FLEXIBLE CURRICULUM AS A HIERARCHICAL PUZZLE

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ABSTRACT

The curriculum is one of the most important components of the educational program. Through it, an educational strategy is being implemented. The effectiveness of the implementation of the educational program depends on how well the curriculum is balanced. The high rate of change in the trends in the development of a technological society creates new challenges for universities. The ability to promptly modify educational programs for current market changes ensures the demand for such programs among students.

The flexibility of the curriculum can be significantly increased by making it modular and giving the modules characteristics of a puzzle. The modules of disciplines can be considered as an analogue of the kinematic links of the mechanism, and the places of their docking can be associated with the joints. The result is a dynamically reconstructing plan structure. This structure allows you to build a given trajectory in the educational space. And, figuratively speaking, to deliver the graduate to the desired point of the professional space, providing him with the formation of the required competence portrait.

KEYWORDS
Curriculum, Modules of disciplines, Standards 3, 4, 5.

INTRODUCTION

The current state of trends in the development of a technological society is characterized by high dynamics of change. Accordingly, the conjuncture of the labor market and the attractiveness of a particular field of activity are changing. These circumstances induce the younger generation to dynamically search for relevant educational programs or to search for the possibility of promptly changing the educational program. A modern university should be able to provide a timely prompt response to changes in these trends and maintain a contingent of students. The traditional curriculum structure contributes little to this. Among the main provisions of the CDIO initiative is the need for an integrated curriculum and the intensive use of project-based learning (Crawley E. F., Malmqvist J., Östlund S., Brodeur D. R., & Edström K., 2014).

According to the legislation in force in Russia in the field of education, educational programs with state accreditation must be fully developed before the start of implementation and cannot change significantly during the entire implementation period (from the moment of enrollment of students to their graduation). For undergraduate programs, this period is 4 years and is too long. Many technologies that are in demand at the time of the development of an educational program are no longer relevant by the time of release. This forces us to look for new approaches in building curricula that ensure their dynamic adaptation to the rapidly changing conditions of the technological market.

In accordance with Standards 3, 4, 5 of the CDIO initiative, a number of key requirements for the structure of curricula are identified. Based on the requirements of the Federal State Educational Standards of the Russian Federation and taking into account the provisions of the named CDIO standards, it is proposed to build curricula based on the hierarchical puzzle method.

ORGANIZATION OF THE CURRICULUM DESIGN PROCESS

The processes of transformation of educational programs and curricula, taking into account modern trends in the development of engineering and the characteristics of educational systems in the country, are shown in the works (Arias C. K., & García J., 2017), (Willcox K.E., & Huang L., 2017), (Thiruvengadam S. J., Subramanian B., Venkatasubramani V. R., & Abhaikumar V., 2020), (Tuselim Y. R. M., Muhammad S., & Mai R.C., 2020).

In recent years, there have been changes in approaches to building curricula. They are designed based on the competency model of the graduate. However, this model is often quite static and making changes to the curriculum is problematic. In addition, quite often the curricula of educational programs included in one enlarged group of areas of training differ quite significantly. These circumstances reduce the ability of students to change the direction of training. The teaching staff and classroom fund are not used effectively.

A method for designing curricula based on the principle of a hierarchical puzzle has been developed and tested at Surgut State University for IT educational programs. The elements of the puzzle are the disciplines of the curriculum. All disciplines are grouped into modules, in accordance with the specifics of the subject focus. In turn, the modules belong to certain blocks, in accordance with the list of competencies being formed. The structure of the distribution of modules by blocks is shown in Figure1, which forms the legend of the projected curriculum.

