

PAPER • OPEN ACCESS

## Features of the formation of interdisciplinary competencies in engineering education

To cite this article: S S Kosmodemyanskaya *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **570** 012063

View the [article online](#) for updates and enhancements.

You may also like

- [Conceptual development of learning factory for industrial engineering education in Indonesia context as an enabler of students' competencies in industry 4.0 era](#)  
Hauw-Sen Tan, Ivander, Rienna Oktarina et al.
- [Human resources competencies of worker in small island and coastal area](#)  
T P T Rampisela and F W Ayal
- [Building capacity for societally engaged climate science by transforming science training](#)  
Mary Ann Rozance, Meade Krosby, Alison M Meadow et al.



**ECS**  
The  
Electrochemical  
Society  
Advancing solid state &  
electrochemical science & technology

**DISCOVER**  
how sustainability  
intersects with  
electrochemistry & solid  
state science research

## Features of the formation of interdisciplinary competencies in engineering education

S S Kosmodemyanskaya<sup>1</sup>, I R Gilmanshin<sup>1,2</sup>, Yu I Azimov<sup>1</sup>

<sup>1</sup>Kazan Federal University, Kazan, Russia, 420008

<sup>2</sup> Kazan National Research Technical University named after A N Tupolev, Kazan, Russia

[Is-er@yandex.ru](mailto:Is-er@yandex.ru)

**Abstract.** The contradiction between the demands of employers and the insufficiently developed methodology for the formation of over-subject competencies of graduates of technical universities has been revealed. On the example of federal universities, the technology of forming “flexible skills” in mechanical engineering, allowing to be successful regardless of the specifics of a person’s professional activity, is considered.

The socio-economic changes occurring in our country impose new problems and problems on the formation of a new generation of specialists and university graduates to solve. According to the implementation of the Federal Target Program for the Development of Russian Education for the period 2016–2020, the issue of qualified and competitive specialists is currently provided.

Analysis of the existing literature and advanced pedagogical experience on the problem of training qualified specialists - university graduates, reveals a leading contradiction between the demands of a modern customer (represented by society and / or employer) and insufficiently developed methods of forming supra-subject competencies of university graduates.

Modern society, as a customer, needs qualified personnel to develop and implement the latest technologies of private and public business. The most frequent problem is the formation of not only professional, but also supra-professional competencies. This is reflected in the effectiveness of the use of the technology "softskills" - from "soft skills", "flexible skills", allowing to be successful regardless of the specifics of human activity. Psychology often considers these skills as social - the ability to persuade, work in a team, find an approach in dealing with different people, personal development, time management, creativity, etc. . The definition of the existing definitions of this concept characterizes it as a certain complex of non-specialized superprofessional skills governing the successful participation of a specialist in any working process [1].

The etymology of synergy indicates cooperation, assistance and complicity (synergos - Greek, jointly acting). The meaning of this term is currently considered from the standpoint of various fields in dictionaries of foreign words, business dictionaries, economic, sociological, medical, philosophical dictionaries, and dictionaries of a practical psychologist. This term is similar in nature to synergetics, which has an interdisciplinary character. Synergetic studies are associated with the study of self-organization processes of rather complex open systems [2]. Analysis of the definition



of a concept indicates that the concept of the combined action of any components is most often used, in which the total effect exceeds the additivity of the actions of these components.

Modernity focuses society on the formation of a new generation of specialists. The report "The Future of Jobs", presented by the World Economic Forum [3] in Davos (2016), defines the results of research based on 35 competencies that, in various proportions, cover the needs of the largest number of professions worldwide by 2020.

Analysts' forecasts are focused on the following most sought-after competencies included in the top 10: solving complex problems; critical thinking; creativity; people management; emotional intelligence; judgment and speed of decision making; customer focus; coordination skills; interaction; negotiation skills; cognitive flexibility.

We note practical unity in the need to form such a competency plan for students, both for future engineers and for future chemistry teachers. Chemistry and engineering, in our understanding, represent a specific synergy for the formation of a single material picture of the world. For the release of competent specialists in engineering and chemical education, you need the ability to own the above top 10 competencies.

Leading universities of the country for quite a long time took the focus on the training of competent specialists in the field of softskills. In the Kazan (Volga region) Federal University [4], it has been not the first year that the professional development program "Personal Efficiency" has been adapted, which is aimed at the formation and development of softskills as personal, communicative and managerial competencies. This program is based on practical trainings of personal growth and training seminars on the development of key interdisciplinary competencies. The effectiveness of the implementation of this program is determined by the outcome of the students learning the six training modules: self-development and career planning, self-organization skills (time management), intercultural communication skills, conflict management, leadership development and information management.

