

# PROCEEDINGS

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of the Union of Scientists - Ruse

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Book 5  
**Mathematics, Informatics and  
Physics**

Volume 13, 2016



RUSE

# **PROCEEDINGS**

## **OF THE UNION OF SCIENTISTS - RUSE**

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# **PROCEEDINGS**

**of the Union of Scientists – Ruse**

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**The Ruse Branch of the Union of Scientists in Bulgaria**

was founded in 1956. Its first Chairman was Prof. Stoyan Petrov. He was followed by Prof. Trifon Georgiev, Prof. Kolyo Vasilev, Prof. Georgi Popov, Prof. Mityo Kanev, Assoc. Prof. Boris Borisov, Prof. Emil Marinov, Prof. Hristo Beloev. The individual members number nearly 300 recognized scientists from Ruse, organized in 13 scientific sections. There are several collective members too – organizations and companies from Ruse, known for their success in the field of science and higher education, or their applied research activities. The activities of the Union of Scientists – Ruse are numerous: scientific, educational and other humanitarian events directly related to hot issues in the development of Ruse region, including its infrastructure, environment, history and future development; commitment to the development of the scientific organizations in Ruse, the professional development and growth of the scientists and the protection of their individual rights.

The Union of Scientists – Ruse (US – Ruse) organizes publishing of scientific and popular informative literature, and since 1998 – the "Proceedings of the Union of Scientists- Ruse".

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**BOOK 5**

**"MATHEMATICS,  
INFORMATICS AND  
PHYSICS"**

**VOLUME 13**

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## INTEGRATED MODEL OF EDUCATIONAL PROCESS WITH ELEMENTS OF FOREIGN EDUCATIONAL PROGRAMS

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**Abstract:** *The paper deals with modeling of the educational process with elements of foreign educational programs. We propose a model of educational process, a model of student, a model of specialist and a model of teacher as a tool for building the integrated model. To build models we use set theory and graph theory. The paper also presents the stages of integration process and application of integrated model in the Volga Region State University of Service, Russia and University of Ruse, Bulgaria.*

**Keywords:** *education modeling, educational program, foreign educational programs, integration of educational programs, curriculum design, university, training.*

### INTRODUCTION

There are many publications that address the process improvement of educational services in higher education. Much attention is paid to the curriculum design, learning management, training of teachers, studying the problems of learning and motivation of students, comparative analysis of learning, Web-based educational systems, formation of competence, national and global competition in higher education, joint educational programs and double degree programs.

The models help us understand and improve the educational process. Many publications are devoted to education modeling: discrete mathematical models, structural models, equations models, process models, graphics model, etc., but these publications do not consider the mathematical modeling of educational process with elements of foreign educational programs.

In this paper, we propose mechanism for building the integrated educational process model with elements of foreign educational programs. This model will help university to design the integrated educational program and to train specialists taking into account best practices of leading universities in the world. The integrated educational process model was used in the development of the integrated educational program on the basis of the Volga State University program (Russia) and University of Ruse "Angel Kanchev" program (Bulgaria).

### EXPOSITION

#### 1. EDUCATIONAL PROCESS MODEL

Let  $\Omega$  be the educational process for one educational program in High School. Let  $P_i$  be the educational process in the  $i$ -th semester and  $NS$  is the number of semesters. Then,  $\Omega$  is the set of the processes  $P_i$  and can be defined as follows:

$$\Omega = \{ P_1, P_2, \dots, P_{NS} \} \quad (1)$$

The main components of the educational process are: teaching in the disciplines (courses), practice, final qualifying work, research work. The set  $P_i$  can be written as:

