Developing teamwork skills for students trained in compressors and refrigeration programs

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Abstract. While implementing the bachelor’s program in the fields of compressors and refrigeration, modern educational standards provide for the teamwork competence developing. The purpose of this study is to propose a system of developing this competence for students of the Petrochemical Institute, Omsk State Technical University. The main idea of the research is the application of an integrated interdisciplinary approach to all the competences of the graduate, involving various forms and methods of implementing the system of training highly skilled engineers. The team-building competence is formed both during instruction time and extracurricular time: in research, internships, sport and other activities. In addition, the work experimentally revealed that the competence under consideration is consistent with both the requirements of employers and the need for students self-realization while studying at a university. The article presents particular examples of this competence development in the course of basic professional subjects, as well as of Foreign language and Physical education. In particular, the Foreign language course was extended for the students of the mentioned training programs in comparison with other students. As for physical education, team skills are formed in the classroom and through the students participation in various sport competitions. Besides, the article describes the results of students participation in the program "Young professionals of Russia", WSR. In addition, the interdisciplinary Petrochemical Institute project of the summer school for the first-year undergraduates, fully implementing the principles of complexity and consistency, is presented in the paper.

1. Introduction
While implementing the bachelor’s program in the fields of compressors and refrigeration, modern educational standards provide for the teamwork competence developing. In Russian higher education standards this competence is formulated as a person’s “ability to interact in society and realize his/her role in a group” [1]. Another aspect of team-building is achieving group goals: “Team building is a process that aims at improving the performance of a group of people working together to achieve a common goal” [2, p. 847].

So, teambuilding skills have a double effect: on the person’s professional and social self-realization, on the one hand, and on the society development, on the other.

The sub-aims for developing a teamwork competence are:
• collaborative critical thinking development;
• team-building in professional sphere;
• learning more and better through interaction with others;
students’ self-realization.

The purpose of this study is to propose a system of developing this competence for students of the Petrochemical Institute, Omsk State Technical University. The main idea of the study is the use of an integrated interdisciplinary approach to the formation of all the competencies of a graduate, involving various forms and methods of implementing the system of training a highly qualified engineer. This competence is formed both in a classroom and during extracurricular time: in research and extracurricular activities, during professional work experience and internships. The article presents specific examples of the formation of the teamwork competence in the course of basic subjects, as well as the disciplines "Foreign Language" and "Physical Culture." In addition, the project of the Professional skills summer school for the first-year undergraduate students of the named areas, fully implementing the principles of complexity and consistency, is described.

2. Problem statement

The problem of skills and competences forming and development is widely discussed nowadays in Russian and world educational practice [3, 4]. As it is shown in a number of publications [5, 6, 7], teambuilding skills provide for both professional realization and getting accustomed to working environment of graduates and their socializing. Ekimova et al. suggest that team-building exercises do well in the areas where students do not feel themselves confident enough [2], so they help to develop motivation and self-confidence. Riebe et al. also underline that building teamwork skills is as important as developing other technical competences needed in career [7].

That is why the involvement of stakeholders into the development of the general educational programme and the summer school design has ensured the connection with practical implementation of the students skills formed and developed.

A lot of researchers suggest methods and technologies providing team building skills development. Eliasa analyses games in education as a way of teambuilding. She considers doing home assignments in group and compares the results with those made individually in terms of responsibility, talent, and even the speed of doing tasks [8, p. 197, 9, 10]. Okuneva analyses project work and interdisciplinary approach in developing team-building skills [11, pp. 17-19].

Among main problems identified in the literature on the topic under study, we highlight the following:

- negative attitude of students to project / team work is most often caused by the fear of uneven workload when performing individual and group tasks;
- not all teachers understand the potential of teamwork and the need to form these competencies;
- not all students are psychologically ready to work in a team; there are different attitudes towards teamwork [12];
- leadership is an alternative teamwork;
- time is needed to form the teamwork competence [6];
- question of teamwork assessment: if we should we assess group or individual work, result or process.

Therefore, when it comes to developing teamwork skills, curriculum design that incorporates both process and product outcomes are of great importance. It should take into consideration students needs, readiness of teachers to organize group work, time limits, possibilities of incorporating out-of-classroom activities and employers support into the teamwork competence development.

