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**WIDE PROFILE SPECIALITY "APPLIED NATURAL SCIENCES" AND POSSIBILITIES  
OF THE UNIVERSITY OF MINING AND GEOLOGY TO TEACH STUDENTS IN IT**

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**ABSTRACT**

The student subject "Natural History" has been studied in the Bulgarian schools. It concerns themes about mutual interaction between the man and the environment, human responsibility, role and activity for its protection. In an Education and Science Ministry (ESM) project for education syllabus for students from 1<sup>st</sup> to 12<sup>th</sup> classes, proposed in 1999, all natural sciences, ecology and other earth sciences were united in a cultural educational area (CEA), titled "Natural sciences and ecology". CEA "Natural sciences and ecology" teachers need a wide-profile nature-mathematical and engineer-technological training. Specifics of the UMG specialities is a precondition a new speciality to be open there. It could train the high qualified teachers (engineer-pedagogues), necessary for teaching in subjects of CEA "Natural sciences and ecology" in Bulgarian schools.

In this work the ESM project for education syllabus in the subjects of the CEA "Natural sciences and ecology" was presented; necessity from a wide-profile high-qualified training of pedagogues for needs of new secondary educational syllabus was considered; UMG was shown as a high school, where a new speciality "Applied natural sciences" is possible to start even in 2003-2004 academic year, training engineer-pedagogues with bachelor degree; the project of the educational syllabus in this speciality proposed by UMG was considered; our opinion that the department in "Physics" should be the one, coordinating student teaching in "Applied natural sciences" disciplines.

**INTRODUCTION IN THE PROBLEM**

According to the ESM Instruction № 6 / 28 May 2001 /DV issue 54, 5 June 2001/ and its §2 change /DV issue 95, 6 November 2001/, studied in primary and secondary schools natural sciences were differentiated in a area, titled cultural educational area (CEA) "Natural sciences and ecology". After 4<sup>th</sup> class subjects studied in it are: "The man and the nature" in 5<sup>th</sup> and 6<sup>th</sup> classes with a horarium by 85 hours for each, "Biology and health education" in 7<sup>th</sup> and 8<sup>th</sup> classes with a horarium by 68 hours each, 9<sup>th</sup> class - 72 hours и 10<sup>th</sup> class - 36 hours, "Physics and Astronomy" and "Chemistry and environmental protection" with a horarium for 7<sup>th</sup> и 8<sup>th</sup> classes by 51 hours for each, 9<sup>th</sup> class - 72 and 10<sup>th</sup> class - 36 hours. According change of §2 of Instruction № 6 term distribution for primary educational degree has become valid since 2002-2003 school year for the 1<sup>st</sup> class students.

The gradual introducing of the new curriculum in the entire school course will lead to a few syllabus changes. At present the subject "Natural History" is studying in 5<sup>th</sup> and 6<sup>th</sup> classes with an annual horarium by 68 hours for each. The new curriculum foresees its title "Natural History" to be changed to "The man and the nature" and its horarium to be increased. The new syllabus projects have been already worked out (jurnal "Physics", 5/2002). Its interdisciplinary character as whole is conserved - some themes in physics, chemistry, biology and geography will be studied. The curriculums in different natural sciences for 7<sup>th</sup> -10<sup>th</sup> classes are also

expected to undergo changes in subject titles, contents and their horarium.

At the moment teachers in physics, chemistry, biology and geography or teachers possessing hybrid specialties – physics and chemistry, biology and chemistry etc., teach in subject "Natural history". So, the former supplemented their horarium. Introducing of the new syllabus will lead to specialist-pedagogues deficit, possessing knowledge in more scientific areas, ready to teach in the subject of the CEA "Natural sciences and ecology". It ensures a wide-profile student training. The lack of the qualified wide profile teachers puts the necessity the new speciality to be introduced in academic syllabus as soon as possible. The new speciality could be introduced in UMG speciality list even during 2003-2004 academic year because the themes foreseen for studying in the subject "The man and the nature" appear to be basic educational elements at teaching in many accredited specialities. For the teaching period in the speciality, which will ensure wide profile specialists - engineer-pedagogues, the students will be learned fundamental knowledge in all natural sciences, mathematics, informatics and methods and technology for environmental protection. They should be a ground element in the professional competency of the future specialist. That is why it is relevant the professional speciality title to be "Natural sciences" and in mind of its applied character – "Applied natural sciences". This choice is suitable because:

The full of content definition of the natural sciences, which according to Stanev (1980) unites in an undivided entirety all science for the nature and their main tasks to know the

natural laws and its existing forms, the types and forms of the matter motion;

The subject "Natural sciences" essence at the secondary school – self-dependent discipline with its own specific purposes and tasks, included in its content elementary knowledge for animated and unanimated nature, which are considered in dialectic unity, correspondingly to their connection and dependencies.

