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Educational programs improvement directions of different levels in high school

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Abstract. The paper presents the results of research on the possibilities to improve the educational process at the university and the basic conditions of their realization. The authors developed the model of the next generation education program (EP) based on the analysis of the experience of "International Society for Engineering Pedagogy" and the CDIO. The paper presents data poll of young and experienced lecturers on need and importance of the next generation EP, as well as the readiness of their education departments and teachers to implement the next generation EP requirements in training bachelors and masters. Qualification characteristics of university lecturers, capable of solving problems of the next generation EP development and effective implementation; requirements for methodological tools for educational process monitoring; needs to raise the educational culture in order to form valuable attitude and responsibility of both lecturers and students for the results of their joint work are defined in the paper on the basis of empirical data. Generalization of results of the research allowed formulation of a number of actual tasks for education departments since their decision influences the quality of the ultimate results realized in the educational process.

1. Introduction

The creation, design and renewal of new education programs (EP) satisfy the requirements to develop graduate professionalism in constantly and dynamically changing environment. The ability level of graduates to practice a profession without assistance is dependent on the quality of education programs, which is considered to be the main criterion in higher school accreditation in many countries. Accreditation agencies in the USA, for example, generally accept the criterion "*education programs*" as the principle one out of nine standard criteria.

Education program assessment is performed with respect to the comprehensive points of the learning process: fundamental and technologic knowledge, data analysis skills, design and computing. We are to take into consideration both after-accreditation rating and requirement determination when developing programs that should meet the requirements at present and in the future. The accredited EP once ensured core competences of a graduate, now is irrelevant for the first-year students who will graduate from a higher school in 4–5 years.

It is obvious that the development of Russian universities and their competitive advantages on the international level supposes the creation of education programs that are comparable with their counterparts in the world leading universities. To that end, the fundamentals of the program design are in the interest of researchers, lecturers and university governing body.



2. Approaches to the education program creation

The analysis and specification of the requirements for contemporary EPs of higher professional education are carried out based on the following factors: advanced studies and experiments of the leading Russian and foreign universities; up-to-date achievements in science and technological progress; requirements for the graduates of particular education program specializations made by employers. We consider only two rapidly growing approaches in engineering education. The fundamentals of these approaches can be applied in training the graduates of any specialization. The first approach is IGIP (International Society for Engineering Education). Activity analysis of IGIP centers and the International Federation of Engineering Education Societies (IFEES) allows marking out the key requirements developed by these organizations to the educational process:

- 1) free choice of the educational path (the possibility to create the unique personality-based learning path);
- 2) great flexibility in selecting elective courses (the alternative is 8 various modules);
- 3) high level of software and information technology, including knowledge management in training engineers;
- 4) the application of Internet-tuition projects, including remote access to the Internet laboratory, standardization of the net smart-objects in order to study by means of on-line laboratory;
- 5) the educational process operation with feasible projects and the development of engineering innovations and projects during the educational process [1, 2].

Analysis of experience of the Global initiative CDIO practice-oriented learning realization (Conceive – Design – Implement - Operate (CDIO) and CDIO standards [3]) allows distinguishing more requirements to EP, which are successfully implemented in training modern engineering skills. First, this is active implementation of interrelated projects and practices in academic work enabling students to master the principle stages of a new product development. Such training can be successful provided that a university is supported by partner enterprises and highly qualified expert lecturers are attracted. When creating a CDIO-oriented EP, one should consider the requirements for learning outcomes, their structure, content and design.

The requirements for graduate engineers, which will improve the quality of training, were specified on the findings of the Ural region employer poll. The employers demand graduates to examine new tasks independently, to apply theoretical knowledge in solving practical tasks, to be able to communicate with specialists from other professions, to relate the tasks of their field of activity to those of relating fields. In addition, they expect graduate to be able to take into account technological nature of business, to see the relationships between various business activities, to apply effectively the project-based approach in dealing with production objectives.

3. Requirements for the next generation EP

The requirements model for the next generation EP was created to enhance the educational process in Ural Federal University (UrFU); then, the research was conducted to study model feasibility to be employed in various areas and education program specializations. There the requirements are divided into the versatile ones applied for all education program specializations as well as for Bachelor's and Master's programs and technologic needed only for the programs of a specific area.

Versatile requirements for the next generation EP.

