

Table 1. Relative level of SEFI competencies at the beginning and end of the course

№	SEFI competences (large groups)	SEFI level	1 group (traditional curriculum)		2 group (improved curriculum)	
			Pre-testing (%)	Post-testing (%)	Pre-testing (%)	Post-testing (%)
1	Real number arithmetic	0	87,36	83,81	88,41	92,16
2	Linear equations	0	96,55	94,29	82,61	94,12
3	Trigonometric functions and their applications	0	57,47	40,95	44,93	54,90
4	Trigonometric identity	0	82,76	80,00	65,22	94,12
5	Functions and reversed to them	0	51,15	51,43	61,59	82,35
6	Sequences and Series	1	43,97	76,43	40,22	86,76
7	Progressions	0	69,83	65,71	68,48	69,12
8	Logarithmic and exponential functions	0	52,59	63,57	70,65	75,00
9	Differentiation	1	75,86	82,86	65,22	94,12
10	Stationary points, maximums and minimums	0	70,11	58,10	60,14	76,47
11	Function study and graphing	1	48,28	94,29	45,65	97,06
The number of tested students			29	35	22	19

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Interdisciplinary-Based Additional Professional Education for Students of Technological University

Kazan National Research Technological University
F.T. Shageeva, V.G. Ivanov

The article describes the project of National Research University. It has been revealed that additional professional education based on the interdisciplinary approach enhances interdisciplinary competence of students, thus, increasing their competitiveness. Such a training requires not only application of universal education technologies, but also search for numerous alternative solutions.

Key words: interdisciplinary research, additional professional education, students of National Research Technological University.

Reflecting the integrated character of the current science and knowledge acquisition, interdisciplinarity or interdisciplinary approach does not only imply a synthesis of knowledge, methods and approaches of various fields of science, but also suggests a certain degree of integration. It is regarded as an innovative methodology that definitely has indisputable value due to its synergetic character.

As a number of researchers stated, "division of contemporary science more likely rests on various scientific problems of disciplinary character than on the disciplines themselves [1, p.13]. Educators and psychologists suggest transfer of knowledge from one field of science to another one as one of the methods to develop way of thinking [1, p.12]. Most of the recent scientific advancements and discoveries have been made at the confluence of two or even more disciplines.

Interdisciplinary connections [2, p.27] are didactic equivalent of interscientific connections. According to the opinion of a number of scholars, the highest level of the interdisciplinary connections is integration stipulated by the objectives of the scientific knowledge and assumptions that reflect the unity of the real world [3,p.162].

The mission of Kazan National Research Technological University is to develop as a Russian Engineering-Training

Center of Chemical Technologies which would provide training, scientific, design and manufacturing services and, thus, contributing to the complex development of the industry in the interests of the region, country and the whole world. The increase in the competitiveness of the University as a training and scientific center due to interdisciplinary professional teams is one of the priorities of the university.

In order to achieve the above-mentioned goal, the project "Additional Professional Education for Students as a Career Perspective (from student bench to the position of supervisor)" has been launched. The project itself is based on the interdisciplinary principles.

In the current context of ever-changing professional activity content when a modern engineer should be able to switch from one activity to another one and perform various professional functions, revision of engineering training system is of particular urgency. In this regard, the issue of additional training becomes especially important [4, c.103-106].

Additional professional training can be offered within various education programmes and completed in several stages in parallel with basic degree programmes. A student can choose additional professional programme according to his/her interests and needs, and



F.T. Shageeva



V.G. Ivanov

it can be additional language programme, programme in general sciences and mathematics, humanitarian programme or specific engineering training. The following programmes are the most popular among students:

- Staff Management.
- Business Management.
- Legal Fundamentals of Business Activity.
- Business Economy and Management.
- Translation in the Field of Professional Communication.
- Psychology of Professional Activity.
- Pedagogy of General and Professional Education.
- Information Systems and Technologies.
- Industrial Product Marketing.
- Design of Forest Products.
- Social Communication.

Additional professional training is based on a number of didactic principles of interdisciplinary character: interconnection between basic and professional education, integration and differentiation, intellectualization of professional training, reflection of professional activity, personality development by means of activity, communication, humanitarization of education, etc. The content of additional professional education for students is based on the basic principles of engineering and socio-humanitarian training being regarded as mutually reinforcing systems.

Making a decision whether to complete such a programme or not, a student is basically governed by internal motives directly relating to education programme and future occupation. This kind of motivation is rather strong and drives students to satisfy their spiritual needs which are often beyond the education programme frame.

The education of the Russian students are characterized by stronger psychological and managerial training. This fact is proved by the analysis of the most valuable skills and competences, which is carried out according to the well-known

methodology [5]. Students were asked to complete the questionnaire in order to identify the following skills and attributes: **goal-orientation, businesslike manner, leadership, self-confidence, conservatism, negativism, flexibility, dependence, conformism, generosity.** To create a personality profile, coordinate plane was used: the x-coordinate axis shows attribute number, the y-coordinate axis illustrates attribute intensity ranked as 1-4 – nominal, 5-8 – potential, 9-12 – perspective, 14-15 – super zone.

