ADDITIONAL PROFESSIONAL EDUCATION OF HIGH-DEMAND PERSONNEL FOR COAL MINING: KEY COMPONENTS OF ADAPTIVE ORGANIZATION-AND-PEDAGOGY SYSTEM

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The global trends show the booming growth of the resource-intensive industries, which calls for highly qualified mining engineers possessing knowledge and skills in geology and design. A mining engineer should possess flexible thinking, be able to respond promptly to any emergency, and keep in mind procedures and instructions. Smart management of team work governs efficiency of meeting the goals and safety of team workers, thus, all listed faculties should be matured and improved.

The burning issue for the coal mining industry is currently the improvement of occupational training and refresher training of engineering personnel.

The long-term development program of the coal industry emphasizes that the effectiveness of the national fuel and energy sector in many ways depends on the qualification and skills of trained engineers in mining.

The additional professional education (APE) is an essential part in upgrading of the society and economy. APE serves the interests of an individual and the whole society as it allows training of specialists in conformity with the wants of employers and connects the human capital and economic sectors.

Engineering schools are to ensure both the full-fledged professional education of engineers and the refresher training of active technicians in the short term, for the sustainable economic growth to bring the national high tech products to the international market, as well as for the strengthening of international credibility and defensive capacity of Russia.

The authorial review of the Russian and foreign psychological and pedagogical literature reveals the scientific and educational prerequisites for the effective adaptive teaching and organizational structure for personnel training and re-training. The authors lay emphasis on the studies into the pedagogical techniques applied in the system of APE by Tsibizova E. B. [1], Gordeev M. A. [2], Davis E. R., Wilson R. [3], Llopis F., Guerrero F. G. [4], Winzar H., Baumann C., Chu W. [5] and others.

Based on the above-listed studies, the authors have developed the teaching system and organizational structure for APE and introduced it at the Tomsk Polytechnic University.

Research methodology

Evaluation of the adaptive system of organizational structure and pedagogy should use certain criteria of the APE quality. These include the analysis of the attitude of the educational service consumers—students.

The indication of the educational service compliance with the needs and expectations of respondents is the index of education service quality satisfaction.

The measuring scale is usually the Likert five-point scale: totally satisfied, partly satisfied, partly unsatisfied, totally unsatisfied and undecided.

The scope of the present research embraced interrogation of 293 people educated under 19 APE programs in 43 refresher courses in conformity with the APE program list at the Tomsk Polytechnic University.

Results and discussion

The major mechanisms of providing conditions for the sustainable development of the APE system include:

1. Creation of education-and-industry clusters for all participants of the learning space at the University.

An education-and-industry cluster as an instrument of social partnership as an aggregate of interrelated institutions of occupational education, united sectorially into partnership with industrial undertakings [6]. The industrial institutions included in a cluster serve the platforms for practical training and for getting hands-on experience of future trading.

An important area of interaction with the social partners in the sphere of education is their participation in development of training programs and manuals on refresher training.

The social partnership is crucial in actual teaching and in additional education services. The actual teaching practices need that the industry possesses the advanced technologies and equipment.

A special part belongs to the partnership in the labor market exploration to ensure conformity of the training scale and structure with
the personnel requirements in each specific region. To this effect, it is necessary to:

- develop interaction between the APE institutions and regional placement services;
- negotiate and materialize agreements on refresher training between employers and the APE institutions.

The authors think the network interaction between the industry, employment services and educational institutions can promote a brand-new system of education and its organizational structure. Participants of such social dialogue shape a motivation environment for the subjects of an education process to actualize the intelligence and creativity potential, and to focus on formation of competitive professional abilities and competences, and personal qualities of young professionals with regard to the labor market demands.

The advantages of an education-and-industry cluster for the learning process include:

- creation of educational programs with regard to the third-generation occupational standards and production specifics jointly with industry practitioners;
- creation of conditions for training specialists of different occupational education levels with regard to the needs of a region economy;
- integration of education, science and industry.

Figure 1 describes the structure of an education-and-industry cluster.

Thus, since the first academic level, based on the preliminary agreements reached, it is recommended that an education-and-industry cluster provides:

- traineeships at operating plants;
- assignment of a tutor from the staff of the plant to supervise the traineeship;
- coordination of project topics between students and the tutor;
- consulting services for the face-to-face and one-to-one communication between the tutor and students;
- evaluation of a student’s achievements by the tutor;
- participation of the tutor in placement of students.

