living things in their environment
Biology and Geography *grades V and VI – 114 lessons*	***Science*** *grades III – VI (Key Stage 2)*
Organisms and living environments Anatomy, vital functions, growth, development and health of the human being Biodiversity Europe as part of the world Diversity of human life and living environments in the world	Life processes Humans and other animals Nutrition Circulation Movement Growth and reproduction Health Green plants Growth and nutrition Reproduction Variation and classification Living beings and their environment - *Adaptations* Feeding relationships Microorganisms
Biology *grades VII – IX – 133 lessons*	***Science*** *grades VII – IX (Key Stage 3)*
Nature and ecosystems Life and evolution The human being The common environment	Organisms, health and behavior Environment, Earth and universe
Health Education *grades VII – IX – 114 lessons*	***Science*** *grades X and XI (Key Stage 4)*
Growth and development Health in choices in daily living Resources and coping skills Health, society and culture	Organisms and health

According to the national curriculum of compulsory education in Finland, biological contents are part of the integrated subject *Environment and Natural Studies*, which is taught from grade I to IV at the rate of 9 lessons per week. In grades V and VI, biological contents are taught within the subject *Biology and Geography*, which combines content from biology and geography, at the rate of 3 lessons per week. *Biology and Geography* are alternately taught during the academic year. In grades VII, VIII and IX, *Biology* is taught as a separate subject at the rate of 2 lessons per week (Stål, 2012). *Health Education* is present as a separate subject in grades VII, VIII and IX at the rate of one lesson per week (Table 2). For each sub-

ject objectives, key contents and descriptions of students' achievements have been shown. The objectives are set out within the entire period for each subject. The integral part of the curricula for the subjects *Environment and Natural Studies* and *Biology and Geography* is the description of good achievements at the end of grades IV and VI, and for subjects *Biology* and *Health Education* the criteria for final assessment are given in grade VIII.

The curriculum of the subject *Environment and Natural Studies* includes the integrated contents of biology, chemistry, physics and geography. Two teaching topics with emphases on sustainable development – *Organisms and Living Environment* and *Individual and Health*, are present in this curriculum. Biological contents are realized in the immediate student environment and they are not specifically planned for particular grades, allowing teachers, within their teaching program during the four years of its realization, to choose contents for a particular grade based on working conditions and student predispositions (Finnish National Board of Education, 2004). Within the subject *Biology and Geography*, biological contents follow up the contents of the subject *Environment and Natural Studies,* and are expanded within the range of similar topics related to ecology, classification of plants and animals, and anthropology. Special emphases within anthropological contents are placed on puberty and health preservation. The curriculum of *Biology* as a separate subject took over the principle of concentric content layout from previous grades, whereas the contents are expanded and supplemented by new ones. The most dominant contents are those related to ecology and anthropology, while those related to other biological disciplines (organism systematics, physiology, genetics and evolution) are less present. The contents of genetics and evolution are related to biological evolution of humans, human genotype and inheritance of human characteristics, while the contents of physiology are related to the life processes of a cell as well as human organisms. The curriculum is realized through a number of minor field researches in the immediate surroundings and laboratory, which is the best way for students to be introduced to it. The curriculum of *Health Education* is based on an interdisciplinary approach to learning, with the specific task of developing the cognitive, social, functional and ethical abilities of the students (Finnish National Core Curriculum for Basic Education, 2004). The contents related to the structure and function of the human body are the basis of this curriculum. They deal with everyday questions of health, disease and health preservation, but also wider questions of physical and social development that are age-appropriate.

According to the national curriculum of England, each grade of compulsory education, which is divided into four Key Stages, includes the integrated subject *Science* (Department for Education, 2011). The number of lessons per month or year is not strictly determined. The curriculum elements of this subject differ from stage to stage (Table 2). Besides the contents of three subjects – biology, chemistry and physics, the curriculum also includes parts related to scientific research, key concepts, processes and the functioning of science. The national curriculum determines the general objectives of education, while at the level of the subject *Science* itself, there are no specifically determined objectives. Descriptions of the level of student achievement are provided at the end of key stages 2, 3 and 4.

In Key Stages 1 and 2, biological contents are realized in the students' immediate surroundings with emphasis on the principle of sustainable development. The contents on basic life processes and the external structure of plants and animals are very similar to the contents within the subjects *The World Around Us* and *Nature and Society* in Serbia, and the subject *Environment and Natural Studies* in Finland, while the contents on microorganisms, plant elements and their functions and anthropological contents are provided on a larger scale. The curriculum of *Science* from grade I to grade IV includes content dealing with the harmful effects of the use of tobacco, alcohol and drugs on human health; this content is not present in curricula in Serbia and Finland in the first cycles of compulsory education. The content on health, proper nutrition and exercising are of similar scope as in the subject *Environment*

and Natural Studies in Finland. Biological content within the curriculum of *Science* for Key Stage 3 are concentrically distributed regarding to Key Stages 1 and 2, and previous contents are in this phase expanded and adapted to student age. It also refers to the contents related to the fields of plant anatomy and human physiology. In Key Stage 4, the ecological contents are expanded by the introduction and study of ecosystem processes, as well as by including content on ecosystem contamination and the influence of this contamination on healthy humans. In this way, the biological contents of Key Stage 3 make a good basis for the further study of biological contents in Key Stage 4, where they are expanded by introducing contents related to biochemical processes in plant and animal cells, energy transfer and the physiology of human organ systems. This curriculum also includes the concept of sustainable development dealing with the ecological consequences of human activities on Earth. These biological contents are given in the wider context of scientific research, the analyses of processes and procedures, collecting information from different sources, systematic observance and measurements, all performed by the students, using a number of appliances and information technology. The specificity of the curriculum of *Science,* as well as of biological contents in Key Stage 4, is in that their scope is not the same in all schools and for all students, but depends on the choice of "courses" the students decide to continue with in their further education.

