

## Career Guidance and Counseling to Develop Engineering Education at School and University: Technologies and Models

Elabuga Institute, Kazan Federal University  
O.V. Shatunova, T.I. Anisimova

The paper deals with psychological and pedagogical aspects of engineering career guidance provided for pupils. It describes the experience of Elabuga Institute, Kazan Federal University, where they efficiently implement career guidance activities and develop engineering education based on interaction between school and university. One of the priorities is to involve pupils into research and technical activities through participating in innovation projects developed by the university.

**Key words:** career guidance, engineering education, engineering professions.

It is becoming more and more essential in Russia that school leavers should choose engineering as a future career. The current engineering education is intended not only to provide the required number of engineers for enterprises, but also to develop a special class of creators aimed at transforming an objective environment by implementing scientific and technical innovations [1].

Here we defined engineering education as a specially organized educational and training process at all levels of general education (including preschool one) and higher education. In this case, forms, methods and content of the educational activity aim at developing trainees' engineering thinking and their wish to become an engineer.

As V.V. Putin says, an engineer is a high-qualified expert who ensures not only maintenance of hi-tech equipment or design modern facilities, but also construct surrounding reality [2]. Thus, the quality of engineering staff is a key factor of the nation's compatibility. The task of engaging the youth in engineering careers is important for Tatarstan as well. Its economy is quite dynamic: new business projects are being developed, the production capacity is growing. The lack of engineering staff may strongly impede the economical development of the republic. This fact

necessitates considering new approaches to career counseling management at schools in order to develop sustainable interest in engineering jobs with regard to real labour market demand.

Career guidance is considered to be one of the most important school pedagogical activities. Career choice can be an important condition of happiness and well-being of a person; so, career guidance and counseling are in focus of research conducted in Russia and other countries [3-8].

The most popular jobs in our society have been a lawyer, an economist, and a manager for a long period. Thus, a lot of school leavers aimed to get a degree in these majors. A traditional career guiding scheme "want-can-must" failed to work, since "must" was omitted because neither students nor their parents were interested in the demand for the jobs on the labour market. No matter how motivating "want" and "can" might be, they did not guarantee proper employment.

The modern postindustrial society requires school leavers not only to know textbook information and solve standard test tasks, but also to develop personal qualities that would condition successful teamwork, self-development, continuous improvement and professional mobility. According

to S.V. Malin and A.Y. Kozevnikov, the postindustrial society is characterized by the fact that a person manages his/her professional career, and the success criterion is a subjective value of personal awareness of success, or "psychological success" [9, p. 147]. There is no doubt that most school children dream of the job that would bring them not only financial satisfaction, but a moral one. They would like to be engaged in the activities they like and succeed in. Very few of them would like to perform physical work, which is quite reasonable in the light of social values of the XXI century. Thus, one of the important current pedagogical goals is to prepare school children for future professional activity of intellectual and creative character. Nowadays, it is intellectual work that makes basic contribution to the prosperity of any developed country.

Intellectual work is defined as a creative activity that requires intellectual energy to treat information and create new knowledge relating to important social value or hi-tech production [10, p. 212]. It follows that only creative people with non-standard thinking can be engaged in intellectual professional activity; they also should be well educated and smart. These features should be developed at schools; and the school career guidance should be of innovative nature.

A school subject "Handicraft" aims at facilitating professional choice of schoolchildren; it allows them to know more about different jobs and make future plans [11]. Besides, these classes make it possible for children to develop creativity and productive skills, and acquire learning and practical experience; these are the skills that constitute the base for the key universal competencies required for any activity.

However, as practice shows, the course of "Handicraft" does not always prepare schoolchildren for conscious choice of future professional career. There are several reasons for it, with one of them being poor teachers' awareness about modern labour market demands.

To identify professional intentions of modern schoolchildren, we made a survey among schoolchildren of the ninth grade at schools in Naberezhnye Chelny, the Republic of Tatarstan. 46 schoolchildren were interviewed, 24 girls and 22 boys, aged 15-16 years old.