#### PROJECT FOR SYLLABUS FOR SPECIALITY "APPLIED NATURAL SCIENCES"

The project was proposed by the department of Human sciences at UMG and supplemented by the department of Physics. The following educational purposes are pointed out in the project in order to ensure a high profile natural-mathematical and engineer technological training of the students taught in bachelor speciality "Applied natural sciences":

To form creative and self-dependent thinking specialists, capable to apply scientific approach for solving of concrete situation problems;

To ensure higher educational degree and scientific qualification having interdisciplinary character.

Students graduated the speciality "Applied natural sciences" will learn during the training period:

- Fundamental knowledge in the natural sciences field, mathematics and informatics;
- Specific knowledge in pedagogic sciences;
- Profiling knowledge in area of technical and technological sciences as: geodesy, mineral technology, electrician, electronics, mechanics, mining technologies, technical mechanics etc.;
- General knowledge in humanities, social sciences, law and economic sciences.

Bachelor in "Applied natural sciences" will be able:

To organize and realize training in natural sciences in Bulgarian school;

To find, chose and purposefully use information for natural sciences area problems appearing in their activity;

To plan, organize, realize and manage administrative and economic activity connected with using of nature (nature-using)<sup>1</sup>. In this connection activity, efficiency, self-dependence of thinking behaviour, critical attitude and other positive quality of the specialist person are advanced;

To use computer technologies, in this number the specialized products for nature-using servicing and teaching in natural sciences in Bulgarian school;

To conscious of problems, connected with nature-using, to define and analyze, to solve and check them;

To assess practical applying of the learned fundamental and special knowledge;

To apply high linguistic culture and social-communicative abilities for organizing and communication, for establishing and supporting of right relations with others and their changes accordingly circumstances in their professional activity.

<sup>1</sup> Nature-using means relation to the nature and its using, conformably to ecological problems.

The training parameters in speciality "Applied natural sciences" proposed are following:

Form – regular редовна;

Horarium – 2415 hours;

Duration – 8 semesters;

Disciplines – 32 (16 from which are compulsory);

Pedagogic practice – 26 hours;

Graduation – state exam.

The main teaching sphere and adequate disciplines, proposed in the project for bachelor speciality "Applied natural sciences" are:

"Pedagogic sciences" – Teaching pedagogy in techniques and technologies, Teaching methods, Pedagogic basic, Pedagogic practice;

"Natural sciences, mathematics and informatics" – Informatics and computer sciences, Mathematics, Earth sciences, Physical and Chemical sciences;

"Social and Law sciences" – General psychology, Culture, Pedagogic psychology, Law basic, Social psychology etc.;

"Economic sciences" – General theory of market economic, Economic of nature-using, Economic and stable development etc.

Every discipline was divided into two parts: a compulsory part, where the basis of correspondent science was studied, and a part, chosen by the students, which the specialized theoretic knowledge and practical skills in narrower field could be obtained in.

The considered project for the student syllabus in the speciality "Applied natural sciences" give grounds the department of Physics and that of Geology and paleontology to be proposed as the most suitable for teaching organization and coordination.

#### HISTORICAL REVIEW OF NATURAL SCIENCES TEACHING IN BULGARIAN SCHOOL

Studying the place of the "Natural sciences" as subject in the Bulgarian education system after Bulgarian liberation from Ottoman rule showed existing of determined traditions. According to Stanev (1980), historically three main periods were separated, when the subject "Natural sciences" possessed its own specific aims and problems in the curriculum. First period is that after Bulgarian liberation in 1978 till 1923, the second one - 1923 - 1944 and the third one - 1944 till now.

