Competence requirements of employers to graduates of agro-engineering universities (specialties)

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Abstract
According to the conducted research and expert estimations, in order to form the required adequate competences of potential workers, the graduates should know and be able to apply the received fundamental scientific, socio-economic and agro-engineering knowledge as a basis for professional activities, should have the experience of using universal methods of engineering analysis, intelligent technologies and methods of computer analysis in solving complex engineering problems in agricultural production. However, the involvement of individual employers cannot be considered as a sufficient measure for assessing the quality of higher education, because employers often tend to judge the quality of graduates in terms of a particular sphere of activity, profession, occupation, or even their own company. It is therefore necessary to involve the public employers’ organizations.

Keywords: agricultural engineering, competence, education quality criteria

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1. Introduction

The criteria for assessing the quality of engineering education, used in public and professional accreditation of educational programs in engineering and technology in universities in different countries are currently defined by two authoritative bodies – Washington Accord (http://www.washingtonaccord.org) and the European Network for Accreditation of Engineering Education (ENAEE) (http://www.enaee.eu). The Association for Engineering Education of Russia (http://www.ac-raee.ru) is a signatory of Washington Accord and a member of ENAEE. It provides accreditation of educational programs for bachelors, masters and graduates of Russian universities in engineering fields and professions in accordance with international criteria. We propose to include a number of requirements (competency) also in the specific criteria for assessing the quality of agricultural engineering education.

With reference to particular employer, the graduate must demonstrate specific competencies associated with the unique challenges of agriculture, objects and types of innovative engineering in the field of agricultural specialization (research, industrial and technological, organizational, managerial, engineering and others.) in agricultural enterprises and organizations, which support agricultural production (sales and maintenance of equipment, supply of relevant agents, research institutes, etc.), as well as the willingness to follow their corporate culture.

The requirements of the employer to the graduate vary depending on the industry branch and the legal form of the company. However, any employer pays attention to the following factors: knowledge, professional and personal qualities, health, references, and additional skills. As to other knowledge and skills, the employer is ready to provide them to his employee if the latter has relevant potential in place.
2. Data and Methods

Among other competencies of university graduates a major one is the employer orientation. It means the graduates need to demonstrate specific competencies associated with specific tasks, objects and kinds of innovative engineering activity in agricultural enterprises in general, and in individual organizations, in particular (with potential employers).

To develop this competence at the appropriate level, the graduates need to gain experience in practical application of the following knowledge (Chuchalin, 2009):

- areas of expertise (research and development, production, management, design) in comprehensive and innovative engineering activity in enterprises and organizations (potential employers);
- the overall strategy, regulatory documents, technical and technological status and development trends of enterprises and organizations (potential employers);
- organizational (corporate) culture of enterprises and organizations (potential employers).

The Ministry of Education and Science of Russia recognizes the need to consolidate the role of employers in the educational process – to involve them as lecturers, supervisors of practical training and graduate work, the members of State Examination Boards – these may be called the standard roles. According to most Federal State Educational Standards (FSES) (http://минобрнауки.рф) the share of employee from among top managers and specialists of organizations, i.e. potential employers, should be no less than 10%. The inclusion of employer's standard roles in the educational process makes it impossible to take into account the requirements of most employers to future professionals.

The wording of general and professional competencies for directions and specialties assumes their coordination with the labor functions specified in existing professional standards. However, amended FSESes offer generalized definitions of competencies, including professional ones. To understand them and to further fill them with specific skills and knowledge it is necessary to carry out extensive work with potential employers. This work includes not only questioning of employers, but also explaining what the competencies are; it should be carried out within a limited time period, ideally - before the training of future specialists starts.

The educational system itself is an inertial one; the higher education programs of different levels, including those for agricultural engineers, last for two to four years. Requirements to the graduates, and consequently, to the competencies, may vary dramatically during the training period, especially for agro-engineering specialties.

On the one hand, the generalized definitions of the necessary competencies provide the freedom in filling the professional competencies with specific skills and knowledge; on the other hand, they do not allow to directly conduct a survey of potential employers in terms of the necessity of teaching a particular competence specified by the standard.