When asking "What are the most demanded jobs nowadays?", we received the following answers: an engineer (76% of the interviewed), a doctor (48%), a lawyer (22%), a teacher (22%), car mechanic (20%). The answers show that the schoolchildren in Naberezhnye Chelny assess the labour market demands adequately.

We were also interested in personal career choice of the interviewees. The question "Which jobs appeal to you?" was answered as follows: a psychologist (17%), a manager (15%), and an engineer (13%). A car mechanic, a journalist, a teacher, a policeman, and a lawyer got 9% each.

Although an engineering career is considered to be in demand, it is not chosen by many schoolchildren. They explain it by the fact that this job is too demanding in terms of high intellectual skills, personal responsibility, accuracy and punctuality in task performing.

Our questionnaire contained the following question: "Did 'Handicraft' help you to know your abilities and choose your future professional career?". Only 30% of the schoolchildren gave a positive answer, which proves that unfortunately, teachers of handicraft cannot be called efficient career counselors.

Thus, it should be noted that all the applied methods of career guidance and counseling are not efficient. For example, participation of senior schoolchildren in academic competitions does not always facilitate their career choice. Successful school children have to participate in numerous academic competitions, since teachers choose the most capable and responsible children without taking into consideration their academic workload. As a result, instead of developing the strongest abilities of a pupil, his/her aptitude" is torn into pieces".



O.V. Shatunova



T.I. Anisimova

This statement is proved by the result of the survey conducted among the participants of the regional round of the All-Russia academic competition in "Handicraft", Kazan', 2015. 63 pupils of 10-11 grades, schools of the Republic Tatarstan, were interviewed.

When asking the question "What other academic competitions apart from "handicraft" did you take part?", we received the following answers: biology – 28.6%, geography – 27%, physics and the Russian language – 23.8%, mathematics, history and literature – 12.7% for each subject. The result can be explained either by a wide range of the schoolchildren's interests, or by the fact that their teachers make them participate in academic competitions in various subjects. The question "What competition do you consider to be the most interesting and useful for you?" was answered as follows: handicraft – 81%, physics – 47.6%, mathematics – 33.3%, the Russian language – 27%, biology – 22.2%, geography – 20.6%. These answers proved the fact that the schoolchildren participating in the regional round of handicraft competitions are mostly focused on science. They can also have aptitude for technical subjects.

The teachers of "handicraft", who were present at the competition, state that schoolchildren can really succeed in the subject if they are highly focused on it. The competitions in handicraft differ very much from those in other subjects, since handicraft requires not only intelligence, but also creativity and project skills, which is of vital importance for a modern engineer. It also should be highlighted that almost all the participants do like performing project work in handicraft (98.4%). Thus, to involve schoolchildren in project activity, and to motivate them to develop their intellectual and creative skills via academic competitions are an effective form of career guidance and counseling at school.

Besides, the interviewed teachers consider it useful to apply interactive educational technologies that favour successful career choice. These technologies involve business

and role plays, psychological trainings, group discussions, disputes and debates, case-study, brain-storming, etc. These methods allow the teachers to involve schoolchildren in the activity that develops goal-setting and planning skills; communicative and social competencies.

Pedagogical universities can support career guidance and counseling at schools. For example, Kazan' Federal University (KFU), Elabuga Institute, provides a regular support and development of engineering education in the framework of the model "University – school". It regularly organizes academic competitions, summer and vacation schools, conferences, and educational courses for schoolchildren of 7-11 grades.

Schoolchildren are engaged in research work and engineering activities within the framework of the following projects:

- University for children.
- Summer camp "Intellecto".
- Summer physics and mathematics school.
- Center of educational robotics.
- Vacation school.