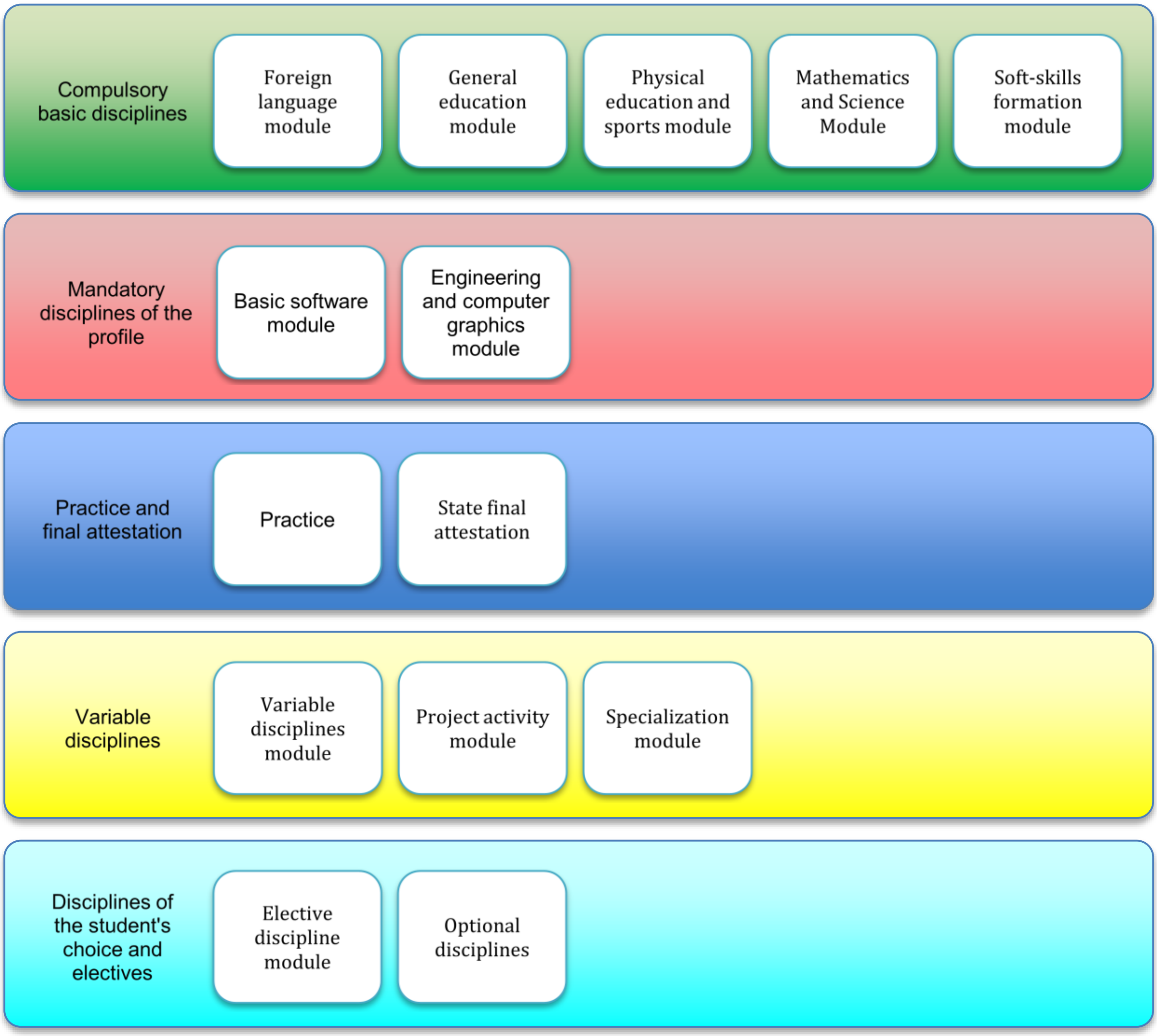

Figure 1. Legend of the distribution of modules of disciplines by blocks of the curriculum

CREATING THE MATRIX OF THE HIERARCHICAL PUZZLE OF THE CURRICULUM

The formed curriculum is a matrix. The original curriculum matrix is represented as a rectangular box. The abscissa axis is the time axis. It displays the semesters of the curriculum. The ordinate axis reflects the volume of the program, measured in credits. The conventional axis of the applicate reflects the layers of the puzzle corresponding to the degree of specialization (the transition from general to professional competences). The general principles of matrix construction are:

- organization of the educational process by semesters;
- grouping of disciplines and modules of disciplines into blocks corresponding to the levels of mastered competencies;
- the complexity of the educational program is strictly equal to 60 credits per year (about half of this amount in each semester).

