Advances in Economics, Business and Management Research, volume 47

International Scientific Conference "Far East Con" (ISCFEC 2018)

Development of Engineering Education According to Demands of World Standards

S. I. Osipova, N.V. Gafurova, V.V. Osipov
Federal state Autonomous educational institution of higher education
"Siberian Federal University», Krasnoyarsk, Russia
osisi@yandex.ru

Abstract— **System gap between market of educational services and labor market determines the crisis of engineering education. It causes necessity of essential changes in training of qualified personnel, competitive in world`s labor market in accordance with its demands. Perspective direction of engineering education`s modernization was offered by international CDIO initiative (Conceive – Design – Implement – Operate). Priority of active approach and practical-professional direction in engineering education, oriented at formation of a graduate able to make the whole technological cycle of making engineering product serve as basis of CDIO ideology. The theoretical grounding and experience of modernization of students training in Siberian Federal University, majoring in 'Metallurgy', 'Welding production' and 'Heat and power engineering' are presented in the article. Research was carried out on the basis of polyparadigmatic approach with consistent and reasonable use of systemic, active, personal-oriented, competitive and synergetic approaches. Theoretical methods were used in the research (context search of information, content analysis, systematization, simulation), empirical (pedagogic observation, questioning methods, estimation and self-estimation, expert estimation of activity products). Descriptors of separate parts of innovative education program, which demonstrate effectiveness of system changes in engineering education quality improvement are given.**

Keywords— engineering education, international initiative CDIO, project-innovative competence, system changes.

1. INTRODUCTION

Nowadays the engineering education quality doesn't meet the demands of modern industry. The urgent scientific problem of engineering education quality increase can be solved in frames of using quite developed technological ideology of International initiative CDIO (Conceive-Design-Implement-Operate) [2, 3, 5, 6, 8]. At the same time system of engineering education, being closed one, is deprived of the source of its development and requires transition to open interactions with external environment by means of implementation of mutually beneficial and voluntary web interaction with various social institutions and firstly with basic enterprises, as education services consumers [4, 13, 14, 15, 16, 19, 20].

The task research is the substantiation of system changes in training of bachelors in direction "Metallurgy" and its modernization experience using ideas and standards of international initiative CDIO in conditions of private-government partnership [2, 3, 6, 8].

The proper effect support in increasing of engineering education quality is achieved by the use of practical-professional orientation of education process, activity approach priority, focused on competitive graduate formation able to make the whole technological cycle of creating engineering product in conditions of web interaction with leading firms of the branch. Scientific importance of this research is determined by its results generality, which can be used to solve problems of engineering education quality improvement for other directions of students training.

2. METHODOLOGY AND METHODS OF RESEARCH

Variety of tasks, appearing in projecting, organization and evaluation of educational process results, called for using of polyparadigmatic approach, which includes consistency and reasonable using of system, activity, person-oriented, competitive and synergetic approaches.

Theoretical (context search of information, content analysis, systematization and modeling), empirical (pedagogic observation, questionnaire methods, estimation and self-estimation, expert estimation of activity products) methods were used in the research. Results analysis of experimental part of research was based on using mathematical- statistical methods.

Variety of tasks, appearing in projecting, organization and appraisal of results of educational process, demanded using of polyparadigmatic approach, which includes consistency and reasonable using of systemic, activity, personal-oriented, competitive and synergetic approaches.

Theoretical (context search of information, analysis of content, systematization and modeling) and empirical (pedagogic observation, questionnaire methods, estimation and self-estimation, expert estimation of activity products) methods were used in the research. Analysis of results of experimental part of research was based on using mathematics` and statistics` methods.

3.THEORETICAL PART

Basic idea in engineering education quality improvement is system-complex changing in teaching and training of future bachelors related to all components of education process and conditions of its implementation. Introduction of CDIO initiatives [5] called for the leading principles identification of system-complex changes [2] in the system of future engineers training:

at the level of the educational program through implementation of the principle of openness to the external environment [3], [4], [13];

at the level of management by means of transition to the new form of management according to the educational program [11], [12];

at the level of the education content through practical-professional orientation [1], enrichment of engineers training content [7], integration of inter-disciplinary areas [14], [15], modular organization [17], [19], [20];

at the level of staffing by means of the organization of continuous system of professional development of teachers with use of external and internal opportunities [6].

The practical importance of a research consists in a possibility of use of the proved and actualized principles of system changes in training of engineers of new generation for metallurgical branch in other directions of engineering education in the context of its quality improvement.