The Southern Federal University [5] represents the softskills laboratory, which (as well as at KFU) proposes to form an individual program (individual development plan) after analyzing the corresponding testing using a specific course matrix. This matrix contributes to the optimal choice of courses in two ways: through the formation of a comprehensive program for the development of specific competence competencies and / or opportunities to work in the field of those courses that contribute to the development of a wide range of competencies relevant to a particular student.

Based on this context of the development of softskills-competencies, higher demands are placed on graduates of universities. We are interested in the data of the ranking of the best universities in the world - QS World University Rankings [6].

This is an annual (since 2004) large-scale study of the best world-class universities, which is conducted by the British consulting company Quacquarelli Symonds (QS). This project, developed by QS in conjunction with the British Times Higher Education, functioned as the World University Rankings. Since 2010, the single rating has been divided into two: Times Higher Education publishes the World University Rankings in partnership with Thomson Reuters, and Quacquarelli Symonds continues to issue a rating called QS (World University Rankings).

Currently, the founder of QS [7] urged universities to teach students softskills. N. Kvakvarelli noted that as one of the indicators of a university's performance, a rating company takes into account the gap between the competences that students received in the learning process and those that the employer needs. Research data indicate a lack of softskills-competencies - teamwork, interaction with other people, solving complex problems [7].

Thus, based on the requirements of the employer, the result of the engineering education of a technical university changes also. A graduate engineer (2010-2016) is responsible for work in production, solving tasks close to the type of worker, and / or in the project office, performing the functions of administrator / manager / designer according to the regulations; carries out strict regulations of activities; knowledge of "English with a dictionary"; responsible for certain technological stages of

production, etc. For the period 2020-2030, there is a gradual transformation of design engineers into the status of management engineers and business engineers. In this case, the skill of working in a network management team will be demanded [8]; solving routine administrative and managerial tasks through automated control systems and, further, using artificial intelligence; management on the full life cycle of technology; compulsory knowledge of two foreign languages (English and Chinese), the third is desirable, etc.

In Russian universities, the discrepancy between the level of competencies of a graduate and the expectations of employers has been noted for quite some time. Therefore, it is necessary to form students' competencies not only through appropriate leadership training, but also within all professional disciplines, creating a practice context in the classroom, imitating some of the conditions that professionals face in real professional activity [9]. Formation of critical thinking activities is defined as a factor in student readiness for the teaching profession. Many researchers pay attention to the leading role in evaluating student practice.

One can consider engineering thinking ([10], [11], [12]) not as a body of knowledge of specific disciplines, but in the aggregate to see the world as a system, design its elements and structural components and manage them.

Above, we have repeatedly expressed the idea that there is a connection between engineering and chemical-pedagogical education. To summarize the results of our study, data for the last 10 years was used ([9], [13], [14], [15], [16], [17]).

In their teaching activities for the training of engineers ([18]) (Engineering Institute K (P) FU) and future chemistry teachers (Chemical Institute im.B.A. Butlerov K (P) FU) we use the experience of implementation in the educational process project team, which allows to gradually form softskills-competencies. This form of training is quite relevant and most effective for the planned immersion of students in their future professional activities as highly qualified future professionals who successfully solve fairly complex tasks in unusual situations. We train specialists who own softskills-competencies, both for state institutions and for private business organizations. Gradual immersion takes place through the gradual formation of professional, over-subject and interdisciplinary competences with the gradual complication of practical experience in educational laboratories and / or when working with students in basic organizations. The activity of such multi-level project groups is organized at the request of customers and is carried out taking into account theoretical and experimental questions of scientific research of coursework, graduation qualified works of specialists, bachelors and undergraduates. The qualitative and quantitative composition of such variable groups is constantly changing, depending on the goal or experimental task. Logical modeling, forecasting and modeling of various processes and situations in standard and non-standard situations allow students to develop creativity, critical thinking and the ability to work in teams of replaceable staff, form cognitive knowledge and multi-variant solution of a variety of problems. Students acquire the skills of posing and solving problems of scientific research. We note the increased participation of students participating in this form of work in conferences, festivals and seminars at various levels - university, city, regional, Volga, All-Russian and international levels. We also note not only the increased inter-institutional integration within the university, but also inter-university cooperation (and also at the international level).