$$P_i = \{ DT_i, PR_i, FCW_i, RW_i \} \tag{2}$$

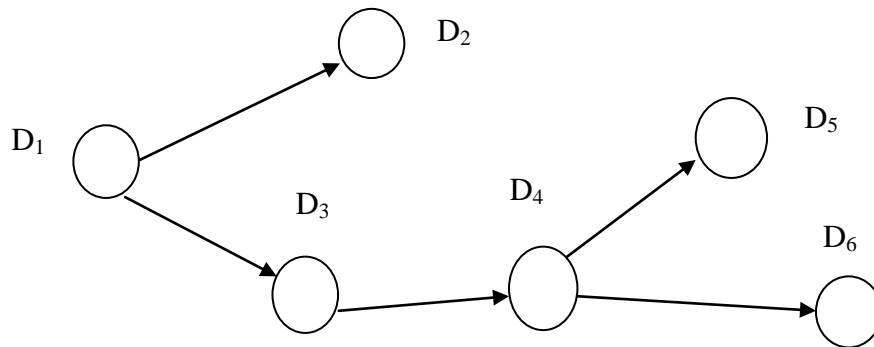
where  $DT_i$  is the teaching in the disciplines in the  $i$ -th semester,  $PR_i$  is the practice in the  $i$ -th semester,  $FCW_i$  is the final qualifying work in the  $i$ -th semester,  $RW_i$  is the research work in the  $i$ -th semester.

The relationship between disciplines can be represented as a directed graph, whose vertices are the processes of teaching in the disciplines and the links between the disciplines are represented by edges of the graph (Figure 1).

Teaching in the disciplines throughout the educational program can be defined as

$$D = \{ D_1, D_2, \dots, D_{ND} \} \tag{3}$$

where  $D_j$  is the training in  $j$ -th discipline,  $ND$  is the number of discipline in this educational program.



**Fig.1. The relationship between the disciplines (part of the graph)**

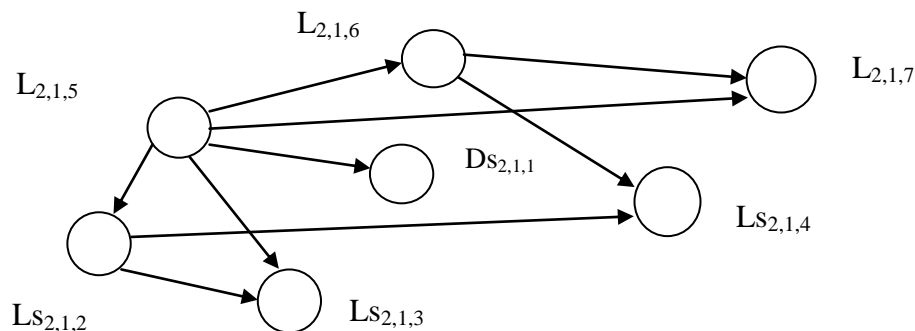
Teaching in the disciplines contains the following elements: lectures, discussion session, lab sessions, course works, course projects, colloquiums, consultations, tests, exams, individual works. Let  $D_{ij}$  be the training in  $j$ -th discipline in the  $i$ -th semester. We can write:

$$D_{ij} = \{ L_{ij}, Ds_{ij}, Ls_{ij}, Cw_{ij}, Prj_{ij}, Col_{ij}, Con_{ij}, Tst_{ij}, Exm_{ij}, Iw_{ij} \} \tag{4}$$

where  $L_{ij}$  is the set of lectures on  $j$ -th discipline in the  $i$ -th semester,  
 $Ds_{ij}$  is the set of discussion sessions on  $j$ -th discipline in the  $i$ -th semester,  
 $Ls_{ij}$  is the set of lab sessions on  $j$ -th discipline in the  $i$ -th semester,  
 $Cw_{ij}$  is the set of course works on  $j$ -th discipline in the  $i$ -th semester,  
 $Prj_{ij}$  is the set of course projects on  $j$ -th discipline in the  $i$ -th semester,  
 $Col_{ij}$  is the set of colloquiums on  $j$ -th discipline in the  $i$ -th semester,  
 $Con_{ij}$  is the set of consultations on  $j$ -th discipline in the  $i$ -th semester,  
 $Tst_{ij}$  is the set of tests on  $j$ -th discipline in the  $i$ -th semester,  
 $Exm_{ij}$  is the exam on  $j$ -th discipline in the  $i$ -th semester,  
 $Iw_{ij}$  is the set of individual works on  $j$ -th discipline in the  $i$ -th semester.