A traineeship program should represent to a maximum extent the practical activity of a student to ensure the theory and practice integration.

Furthermore, traineeship allows a student to gain the personal professional experience, and to identify independently the new and personalized areas of theory and practice exploration and to strengthen the part of knowledge in practical activity, which eventually can increase professionalism [7].

So, the advantages of traineeship within the system of APE are:

- additional education, familiarization with specifics of a certain factory, specific job learning;
- gaining competences necessary for a professional occupation, i.e. abilities required for a modern engineer in the new conditions;
- mastering of managerial and team-working skills.

Regarding the APE students, the traineeship is included in their personal plans in the network of an education-and-industry cluster.

The content of a traineeship depends on the recommendations of companies which send students for learning, or the wants of the students themselves, as well as on the content of learning programs and capabilities of educational institutions.

In this manner, during traineeship, an employer as if ‘breeds’ a student into a professional specially adjusted for the needs and wants of the employer. Traineeship allows a higher education institution to implement the practice-oriented learning, while students acquire actual hands-on experience and real employment.

1. Activation of educational performance of the APE students. Efficient formation of competitive abilities of a graduate needs the educational process to focus on stimulation of cognitive work of students, which is possible through drawing individual educational trajectories [8].

An individual educational trajectory depends on the goals of education subjects and on the specifics of the problems solved within this area [8].

On the basis of the psychological and pedagogical literature review, the authors distinguish between three implementation areas for drawing individual educational trajectories (Fig. 2) [10–12].

An individual educational trajectory is a personal way of formation and development of vocational competences.

Within APE the individual education trajectories enable formation of new knowledge and personal characteristics of a specialist on the ground of activation of a student’s status when a student independently chooses the goal, the content, as well as the form, methods and tools of variable education under an APE program.

In this manner, an individual educational trajectory can be considered as a certain sequence of activities aimed at implementation of personal cognition objectives. The individual educational trajectory should conform with abilities, interests and capacities of a student.

3. Engagement of students in near-real professional activity. Sustainable motivation of students requires them to become active participants rather than sideliners of a production process.

It is recommended to involve students in practical activity by way of:

- focusing learning projects on future trading [13];
- applying interactive technologies and stimulators of real-life production processes;
- organizing business games for students to dip in a model atmosphere of a real trade;
- proving the weight of a course in development of professional competencies;
- supporting the learning processes by actual practice cases, including advanced IT, for instance, streaming from workplaces at operating plants;
Fig. 3. Structure of adaptive organization-and-pedagogy system of APE

- teleconferencing with engineers and experts from operating plants.

Eventually, a student, while perceiving the practical benefit and personal usability of the knowledge absorbed, not only stimulates motivation toward learning but also fosters a value attitude to a future professional occupation.

4. Individual approach to each student.

The mission of an educational system is the all-round development of a person. This is only possible through disclosure of a student’s identity and potential to reach the highest level of development. This is the only way of receiving and mastering the skills and expertise by a student, as well as the possibility to cultivate the student’s aspiration toward self-cognition and self-development.

The individual approach assumes:
- identification of a student’s interests by the student and teacher jointly, and correlation of these interests with the basic topics of research projects;
- compilation of a personal development plan by a student (obligatory);
- teacher assistance in implementation of the personal development plan by a student;
- routine monitoring of a student’s traineeship performance at an employer’s company by a teacher;
- student–teacher feedback on the outcome of the personal performance monitoring and development of recommendations to improve professional competencies.

The described mechanisms represent the organizational structure-and-pedagogy system components to meet educational challenges within APE.

The authors present the structure of an adaptive organization-and-pedagogy system as the logically substantiated, interrelated and inter-dependent components (Fig. 3).

Learning under additional professional programs is a discrete (stage-wise) process. Modular technologies enable prompt response to the needs of economy and specific employers, and help form the required competencies of students with regard to their education level, construct and implement personal educational trajectories to generate a wanted profile of competencies. Introduction of modular technologies in education processes within APE ensures modular programs to be constructed using the reverse technologies of basic educational program development, and enables application of innovative teaching technologies, including network resources, as well as the storage and achievement evaluation functions.