4.INTRODUCTION RESULTS

Innovativeness of educational program "Metallurgy" is provided with its openness to the external environment, interaction establishing with employers during all steps of projecting, organization and evaluation of achieved education results. At the stage of goal-setting there are specified with employer education results in the form of necessary competences as well as course and diploma works, which are actual for the enterprises. At the stage of educational process projecting, there are specified participation of employers in educational process at the university and enterprises during the advanced on the job trainings. Effectiveness of educational process in the frames of during control is estimated during the student`s presentation of project works and current and final attestation with participation of employers.

Leading metallurgical corporations are involved in combined interaction with CDIO educational program [12].

Web interaction with universities and schools of Russian Federation is carried out.

Management modification called for the new type of educational process management according to educational program (EP), instead of traditional subject-department. What is more, all curriculum subjects as well as academic load are set to EP. Teaching staff, as employees, who provide fulfilment of the curriculum are hired for the educational program. It allows integrating not only curriculum subjects, but also to coordinate activity of all lecturers to achieve educational results. Teaching staff who follows exact, coordinated goals/educational results during all stages, is formed in these conditions [10; 11].

Orientation of educational program on educational results (ER) in the form of developed competences, the basic of which is projecting-innovative competence, according to content of standard 1 CDIO called for necessity of the subject "Introduction to engineering business/engineering". Educational practices between various educational programs (EP), such as Engineering cluster, Engineering start are implemented in the frames of this course [7].

Students trained according to innovative educational program "Metallurgy" during the whole training period, beginning from the first year take part in project activity in the frame of 40 credit units of curriculum. Project activity becomes system-creating, prolonged for the whole training period. Bank of projects of different levels and orientation, including social, general engineering, engineering and manufacture-technological projects is developed with participation of employers. The performed procedure of project activity beginning (online/offline) allows students to gain independence in the choice of the project, to present its development. Student`s independence in introduction of own project is allowed. Educational project activity, which is included in integrated subject "Introduction to engineering business" in the format of holding the Engineering cluster in the web interaction with Moscow Polytechnic University, renders the methodical help for first year students of CDIO of all EPs on the portal of students` initiatives on the electronic resource "My SFU" [1, 14].

Integrated subjects are developed and actualized: History and philosophy of science, technology and manufacture; Project management; Quality management; Changes management; Solution of technological cases; System engineering; Bases of industrial design; responsible innovations: ethics, safety (Engineering ethics); innovation studies: Analysis of information, visualization.

Subjects listed above, enrich content of training of future bachelors with modern approaches and technologies, which are implemented on basic enterprises [9, 17, 18, 21].

EP innovativeness in using pedagogical technologies and new forms of classes (Standard 8) CDIO is expressed in promotion of idea and direct creation of new forms of classes: classes in active methods; classes with participation of employee; integrated classes; classes held at enterprises-field classes.

EP staffing is based of internal continuous system of lecturers' skill improvement according to basic problems of innovative activity, lecturers' training for a work in conditions of changes:

Implementation management of innovative educational program "Metallurgy" according to initiative ideology of CDIO (2014-2015);

Development of stakeholders' competence team in conditions of innovative educational program implementation "Metallurgy" in ideology of CDIO (2015-2016);

Development of performance) assessment system for educational program "Metallurgy", implemented according to ideology of CDIO (2016-2017);

Students` competences development in individual work (2017-2018).

Lecturers are using outside Advanced Training Faculties (Tomsk Polytechnic University, Skoltech, Moscow Polytechnic University, masters' program for lecturers in Higher School of Economics (HSE) as well as trainings at the basic enterprises (usually, short-period up to 2 weeks). It is planned to increase trainings up to 3-6 months with complete learning of all details and modern problems of "Metallurgy".

The teacher introduces retraining and skill improvement results into educational process of EP with obligatory open class in the presence of external experts.

The innovative educational program implementation process and achievement of educational results (Standard 11, 12) is followed by constant monitoring of the personal and interpersonal students` competences development according to the plan of monitoring measures as well as the faculty, students and employers questioning.

On the data monitoring basis there is made the analysis of competences deficiency of faculty, are specified indicators of education quality assessment from the point of view of students and employers. Activities for development of the management decisions are carried out. The system of expeditious introduction of decisions on feedback results, so-called "Process of constant improvement" is constructed nowadays, validity of various administrative decisions is estimated.

Systems of experts` control of innovative process are developed.

The experts board of CDIO consisting of representatives of administration of SFU (the rector's office staff), the internal experts who have passed the corresponding training, external experts, and also leading practicing lecturers and engineers-designers carries out monitoring of the EP implementation process.

5.CONCLUSION

System-complex approach to modernization of all components of educational system according to the ideology of international initiative CDIO (new curriculum, enriched with professionally-oriented integrated modules; use of procedural pedagogical technologies; training lecturers for a work in conditions of changes; educational program control implementation) showed positive changes in results of future bachelors' education, noted in reports of external experts.