A feature of this approach is the ability to implement a multi-scale unification of educational programs of various directions. At the first - the initial level of the hierarchy, it is possible to unify most of the engineering educational programs of the university. As we move through the layers of the matrix, the range of cardinal differences in educational programs narrows, but the range of specializations increases. The proposed approach allows for modifications at various levels of the matrix hierarchy and to create a system of educational programs that is understandable for students and staff within the university or association.

Formation of the base layer of the puzzle matrix

The filling of the matrix starts from the base part. The structure of the puzzle matrix of the curriculum at the initial level of the hierarchy is shown in Figure 2.

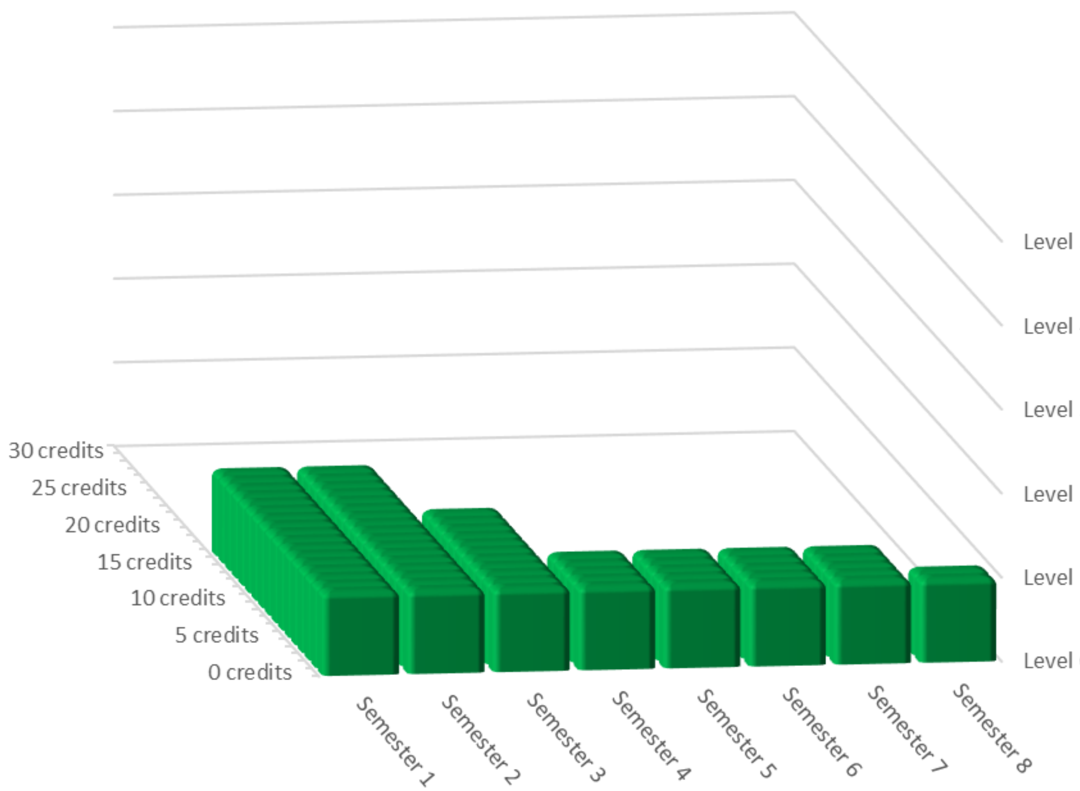

Figure 2. Figure 2. The structure of the puzzle matrix of the curriculum at the initial level of the hierarchy.

The first (initial) level includes modules of compulsory disciplines, such as:
- Foreign language;
- Physical education and sports;
- Mathematical and natural sciences;
- Formation of Soft-skills.

These modules provide the formation of universal and general professional competencies. These competencies are common for all educational programs included in one large group of training areas. Moreover, they are often the same for many engineering educational programs. The disciplines of these modules are distributed in such a way as to exclude their predominance in junior courses. As a result, static, horizontally oriented, basic components are formed in the plan matrix.