A teaching module structures the whole educational material by the types of job tasks. All subjects are studied at different levels: general introduction, in-depth study and decision-making using standard techniques, special approach on the basis of personal choice and justification, etc. Subject to the learning objectives, a student may abide to the general level, or can master additional education levels.

The modules are highly self-contained and possess individual strategy, criteria and conditions. The modules can change places and, if necessary, include new modules subject to objectives and priorities of an educational program. The modular programs allow:
- fluent response to educational needs and interests of students thanks to integration ability of components of disciplines, at different styles and rates of learning per professional groups, with focusing not on delivery of knowledge but on fostering critical competencies on the basis of the domain knowledge and job-related experience;
- replacement of modules depending on education program goals, adjustment of learning process with regard to priorities, repositioning of modules within the general logics of the content.

The modular programs offer conditions for the person-oriented education and enhance competitiveness on the educational service market.

Having mastered the technique of modular structuring of a teaching material, a teacher and a student can make individual programs with regard to personal needs, update education content and thereby enhance efficiency of the whole education process.

<table>
<thead>
<tr>
<th>Table 1. Education program per stages and activities</th>
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<tbody>
<tr>
<td><strong>Stage</strong></td>
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<tr>
<td>Identification of problem</td>
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<td>Formulation of goals</td>
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<td>Outline of initial conditions</td>
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<tr>
<td>Selection and structuring of content</td>
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<td>Selection of teaching strategy</td>
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<td>Evaluation</td>
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Table 2. Service consumer satisfaction

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<th>Criteria</th>
<th>Indicator</th>
<th>Satisfaction</th>
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<tr>
<td>Professionalism of teachers and lectures</td>
<td>Expertise</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>Skills</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>Presentation quality</td>
<td>4.7</td>
</tr>
<tr>
<td>Learning process supply</td>
<td>Modern technical means</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td>Learning and teaching aid quality</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>Education course content</td>
<td>4.7</td>
</tr>
<tr>
<td>Quality of knowledge and skills</td>
<td>Novelty of knowledge acquired during learning</td>
<td>4.8</td>
</tr>
<tr>
<td></td>
<td>Applicability of acquired knowledge in professional activity</td>
<td>4.8</td>
</tr>
<tr>
<td>Satisfaction index</td>
<td></td>
<td>4.7</td>
</tr>
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A modular program is a stage-wise learning schedule (for a package of subjects, a subject, a section, etc.) including modular programs of open and flexible training. Table 1 describes the stages of a modular program.

Any modular program has a content composed of a set of modules and a procedure. It is necessary to try to make the content and procedure modules structurally uniform to enable all participants of an education process to follow common rules while keeping flexibly adaptable to probable changes.

An advantage of integration of modular technologies in a learning process is the combination of formal education and nonformal teaching resources such as:

- open online courses;
- learning at workplace;
- self-learning using the Internet resources.

Learning only achieves its goals when meets the needs and expectations of consumers of education services.

With a view to evaluating efficiency of the adaptive organization-and-pedagogy system, the authors collected information on satisfaction of students with the adaptive teaching and organizational structure of APE and identified the factors and conditions capable to affect the education quality.

For exploring the education service satisfaction, all students included in the additional professional education programs were involved in a questionnaire survey. Table 2 compiles the survey results on 2020–2021 academic year.

The questionnaire data and their analysis show that students appraise education at the University very high. The highest scores belong to the Novelties of Knowledge Acquired during Learning (4.8 out of 5 points), Applicability of Acquired Knowledge in Professional Activity (4.8 out of 5 points) and Modern Technical Means (4.9 out of 5 points).

The monitoring outcome demonstrates the increasing index of satisfaction. Satisfaction with education quality depends in many ways on conformity of the APE content with the learning needs of students.

Conclusions

Finally, the model of training high-demand personnel within the framework of the additional professional education at the Tomsk Polytechnic University allows:

- shaping practical skills during traineeship;
- encouraging students to develop and master competencies required by an employer and with regard to the regional specifics, as well as the personal characteristics and interests;
- eliminating deficiency of personnel at agencies–participants of the network partnership.

Acknowledgement

The study was supported by the Russian Science Foundation grant No. 23–28–00046, https://rscf.ru/project/23-28-00046/.

References