Why and how to engage students in the learning process

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Following educational standards and stakeholders requirements, universities define a set of core professional competencies and transferable skills which a student should have upon graduation from the engineering educational program. However, formulating a set of core competencies is only the first step that does not guarantee successful achievement of program learning outcomes by graduates. Among many important issues that should be taken into account is the engagement of students in learning. They need to be really motivated in acquiring intended learning outcomes.

According to the research study of student involvement there are three types of engagement [1]:

- academic, characterizes students' mental investment, expended effort in the learning process. Criteria for measuring this type of involvement include preparation for classes, homework, participation in classroom discussions, academic achievements;
- social / behavioral, emphasizes students actions and participation in university life outside learning process. Mainly focuses on students' interactions with other students and student communities;
- emotional, encompasses students' feelings of connection to their university, general attitude of students to the university level of support students perceive from members of the university community and their place in this community.

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If we focus on academic engagement, then the program should ensure active participation of students in the training process and provide them all tools to become competent professionals able to solve real engineering problems. Success of the high quality professional training, in accordance with the principles of outcome based approach, largely depends on the choice of learning and teaching methods. It is important that program leaders pay particular attention to the content of the courses as well as to the forms of educational activities.

Academic community has mutual understanding that teaching methods and techniques should motivate and encourage students for cognitive activity. The learning process should be organized so that students have the desire to participate more actively in the learning process, to take the initiative, and not just follow the prescribed rules.

Wider implementation of problem-based learning could be one of the possible changes on the way of improving the educational process. *Table 1* shows those features that in our opinion distinguish traditional forms of learning from the problem-based ones.

Table 1. Specific characteristics of traditional and problem-based learning

	Traditional training	Problem-based learning
1	A large number of lectures, providing the basic content of the discipline (module)	A small number of lectures, integrating a number of topics related to the problem being solved and place students in the context of the real-world problems
2	Passive learning in large groups (25-30 people)	Active self study and teamwork in small groups (6-8 people)
3	Discipline (module) is divided into separate topics	The content of the discipline (module) integrated in problem-oriented case studies within interdisciplinary context
4	The leading role of the teacher, passive knowledge translation	The educational process is aimed at students independent search of information and new knowledge. The teacher acts as a mentor, consultant
5	Form of control of learning outcomes achievement: assessment of knowledge on the subject at the end of training	Degree of graduates' competencies development evaluated within the learning process. Integrated assessment

Unfortunately, still popular in technical universities traditional approach focused on lesson training system, does not allow achieving expected learning outcomes. Students just require ability to listen and remember the facts instead of active independent work. The most common forms of educational activity are lectures and workshops that do not provide one of the main conditions of motivation for learning - engagement of each student in the learning process.

According to the Federal State Educational Standards (FSES) the outcome-based approach requires "... vast implementation of interactive forms of training (workshops,

discussions, computer simulations, business and role-games, case studies, psychological and other trainings) combined with extracurricular activities with the purpose of students' professional skills development. The training process should include meetings with representatives of Russian and foreign companies, state and public organizations, workshops provided by experts and high qualified specialists" [2]. In fact, practice-oriented, problem-based and project based learning are based on interactive forms of training.

Despite the fact that FSES requires at least 20% of interactive learning in bachelor degree programs and at least 40% in master degree programs, the actual level of interactive practice-oriented teaching methods implementation in Russian universities remains dramatically low as demonstrated in *Fig.1*(based on the results of study conducted by the Association foe Engineering Education of Russia) [3].

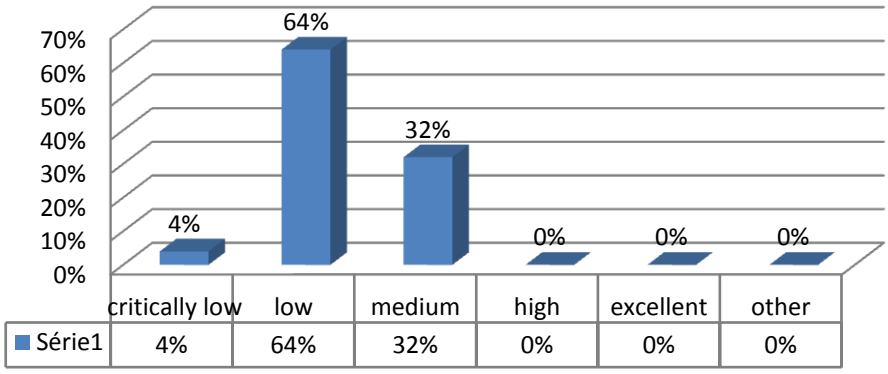

Fig. 1. Expert evaluation of practice-orientedlearning methods implementation in Russian HEI

The real implementation of interactive training often faces difficulties and contradicts the system of educational process planning that remains committed to the traditional teaching methods and forms of educational activities.Experience of Russian universities shows that educational technologies required to ensure the achievement of intended learning outcomes are addressed only at the final stage of educational program designing, after the curriculum structure and academic hours for each discipline are defined. This indicates a sequence of actions confirming the priority of curricula for specific disciplines over teaching methods in educational programs implementation. It also leads to domination of knowledge-based approach over the activity approach in future engineers competence development.