3. Results and Discussion

Following the requirements of FSES, when training the future agricultural engineers, the universities define a set of core competencies (professional and common cultural) for a graduate to possess as a result of successful mastering of educational programs in the field of agricultural machinery and technologies (Order of the Ministry…, 2014). However, to define a set of core competencies is just one of the steps that should be made, but it is not enough for the graduates to successfully achieve the planned learning outcomes. High quality of professional training of a specialist largely depends on the choice of educational technologies. Learning outcomes may be different within the same educational program and depend on the chosen educational technology. The educational process should ensure the active involvement of students that allows to form more efficiently and quickly the necessary professional competence. It seems certain that teacher’s qualification as an educator and as
a professional in the taught subject is also an essential element in the achievement of educational process objectives.

In accordance with the FSES in different fields of study, realization of competence-based approach should “provide the widespread use of interactive forms of training (workshops, discussions, computer simulations, business and role-playing, case studies, psychological and other trainings) in the learning process combined with extracurricular work aimed at formation and development of professional skills of students. The framework of training courses should include the meetings with representatives of Russian and foreign companies, state and public organizations, as well as the master-classes of experts” (FSES, 2014). Essentially, interactive forms of training activities are the basis of practice-oriented, problem-oriented and project-based educational technologies.

The share of interactive sessions in the total classroom work under the FSES of higher professional education should be at least 20% in bachelors training and not less than 40% in masters training. However the actual level of implementation of interactive practice-oriented methods of teaching in Russian universities, according to the study conducted by the Association for Engineering Education of Russia, remains low (Status of implementation..., 2013).

Real life application of interactive forms of teaching often conflicts with the system of educational process planning, which remains committed to the traditional teaching methods and forms of organization of educational activities.

The traditional approach to education, which focuses on class-and-lesson training system and is widely applied in technical colleges, unfortunately, does not allow achieving the desired goals (Pokholkov&Tolkachev, 2014; Augusti, 2012). The educational process under this approach basically requires the student’s ability to listen and record rather than an active individual work. The most common forms of training are lectures and workshops, which do not provide one of the key elements of learning motivation – involvement of each student in the learning process. Apparent is the necessity for improving changes, primarily aimed at selection of appropriate educational technologies and teaching methods, at enhancement of their effectiveness to develop the creative thinking through transition from teaching to learning, from passive to active methods, from the reproductive activity of students to their individual research and creative work.

High motivation level and involvement of students in the educational process, of course, depends on the teacher's skills especially in the field of interactive teaching methods, his/her ability to organize the educational process with the use of such techniques as brainstorming, expert panels, training, role play, case analysis and others.

Teacher's professional qualification is also determined by the frequency and the duration of his/her practical training on advanced production facilities. This, in turn, allows him/her to expand the range of contacts with the industry representatives and to invite, where appropriate, the experts to participate in classes with students related to the challenging problems of actual production. The possibility to sign economic agreements and to involve the students in addressing realistic production problems plays an important role in this context.

Setting a task to train competitive specialists, the educational software developers need to pay special attention to the content and organizational forms of educational activities. Training should be carried out by competence-based educational programs with interdisciplinary content, modular and student-oriented structure, and with the possibility to introduce individual education plans. The items listed above should be given sufficient attention at the stage of development of the basic educational program (Chuchalin&Boev, 2007; Motajlenko, 2015; Augusti&Feyo de Azvedo, 2011). Applied educational technologies and techniques should help to achieve the planned learning outcomes, providing interactive learning, involvement and autonomy of students, adaptability to challenges of external medium through transforming the students from passive listeners to active figures in educational process.
Recently, one of the basic requirements for a graduate of any training level in agricultural engineering schools is a necessary professional competence, which subsequently has to develop into a high level of professionalism. It is understood that the "high level of professionalism" means the competence of a specialist + various kinds of experience related to the profession. Experience comes over time (many confuse this concept with the concept of skill – automatic human performance) but the competence (including skills) an agricultural engineer should receive in the course of training in a high school.

There are many classifications of professional engineering competencies (Chuchalin, 2009; Pokholkov& Tolkachev, 2014; Augusti, 2012). Most scientists have concluded that the competence for an engineer is the sum of qualifications, which are defined by a set of expertise, knowledge and skills, i.e. professional competences and social behavior (Fig.1).

Figure 1: Professional competences of an engineer

For a future agricultural engineer to become a professional person, it is necessary to mould such a consciousness, which would incite to fruitful professional work. Engineer’s consciousness becomes truly professional only when he perceives and interprets the engineering activities in the scientific, technical, vocational, qualification and personal terms.

