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STRUCTURAL CONTROL OF THE EDUCATIONAL PROGRAM BASED ON INFORMATION TECHNOLOGY

S. A. Bronov (a)*, E. A. Stepanova (b), N. F. Panikarova (c), S. Y. Pichkovskaya (d)
*Corresponding author

(a) Siberian Federal University, Svobodny 79 & Krasnoyarsk State Agrarian University, Mira 90, Krasnoyarsk, Russia, nulsapr@mail.ru
(b) Siberian Federal University, Svobodny 79, Krasnoyarsk, Russia, nulsapr@mail.ru
(c) Moscow State University of Technologies and Management named after Razumovsky, Zemlyanoj Val 73, Moscow, nfp65@yandex.ru
(d) Siberian Federal University, Svobodny 79, Krasnoyarsk, Russia, nulsapr@mail.ru

Abstract

A curriculum is the basis of any educational program. It contains a list of academic disciplines, the distribution of training time in semesters, types of training sessions (lectures, practical and laboratory classes) and types of control. Normative documents contain many conditions for these curriculum parameters which should be taken into consideration. Currently this problem is being successfully solved with the help of a special computer software which is the same for all universities in Russia. Curriculum developers manage the educational process by changing its structure, i.e. in this case the structural control is used. A structural control is a change in the object structure to achieve its goal. The structure reflects the system and consists of the elements and links between them. The structural control is accomplished by changing the elements or links. The mathematical model of the system contains the input actions, output actions and parameters. These components should be highlighted for control implementation. The structure of the educational program is formed based on two sets: input elements (knowledge) and output elements (competencies). The goal of the educational program is to transform the input elements into output competencies. To do this, each competency is divided into Modules. To control the educational program the links between the Elements are created which subsequently form Units, Modules and Competencies. Here one can apply the theory of fuzzy sets.

Keywords: Curriculum, structural control, educational program.

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1. Introduction

The Bachelor's and master's degree educational programs are the main ones at Russian universities. The Bachelor's degree educational programs are more complex and last for four years. As a result, the bachelor should receive basic general education and the possibility of further specialization (Bronov et al., 2019; Tonakiewicz-Kołosowska et al., 2016). The students are taught in the magistracy for two years after getting the bachelor's degree according to the individual program as they carry out the research on their dissertation theme. The main aim in the magistracy is to deepen the special knowledge obtained in the bachelor's degree program in a specific professional field. Therefore, there are many academic disciplines in the undergraduate program and in the master's program the number of academic disciplines is significantly less, and they are all related to the dissertation themes in the corresponding program. Creating and implementing the educational programs for bachelors is a more difficult task than for masters.

Any educational program is created and carried out by a specific department. The department develops the curriculum, draws up a list of academic disciplines, distributes the teaching load among teachers, organizes the interaction with other departments, contacts the students, controls the creation of methodological support and the use of special technical means (for example, for laboratory classes), organizes practices, current monitoring, defence of Bachelor's qualification works and is fully responsible for the training quality.

Accreditation is the most important form of government control. During the accreditation a special commission carries out the examination of educational programs based on the documents prepared by the department. The educational program at the university must meet many regulatory requirements. These are the state laws, ministries' orders, the university methodological recommendations and the department wishes. To meet these requirements, the resources are used such as teachers and technical means**.** Teachers create training manuals and implement training using these manuals. Technical means are auxiliary and are used for the skills formation while assimilating the training material.

2. Problem Statement

The usable software helps to fulfil only the formal requirements related to the number of hours and their distribution by academic disciplines, weeks and semesters. Presently, the curriculum creators are developing its structure: they divide it into academic disciplines allocating hours for them by the training load type. As a result, an empty curriculum template is formed. Then this template is filled in with the names of academic disciplines. The curriculum developer determines their sequence based on his own experience and the previous curricula (Ramrathan, 2016). When a specific academic discipline is placed in a specific curriculum position, it has a link with other disciplines. Therefore, the same position in the curriculum can be associated with other positions depending on which disciplines are placed in the specific curriculum cells. Thus, the curriculum structure is created.

This structure affects the entire educational process as it provides a consistent study of the material and the formation of relevant competencies. Curriculum developers manage the educational process by changing its structure, i.e. in this case the structural control is used.

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3. Research Questions

A curriculum is the basis of any educational program. It contains a list of academic disciplines, the distribution of training time in semesters, types of training sessions (lectures, seminars and laboratory classes) and types of control (Kukartsev et al., 2018; Lozitskaja et al., 2019; Mitchell, 2016).