Many disciplines of social, humanitarian and economic orientation require a systematic and even philosophical approach in the field of professional knowledge from the student. Such an approach is formed in the process of practical activity, reflection, assessment of the results of one's own activity and generalization of one's own experience. Such disciplines are distributed along the entire time axis and are shifted to later stages of the educational program. It is impractical to consider them fundamental for junior students, because a young person who does not have his own professional and life experience is often unable to freely and independently talk about system-forming and philosophical categories. In addition, it frees up time for mastering professional disciplines and practical activities for which the student is motivated, starting from the first semester of study, as will be shown below.

At the next level of the hierarchy, shown in Figure 3, disciplines are added to the puzzle that are included in the compulsory block, which are characteristic of educational programs of only IT orientation. These are disciplines of modules:
- Basic software;
- Engineering and computer graphics.
As a result, the stage of formation of the level of compulsory disciplines or the second level of the hierarchy is completed.

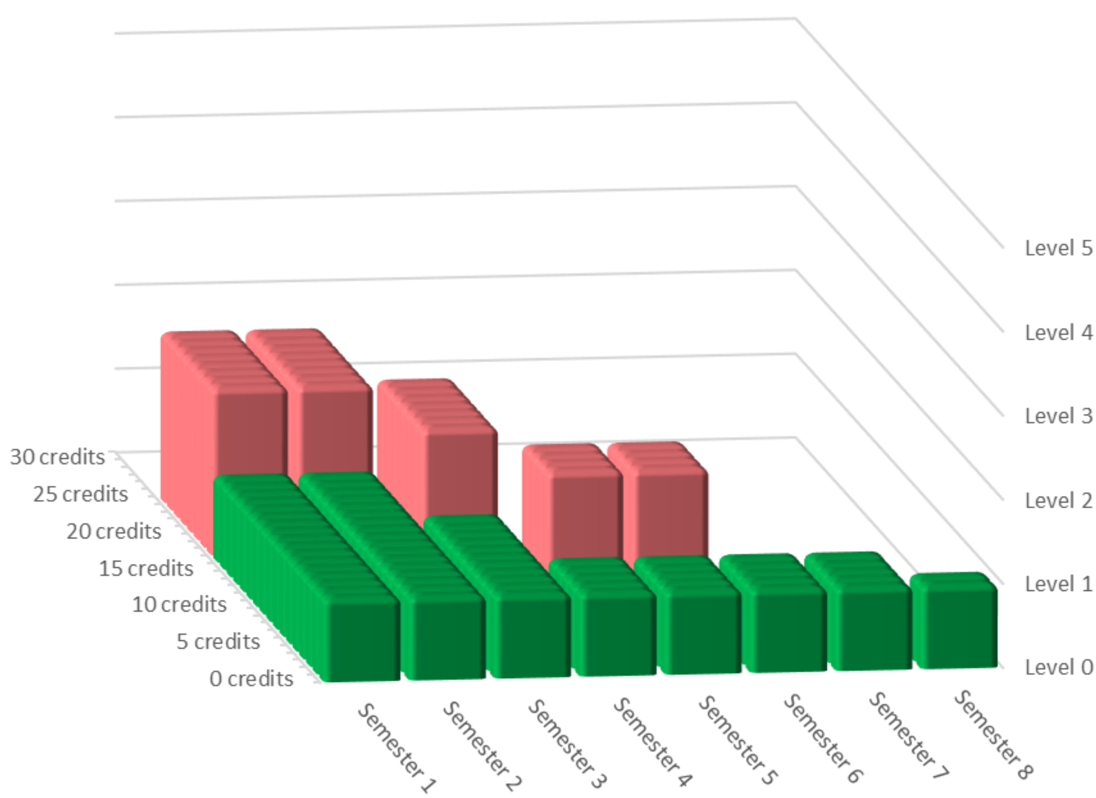

Figure 3. The structure of the curriculum's puzzle-matrix of the formed second level of the hierarchy.

The next level of the compulsory part of the curriculum is represented by practice and state final attestation. Practice, as a type of educational activity, is aimed at mastering general interprofessional and professional competencies as a result of activities to solve real problems in the professional sphere. During the entire training, the student performs several types of practice from educational at the university to production at the enterprise, including the implementation of the final project. The presentation of the results of this activity is the basis of the state final attestation of the graduate. These components complete the compulsory part of the educational program in accordance with the requirements of the educational standard. Figure 4 shows the generated puzzle matrix, which is common to all IT programs.