There are courses in drawing for 9-11 grades, and preparation courses for United State Exam (USE) in mathematics and physics for 10-11 grades. The university provides preparation for municipal and regional academic competitions in mathematics "Gifted children". The participants of the regional and final rounds of the All-Russia competition in handicrafts are supported and consulted.

Elabuga Institute (KFU) holds on an annual base the following events:

- Trans-regional scientific universiade for schoolchildren, 9-11 grades, (handicraft, IT, physics, mathematics, and biology).
- Open competitions in robotics.
- Trans-regional competition in handicraft "Creative work of schoolchildren".
- Project competition in technical work, 7-11 grades.

- Academic competition in drawing, 7-8 grades.
- Scientific conference in mathematics "Student + School pupil".
- Scientific schoolchildren conference in physics and mathematics "Mathematics and physics in modern information environment".
- Scientific schoolchildren conference in IT "Me and the Internet of the future".
- National scientific schoolchildren conference "Biological sciences: past, present, and future".
- Internet-competition for schoolchildren in IT.

The exhibitions of technical creativity of schoolchildren and students are held every year on the base of engineering-technological faculty.

Thus, career guidance and counseling conducted by Elabuga Institute (KFU),

contributes to the promotion and development of robotics and technical creativity of teenagers, enhance prestige of engineers via technical workshop and scientific conferences for children. There is a mechanism that creates a motivating environment ensuring teenagers' interest in mechanics, mathematics, and science. It also provides motivation for knowledge, research and project activities, technical work and awareness of contemporary technologies. Close integration of formal education (basic education programmes that implement the federal state education standards) and informal one (general and professional programmes of additional education for deeper knowledge and improved skills allows developing more flexible and adaptive technologies of career guidance and counseling.



## REFERENCES

1. Kotova N.V., Osipov P.N. Stimulirovanie professional'nogo samoopredeleniya shkol'nikov k polucheniyu inzhenernogo obrazovaniya [Stimulating engineering career choice of schoolchildren]. *Obrazovanie i pedagogicheskaya nauka v modernizatsii rossiiskogo obshchestva* [Education and pedagogical science in modernization of Russian society]. Moscow: Publ. ITIP RAO, 2012, pp. 330-336. (In Russ.)
2. Putin V.V. Stenogramma zasedaniya Soveta po nauke i obrazovaniyu 23 iyunya 2014 goda [Transcript of the meeting of the Board on science and education, 23 June, 2014]. <http://www.kremlin.ru/events/president/news/45962> (Accessed 11.05.16).
3. Dehaas J. Students like diploma-degree option at Guelph-Humber. *The Maclean's Guide to Universities*. <http://www.macleans.ca/education/university> (Accessed 14.08.2014). (In Engl.)
4. Demoulin E., Murphy J. Representations temporelles et decision dans la relation de conseil en orientation scolaire. *L'orientation scolaire et professionnelle*. 2005, vol. 34, no 4, pp. 479-498. (In Fr.)
5. Hughes K.L., Bailey Th.R., Karp M.M. School-to-work: making a difference in education. *Phi Delta Kappan*. 2002, no 4, pp. 272-279. (in Engl.)
6. Razumova M.V. Proforientatsiya v Rossii: stanovlenie, problemy, perspektivy [Career guidance in Russia: development, challenges, prospects]. *Professional'noe obrazovanie i obshchestvo* [Professional education and society]. 2014, no.3 (11), pp. 49-57. (In Russ., abstr. in Engl.)
7. Tolstoguzov S.N. Opyt proforientatsionnoi raboty za rubezhom [International experience in career guidance]. *Obrazovanie i nauka* [Education and science]. 2015, no., 1(120), pp. 151-165.
8. Faizrakhmanova A.L. Formirovanie proforientatsionno znachimoi kompetentnosti u uchashchikhsya srednikh klassov obshcheobrazovatel'noi shkoly [Development of professional valuable competency at secondary schools]. *Avtoreferat dis. kand. ped. Nauk* [Dissertation theses]: 13.00.01. Ioshkar-Ola: Publ. Mariiskii gosudarstvennyi universitet, 2014, 23 p.
9. Malin S.V., Kozhevnikov A.E. K voprosu o spetsifike proforientatsii v postindustrial'nom obshchestve [Career guidance in postindustrial society]. *Teoriya i praktika obshchestvennogo razvitiya* [Theory and practice of public development]. 2010, no.3, pp. 144-148. (In Rus., abstr. in Engl.)
10. Bardina I.V., Zemlyanukhina S.G. Rynok intellektual'nogo truda v innovatsionnoi ekonomike Rossii [Intellectual labour market in innovative economy of Russia]. *Vestnik Saratovskogo gosudarstvennogo tekhnicheskogo universiteta* [Vestnik of Saratov State Technical University]. 2010, vol.4, no.1, pp. 207-217. (In Russ., abstr. in Engl.)
11. Demeshko L.V. Proforientatsionnaya rabota na urokakh tekhnologii kak sredstvo sotsializatsii uchashchikhsya [Career guidance in "handicraft" classes as a means of social adaptation of children]. *Aktual'nye voprosy razvitiya obrazovatel'noi oblasti «Tekhnologiya»* [Actual issues of subject area "Handicraft" development]. 2013, no.1, pp. 67-71. (In Russ., abstr. in Engl.)

