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

The article describes the key tools of training the high-demand personnel for the coal industry within the system of additional professional education. The proposed tools of the high-demand personnel training include the legal, managerial and pedagogical mechanisms, as well as the public–private partnership in the additional professional education. These tools represent the key components of the adaptive system of organizational structure and pedagogy in the high-demand personnel training in the framework of the additional professional education. The authors report the results of the proposed system application.

Keywords: *coal industry, high-demand personnel, additional professional education*
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Introduction

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 the 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

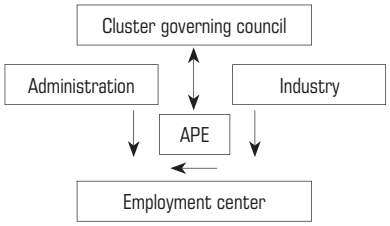

Fig. 1. Parties in education-and-industry cluster

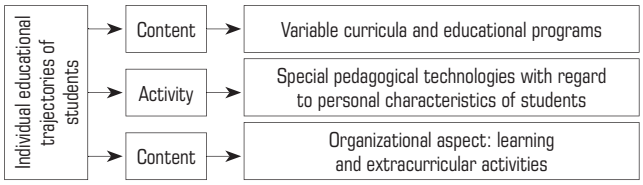

Fig. 2. Individual educational trajectory of student

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.

2. 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 [9].

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;

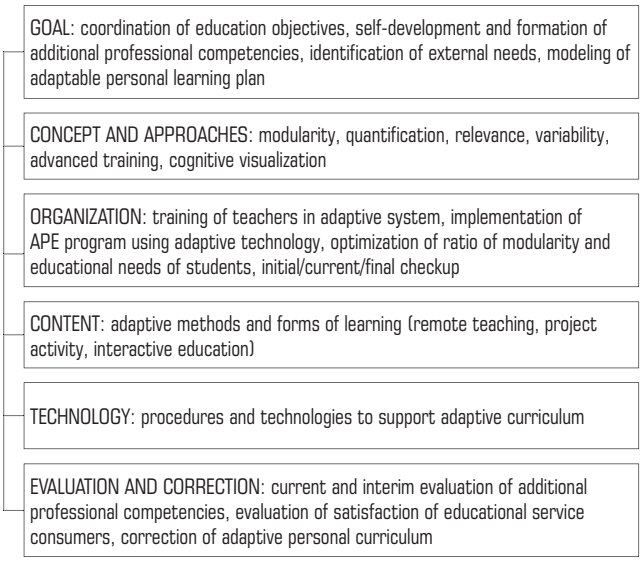

Fig. 3. Structure of adaptive organization-and-pedagogy system of APE

Table 1. Education program per stages and activities

Stage	Activity
Identification of problem	Analysis of economic and social needs. Exploration of education necessity by setting the competence level to be reached by students (resultant profile of a specialist) and the initial competence level (initial profile of a specialist). Assessment of available resources and constraints in program implementation.
Formulation of goals	Identification of general didactic goals. Identification of partial didactic goals.
Outline of initial conditions	Setting of minimum allowable competence level per program.
Selection and structuring of content	Analysis, selection and structuring of content per didactic sections and topics, and learning sequencing.
Selection of teaching strategy	Selection of teaching methods and tools. Embracement of individual peculiarities of students. Creation of support system.
Evaluation	Setting of evaluation criteria. Selection of evaluation tools. Setting of control stages (current, initial and final check).

• 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 interdependent 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 2. Service consumer satisfaction

Criterion	Indicator	Satisfaction
Professionalism of teachers and lecturers	Expertize	4.4
	Skills	4.5
	Presentation quality	4.7
Learning process supply	Modern technical means	4.9
	Learning and teaching aid quality	4.6
	Education course content	4.7
Quality of knowledge and skills	Novelty of knowledge acquired during learning	4.8
	Applicability of acquired knowledge in professional activity	4.8
Satisfaction index		4.7

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 Novelty 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:

- raising the level of knowledge and skills in the sphere of the major job of a specialist;
- 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.

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References

1. Tsibizova E. B. Additional education: Purpose, content, problems program development. *Narodnoye obrazovanie*. 2020. No. 1(1478). pp. 129–135.
2. Gordeev M. A. Factors of improving the management model of additional professional education. *International Journal of Humanities and Natural Sciences*. 2019. Vol. 9–2. pp. 36–41.
3. Davis E. R., Wilson R. "Not so globalized": Contrasting media discourses on education and competitiveness in four countries. *Journal of Asia Business Studies*. 2019. Vol. 13, No. 1. pp. 155–176.
4. Llopis F., Guerrero F. G. Introducing competitiveness and industry involvement as learning tools. *IEEE Global Engineering Education Conference, EDUCON*. 2018. pp. 298–307. DOI:10.1109/EDUCON.2018.8363243
5. Winzar H., Baumann C., Chu W. Competitiveness vis-à-vis motivation and personality as drivers of academic performance: Introducing the MCP model. *International Journal of Contemporary Hospitality Management*. 2018. Vol. 32, Iss. 1. pp. 637–660.
6. Petkov V. A., Filonenko V. A. Mechanisms of social mobility operation in university educational space. *Theory and practice of social development*. 2014. No. 12. pp. 55–57
7. Klucharev G. A. On the training of engineers for high-tech industries. employers' view. *Sotsiologicheskie issledovaniya*. 2020. No. 3. pp. 51–59.
8. Mikerova G. Z., Zhuk A. S. Algorithm of creation of the individual educational trajectory of training. *Sovremennye naukoemkie technologii*. 2016. No. 11–1. pp. 138–142.
9. Chupriyanova O. M. Model for designing individual educational routes for young teachers in additional education. *Higher education today*. 2021. No. 5. pp. 36–40.
10. Chertischeva E. A. Additional professional education : State-of-the- art. *Molodoi ucheniy*. 2020. No. 26(316). pp. 323–324.
11. Woit C., Yuksel N., Charrois T. L. Pharmacy and medical students' competence and confidence with prescribing: A cross-sectional study. *Currents in Pharmacy Teaching and Learning*. 2020. Vol. 12, Iss. 11. pp. 1311–1319.
12. Sankaranarayanan S., Kandimalla S. R., Cao M., Sakr M., Penstein Rose C. et al. Designing for learning during collaborative projects online: tools and takeaways. *Information and Learning Science*. 2020. Vol. 121, No. (7–8). pp. 569–577.
13. Shegai N. A. The specifics of project-based learning at the university based on SCRUM. *Pedagogicheskiy zhurnal*. 2021. Vol. 11, No. 5(1). pp. 544–554. EM