Normative documents contain many conditions for these curriculum parameters which should be taken into consideration. Currently this problem is being successfully solved with the help of a special computer software which is the same for all universities in Russia. But the content of the curriculum is developed manually.

The purpose of an educational program is to transform the input competencies into output competencies. The problem is to form the structure of the educational program (Vainshtein et al., 2019; Vainshtein, 2018).

The control of the educational program consists of changing its structure to achieve the specified goal.

3.1. Design general structure of the educational program

A curriculum structure should be developed for the subsequent automation of its filling.

3.2. Design general principles of the structural control system

The educational program control is a change in the structure of the curriculum. It can be called «a structural control». The structural control is used in technical systems. It is proposed to use these principles to control the educational program.

4. Purpose of the Study

There are studies to develop a curriculum structure. Currently, the program «Plany» is used for the development. It solves the problem of the curriculum parameters calculating but excluding the content. With its help an empty curriculum structure is created. But it is advisable to design an educational program (and its curriculum) both taking into consideration the content of academic disciplines and the transformation of input competencies into output competencies (Zykova et al., 2018).

5. Research Methods

5.1. Structure of the educational program

A structural control is a change in the object structure to achieve its goal. The structure reflects the system and consists of the elements and links between them. The structural control is accomplished by changing the elements or links.

The mathematical model of the system contains the input actions, output actions and parameters. These components should be highlighted for control implementation.

Input actions are educational disciplines and their positions in the curriculum.

Output actions are formed competencies at the end of the educational process (Taryma et al., 2019).

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Parameters are the content of academic disciplines, the types of training sessions associated with them (lectures, practical and laboratory classes) and the corresponding planned time.

The structural control is implemented by changing the input actions to obtain the desired output action and it has the following features (Drozd et al., 2019; Drozd & Kapulin, 2017; Kapulin & Russkikh, 2019; Zaharin, 2018).

The structural control does not provide an unambiguous link between each input and output action. It means that you cannot specify which input action needs to be changed to obtain the desired result.

Each academic discipline contains the material that is associated with other academic disciplines. A specific academic discipline is considered a fragment of the general sequence of the educational material. Therefore, when one discipline changes (or its position in the curriculum), other related disciplines (or their positions) are likely to have been changed.

The purpose of the structural control is the formation of predetermined competencies at the output. But competencies contain many components such as knowledge and skills. Each academic discipline is involved in the formation of the corresponding parts of different competencies. The unambiguous link between academic disciplines and competencies is not obvious.

The structural control is discrete – there is a limited set of states for input actions.

One of control options is to iterate through all possible control actions combinations and evaluate the obtained result. Then will be the choice of the best combination of input actions. However, it is required to select the criteria for comparing options. Here one can apply the theory of fuzzy sets. The structure of the educational program (figure 1) is formed based on two sets: input elements (knowledge) and output (competencies). The goal of the educational program is to transform the input elements into output competencies.

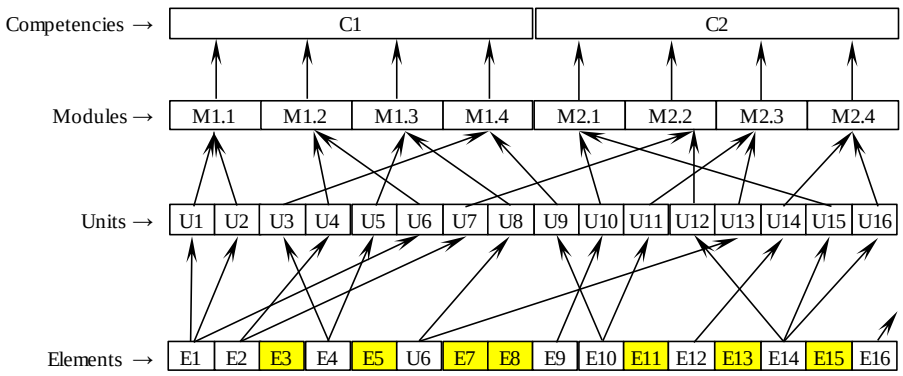

Figure 01. Educational program structure

To do this, each competency is divided into Modules.

For example, the competence “the ability to develop a computer application program for a specific task” can be divided into the following Modules:

1) the algorithm development;

2) a software code development;

3) the program testing and debugging;

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4) the program installation procedure development;

5) the development of the methodological support to work with the program.

