COMPLEX STRATEGY OF CDIO INITIATIVE IMPLEMENTATION IN A REGIONAL RUSSIAN UNIVERSITY

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ABSTRACT

Since 2012 within CDIO initiative Astrakhan State University has been designing engineers training programs in compliance with CDIO ideology. ASU has elaborated and is implementing an original strategy of transferring from the system of disciplinary theoretical education to the project-based one. Evaluation program showed that the given approach is effective. However, some "bottlenecks" were identified. Much of the success is associated with the creation of a creative atmosphere at the university, where students can fully realize their potential. It is one of the priorities of the university.

KEYWORDS

Results of an assessment of the program, new pedagogical technologies, developing skills and competencies. Standards: 2,3,4,5,7,8,9,10,11,12.

Advancing of the existing research and technology branches and development of new ones take place in the context of complication of technical objects and technologies and defines the requirements to the qualification and creative potential of the engineers. Creation of a universal “model of an engineer” is a complicated process, for there is a number of engineering specialities. Many countries have their own system of requirements to the training quality and acknowledgement of engineering qualifications (ABET, FEANI, WA and others).

Russia lacks mechanisms facilitating a prompt adaptation of the higher school to the current pace of technology changes. The reason may lay in Education Standards containing some restrictions of planning a training process in higher and secondary educational establishments. At present many Russian establishments of higher education are actively maintaining the integration into the world educational space that involves development and introduction of flexible adaptive teaching technologies and planning of training process.

Since 2012 within CDIO initiative Astrakhan State University (ASU) has been designing engineers training programs in compliance with CDIO ideology. ASU has elaborated and is implementing an original strategy of transferring from the system of disciplinary theoretical education to the project-based one. This required reliable mechanisms of actualization of new pedagogical technologies, which presuppose development of an appropriate innovative mechanism in the project. And this mechanism must rest upon mastering the professional activity in line with “Conceive – Design - Implement – Operate” model in the context of education modernization that Russia is undertaking.

The innovative mechanism of actualization of new pedagogical technologies that ASU applies within CDIO framework has three mail objectives – to train students able to:
1. Acquire deep knowledge of theory
2. Manage the building and operation of new products and systems.
3. Realize the importance and impact of scientific and technological progress on society.

A year after CDIO introduction into Astrakhan State University according to Standard 12 the program was evaluated. The feedback was provided by students and teachers of the university.

Self-evaluation of the compliance with CDIO standards, which made 43%, was of great interest. The results showed that most of the teachers are aware of and are ready to use CDIO standards in their teaching activity (Fig.1)

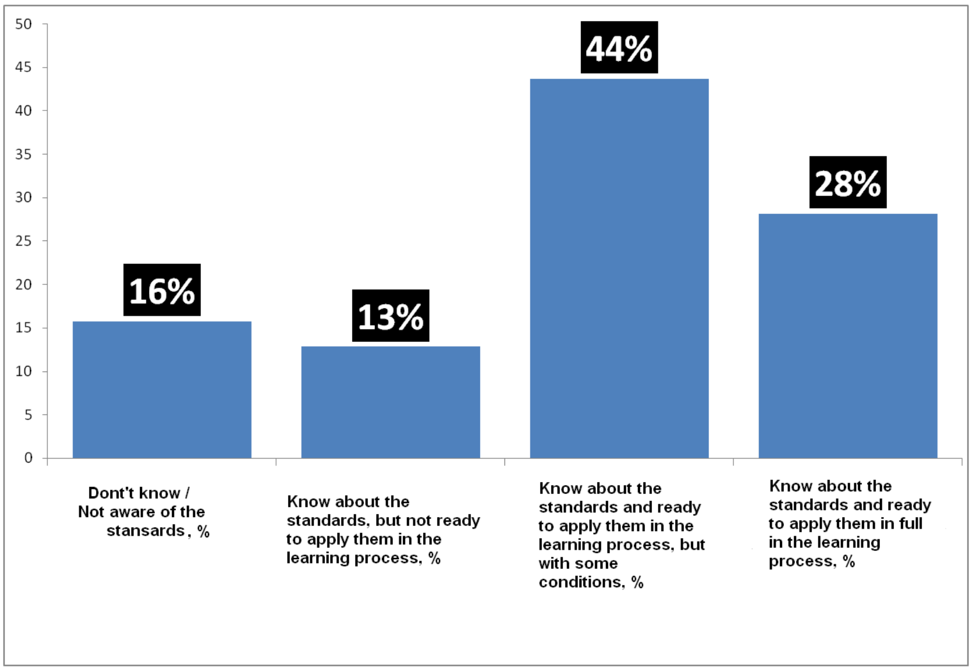


Fig. 1. Level of awareness and readiness to use CDIO standards by teachers of Astrakhan State University