The mean values of students' attributes involved in such additional programmes as "Business Management", "Pedagogy of General and Professional Education", "Translation in the Field of Professional Communication", "Legal Fundamentals of Business Activity" are given in Tab. 1.

As shown, goal-orientation and businesslike manner are the strongest attributes. This fact proves students to be leaders. At the same time, if future engineers-managers are very confident and dominant, future engineers-educators are more goal-oriented and kind-hearted. The attributes of students completing the programme "Translation in the Field of Professional Communication" are almost all equally strong with only exception of such attributes as conformism and conservatism. Students who complete engineering programme in parallel with the additional training in Legal Fundamentals demonstrate very strong negativism and low level of conformism. Thus, the attributes of students who complete additional professional programmes reflect the peculiarities of the chosen professional domain and are in accord with so-called "multi" competence.

The survey of teachers' opinions allowed us to draw a "portrait" of a student. In general, students are rather intelligent, versatile, and creative demonstrating high potential for leadership. They are initiative, goal-oriented and are willing to acquire new knowledge and competences. In addition, they are quite independent,

Table 1. Mean Values of Students' Attributes

Student's Attribute	Additional Professional Programme			
	Business Management	Pedagogy of General and Professional Education	Translation in the Field of Professional Communication	Legal Fundamentals of Business Activity
Goal-orientation	9	12	9	10
Businesslike manner	12	8	8	11
Leadership	8	8	6	9
Confidence	10	10	7	7
Conservatism	7	8	4	8
Negativism	2	2	2	5
Flexibility	4	4	4	4
Dependence	3	3	3	3
Conformism	5	6	10	4
Generosity	7	12	8	7

responsible and diligent. They respect teachers and maintain good relationship with them. They are able to work with information, analyze it in terms of social needs, moral and ethical values making difference between facts and opinions. It is these attributes that distinguish them from other students.

The staff selection has been also changed: basically, teachers who deliver additional professional programmes have knowledge both in engineering and humanitarian sciences. Besides, they should possess the following qualities: kindness, loyalty, tactfulness, willingness to help, ability to listen and understand a student, etc.

When pursuing addition professional programme, a student cannot avoid using knowledge and skills acquired as a result of basic programme completion. That is precisely the way how interdisciplinary approach works. Thus, "translators" do not

just acquire information that is unrelated to anything, but gain insight both into engineering and foreign language, theory and practice of translation. As a result, they obtain qualification that is currently in high demand. The same can be said about the programme "Pedagogy of General and Professional Education". The combination of knowledge in engineering, pedagogy, and psychology allows students in future to teach general science within the system of professional education.

Interdisciplinary approach can be successfully implemented by the teachers who possess deep knowledge in various instructional methods, demonstrate commitment to constant improvement in teaching technologies and are actively involved in interdisciplinary research.

The question arises whether it is necessary to apply unusual teaching technologies in additional professional programmes? Trying to find the answer, we

turned to the interdisciplinary approach. We have proved the efficiency of using methodology of strategic planning and management in pedagogical design [6, p. 16-19]. In this case, the design of teaching technology would acquire adaptive character which allows reacting quickly to any changes, both internal and external, maintaining the integrity and efficiency of the designed technology and ensuring compliance with consumers' needs and requirements of the labor market [7,p.137-140].

It includes the following stages: the mission statement and definition of the strategy for educational institution development; formulation of both learning objectives and outcomes; analysis of external conditions; analysis of internal potential of educational institution to implement the designed programmes; development of strategic alternatives; selection and use of teaching strategy; results analysis and assessment; new trends examination and implementation of corrective actions.

The process involves generation of numerous alternative solutions among which a teaching technology will be chosen with regard to internal capacities of the educational institution and certain implementation conditions. Generating alternative strategic solutions is the final purpose of external analysis. Educational potential (internal environment) of the educational institution and educational

climate (external conditions) have a decisive influence on teaching technology. The assessment of educational potential includes analysis of teaching staff competence, level of education services and financial resources spent on teaching process itself. In addition, selection of teaching technology is also dependent on the following: experience in implementing teaching technologies; risk of failure in learning outcomes achievement; university management's policy; time required for teaching technology implementation.

Additional professional education for engineering students is so-called elite education intended for best students. It can be regarded as an element of engineering graduate's professional perspective. Professional competence of an engineer is gradually developed at the university. When pursuing the basic education programme, a student acquires a number of competences which are typical for the chosen professional domain and absolutely required for the professional activity. When completing additional professional programme, students can easily improve the acquired competences which become their core distinguished attributes. In fact, additional professional education which is implemented on the basis of the interdisciplinary approach leads to the interdisciplinary result, i.e. enhanced competitiveness of the graduates of Technological University.

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