3. Methods and technologies

The main methodological basis of the present research is competency-based approach [3, 4, 5]. Teamwork competence is considered in a complex of other competences formed at the university: both general and specialised ones.

The basic structure includes four team-building components:

- goal setting.
interpersonal relations,
problem solving,
and role clarification

Still, we follow the path of team-formation described in [6] and corresponding to the necessity in student’s self-realization while studying:

- preparatory stage (warming-ups, motivating beginning, etc.);
- formation (stage for beginning the group interaction, choosing the style and the leader;
- discussion;
- creation of friendly environment and attitudes;
- task solution (exercises);
- reflection.

The supplementary methods of this study include: survey, questioning, development of professiograms, timing, ranking, testing, pedagogical experiment, analysis and synthesis of the material obtained. Besides, we carried out surveys of the university teaching staff to find out what kind of a graduate is expected by them. In addition, an analysis was conducted of the requests of the employers - representatives of industrial enterprises of the region [5].

Moreover, at various times, students were interviewed, their research competence was diagnosed, which is also largely related to the ability to work in a team. The possibilities of self-realization of students of a technical specialties were studied, which made it possible to identify and design the most interesting and motivating forms of student extracurricular activities which could ensure the development of their professional competence.

When designing a training program, the possibilities of the differential approach are taken into account — students' individual educational trajectories are designed and implemented in various ways described in detail below.

4. Results

The basis for team-building skills is for sure general and special professional skills. Petrochemical Institute of the Omsk state Technical University is more than 12 years old. All these years Institute has training specialists for petrochemical and oil-and-gas complex enterprises, chemical and oil-and-gas machine fields of Omsk and Ural-Siberian region. The quality of the educational process is ensured by high-qualified teaching stuff, the connection between educational process and research, cooperation with a large amount of partners from all around the country, where the students from Omsk have their professional internships and are employed after the graduation, as well as huge laboratory facilities of the Institute departments.

Comprehensive training of students studying at Petrochemical Institute is provided by a number of subjects among which are those forming professional skills in general, such as Computer Design and Engineering Analysis of technological machines and complexes, and specialized disciplines among which are Refrigeration machines, machines for chemical and oil-and-gas plants; Theory, calculation and design of displacement compressors; Vacuum technologies and systems; Theory, calculation and design of dynamic-range compressors; Heat exchange equipment and others.

The partners of the Institute are the largest regional enterprises: “Gazpromneft – ONPZ” refinery, Omsk Carbon Group, Scientific and Technical Complex “Cryogenic technique”, Group of companies “Titan”, “Danfoss”, Institute of carbon processing problems - Siberian department of Russian Academy of Science, and others. There are some specialized basic departments of this companies in the Institute. The main goal of the specialized departments is ensuring qualitatively new level of specialists training by increasing practical part of educational process based on the involvement high qualified specialists working at these enterprises.

Let us start with such extracurricular aspects of the educational program, as World skills championships and Summer school held by the Petrochemical Institute.
World Skills Russia

The prestige of engineering professions is increasing through the participation of students in professional skill contests of various levels, championships, all-Russian competitions and contests in promising and popular professions and specialties, including the WorldSkills Russia (WSR) Open Championship among youth [13, 14].

Since 2017, OmSTU has actively joined the WorldSkills international movement, which task is to popularize engineering professions and meet international standards for the quality of engineering training. Competitions in the format of the championship allow to identify the best masters among students; there is an opportunity for early vocational guidance and training for specialized professions, forming motivation to work in the real sector of economy.

According to a survey of 15 thousand organizations that was conducted by the Russian Ministry of Labor, “refrigeration specialist” profession is in the TOP-50 in the labor market out of 1600 professions in Russia. Department "Refrigeration and compressor equipment and technology." Was one of the first in OmSTU which held competitions according to the WorldSkills standards. Based on the WorldSkills occupational standards, educational standards are being updated. The relevance of this system is based on the existing requirements to the level of formation of professional competencies made by modern society; skills in performing professional tasks aimed at the development and formation of a competitive learner.