Obviously similar results are connected with need of more careful study of questions, to be exact with development of quantitative standards of an assessment of the program and the comparative analysis of results "to" and "after" its introduction and use. The comparative analysis of answers of teachers and students allowed to allocate the key moments defining the mechanism of further increase of efficiency of the program by training of engineers. Full results of a self-assessment are presented in table 1.

Table 1. The results of an assessment of the program

CDIO standard	Compliance assessment	Rating
CDIO as a general context of development	1. Actualization of CDIO principles is recognized necessary 2. A plan of transferring to CDIO for some specialities was worked out (“Robotics”, “Bioengineering” and others) 3. Academic Council approved a new curriculum based on CDIO principles	1
CDIO learning outcomes	1. The main curriculum contains the learning outcomes including knowledge, personal and interpersonal competences. 2. The learning outcomes were agreed with the key stakeholders, including teachers, students, graduates and industry	2
Integrated curriculum	1. We have started work on comparing the	3

	disciplines with the learning outcomes achievement and competences to be formed 2. The curricula provides for interrelation between the disciplines	
Introduction to Engineering	1. Implementation of the introductory course is considered necessary 2 We have started to elaborate course “Introduction to Engineering” within main curriculum “Robotics”	1
Design-implement exercises	1. The curriculum provides for acquisition of some experience in engineering 2. At least two projects involving engineering activity are being implemented, the level of difficulty is rising.	2
CDIO workspaces	1. Workspaces for a number of specialities were created and are operating 2. More workspaces are planned for the next academic year	3
Integrated learning experiences	1. The work on evaluation of the curricula compliance with the integrated work plan 2. Integrated learning experiences are being worked out	1
Active learning	1. Active learning methods are incorporated in the learning process 2. Most of the faculty master methods and techniques of active learning	3
Enhancement of faculty competence	1. The faculty took training to increase their qualification with emphasis on personal and interpersonal skills, skills of products, processes and systems building 2. Workshops and traineeships in foreign CDIO member universities are organized.	3
Assessment of CDIO skills acquisition	1. Assessment methods are used throughout the whole curriculum (work programs of the disciplines) 2. Assessment methods are used in all the courses 3. Students assess their mates’ progress during classes	3
CDIO program evaluation	1. The evaluation of the curricula compliance with CDIO standards is acknowledged necessary 2. We have started to compare and choose the evaluation methods	1

The results of self-evaluation helped to identify “bottlenecks”. The focus is on the modernization of training engineers in a long term by changing the attitude to education and vocational guidance of schoolchildren. To unify the “school-university” educational process, to introduce a competence- and project-based method in secondary school, ASU organized and holds Workshops, Training Day etc for teachers with the assistance of international experts.

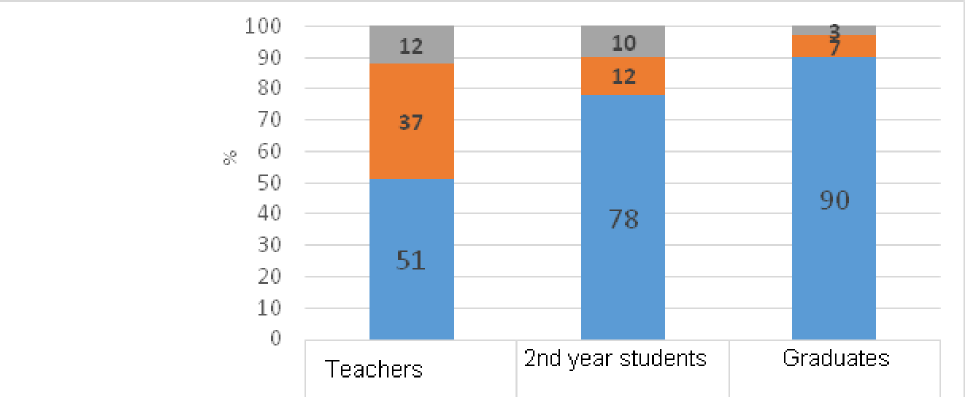
Engineers training in ASU is intimately connected with forming of systems thinking based on diversity of intellectual operations and modes of thought. Module-based method of forming an integrated syllabus turned out the most efficient. The following elements were distinguished:

• Basic level module
• Intermediate level module
• Advanced level module
• Specialization module (extension of knowledge and experience in a specific discipline)

Two-dimensional learning is taken as a basic principle. The vertical component of the academic program is based on the logical structuring of educational material within the studied subject area, in which the previous themes are the basic foundation for the next ones. The learning process is consistently goes vertically up, i.e. from the simple theme to the difficult one. The place in the system of multi-disciplinary knowledge and examples of the use in engineering and other subject areas are determined for every theme as part of the horizontal component.

We introduced subjects that help our students master skills of innovative engineering. There is a special discipline for the practical application of acquired knowledge, creativity, imagination, mastering the analysis and synthesis of systems, systems engineering, methods of formulating and solving inventive problems. A unique course was developed at ASU on "Lean Production+6 Sigma" aimed at deepening students' knowledge in the field of production management and developing skills and competencies for professional participation in strategy development of innovative companies and increase of their competitiveness.

To evaluate the efficiency of new technologies with the aim of enhancement the faculty qualification (standards 9, 10) and introduction of new learning trajectories (standards 2-5, 7, 8, 11) we have carried out a questionnaire survey of different groups of respondents (teachers, students of different years) with respect to increase of the training quality and motivation of students while preparing for their prospective professional activity after CDIO standards wee introduces. The results can be seen in Figure 2.



	Teachers	2nd year students	Graduates
Don't know	12	10	3
No changes	37	12	7
Significantly better	51	78	90

Fig. 2. The results of the questionnaire survey with respect to increase of the training quality and motivation of students while preparing for their prospective professional activity after CDIO standards were introduces

To apply CDIO standards efficiently while designing training programs we have amended, to be precise restructured, the curricula which should provide for the students while studying acquires not only disciplinary knowledge, but personal and interpersonal competences, as well as products and systems building skills. In such a curriculum disciplines complement each other, their contents intersect and jointly they lead to the desirable learning outcomes. That means while elaborating the precise plan the interrelation of the disciplines and CDIO competences should be stipulated. There are several models of the structures of integrated curricula proposed by CDIO. Taking into account the peculiarity of the specialization we have chosen the model in which the integrated curriculum is a set of independent disciplines that interconnect, overlap and interact with each other so the students understand that resolving a real problem requires involvement of components of different disciplines.

Project-based learning activity is an essential part of successful using of CDIO initiative. The work on the projects is not about design and team work only. If the projects are organized in a proper way they are extremely important as they help students to study the fundamental bases of engineering sciences, this is directly related to the concept learning and a deeper understanding of their speciality.

There are several variants to “implement” project–based learning activity into the educational process as in the case with the structure of the curriculum. The analysis of the given variants let us choose modular arrangement of disciplines and “spike” or merger approach that means 75% of time, given for modular disciplines, are taught separately but some academic hours of the discipline are joined into a single project. It helps students understand that you need to apply communicative and technological skills from different disciplines in order to solve the real problem.

There is a schematic map of interdependence of disciplines and the "input" and "output" competencies for each project assignment. For the given module of academic disciplines (Fig.1), an example of project tasks is the development of mobile 3- wheeled robot for use as a universal platform with a given load capacity, maximum speed, size and motion for a given type of surface. The size of the mounting pad, mounting dimensions and connection interface for user-installable auxiliary equipment are also given in the description. The presence of components of all disciplines included in the module is the key thing for the project assignment. Completion of this project assignment involves mastering all competencies of these disciplines.

Reorganization of the educational process is a very important factor in students’ motivation. Integrated control of the knowledge process formation and the levels of skill and competency mastering of students are a component of the separate academic discipline content and cross-discipline relationships. There is an authors' database of integrated assignments and assessment tools for all major structural units of the curriculum (taking into account the modules) at ASU. The use of integrated assignments to evaluate students' ability to transfer research methods from one area of knowledge to another and apply them in the new circumstances. The source of integration is interdisciplinary and intradiscilinary relations that play an important role in improving the practical, scientific and theoretical training of students.

Evaluation program (Standard 12) showed that the given approach is effective. However, some "bottlenecks" were identified. Much of the success is associated with the creation of a creative atmosphere at the university, where students can fully realize their potential. It is one of the priorities of the university.

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