1. Competency-based approach in creating an education program (EP) means, on the one hand, the design of learning outcomes in the form of professional competences, on the other hand, the design of methods and EP realization tools on the competency-based methodology. Training is organized by selecting the content and technologies of learning that ensure the formation of specified competences [4, 5].

2. EP possibilities for learning personalization suppose the variability of the education program realization subject to students' individual interests and abilities when organizing learning in disciplines, modules and end results in the terms of professional training [6, 7]. Overall, this

requirement is realized through the possibility to form individual learning paths for students who are interested in it.

3. Interactivity of an EP realization provides active interaction between students, teachers and students to advance the motivation to study, the feedback informativity and the creation of real possibilities to manage the process of achieving specified learning outcomes. By motivating the academic work reflection and the content of the learning process, interactivity increases the level of learning outcomes [8, 9].

4. Processability of an EP development supposes, on the one hand, the unambiguous understanding of algorithm, which shapes the educational process; on the other hand, the possibility to build the technological complex of the educational process using contemporary learning methods and technologies enabling to manage the training efficiency, providing the conformity of specified learning outcomes with the obtained ones [7]. It also includes the effective utilization of modern information technologies in training, including the availability of education program disciplines in Learning Management system.

5. Database and software facilities of EP suppose that students are provided with the access to the library computer system with publications in main branches of learning formed by agreement with the right holders of educational, academic and methodological literature [5, 7, 10]. Database and software facilities of learning process correspond to the present-day level of software product application in enterprises and world practice tendencies towards informatization of industrial processes.

6. Remote EP realization provides possibilities for both distance and e-learning, including the completion of individual and group formative assignments and the Internet projects, the work in virtual laboratories and simulators, extracurricular study of teaching materials like e-books, audio and video lectures, participation in web-seminars and online-conferences [11].

7. Regular updating of EP supposes the creation of special search engine making it possible to discover emerging innovations and transform them into the EP contents. We mean innovations that appear in science and industry as well as new demands from employers, the market and society [12, 13]. The procedure in question ensures monitoring, rapid and appropriate transformation of changes into the EP content.

Technologic requirements for the next generation EP.

8. Practice orientation supposes the substantial amount of probation periods and in-house training in the branches of learning. Its implementation should provide students' acquisition of practical professional skills and value attitude towards labour even at the learning stages [14].

9. Involvement of partner enterprises in EP to whom the training of graduates is fulfilled [15]. The organization of cooperation between a university and a partner enterprise increases the quality of making curricula for modules and disciplines, and developing learning aids, laboratory and tutorial methods, courseware. In addition, specialists may provide technical assistance and class exercises using in-house resource-and-technical base.

10. Project orientation of the content and EP implementation methodology includes the requirements for student project-based learning activity in all modules and the majority of disciplines. The EP contains project-based learning of different scales, including disciplinary and interdisciplinary projecting in proper methodology-organizing forms [16, 17]. Project based tasks hold analytic and evaluating tasks in submission in most training courses, and uppermost, in core disciplines where core competences are formed.

11. Intergratedness of research activity in EP provides the training of highly qualified specialists for high-tech and science intensive enterprises. This condition facilitates the formation of high-level readiness to create innovations and implement them in production [18].

4. The research of requirements for the next generation education program

To evaluate the significance of either basic requirements for the next generation EPs or the level of readiness to realize these requirements, the teaching staff of the University engaged in learning process improvement – expert and young lecturers – were questioned (Table 1). The experts are

lecturers with Candidate or Doctor of Science degrees (professors and associate professors), who have more than 15-year-teaching experience and are involved in new education program development. The lecturers, who are under 30 years old, have the teaching experience less than 5 years, conduct research work, particularly candidate thesis, are referred to young lecturers. These 23 expert lecturers (17 from engineering departments) and 74 young lecturers (59 from engineering departments) took part in the research.

Table 1. Significance assessment of basic requirements for EP to improve the educational process and realize the readiness level of departments.