Character feature of the "Natural sciences" as a subject in the primary school during the first period is that it has own specific aims and problems, which determined its relative independence. The themes chosen in its curriculum included knowledge in basic area in natural sciences: botany and zoology, anthropology, general knowledge for minerals, soils, elementary knowledge for the nature, in particular for physical laws. These themes determined the course structure. Relatively big total number of hours, given to this subject, allowed to realize enough student excursion directly in the nature with aim observation and the teaching content was conformable to the respective season. The progressive views

of the pedagogues-specialists from this period was that the knowledge in botany, biology, physics and chemistry should be cleared uniformly, according to the connection between the phenomena and conditions for their existing. That was why the natural knowledge which the students obtained was united into one subject – "Natural sciences". It was pointed out that one of the main teaching tasks was students to understand the essence of the phenomena, the reason for their appearing in the nature because only in this way they could give a meaning to and use the scientific knowledge in their life. It was also taking into account the necessity the students to understand the nature uniformly in its unlimited multiform, to understand the reason for arising of the different processes, to convince themselves that there are mutual influence and determination between inorganic and organic nature.

The curriculum review during this period showed a big respective part of included physical themes – problems from almost all area of classical physics were considered. It allowed the natural sciences teachers in terms of the formalizations and analogues to represent to the students some basic theoretical treatments explaining the studying physical processes and phenomena. The first physics ideas and concepts were constructed in keeping with the principles of accessibility and conformity with the student age features. In the "Natural sciences" course it was determined a place for studying the natural phenomena with physical essence and physical ideas, concepts and dependencies, affecting the whole student person advance, were included in it. Problems included in the curriculum were multilateral and their schoolbook interpretation was characterized by depth.

During the period the scientific methodical formulations, which have an important role for the system and contents of the certain subject, were progressive. It was emphasized that the subject "Natural sciences" was not a mechanical sum of the bases of the different sciences studied the nature, but at its structuring it was taking into account that "during their life "creations", organic and inorganic, are not grouped into systems, but live together by force of known conditions and at the interaction of the certain physico-chemical conditions (Manov, 1922). In this way, the physical phenomena studying in the natural sciences frame was adopted as a necessary condition for the understanding and learning of the natural phenomena.

In the end of the period, however, it was realized that the natural sciences were converted into descriptive subject with a lot of facts and little phenomena explanations which affected negatively on the students interest.

During the second period (1923 – 1944) the established negative orientation in the course of the natural sciences was continued as it was accented again on the descriptive content, but predominantly in botany, zoology and geography. The part of the exact sciences, including physics, was significantly decreased. The week number of hours was conserved, but a negative relation was formed both to physics problems and to all unanimated nature problems with explaining content. Gradually, a view was imposed that during the "Natural sciences" hours knowledge, exceptionally in botany and zoology fields, should be learned. As a result, the knowledge

obtained was insufficiently deep, because the organisms were studied out of the surroundings where they lived and its affect their advance was neglected. The reason of such curriculum changes in the subject might be sought in the views of the specialists, who systemized the complex course.

The third period span the time after 9 September 1944. Basic changes in the whole education system and also in the different subject contents were performed then in Bulgaria. The themes of the unanimated nature sciences determined the main part of curriculum content. The relative part of physical knowledge in the curriculum rose again. The general structure of the "Natural sciences" included the following parts: Water, Air, Electricity, Mineral resources, Human body and care for it (an additional material). In particular, in the physics curriculum of the primary course, simple experiments from the electricity were included; knowledge about methods for electric current getting, conductors, the lightning-conductor principle of action, and, on the whole, knowledge concerning the application of the electricity in human life. It was first time when many summary lessons, which were of important meaning for forming of natural-scientific ideas and regularity. After 1956 the first schoolbook in "Natural sciences" was published in the country by Bulgarian authors. This schoolbook and also the syllabus laying in its base were according to our conditions.

During 1976-1979 period in consequence of team work of the scientific workers and teachers with different specialities a curriculum in "Natural sciences" was done for the 4<sup>th</sup> class of the primary school, whose whole system were consisted of natural fields and involved the following chapters: "Nature - introduction", "Our planet Earth", "Atmosphere", "Hydrosphere", "Lithosphere" и "Biosphere". The theoretical and experimental studying done for the new curriculum revealed a few curriculum disadvantages: because of limited hour number (1 hour weekly), separated in the curriculum for "Natural sciences" studying, important themes were not included in some sections but another ones were united and represented not enough deep. This did the teaching by this curriculum difficult.