The relationship inside  $D_{ij}$  can be represented as a directed graph where each vertex is a set of elements  $L_{ijk}$  ( $k$ -th lecture on  $j$ -th discipline in the  $i$ -th semester),  $Ds_{ijk}$  ( $k$ -th discussion session on  $j$ -th discipline in the  $i$ -th semester)  $Ls_{ijk}$  ( $k$ -th - Lab session on  $j$ -th discipline in the  $i$ -th semester) and other elements of teaching process for the discipline  $D_j$ . Part of the graph is shown in Figure 2.

From Figure 2 we can see that the first discussion session on discipline  $D_1$  in the second semester requires the prior reading of the 5th lecture of the second semester, and the 4th lab session on discipline  $D_1$  in the second semester is based on the materials of the second and the 6th lecture of the second semester.



**Fig. 2. The relationships inside  $D_{21}$**

This model is based on the analysis of educational programs of Russian universities. We believe that the model of education in a foreign university is similar. The conclusion is based on the curriculum analysis more than 10 universities in Bulgaria, France, Italy, USA, Canada.

## 2. INTEGRATION OF EDUCATIONAL PROGRAMS

The integration of educational programs can be regarded as the process of creating a new set of integrated educational process  $\Omega$ . We suggest the following stages of the integration process of educational programs:

1. Analysis of the curriculum of the educational program of the university and the identification of "bottlenecks" of specialist training in accordance with the requirements of employers;
2. Analysis of foreign educational programs in order to select components for integration into educational process of the university, taking into account trends of the professional area development;
3. Analysis of possibility of programs integration, the establishment of the partnerships with foreign university;
4. Integration of selected elements into the curriculum of the university. Teachers training and the development of training materials;
5. Training of students. Foreign professors can participate in the educational process in various ways: lectures and practical training, including on-line mode, exams, training materials.

## 3. STUDENT MODEL, SPECIALIST MODEL AND TEACHER MODEL AS INSTRUMENTS TO BUILD THE INTEGRATED EDUCATIONAL MODEL

To analyze the existing curriculum, to select elements of foreign educational programs and to construct the integrated model of education process we offer the student model, the specialist model and the teacher model.

The student model is determined by knowledge, experience and competencies that student has acquired in the learning process. Thus, the model student is as follows:

$$St = \{Kn_{st}, Exp_{st}, In_{st}, Cmg_{st}, Cmp_{st}, \{Ln_{st}(D_1), \dots Ln_{st}(D_{ND})\}\}, \quad (5)$$

where  $Kn_{st}$  is the student knowledge,  $Exp_{st}$  is the student experience,  $In_{st}$  is the set of student interests,  $Cmg_{st}$  is the set of student general competencies (teamwork skills, ability to learn new technologies, etc.),  $Cmp_{st}$  is the set of student professional competencies,  $Ln_{st}(D_i)$  is the result of student training in discipline  $D_i$ .

The specialist model includes specialist knowledge, specialist experience, general and professional competencies. It can be represented as a set:

$$Sp = \{Kn_{sp}, Exp_{sp}, In_{sp}, Cmg_{sp}, Cmp_{sp}\}, \quad (6)$$

where  $Kn_{sp}$  is the specialist knowledge,  $Exp_{sp}$  is the specialist experience,  $In_{sp}$  is the set of specialist interests,  $Cmg_{sp}$  is the set of general competencies,  $Cmp_{sp}$  - is the set of professional competencies (including the ability to meet new challenges in the professional field).

The teacher model is one of the basic mechanisms of the learning process. It can be represented as the set:

$$Tch = \{Kn_{tch}, Exp_{tch}, In_{tch}, Cmg_{tch}, Cmp_{tch}\} \quad (7)$$

where  $Kn_{tch}$  is the teacher knowledge,  $Exp_{tch}$  is the teacher experience,  $In_{tch}$  is the set of teacher interests in the field of teaching and in the professional field,  $Cmg_{tch}$  is the set of general competencies,  $Cmp_{tch}$  is the set of professional competencies (including the ability to design new courses).

