Organizational capacity of cdio syllabus in actualization of the objectives of engineering education from regional perspective

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Abstract. Engineering and technical progress is transforming the automotive industry rapidly. Conformance of professional competencies of college graduates to the requirements of the regional industry is seen as the main competitive advantage at the regional labor market. Both the business and engineering academic communities recognize the importance and stand ready for continual actualization of educational objectives. An important (from both theoretical and practical standpoints) question is the form of presentation of training results declared by a higher education institution for the purpose of assessing its relevance by the business community. Using the CDIO Syllabus architecture as the basis of a structured system for polling representatives of the industry and the academic community of the region, i.e. the two main stakeholders, certain information was obtained for updating educational objectives of automotive engineering undergraduate programs. The study conducted made it possible to distinguish and detail value and target-based opinions of respondents, as well as to evaluate, in absolute and relative terms, the level of relevancy of a graduate’s competencies declared by a college.

Presently, a strategic program to develop the national system of competencies and proficiencies within the Russian industry is being implemented [Natalia Shmatko, 2016, pp. 340-354], [Gurtov V. A., Garifullina N. Yu., Sigova S. V., 2016, pp. 68–75]. The purpose of this reform is to transform today’s labor market into a market of professional competencies. The production sector of the automotive industry also develops a new set of requirements to labor resources, which views personnel competencies as main productive values. This major restructuring of the Russian national qualification system has created an intense impetus of changes within the system of engineering training. Updating training programs with the aim of “improvement of quality of professional training, as well as ensuring its flexibility and adaptability with respect to labor market challenges” is deemed of vital importance.

Professional training of engineering and technical staff for the automotive industry is closely related to the modern trends of development of the said industry’s regional sector. Conformance of professional competencies of college graduates to the requirements of the regional industry is seen as a major asset and the main competitive advantage at the regional labor market. It is common knowledge that “when
facing a highly competitive professional labor market college graduates that have inadequate competency are bound to accept positions requiring a lower level of training, which is lower than the training level of such graduates”.

The main source of engineer and technical staff of automotive service enterprises in the Oryol Region is the Polytechnic College named after N. N. Polikarpov, a division of the Oryol State University. A study of relevance of the College graduates’ competences included into automotive engineering training curriculum was carried out on the basis of Vehicle Service and Repair Department. During the study, the degree of conformance of the professional competency of a graduate who has completed the undergraduate program “Operation of Vehicles and Production Machinery and Complexes” declared by the College with the requirements of the regional industry to qualitative characteristics of engineering and technical staff of a vehicle service business was determined.

Empirical data for the study were obtained using feedback of respondents, managers and employees of the most competitive car servicing enterprises of the Oryol Region. The respondent selection also included representatives of academic staff and students of the University.

The competency-based approach was selected at the methodological framework of studies. The applied method of study used a formalized expert poll having the form of a questionnaire survey, which used modular questionnaires to allow for a comparative analysis of respondent feedback. Actual significance of graduate competencies declared by the College was adopted as the subject of evaluation. An important issue, which arose during the preparation of the survey, was the problem of selecting the form of representing training objectives to the professional community in view of the difference of terminology used to describe competencies by the industry from that used in training standards.

CDIO Syllabus, the architecture of educational objective representation was used as the form of presentation of educational objectives to the professional community with the purpose of analyzing their relevance. This methodological approach was applied in order to focus respondents’ attention on major structural elements of a college graduate’s professional competency, and not just on their constituent individual competencies that are frequently perceived by the academic circles and the industry differently. The analyzed set of graduate competencies was comprised of four blocks: 1) fundamental knowledge, 2) professional competencies, 3) communicative skills, and 4) system engineering. A 100-point grading scale was used.

Survey results revealed major differences in the perception of relevant significance of education standards (competencies) by respondents. The results of evaluations given by employers, graduates, teachers and students expressed in relevant significance points are shown in Figure 1.

Consolidation of response analysis results reveals that there is a substantial gap between employer’s expectations relating to professional training level of college graduates and the regulation-based competency level declared by the college. Interestingly, these competencies are not part of professional or operational sphere, which could be expected, they lie in managerial, ethical and moral sphere instead.
Figure 1. Respondent Evaluation of Relevance of Regulation-Based Training Objectives (College Graduate Competences).