The syllabus and curriculums after 1979 were suffered multiple changes each of them characterized with its advantages and disadvantages. In general, the trend was conserved the separate natural sciences problems to be studied in the same subject till 6<sup>th</sup> class. The place of physics, which studies the nature on a new higher level of matter structural organization and is the base of the development of all technical sciences is naturally in this subject. The teaching in the natural sciences in Bulgarian schools needs pedagogues cadres with similar speciality.

#### THE NECESSITY OF TRAINED PERSONNELS WITH SPECIALITY "NATURAL SCIENCES"

In the contemporaneous Bulgarian school system teachers with hybrid specialities (two or more disciplines) are increasingly necessary on account of pedagogues, specialists in one discipline field. Because of that at present the teachers, graduated high schools with hybrid specialities, have

significantly bigger possibilities for their professional realization.

During last years the curriculums were undergone to continuous changes in respect of teaching content as well as their horarium. Sometimes completely groundlessly the hours separated for a determined subject, were diminished on account of horarium increase of another one. The school directors were forced to castles continuously teachers from upper to middle course and vice versa. Number of hours decrease caused laying off even teachers known as good professionals. The hybrid speciality teachers have a priority over the teachers, specialists only in one science field because they could complete lack hour number in their horarium with hours in their second speciality. In this reason teachers with a wide profile (two or more specialities) have been preferred at appointment.

In the training curriculum project in speciality "Applied natural sciences" UMG was foresees training cadres with professional competency in the natural sciences field - physical, chemical and Earth sciences, mathematics, informatics and computer sciences, social and law sciences, economics and pedagogic sciences. This training will help teacher to do methodology, by which they will be able to do scientific discoveries and technical innovations accessible for the students. Engineer training, on the other hand, could be in teacher's favor to stimulate and advance the creative student skills.

The correct realization of connection between the subjects during the teaching process is a problem, which the necessary attention has to be paid to in the future teachers training. Disadvantages in the present syllabus structure in respect of incorrect placed at the time curriculum themes in certain subject toward necessity of the corresponding knowledge for learning themes from the another one could be overcome successfully by teacher graduated speciality "Applied natural sciences". When concepts common to different sciences as mass, density, velocity, quantity of matter etc. have to be introduced for the first time the teacher with speciality "Applied natural sciences" could determine the right time to their correct and simple definition, without meaning the science area. When natural phenomena were studying he could explain them on the base of the determined science during subject hours and they could have a possibility to clear up correctly mutual determination and complicated reciprocal connection of physical, chemical and biological processes.

Except as a teacher in Bulgarian school in subjects from CEA "Natural sciences and ecology" the bachelor in "Applied natural sciences" will be able to realize themselves as an expert at state institutions, ungovernmental organizations and commercial companies with subject of activity in the nature-using field.

#### PHYSICS POSITION IN THE NATURAL SCIENCES SYSTEM

In the antiquity the science for the nature (physics) included all human knowledge for celestial and earth phenomena. That is why till the end of XIX c. in some countries it was named nature-philosophy – philosophy of the nature.

Till XVII–XVIII c. physics as a part of the nature-philosophy had a descriptive character and the man - researcher has been able predominantly to register and describe processes and phenomena occurring in the nature. Heaping of the significant amount scientific facts as a result of the observations and its systematization led to its differentiation to the present natural sciences - physics, chemistry, astronomy geology, biology etc., characterizing with different subject and studying methods. But physics, studying the primary form of the matter from which all the complicated systems were built, was differentiated as a basic science in the system of the other natural sciences.

Generalizing scientific facts the scientists found determinations in the course of the processes, as well as in the conditions, at which a certain phenomenon was possible to be observed, and formulated mathematical dependencies between physical quantities, characterizing objects and their interactions. So physics converted from descriptive to quantitative science, which could foresee the result from a determined interaction and process. Introducing the physical achievements in the technique give the possibility to the man to be independent on time and the condition of the phenomena appearing, to have an active role as research-worker of the environment world, to plan in advance experiments for hypothesis checking, to improve precise of the experimentally measured physical quantity and constants, which were of the essential importance for the science. As a result from the theoretical generalization of the experimentally established facts, the basic physical principles were formulated. Physics is the first science, which in order to understand the essence of the phenomena studied by it, used mathematical modeling. It studied and foresaw quantitatively exact physical phenomena.