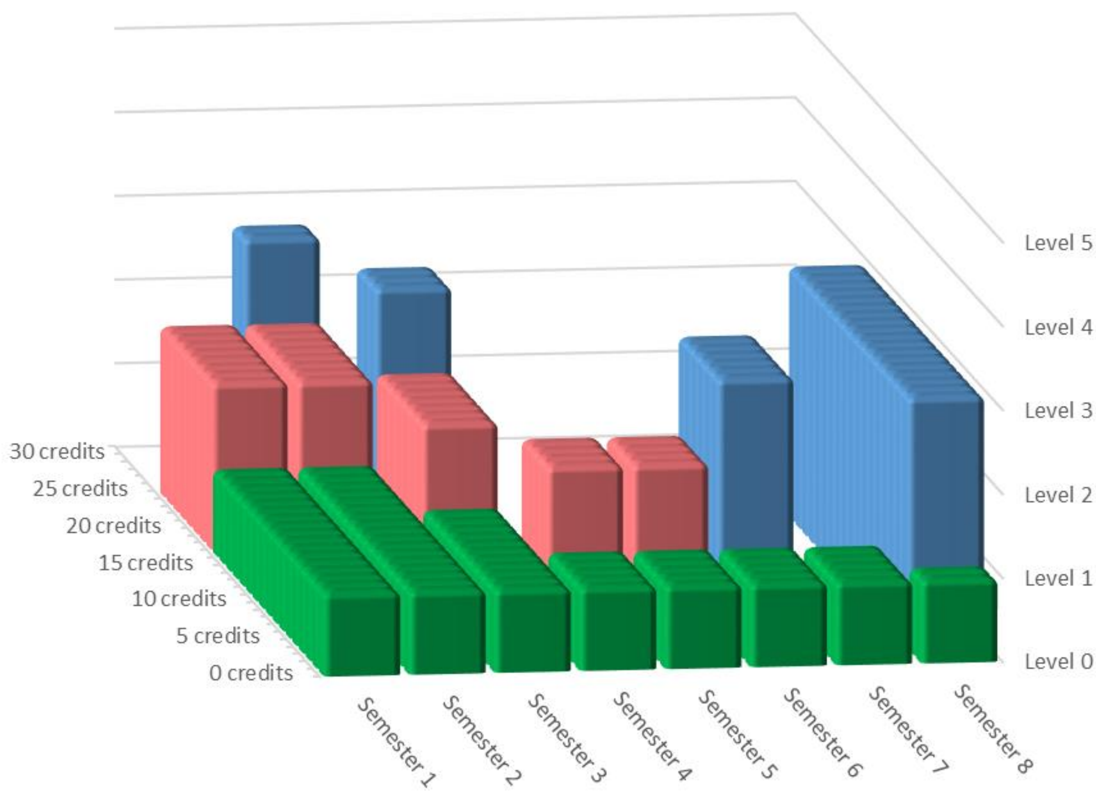

Figure 4. The structure of the puzzle matrix of the curriculum at the third level of the hierarchy

Formation of curriculum specialization layers in a puzzle matrix

The rest of the matrix field is filled with discipline modules corresponding to a certain direction of training. They belong to the blocks of Variable Disciplines and Disciplines of the student's choice. Disciplines complete the formation of general professional competencies and ensure the formation of professional competencies. These disciplines form a block of direction disciplines and are grouped into a specific set of modules that form a polygon. As can be seen in Figure 5, this area occupies the largest area in the matrix and expands in the part of senior courses.

The module of variable disciplines contains the main disciplines of the formation of professional competencies. The composition of this module is unique for each educational program within one direction of training and is formed in accordance with current and future production needs.

The specialization module is the most dynamic part of the educational program, which can be considered as a tool for fine-tuning it. The disciplines of this module are directly related to practical activities and are focused on current production technologies that meet modern trends in the regional, national and international economy. According to the principles of CDIO, the content of these disciplines is formed with the direct participation of representatives of partner organizations: industrial enterprises, IT companies, scientific and educational organizations.