UDC 371.842

## Pre-University Engineering Training for Children

Vyatka State University  
I.V. Vylegzhanina

The paper considers engineering training provided for children in terms of its objectives, content, methods, and ways of implementation.

**Key words:** engineering education, additional education of children, organization of training.

Recently, the interest in children's engineering additional education has significantly increased. To develop children's engineering abilities and bring up engineers and scientists of the new generation, innovative models of children's additional education are widely introduced. Among them: joining of Russia WorldSkills International and organizing centers for skill and competency development SkillsCenter, participating in international competitions World Robot Olympiad and RoboTraffic, arranging children's technology parks "Quantorium", etc. One can conclude that additional education is taking a new turn in developing children's engineering and technical creativity.

The goal of our research is to determine the prerequisites of new stage in children's engineering-technological creative development, as well as to describe the trends in children's general engineering training and training of future engineers as a part of additional education.

The system of extracurricular training and education of various artistic profiles including engineering ones was intensively developed during the Soviet era. A wide network of young technicians' clubs, technical art centers, local clubs, technical unions were organized. In N.N. Yartsev's opinion (dissertation of 2006), the system of children's engineering art has gone through the following stages: 1 stage: (up to 1918) – syncretism; 2 stage: (1918-1939) – development; 3 stage: (1940-1960) – maturity; 4 stage: (1961-1986) – boom; 5 stage (1987-1992) – crisis; 6 stage: (1993 – present) – transformation [1].

From the standpoint of content, the transformation stage of children's additional engineering education is conditioned by intensive development of new technologies. Thus, in January 2016, Klaus Schwab, the Presidents of the World Economic Forum in Davos, made a report about the fourth industrial revolution that had emerged and developed since the middle of the last century. Its peculiarity is a fusion of technologies dissolving the initial boundaries between material, digital, and biological worlds. The first industrial revolution was based on using water and steam power to save labour and develop industry, while the second one used electricity to increase the scale and development of mass production, the third one rested on electronics and information technologies for production automation, while the fourth industrial revolution is aimed at development of cyber-physical systems based on big data technology, Internet of things, virtual and augmented realities, 3D-print, printed electronics. In scholars' and practitioners' opinion, the latter will lead to enormous changes of economy and industry in the near term. The new economy needs staff with not only new engineering but also relevant communicative skills – users and creators. It is due to this fact that engineering education development in Russia is now a strategic objective for Russian economic safety and development of human capital.

Engineering education originates in the childhood when acquiring natural-science and engineering knowledge is of particular significance from the standpoint of children's age and psychological peculiarities. At the



I.V. Vylegzhanina