References

[1] Arnautov A.D., Ryabov O.N.: The potential of project activity of students in the development of their competence. Modern science-intensive technologies 7, 87–91 (2017).

[2] Gafurova N.V, Osipova S.I., Rudnitsky E.A., Stepanova T.N.: Designing environment for innovative engineering education: monograph. under the Society. Ed. N.V. Gafurova. Krasnoyarsk: Sib. feder. Univ., (2015).

[3] Gafurova N.V., Osipova S.I., Stepanova T.N.: Basic ideas of modernization of professional education in the direction "Metallurgy". Fundamental research 11 (part 7), 1418–1422 (2013).

[4] Zubareva K.A.: The openness as the phenomenon of modern education. Pedagogical education in Russia 3. 6–10 (2012).

[5] International Seminar on Innovation and Reform of Engineering Education "CDIO Global Initiative": materials for seminar participants / ed. N.M. Zolotarevoy, A.Yu. Umarova. Moscow: Izd. house MISiS, (2011). 60 p.

[6] Osipova S.I.: Competence approach in the implementation of engineering education. Pedagogy 6. 53–59 (2016).

[7] Osipova S.I.: The content-target orientation of the discipline "Introduction to Engineering" within the framework of the Global Initiative CDIO. Engineering Education 16, 54–58 (2014).

[8] Osipova S.I., Gafurova N.V.: Metallurgical education on the basis of CDIO ideology. Higher education in Russia 12, 137–139 (2013).

[9] Osipova S.I., Gafurova N.V., Butakova S.M.: The potential of the modular curriculum in the implementation of CDIO standards. Vestnik KSPU them. V.P. Astaf'eva 1 (35), 85–89 (2016).

[10] Osipova S.I., Rudnitskiy E.A.: Involvement of stakeholders in the implementation of the ideology CDIO. Higher education in Russia 8–9. 39–45 (2015).

[11] Osipova S.I., Rudnitsky E.A.: The problem of the formation of a team for the implementation of innovative PLO in the ideology of CDIO. Engineering Education 16, 132–136 (2014).

[12] Osipova S.I., Rudnitsky E.A., Loshilova M.A.: Productive network interaction in the context of improving the quality of engineering education. Modern science-intensive technologies 2 (part 3), 543–547 (2016).

[13] Sheveleva S.S.: Open model of education (synergetic approach). M.: Magistr. 47 p. (1997).

[14] Arnautov A., Gafurova N., Arnautov A., Fedoseev A., Fadeev Y.: Fostering Engineering Thinking with Curriculum Integrated STEM Game [Электронный ресурс]. Proceedings of the 13th International CDIO Conference, 18-22 Juni 2017 г. Calgary: University of Calgary, pp. 223–234 (2017). – URL: https://prism.ucalgary.ca/handle/1880/52101 (дата обращения: 19.08.2017).

[15] Drewek, Peter.: Die Entwicklung des Bildungssystems in den Westzonen und in der Bundesrepublik von 1945/49 bis 1990: strulturelle Kontinuität und Reformen, Bildungsexpansion und Systemprobleme. In: Müller, D.K. (ed) Pädagogik – Erziehungswissenscharft. Bildung. Cologne. Weimar. Vienna, (1994). – 300 S.

[16] Gute Schulen sind paedagogisch innovative Schulen. Muenstersche Erklaerung, S.5. (1998).

[17] Marchenko N., Osipova S., Arnautov A.: New Role of Employer in the Educational Process of Metallurgy Programme. Proceedings of the 12th international CDIO Conference, Turku University of Applied Sciences, Turku, Finland, June 12-16, 257–265 (2016).

[18] Osipova S., Stepanova T., Shubkina O.: Implementation of CDIO Standards Within a Modular Curriculum of "Metallurgy" Program. Proceedings of the 12th international CDIO Conference, Turku University of Applied Sciences, Turku, Finland, June 12-16, 250–256 (2016).

[19] Reul G.: Arbeitslehre und polytechnische Bildung – nicht die Vereinigung steht an, sondern die Erstbegegnung. Arbeit und Technik in der Schule 1. – Berlin, (1991).

[20] Thiess G., Gropler H.: Methodische Konzeption und Bedingungsfaktoren fuer die Realisierung des Inhalts des Sportunterrichts in der Oberstufe. Theorie und Praxis der Koerperkultur 5, 309–315 (1998).

[21] D. B. Solovev, A. S. Shadrin, "Instrument current transducers with Rogowski coils in protective relaying applications", International Journal of Electrical Power and Energy Systems, vol. 73, pp. 107-113, 2015 [Online]. Available: http://dx.doi.org/10.1016/j.ijepes.2015.04.011.