The final formation of professional competencies and the development of soft-skills, as well as an assessment of the level of their formation, is carried out in the process of project activities. As noted by the authors (Grishmanovskiy P., Grishmanovskaya O., & Zapevalov A., 2014), students' project activities are important in the formation of professional competencies and are implemented in the educational program both at the level of individual disciplines and training in general. The view of the puzzle matrix at the fourth level of the hierarchy is shown in Figure 5.

In accordance with standards 3 and 5 of the CDIO initiative, the formation of professional competencies and the development of soft-skills, as well as the assessment of their level of formation, is carried out in the course of project activities. As noted by the authors (Grishmanovsky P., Grishmanovskaya O., & Zapevalov A., 2014), students' project activities are important in the formation of professional competencies and are implemented in the educational program both at the level of individual disciplines and training in general. Students carry out projects in each semester from 2-th to 8-th. It should be noted that as the student develops the educational program, the complexity and scale of the projects increase. The view of the puzzle matrix at the fourth level of the hierarchy is shown in Figure 5.

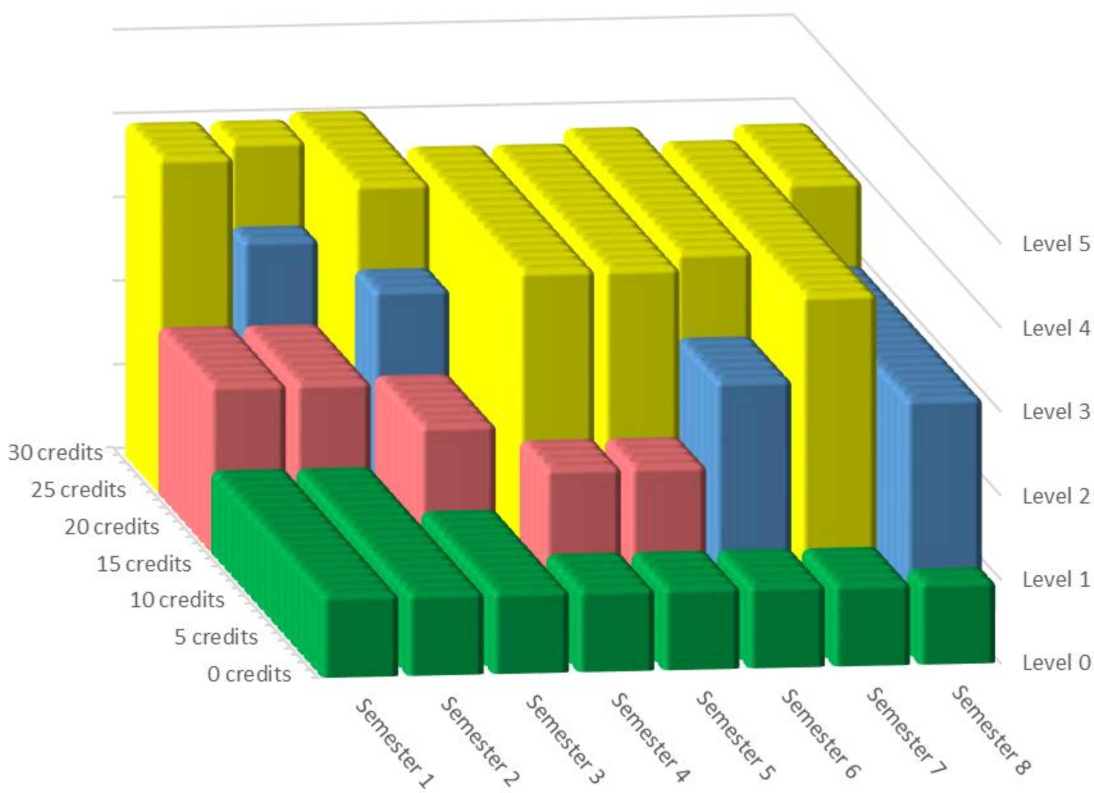

Figure 5. The structure of the puzzle matrix of the curriculum at the fourth level of the hierarchy

The final, fifth, level of the hierarchy, includes the modules of Elective disciplines and Optional disciplines included in the block of Disciplines at the student's choice. The student chooses the disciplines that he masters in a mandatory volume, as well as electives that he masters additionally. In this way, he himself determines his educational trajectory, aimed at mastering certain technologies or deeper study of any subject area. Thus, his specialization is implemented, aimed at the intended or desired area of further professional activity, for example, an IT specialist in economics, bioinformatics, industrial automation, etc. Various combinations of discipline content and focus on the implementation of specific professional competencies can significantly expand the potential competence portrait of a university graduate. A fully formed puzzle matrix of the curriculum is shown in Figure 6.