1.1 Knowledge of math and natural sciences; 1.2 Basic engineering knowledge; 1.3 Knowledge of engineering techniques and methods; 2.1 Ability to solve production-related issues in terms of their technical and economic expediency; 2.1 Ability to solve production-related issues in terms of their technical and economic expediency; 2.2 Ability to experiment and research and ability to gain professional knowledge individually; 2.3 Competencies reflecting consistency of professional reasoning; 2.4 Ability to assume a meaningful social stance in terms of professional activity effectiveness; 2.5 Competencies reflecting the ability to take professional responsibility in terms of ethical standards; 3.1 Ability to take part in group production activities; 3.2 Ability to maintain business communication; 3.3 Communication skills in foreign languages; 4.1 Social and environmental competencies; 4.2 Ability to identify production processes from the standpoint of economy; 4.3 Ability to plan production and managerial activities; 4.4 Ability to design; 4.5 Ability to take part in production; 4.6 Ability to apply engineering solutions in practice; 4.7 Ability to manage engineering activities; 4.8 Entrepreneurship as part of engineering activities.

The most significant inconsistencies between positions of employers and college teachers are the significance of competencies within the group “Professional accountability in terms of ethical standards”. On the average, college teachers evaluated competencies of this block 20% lower than employers. The significance of the group “Leadership as part of engineering activities” was evaluated
by college teachers 23% lower than by employers. Some material divergences of positions of employers and college teachers were revealed in relation to the significance of competencies within the group “Consistency of professional reasoning”.

The level of significance of competencies within the Consistency of professional reasoning group was 21% higher for employers than for college teachers. It should be noted that competencies within this group comprise an essential element of systems engineering implementation, the modern widely acknowledged methodology used in production organization.

The lowest grades of the analyzed competencies were given by graduates employed by the industry. The results of the poll gave evidence that this group of respondents was the most pessimistic in their estimates of relevance of education objectives subjected to analysis.

The results of the study were summarized based on the values of the relative competency block relevance indicator (see the Table 1).

| Block of Analyzed Competencies | Respondent response (points) |
|-------------------------------|-------------------------------|
|                               | Employers | Teachers | Students | Employed Graduates |
| 1. Basic knowledge            | 75        | 82       | 81       | 73                |
| 2. Professional competencies  | 85.4      | 78.6     | 78.6     | 78.2              |
| 3. Communication skills       | 87        | 74       | 72.6     | 67                |
| 4. System engineering         | 84        | 76       | 80       | 70                |

The results of the study with regard to the Basic knowledge block demonstrated a clear focus of teachers and students on gaining theoretical knowledge within future professional sphere.

Relative relevance indicator of the Professional competencies block revealed a minor (8%) difference in its evaluation by employers and teachers. Assessment of employed graduates was much different from that of the other groups of respondents: the difference amounted to 18%.

A major difference in the evaluation of competencies within the Communication skills block by employers and teachers was also revealed. This points to a conclusion that teachers need to focus more on improving the significance of training objectives described by competencies within the Interpersonal skills group.

Relative relevance indicator of the System engineering block allowed to reveal a high level of conformity of competency relevance evaluation within this block between employers and students. This denotes a fairly developed motivation of students in the acquisition of competencies of the block. Nevertheless, numeric values of the indicator reveal that the relevance of this block’s competencies to the teachers is much (by 10%) lower than that expected by employers. This reinforces the already mentioned necessity to change the attitude of teachers to the development of the Systems engineering block competencies.

Conclusion

A comparative analysis of relevant significance of the discussed competencies revealed a definitive exceedance of employer values over the perception of these competencies by college teachers. In 80% of cases, competency relevance estimates given by employers exceeded those of college teachers. This clearly indicates the need for a meaningful alteration of value and conceptual position of college teachers implementing the teaching process of the undergraduate program “Operation of Vehicles and Production Machinery and Complexes”.

One peculiarity of the expert poll results for graduates employed within the industry was that their competency significance evaluations were lower (by 3% to 23%) than those of employers throughout the assessed competency groups. Responses of employer respondents lay within the strategic planning
outlook of “how things should look in the future”. Responses of employed graduates classified as specialists reflect the situation “as is”.

Acquisition of competencies by college students is dependent upon the perception of these competencies as being significant to achieve training objectives by academic staff. Revealed considerable inconsistencies between perception of significance of training objectives by college teachers and expectations of major regional employers pose a real threat to quality level of professional training of the undergraduate program “Operation of Vehicles and Production Machinery and Complexes”.

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