#### 4. THE INTEGRATED EDUCATIONAL PROCESS MODEL AND ITS APPLICATION

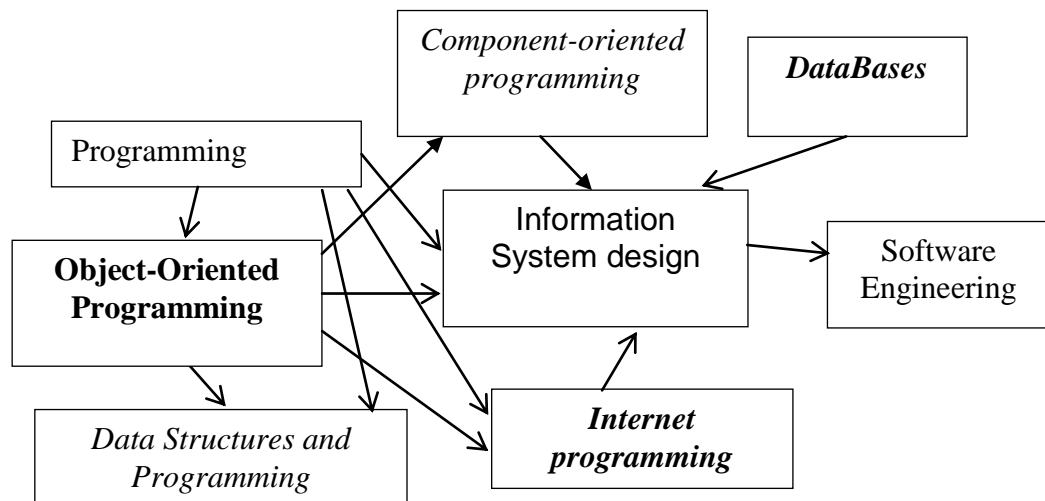
Integrated educational process model can be represented as a function of educational processes models of Russian and foreign universities, student model, teacher and specialist

$$\Omega_{int} = F\{\Omega, \Omega_f, St, Sp, Tch\} \quad (8)$$

where  $\Omega$  is the educational process model of the Russian university,  $\Omega_f$  is the educational process model of the foreign university,  $St$  is the student model,  $Sp$  is the specialist model,  $Tch$  is the teacher model.

The proposed integrated educational process model with elements of foreign educational programs was used at the Department of Applied Informatics in Volga Region State University of Service. Applied Informatics program was selected as the native educational program, Computer Science program of the University of Ruse (Bulgaria) was selected as the foreign educational program. Figure 3 shows a graph "Relationship between disciplines", one of the elements of integrated educational process model with elements of foreign educational programs which is a precise version of Figure 1.





**Fig. 3. Part of the graph “Relationship between disciplines”**

Bold or italics mean that the discipline was added to the curriculum or discipline contains elements of foreign educational program. The curriculum added the discipline "Object-Oriented Programming" and elective courses "Data Structures and Programming" and "Component-oriented programming". Contents of disciplines "Databases" and "Internet programming" have been modified

We have also developed a joint educational program, which includes training courses of University of Ruse for Russian students and courses of Volga Region State University for Bulgarian students. The training is carried out by Russian and Bulgarian teachers in the classrooms and in web seminars mode. Teachers and students travel to the partner universities for teaching, training, participation in scientific conferences.

## CONCLUSION

To build the integrated educational process model with elements of foreign educational programs, we propose to develop the model of the educational process, the student model, the specialist model and the teacher model.

Formation of integrated educational process model, development of the integrated educational program and implementing the educational program would increase the professional level of graduates and competitiveness of graduates on the Job Market.

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**ИНТЕГРИРОВАННАЯ МОДЕЛЬ ПРЕДОСТАВЛЕНИЯ  
ОБРАЗОВАТЕЛЬНЫХ УСЛУГ С ЭЛЕМЕНТАМИ ЗАРУБЕЖНЫХ  
ОБРАЗОВАТЕЛЬНЫХ ПРОГРАММ**

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**Аннотация:** В статье рассмотрены вопросы моделирования процесса предоставления образовательных услуг с элементами зарубежных образовательных программ, представлена модель образовательного процесса высшего учебного заведения, перечислены этапы процесса интеграции образовательных программ, приведены модели студента, специалиста и преподавателя как инструменты формирования интегрированной модели предоставления образовательных услуг, приведена интегрированная модель предоставления образовательных услуг и ее применение на примере университетов России и Болгарии.

**Ключевые слова:** моделирование, образование, образовательная программа, университет, обучение.

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