The need for improving changes becomes obvious, primarily aimed at the selection of adequate educational technologies and teaching methods, enhancing their effectiveness for the development of creative thinking, through transition from teaching to learning, from passive to active methods, from the reproductive activity of students to independent and creative activities [4].

An illustrative example proving the importance of active learning in training of engineers is provided in the CDIO Standards [5], where students' engagement becomes critically important.

CDIO Initiative is one of the progressive approaches to designing and implementing engineering undergraduate education introduced to the international academic community in 2000. The abbreviation CDIO stands for Conceive - Design - Implement - Operate. CDIO concept is aimed at bridging the gap between theory and practice in engineering education, strengthening the practical values of training using problem and project-based learning.

As a part of the CDIO Initiative 12 standards were adopted, where *Standard 8 addresses Active learning methods*. Teaching and learning based on active experiential learning methods engage students directly in thinking and problem solving activities within the training process, including process management, ideas analysis and evaluation, experimentation and knowledge discovery.

Talking about engagement, we cannot ignore the role of faculty, that is expected to use active teaching methods aimed at developing the students' interest, the need for continuous self-improvement, self-education, independent research and discovery of new knowledge needed when searching for solutions to the problem. One of the barriers to the adoption of new approaches and technologies in the training of future specialists is the conservatism of the university community, and low motivation of teachers to apply modern interactive teaching methods. High level of students' motivation and engagement in the educational process, of course, depends on the faculty competence in the field of interactive teaching methods, their ability to organize the learning process, using such techniques as brainstorming, expert seminars, trainings, case study, etc.

In response to this challenge CDIO Initiative provided *Standard 10 - Enhancement of Faculty Teaching Competence*. If teachers are expected to implement new methods for active experiential learning and learning outcomes assessment, it is important to provide them opportunities to improve relevant competencies by supporting internal and external qualification development programs, forums to share ideas and best practices.

Over the past 10 years the CDIO Initiative joined more than 100 universities in Europe, North and Latin America, Asia, UK, Australia, New Zealand and Africa. In Russia, the first CDIO member university was Tomsk Polytechnic University (2012). Today the list of Russian universities in CDIO Initiative has increased and includes: Astrakhan State University, Don State Technical University, Siberian Federal University, Ural Federal University, Moscow Aviation Institute, Moscow Institute of Physics and Technology (MIPT), National Research Nuclear University - NRNU MEPhI, Skolkovo Institute for Science and Technology, Tomsk State University of Control Systems and Radioelectronics, Kazan Federal University (NaberezhnyeChelny Institute).

Being a member of the CDIO Initiative means not just to adopt its principles, but adapt them to your own disciplines, universities, national and regional requirements. It is important to share best practices in applying CDIO approach for reforming educational programs on designing and implementing stages.

Committed to training competitive specialists, leaders and developers of educational programs could use CDIO framework as a guideline for continuous improvement s paying particular attention to the active learning methods, interdisciplinary content,

modular and student-oriented structure with possibility to follow individual curricula. Engaging students in the learning process motivates them to practice acquired competencies, including critical and creative thinking skills, makes them feel important part of the university community, awakes interest to the area of specialization, promotes meaningful learning experiences.

The implemented learning and teaching methods should contribute to achievement of intended learning outcomes, providing interactive learning, engagement and independence of students, flexibility to the challenges of the external environment, transforming students from passive listeners into active participants in the educational process.

REFERENCES

[1] Bédard, D., Lison, C., Dalle, D., Côté, D., & Boutin, N. (2012). Problem-based and Project-based Learning in Engineering and Medicine: Determinants of Students' Engagement and Persistance. *Interdisciplinary Journal of Problem-based Learning, 6 (2). Available at: htp: //dx.doi.org/10.7771/1541-5015.135*

[2] The federal state educational standards [electronic resource] // official website of the Ministry of Education and Science of the Russian Federation - Access mode: http://mon.gov.ru/dok/fgos/

[3] Proceedings of the expert seminar "Implementation level of practice-oriented educational technologies in Russian engineering education" [electronic resource]. - Access mode: http://aeer.ru/ru/trening17.htm

[4] Tolkacheva K.K., PokholkovYu.P.,KudryavtsevYu.M. (2014) Role and choice of educational technologies in training of engineers // Kazan science, No. 10, pp. 13-17.

[5] Worldwide CDIO Initiative. Expected learning outcomes (CDIO Syllabus): inform. method. ed. / transl. from English and ed. by A.I. Chuchalin, T.S. Petrovskaya, E.S. Kulyukina; Tom. Polytechnic. Univ. - Tomsk, 2011. – 17 p.