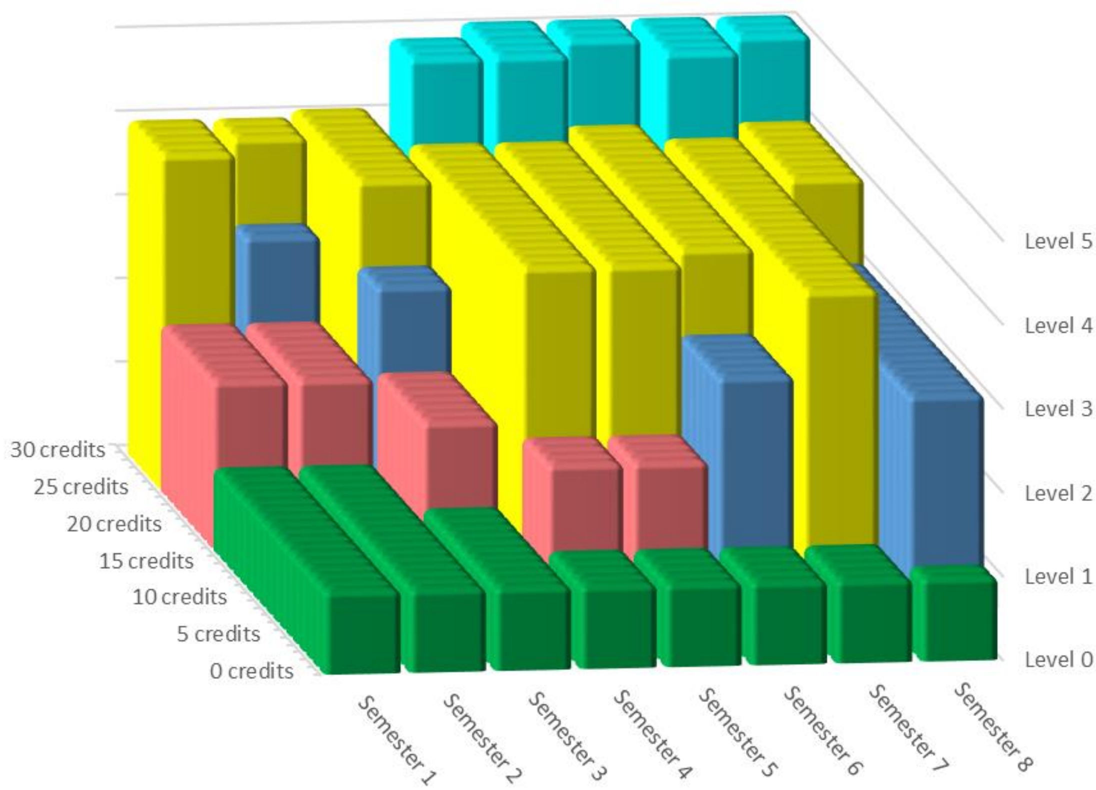

Figure 6. The structure of a fully formed puzzle matrix of the curriculum

CONCLUSIONS

This paper presents the practical results of the implementation of the curriculum design process as hierarchical puzzle matrices. The described approach made it possible to build interconnected plans for seven educational programs, various IT profiles, included in two different areas of training.

The unified concept of building curricula as a hierarchical puzzle made it possible to significantly facilitate and speed up the design process. There is a possibility of prompt dynamic adjustment and adaptation of plans for specific trends and market demands of consumers. These are students and employers.

The unification of the structure of the hierarchy of various curricula made it possible to optimize the academic load of teachers and the distribution of the classroom fund.

The positive experience gained in the design and implementation of curricula for IT educational programs, as hierarchical puzzles, makes it possible to expand this approach for building curricula for a wide horizon of educational programs in engineering.

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