Thus, the work on this form of training allows future engineers and teachers of chemistry to develop and develop softskills-competencies necessary for more successful involvement of young professionals in their professional activities.

### References

- [1] Agapov O D 2007 *Socio-phenomenological understanding of interpretation* Scientific notes of the Kazan State University V 149 Book 5 pp 7–23
- [2] Khoruzhiy S S 2011 *What is SYNERGEIA? Synergy as a universal paradigm: leading subject areas, discursive communication, heuristic resources* Questions of philosophy No12 pp 19–37

- [3] *World Economic Forum in Davos* [Electronic resource] [http://so-l.ru/news/y/2016\\_01\\_20\\_gearmix](http://so-l.ru/news/y/2016_01_20_gearmix)
- [4] *KFU. Competence Development Center Competence Center UNIVERSUM + IMO* [Electronic resource] <https://kpfu.ru/zrk/obrazovatel'naya-programma-39personalnaya-245411.html>
- [5] *Southern Federal University and Center for Career SFU* [Electronic resource] <http://softskills.sfedu.ru/>
- [6] *Analytical portal. ISSN 2310-1792.* [Electronic resource] <https://gtmarket.ru/ratings/qs-world-university-rankings/info>
- [7] *The founder of QS urged universities to train students at softskills* [Electronic resource] <https://www.raspissanie.info/osnovatel-qs-prizval-vuzy-obuchat-stud-soft-skills/>
- [8] *Foresight Competences 2030* [Electronic resource] <http://www.myshared.ru/slide/467083/>
- [9] Khasanova G B 2012 *Requirements of employers to graduates of engineering universities* Bulletin of Kazan Technological University No 20 pp 215-216
- [10] Azimov Yu I, Gilmanshin I R, Gilmanshina S I 2016 *IOP: Conf. Ser. Mater. Sci. Eng.* **134** 12003
- [11] Gilmanshin I R, Ferenets A V, Azimov Yu I, Galeeva A I, Gilmanshina S I 2015 *IOP: Conf. Ser. Mater. Sci. Eng.* **86** 12014-16
- [12] Gilmanshin I R, Kashapov N F, Gilmanshina S I, Galeeva A I 2016 *IOP: Conf. Ser. Mater. Sci. Eng.* **134** 12007
- [13] Patlina A S, Popova E D 2017 *Network interaction of universities and schools as a condition for the formation of students softskills* Pedagogical IMAGE No 2 (35) pp 94-102
- [14] Kosmodemyanskaya S S, Nizamov I D, Yarullin I F 2017 *Information and educational environment in the system of practices of the future teacher of chemistry* QUID-INVESTIGACION/QUID Sp I 1 pp 373-78
- [15] Sakhieva R G, Gilmanshina S I, Gilmanshin I R, Kosmodemyanskaya S S, Akchurina I R, Sagitova RN 2015 *A Portfolio as an Alternative Means of Presenting the University Students Achievements* Asian Social Science Vol 11 No 3 pp 162-67
- [16] Gilmanshina S I, Sagitova R N, Kosmodemyanskaya S S and et. 2015 *Professional Thinking Formation Features of Prospective Natural Science Teachers Relying on the Competence-Based Approach* Review of European Studies Vol 7 No 3 pp 341-49
- [17] Kosmodemyanskaya S S 2016 *Self-Development of the Future Teacher of Chemistry, through Bilingual Education, in Accordance with New Requirements of Professional Standards* The European Proceedings of Social & Behavioural Sciences Vol XII pp 322-29
- [18] Gilmanshin I R, Gilmanshina S I 2017 *IOP: Conf. Ser. Mater. Sci. Eng.* **240** 012022
- [19] Abdullin I Sh, Galyautdinov R T and Kashapov N F 2001 *Inzhenerno-Fizicheskii Zhurnal* **74** (5) 104–107
- [20] Fayrushin I I, Dautov I G and Kashapov N F *International Journal of Environmental Science and Technology* **14** (12) 2555–2560
- [21] Gubaidullin D A, Kashapov N F, Zaripov R G, Tkachenko L A and Shaydullin L R 2017 *J. Phys.: Conf. Ser.* **789** 012017
- [22] Khristoliubova V I, Kashapov N F and Shaekhov M F 2016 *IOP Conf. Ser.: Mater. Sci. Eng.* **134** 012017