Mapping regulatory requirements and professional standards in the mind allows the engineer to fully and adequately perceive engineering and technical reality, be well informed and develop strategies and tactics, plans and objectives of professional activity, knowingly control his/her own behavior. With their help, the specialist generates the attitude to himself as a professional, and to other participants of production process (agronomist, livestock specialist, and economist).

With the aim to identify the level of theoretical knowledge and practical skills, to improve the quality of agricultural education of graduates in Russia, the questioning of employers, who offer employment to the graduates of agricultural universities, was conducted in the framework of TEMPUS project «Development of Public Accreditation of Agricultural Programs in Russia» (PACAGRO) (Golokhvastov et al., 2015). Period of survey: October-November, 2014, creation and analysis of questionnaires. Number of respondents: 95 people. Regional distribution: 10 regions in Russia (+1 in Republic of Belarus). Profile of organizations of respondents: 75% respondents represented agricultural producers. When assessing the theoretical knowledge of graduates of agricultural universities 404 responses were received. Most frequently evaluated qualifications – mechanical engineer – 13.9%.

Besides answering the proposed questions, the respondents identified the following problems for agricultural engineering:
- Insufficient (poor) knowledge of foreign languages,
- Lower competency of teaching staff and reduced financial support of the training process. Material and technical resources of institutes fail to meet the requirements of modern farming,
- Shortage of practical experience among the specialists who graduated from higher educational establishments.

Strong points: 87% of the respondents noted that specialists engaged in the production are familiar with the advanced technologies and best practices in their field of expertise.

It should be noted that the rules of professional conduct and competence are always concrete. They are produced by people in accordance with the terms and requirements of real life and activity, in accordance with their own ideas. Any young agricultural engineer conceives and interprets the rules worked out in practice, already having some ideas of the proper and valuable.

To estimate the competence of an engineer a “sample competence passport of an agricultural engineer” with the rough description of each competency may be used (Table 1).

<table>
<thead>
<tr>
<th>Competence</th>
<th>Description</th>
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<tr>
<td>Planning and organization</td>
<td>Thoroughness, keeping papers in order, advanced skills of planning and control over the following of approved plans</td>
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<tr>
<td>Leadership skills</td>
<td>Enthusiasm, ability to inspire other people with his/her ideas, the ability to gain a team leader reputation</td>
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<td>Analytical thinking</td>
<td>Active search for new information, the ability to work with various sources, developed skills of survey of problematic situations, the ability to make balanced and viable decisions under conditions of uncertainty</td>
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<td>Cooperation</td>
<td>Sociability, aspiration to understand the needs and desires of others, the ability to achieve a breakthrough in the negotiations</td>
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<td>Teamwork</td>
<td>Developed skills of social networking, maintaining good relations with all team members, mutual aid</td>
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<tr>
<td>Results-based approach</td>
<td>Adherence to the established quality standards, insistence in negotiation of obstacles, ambitiousness</td>
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<tr>
<td>Open-mindedness</td>
<td>Positive attitude to innovations, active search for new agricultural technologies and opportunities</td>
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<tr>
<td>Professional skills</td>
<td>High level professional knowledge, abilities and skills, good understanding of the tricks of the profession, clear awareness of the boundaries of his/her professional activity, continuous update of knowledge and skills in the professional field (machinery and technologies), the interest in related professional fields (agronomy, animal science, etc.)</td>
</tr>
<tr>
<td>Independence</td>
<td>Reasonable self-esteem, self-reasoned opinion on important issues</td>
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<tr>
<td>Communication</td>
<td>Verbal intelligence, good command of emotional and expressive oral speech tools</td>
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<tr>
<td>Writing skills</td>
<td>Good command of written language, informative presentation of his/her ideas in writing</td>
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<tr>
<td>Ethical norms</td>
<td>Strict adherence to professional and universal moral norms</td>
</tr>
<tr>
<td>Creative ability</td>
<td>Active generation of new ideas and creative approach to their execution</td>
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4. Conclusion

In order to form the required adequate competences of potential workers, the graduates should know and be able to apply the received fundamental scientific, socio-economic and agro-engineering knowledge as a basis for professional activities; they should have the experience of using universal methods of engineering analysis, intelligent technologies and methods of computer analysis in solving complex engineering problems in agricultural production.
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