The system of planning and organizing professional skill contests provides for coordination the efforts of the university, participants of the educational process and employers. By preparing students for professional skills contests, it is better to take into account and master both professional competencies of educational standards and labor functions of professional standards.

For a specialist in refrigeration and air conditioning, it is an imperative that he should meet high and growing service standards in order to meet customer requirements, maintain and expand your business. These requirements certainly include the ability to work with colleagues of different levels of subordination, as well as with representatives of customers and controlling organizations. As a rule, the specialist in refrigeration and air conditioning works in residential, commercial and public buildings during and after construction and production, in projects of various types and sizes. Organization of work and self-organization, communication and interpersonal skills, problem solving, flexibility and a set of deep knowledge are universal attributes of a first-class specialist.

Regardless of whether the cooling and air conditioning specialist works alone or as a team, he has a high level of personal responsibility and autonomy. Besides, such skills as concentration, accuracy, attention to details are required. Mistakes in this area often entail significant costs and negative consequences, and poor-quality work significantly worsens the performance characteristics of the building or equipment being serviced. Team interaction helps to more intensive and high-quality mastering of professional skills.

The first university qualifying WorldSkills-format championship was held in October, 2017. Competitions were spectacular and demonstrated the professional skills of the participants: installation of the components of the refrigeration unit, soldering of the freon duct, start-up and commissioning of the refrigeration unit and others. Ten students studying in compressors and refrigeration specialties took part in the competition. In July, 2018, the second university qualifying championship in WorldSkills standards was held. In autumn, 2018, Students from Omsk State technical University got the third place in Russian Ws championship.

The partner of our university in this direction is the international concern “Danfoss”. On the basis of the department “Refrigeration and Compressor Engineering and Technology”, training center “Danfoss OmSTU” was opened. Specialists of the center participate in training programs and conduct specialized seminars in the partner training centers having the necessary material, technical and methodological basis. The professional standard competence of World Skills Russia “Specialist for maintenance and repair of refinery equipment” is also being supported. In this project, “Gazpromneft” refinery is a strategic partner of the university.
The next stage is a demonstration exam for students studying at the considered programs. The demonstration exam will be held to determine students and graduates of the level of knowledge and skills that allow them to conduct professional activities in a particular area and to work in specific professions in accordance with World Skills Russia standards. The inclusion of the demonstration exam format into the state final attestation procedure for university students is a model for independent assessment of the quality of training, facilitating the solution of several tasks of the higher education system and the labor market without additional procedures.

New disciplines have been introduced into the educational process: special training in the working profession and special technology, within the framework of which students are trained for professional skill contests. Due to this, it is better to master the competences of the Federal State Educational Standards of Higher Professional Education and the labor functions of professional standards. About 50 students are trained annually; 144 academic hours are provided for every student.

Summer school
In summer, the Institute organizes Summer school for the first year students. It is a multidiscipline project incorporating such subjects as Compressors and refrigeration machine design, Workflow numerical simulation, Psychology, Education, Foreign language (Academic writing and speaking, terminology), World skills training in equipment service (workshops) and Physical Education.

The school is held in July, in the countryside camp of the Omsk State Technical University. Usually, about 50 students and 10 teachers are engaged into the programme. Most classes are organized in the form of competitions and project work which provides the development of team-building skills in various spheres of education: professional, research and free-time activities. The interdisciplinary character of the summer school is supported by its intensive character.

It is worth mentioning that before and after the school the monitoring is carried out: before the project start, students and teachers are asked about their expectations and possible results they expect to obtain; at the end, there is a self-reflection concerning the results achieved and the skills developed.

Let us now turn to two general-educational subjects which are important in both developing a socialized healthy person and his/her teambuilding skills in particular. These subjects are foreign languages and Physical Education.

Foreign languages (English)
The main competence that is formed and developed in a university foreign language course is a communicative one, according to which a university graduate should be “able to carry out business communication in oral and written forms in the state language of the Russian Federation and in a foreign language” [1]. But, unfortunately, students of most regional technical universities who are interested in the development of language skills and abilities of oral (consecutive and simultaneous) translation and written academic communication face the problem of lack of foreign language practice outside the classroom.