Even these days ideas and researching methods of the contemporaneous physics were applied wider and wider in rest natural sciences. Physics had important meaning for the technical development. A number of fields of the contemporary engineering – electrical engineering, electronics, radio engineering, nuclear energetic, laser engineering etc., were narrow connected with physics and their arising was connected with physical findings. Physics stimulates the fast progress of the engineering sciences.

The contemporaneous physics is the most perfect scientific system in the natural sciences. The logical value of its conclusion is the closest to the mathematical one. Because of this one can said that physics is an exact science whose basic principles were formulated in terms of mathematics.

Physics has an important meaning also for the philosophy. Its achievements play an important role at the forming and scientific verification of the philosophical viewpoints. Physics was exactly the science, which in the beginning of the XX<sup>th</sup> century changed radically the scientific ideas (concepts) for the world. The relativity theory and the quantum mechanics creation lead to changes in the human thinking style. The science came out of the frame of the direct observation and evident. This was a qualitative new jump in the cognition theory. Physics achievement helped for the correct world understanding in its dialectic and human culture enrichment.

## THE PLACE OF PHYSICS IN THE ENGINEERING EDUCATION

Engineering sciences arose as necessity one to solve some practical problems, connected with human style of life and different spheres of their activity - industry, building, agriculture, communications etc. Such were geology, hydrology, engineering mechanics, mechanics, electronics, electric engineering, applied geophysics, petrography, heat engineering, nuclear engineering, TV engineering, mining aerodynamics and a lot others. They were differentiated as autonomous sciences because of the studying object specificity, methods used for its studying and its practical purpose. The physics progress stimulated engineering science development.

First engineering schools (building-architectural) were opened in the medium of XVIII c. in France and later in Germany, England and the other countries. In the end of XVIII c. and beginning of XIX c. mechanic-machine schools were opened, and in the second half of the XX c. – electro-engineering ones (Dorfman, 1980). A constant in time basic principle was valid entirely for the engineering education (independently on the directions and national features). "Engineering education consists of knowledge and skills, obtained by symbiosis between the basic scientific knowledge, predominantly physical and mathematical, on one hand, and on the other - the knowledge of crafts, master arts, skills, practice and methods" (Nicolov, Nicolov, 2000). Later engineering-chemical speciality was appeared, which additionally involved chemistry as a basic discipline. In last decades informatics was added for all engineering specialities, as well.

It was pointed in the Encyclopedia of Britain (1980), that "The general for all engineering branches is that the academic training has to start with whole basic studying of the fundamental scientific principles, especially mathematical and physical ones. Later, the education could be continued with general engineering disciplines. In the same reference a definition of the profession "engineer" was given: "The engineering is application of the scientific principles for the optimal natural resources transformation into structures, machines, products, systems and processes for the human prosperity. Despite indirectly, this definition shows the place of physics as an important element in the engineer teaching.

Similar is the views, pointed in XXIII General Assembly of the International Union of Pure and Applied Physics (IUPAP) in 1990. Here are some of them:

- Physics is an important element in chemists, engineers and computer specialists teaching, as well as for workers in other fields of natural and biomedical sciences;
- Physics expanded and enriched our understanding for the other sciences as earth science, agriculture, ecology, chemistry, biology as well as astronomy a cosmology – fields with enormous meaning for the manhood;
- Physics created fundamental knowledge, necessary for the future technological progress, which is in the base of world economic progress.

For the successful realization of the future engineers it is necessary and important they to learn in the course of teaching the bases of physics and significantly deeper those parts of it, on which a certain engineering discipline was developed. Physics is not only basic element in the engineering scientific knowledge. It is necessary for the future technological progress, which is the base of the world economic progress. That is why one could maintain that there is no boundary between the physics as a science and its engineering-technical applications. Ability for the concurrency and mobility of the engineering education in the country in the beginning of the XXI c. requires actual information about the contemporary physical achievements.