Each Module is formed from a huge number of didactic Units, in particular:

1) the algorithm concept;

2) the syntax of the programming language;

3) the basic programming language constructs;

4) the execution of software documentation;

5) the structure of the operating system;

6) the principles of the operating system with the application programs' interaction;

7) the ability to work with the specific programming language compiler;

8) the specific sections of discrete mathematics;

9) the mathematical logic;

10) the set theory;

11) operating the computer;

12) working in application programs, etc.

These units interact with each other and create the Modules that make up the competencies.

The system functions as a relational database. In this case, the Elements and Modules implement the «many-to-many» relationship. This relationship cannot be implemented directly in a relational database. Therefore, it is transformed into the sequence of relations (figure 2):

"many-to-one" → "one-to-many" = "many-to-many"

To control the educational program the links between the Elements are created which subsequently form Units, Modules and Competencies.

The educational program developers have a large array of didactic Elements to use. Only a part of them is required for a specific educational program. To select the specific didactic Units chosen from them Competencies and Modules are analyzed.

For example, the part of the Elements (figure 1) is used while the other part (E3, E5, E7, E8, E11, E13, E14) is not used. The Elements are formed at the previous level of education, for example, in a high school, a college, or as a result of a student's independent work. Therefore, there can be any number of them. The educational program developers always focus on the standardized level, the bachelor's degree, that is the secondary school level. This level is indicated as the initial level in the educational program' official documents.

5.2. Structural control system

A structural control is the control through the structural change. It is realized by selecting the links between Elements that form Units and then by selecting the links between the Units and the Modules that form the Competencies (figure 2).

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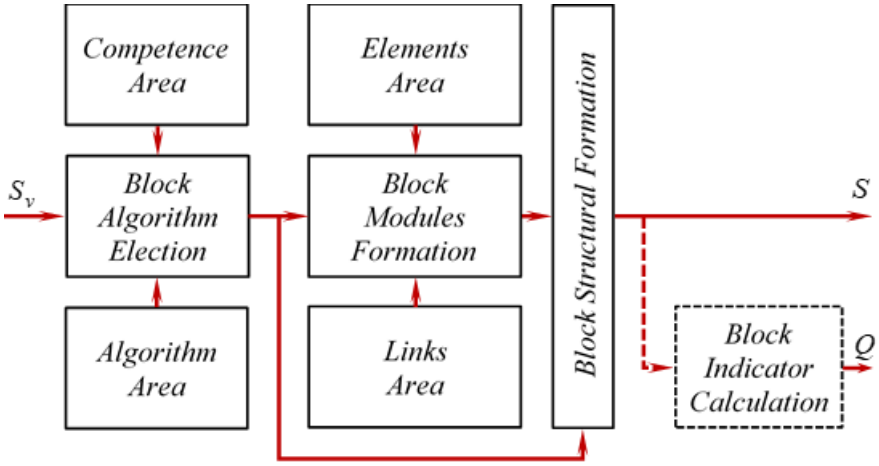

Figure 02. Structural control system for the educational program

The Elements and links between them are selected taking into consideration the purpose of the educational program which is determined by its competencies. For this aim, the competencies are divided into the Modules. The Modules are formed from Elements and the links between them. There are many Elements and many valid links.

There is an input task for the *S* structure. The desired structure S_v is set in the form of desired Modules for the specified Competencies. Then the formation of these modules from Units and Elements starts. The Units are formed according to certain rules.

There are many limitations: a table of possible links between the elements. Other links are impossible. This can be used to automate the links formation. The table of possible links is formed manually based on the developers' experience. Gradually it accumulates a large amount of options. Only appropriate options are used for the educational program with a specific set of competencies.

The pointer to the desired structure indicates the class of tasks to be solved. To do this, the tasks are classified according to various criteria: in particular, by the type of activity (in accordance with the educational standards): scientific work, technical development, operation, consulting, etc. To form the Units, fuzzy logic can be used. It means the following.

The indicator *Q* of the implemented educational program' compliance is selected in comparison with the desired one (Anikyeva, 2019). The indicator reflects the completeness of the competencies' implementation. The general indicator of the educational program is formed from the individual Units and Modules indicators. The corresponding indicator is calculated for each intermediate operation with the Elements when forming the Modules. Then all the indicators are combined according to the appropriate formulas and the general indicator of the educational program is calculated. All these indicators range from 0 to 1 and several options are calculated.

6. Findings

The result of the study is a generalized structure of the educational program which is further reflected in the curriculum. The main provisions related to the structural control organization based on the detailed output competencies for the constituent elements are also formulated.

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7. Conclusion

The proposed structural method to control the educational program allows to partially automate its development and proceed to the creating synthesis algorithms' stage. However, it is required to clarify some aspects of the method and its practical implementation.

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