We agree with Malysheva [6] who found out that the following technologies and forms of teaching a foreign language proved to be very efficient in forming teamwork skills: learning in collaboration, discussion, heuristic conversation, project method; role-plays, “business” games, task-based learning. Such tasks can be used to solve simulated professional situations in a team.

As team-building is closely connected with developing communication skills [15, 16], the Petrochemical institute has decided to widen the course of Foreign languages study for the students of the mentioned specialties. Thus, the bachelor students study English during 4 years (while others - only 2) and have additional year of ESP in Master programs. Besides, the institute works in cooperation with the Students Laboratory of International Scientific Communication of the University and provides students with additional comprehensive courses in English. The laboratory engages students in editing translations of scientific articles, teaching scientific communication skills in Russian and English, organizing seminars, conducting research practices and presenting their results in Russian and foreign languages.
One of the best examples of the laboratory activities is attracting students as volunteers and translators into the annual international events and conferences: Oil and Gas Engineering, International Forum of Social Entrepreneurs and Investors INNOSIB with a 9-year history, and some others. While teachers are responsible for business correspondence with foreign participants in the forum and translating documentation, students meet guests at the airport, help them to check into hotels, accompany them during excursions around the OmSTU resource centers, industrial enterprises, and help guests during conferences. Some students try themselves in translating the reports at conferences sections. In addition, students are involved in another type of activity - translation and editing of articles in English for conferences organized on the basis of the university for publication in high-ranking foreign journals.

Besides, to create a barrier-free environment and provide student convenience, distance technologies are actively used: slide lectures on the university portal and an online course on academic writing [17].

**Physical Education**

In physical education and sports, situations are created that make it necessary to act more meaningfully, restrainedly, and expeditiously against the background of emotional arousal in a stressful situation. As a result, the arsenal of applied motor coordination is expanded, and effective adaptation to hazardous production factors and situational models is also ensured. The effect of physical activity extends to the emotional and mental spheres of human life, contributes to the acquisition of vital social skills and abilities, increase self-esteem and the eradication of bad habits.

For example, in order to create clearer positions in understanding the requirements for professional activity and to identify the role of specially organized motor activity (concerning Physical Education) for the effective development of an engineer profession, a survey of specialists and representatives of industrial enterprises - future employers of students studying at petrochemical Institute was conducted. The analysis revealed professionally important qualities and their importance for professional activities. The professiogram allowed to determine the main areas of physical education: maintaining and restoring work capacity, carrying out prevention and correction of occupational hazards and diseases, preserving health, as well as identifying specific measures to increase the level of professional preparedness of students of a technical college [18].

For example, in aerobics, it became necessary to develop such a system of professional-formative physical training of female students, which would be a holistic design of an interconnected and sequential change in the process of training and education, activity and adaptation in order to increase the productivity of professional activity. Besides, a sports competition was included in the experimental aerobics program. The program provides for an independent composition, which should have a finished look, choreography. The choice of music, style of movements, rebuilding pattern is made independently, under the supervision of the teacher. In each semester, students learn a new complex and at the end of the semester its implementation is assessed and “credited”.

5. **Conclusion**

In conclusion, particular examples of innovative training of specialists with the stress on teambuilding development are given in relation to the content of the general program. It is revealed that the current training program for specialists in the field of compressor and refrigeration equipment is effective. The petrochemical Institute follows the interdisciplinary way of training students taking into account both their needs in professional self-realization and employers expectations. Among the most productive competences, relevant for all the “shareholders”, or educational “players”, is a teamwork one.

That is why it is analyzed on the example of some subjects and out-of-classroom events and activities. In particular, the Foreign language course was extended for the students of the mentioned training programs in comparison with other students; within this course, teamwork skills are formed in connection with communicative competences. As for physical education, team skills are formed in
the classroom and through the students participation in various sport competitions. Both subjects are included in the summer school program along with basic professional courses.

The article describes the results of students participation in the program "Young professionals of Russia” WSR, which involves the formation of professional competencies during classroom training, WSR competitions (state level) and the workshops in WSR during the summer project.

In addition, the work experimentally revealed that the competence under study is consistent with both the requirements of employers and the need for self-actualization of students during their studies at the university.

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