## THE PLACE OF PHYSICS IN THE SPECIALITY "APPLIED NATURAL SCIENCES"

In order to realize as engineer-pedagogues in the subjects in the CEA "Natural sciences and ecology", students, graduated the speciality "Applied natural sciences", should know in very well degree (level) the ground positions of the natural sciences.

The historical review of the "Natural sciences" curriculum content and the subjects which will be studied in CEA, "Applied natural sciences and ecology" according to the ESM syllabus project for primary and secondary schools showed that the relative part of the physical themes is bigger in comparison with the other natural sciences. Because of this the hours number, separated natural sciences connected disciplines, especially with physics, should be sufficient for the necessary knowledge, skills and habits acquiring. On the other hand, engineering disciplines, proposed in the syllabus and accompanying with practical exercises, were chosen so that to be able to supplement and extend students' knowledge and to show how the *придобитите* knowledge, skills and habits could be used to solve problems from the scientific and applied character in the area of atmospheric physics, meteorology, atom and nuclear physics, geophysics, methods (seismic, magnetic, electrical and gravitational), applied in geophysics etc.

Having in mind importance *важността* of physics as a science among the rest of natural sciences, the fact that physics is the science basic for the engineering disciplines as well as the bigger part from the curriculum specialized courses in the speciality "Applied natural sciences" are actually physical parts, physics importance for the knowledge and skills system construction by the students, which should serve as a ground for building over the knowledge for the other natural science and engineering specialities becomes clear. In these reason, about 30% of the hours for the compulsory natural sciences disciplines in the proposed curriculum of wide profile speciality "Applied natural sciences" was foreseen to be devoted to the general physics course studying, atomic and nuclear physics, atmospheric physics and meteorology and geophysics. From 28 disciplines, offered for free choice by the students in no "Applied natural sciences" in dependence on their preferences and intentions for renewal into master degree, 23 of them are directly (gravitational, electrical, seismic and magnetic methods in geophysics, physical field theory) or indirect (mechanics, engineering mechanics, general electrical engineering,

geodesy, general hydrology, subterranean water dynamics etc.) connected with physics.

The learning of the knowledge in the natural sciences field on the level necessary for their applying in special courses teaching put the requirements for a good synchrony between different disciplines teaching. In order an informal teaching to be organized, this synchrony has to be reflected in the "Applied natural sciences" syllabus. The department of physics is that which could decide the synchrony problem. Its priority is determined not only because of the big number of disciplines of the physical fields, but also because of the contemporary views of its members about curriculum construction (Ilcheva, 2002).

## CONCLUSION

The discussed above allowed the follow conclusion to be done:

1. At present sharp deficit of specialists with proper natural-mathematical and engineering-technological training exists in Bulgarian education;

2. UMG is accredited to teach students in the specialities, studying the Earth from different aspects. That is why a new speciality should be included in UMG, which gives special knowledge in pedagogic sciences with aim to ensure high qualified pedagogic cadres (engineer-pedagogues) for teaching the subjects from CEA in primary and secondary schools;

3. Because the students were foreseen to study all natural sciences as well as some engineering disciplines, connected with studying and using earth resources, it was proposed the new speciality title to be "Applied natural sciences" and its place – among the specialities of the University of Mining and Geology "St. Ivan Rilski";

4. According to the ESA instruction № 6 the syllabus changes for primary and secondary schools has become valid for the 1<sup>st</sup> class since the 2002-03 school year, and for the 5<sup>th</sup> class - since the 2006-07 school year. The student teaching course in the bachelor degree speciality "Applied natural sciences" engineer-pedagogues trained in the CEA "Natural sciences

and ecology" disciplines for Bulgarian schools lasts 4 years. That is why the bachelor degree students teaching with speciality "Applied natural sciences" should start during the 2003-04 academic year;

5. Because of the prevailing of the disciplines in the physics and earth sciences fields the departments for organizing and control of student teaching in the speciality "Applied natural sciences" disciplines the departments of Physics and of Geology and paleontology are the most suitable;

6. With the training, which speciality "Applied natural sciences" can offer in the field of the natural sciences as well as the engineering and social sciences, a possibility for obtaining a higher education and scientific qualification in wide spectra of master's and postgraduate's programs in the natural, technical and human sciences field will appear for the graduated students.

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