Requirements for the next generation education program	Significance assessment (10-point rating scale)		Realization readiness assessment (10-point rating scale)	
	Experts	Young lecturers	Experts	Young lecturers
Competency-based approach	6.2	8.9	3.4	5.7
Possibilities for learning personalization	7.3	7.6	3.3	5.3
Interactivity of realization	7.5	8.7	2.7	4.5
Development processability	8.2	9.0	3.1	5.5
Database and software facilities	8.8	9.5	5.4	5.9
Remote realization	7.8	9.2	4.7	5.1
Practice orientation	8.5	7.9	7.4	7.2
Regular updating	6.4	8.6	4.3	5.7
Involvement of partner enterprises in EP	9.1	8.5	6.2	6.4
Project orientation	7.5	7.1	6.1	5.6
Intergratedness of research activity	8.7	8.2	6.3	6.8

Data analysis reveals the following.

The importance of the competency-based approach and regular updating of EP are significantly underestimated by expert lecturers, whereas young lecturers value highly the importance of all requirements for the next generation EP.

Both expert and young lecturers estimate the readiness of the departments to realize the specified requirements lower than the importance of these requirements in the educational process improvement. At the same time, there are significant gaps between high rating of the significance of eight requirements and low rating of readiness to realize them in the development of new EPs.

The discovered gaps in rating are typical of seven versatile and only one technologic requirements and ranked according to a decrease succession of the gap values: development processability, interactivity of realization, database and software facilities, remote realization, possibilities for learning personalization, competency-based approach, involvement of partner enterprises in EP development and regular updating. The values of the given gaps vary from 2.1 points (involvement of partner enterprises in EP development in the young lecturer assessment) to 5.1 points (EP development processability in the expert lecturer assessment).

The research was conducted using the focus-group method and enabled to reveal several main reasons of the gaps being nonuniform for each EP requirement. Most of the reasons are classified in three categories: the lack of financing, educational culture and pedagogical qualification. Meanwhile,

the drawbacks of lecturers' professional competences predetermine the gaps in most requirements and that is why can be considered to be their main reason.

The findings obtained in the focus groups enabled to determine the direction of the main efforts that can provide high-level readiness to create new education programs and to improve the efficiency of the training.

In order to realize them in practical work, one should develop EP in accordance with the specified requirements – it is only the beginning of the training improvement. As the author experience shows, while realizing the training, the underlying EP requirements cannot be implemented in full and some requirements cannot even become apparent. So, the EP introduction stage is the continuation rather than the completion of the work. This stage is aimed at the realization of the underlying EP requirements to be managed efficiently. To fulfill this task, it is necessary to support the next generation EP introduction methodologically, including:

- the purposeful improvement of lecturer pedagogical qualification;
- the monitoring of training in order to evaluate its agreement with the next generation EP requirements;
- the assessment and adjustment of the culture of the educational process.

One should utilize the specific model of the pedagogical professionalism in training lecturers purposefully to develop and realize the EP corresponding to the specified requirements. To create the model, we can use the academic competence matrix of university faculty. The matrix is composed of eighteen competences including 184 indicators developed in UrFU with the direct involvement of the authors.

The required monitoring should be a procedure package for the efficiency rating of the students' primary educational activities (lectures, tutorials, tests, seminars, laboratory works) with the use of parameters reflecting the next generation EP requirements. Students and lecturers should participate in monitoring, its main tools are special made tests and questionnaires that allow an objective estimate of the characteristics of the academic work performed. The utilization of this monitoring allows getting empirical estimates of the correspondence between the educational process and the underlying next generation EP requirements.

The adjustment process of the culture of the educational process is tedious but it should begin with diagnostics, which demands the relevant methodological tools. The development of such tools, in the author judgement, is challenging.

5. Conclusions

1. The proposed model of the next generation education program includes eleven requirements that reflect the objective environment needs to the University graduates. It can be proved by the opinions of the majority of the surveyed teaching staff at UrFU.

2. The significance assessment of the next generation EP requirements and the readiness level to realize them revealed the gaps to indicate that the effective application of the developed model in the educational process design and its further implementation are impossible.

3. The possibilities to realize the requirements in the University educational process can be ensured by the elimination of the revealed gaps. One should overcome the main drawbacks connected with the lecturer pedagogical qualification; the financing of the resource-and-technical base of the training; the University educational culture formed in previous decades.

4. The designed content of the next generation EP requirements and the determined reasons of the gaps allowed defining the means to increase the readiness level of the University to improve the quality of the educational process of most specialities trained at UrFU.

The determination of requirements for the education program is significant but not sufficient to improve the university educational process. The EP introduction and adjustment are no less important and more tedious training stages.

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