CONCLUSIONS

Analyses of the biological content in subjects of compulsory education in Serbia, Finland and England show the presence of the principle of scientificity and availability, as well as graduality and complexity of contents from grade to grade. Within the analyzed education systems, biological contents are concentrically arranged. Such distribution of biological contents in Finland and England is present throughout compulsory education, while in Serbia, during the second cycle of compulsory education, biological contents are arranged linearly. The scope of biological contents within the curriculum of compulsory education in Finland and England is smaller than in Serbia, especially regarding *Biology* as a separate subject. The objective of scientific education within the integrated subjects (interdisciplinary approach to learning) is to develop students' interest in nature by providing them with a basic knowledge about the world that surrounds them, and improving their skills and capabilities for further research. In addition, such an approach brings learning closer to a real life, since it connects different scientific fields that do not exist separately in nature.

In the second cycle of education in Serbia and in Finland, *Biology* is present as a separate subject, which is the usual practice in most European countries. Even though biology in England is still a part of the integrated subject *Science,* in Key Stages 3 and 4 it is taught as a separate subject. Subject teaching starts at the beginning of Key Stage 3, at the age of 11, the same as in Serbia, while in Finland it starts two years later. Based on the research results as well as this analysis, it can be concluded that the presence and structure of biological content in compulsory education differ in Serbia, Finland and England. The smaller scope of biological content, its concentric arrangement, as well as the scientific research through which biological content is realized in the teaching practices of Finland and England, could represent a model for further improvement of the present Biology curriculum in Serbia.

REFERENCES

Commission of the European communities (2008). Improving competences for the 21st Century: An Agenda for European Cooperation on Schools. Available from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0425:FIN:EN:PDF (accessed 4 November 2013)

Department for Education (2011). PISA 2009 Study: How big is the gap? A comparison of pupil attainment in England with the top-performing countries. Available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/181601/DFE-RR149.pdf (accessed 4 November 2013)

Džamić-Šepa, N. (2009). Reforma nastavnih programa biologije za osnovnu školu u Srbiji, Hrvatskoj i Sloveniji. *Pedagoška stvarnost,* **LV** (5-6), 564-587.

European Commission/EACEA/Eurydice (2011). Science Education in Europe: National Policies, Practices and Research. Available from http://eacea.ec.europa.eu/education/eurydice (accessed 4 November 2013)

European Commission/EACEA/Eurydice (2012). Developing Key Competences at School in Europe: Challenges and Opportunities for Policy. Eurydice Report. Luxembourg: Publications Office of the European Union. Available from http://eacea.ec.europa.eu/education/eurydice/documents/thematic_reports/145EN.pdf (accessed 4 November 2013)

Finnish National Board of Education (2004). National core curriculum for basic education 2004. Available from

http://www.oph.fi/english/publications/2009/national_core_curricula_for_basic_education (accessed 4 November 2013)

Government of the Republic of Serbia (2012). Strategija razvoja obrazovanja u Srbiji do 2020. godine. Službeni glasnik RS. br. 107/2012.

Hebib, E. and *Spasenović, B.* (2011). Školski sistem Srbije – Stanje i pravci razvoja, *Pedagogija*, **LXVI**, 3, 373-383.

Miljanović, T. (2003). *Aktivno učenje biologije.* PMF, Departman za biologiju i ekologiju, Novi Sad.

Miljanović, T. (2008). Rezultati tekuće reforme programa biologije u osnovnoj i srednjim školama u Republici Srbiji, *Nastava i vaspitanje*, **3**, 281-291.

Miljanović, T. and *Grujičić, M.* (2003). Reforma nastavnih programa biologije za osnovnu školu u Srbiji i Republici Srpskoj. *Savremena univrzitetska nastava* - Zbornik radova naučno-stručnog skupa, 2004. Banja Luka, 111-121.

Miljanović, T. and *Milivojević, V.* (2005). Reforma nastavnih programa biologije u osnovnoškolskom vaspitanju i obrazovanju, In: *Reforma školskog sistema u uslovima tranzicije* (Ed. E. Kamenov), 141-153, Filozofski i Prirodno-matematički fakultet u Novom Sadu i Učiteljski fakultet u Somboru.

OECD (2010). Organisation for Economic Co-Operation and Development, Finland: Slow and Steady Reform for Consistently High Results. *OECD Publishing*, 117-135.

Potkonjak, N. (2009). Zašto naučni skup o školi. In: *Buduća škola* (Ed. N. Potkonjak), 3-26. Zbornik radova sa naučnog skupa I deo, Srpska akademija obrazovanja, Beograd.

Službeni glasnik RS Prosvetni glasnik, 1 (2005). Beograd.

Službeni glasnik RS Prosvetni glasnik, 2 (2010). Beograd.

Stål, I. (2012). Teaching sciences in the Finnish compulsory school (physics, chemistry, biology and geography). Available from http://artofteachingscience.org/countries/Edsystemfinland.pdf (accessed 6 November 2013)