"Step into the Future" Program as a System of Non-formal Research Education in Russia

Alexander O. Karpov(✉)

Bauman Moscow State Technical University, Moscow, Russia
a.o.karpov@gmail.com

Abstract. The purpose of the study is identification a role of the human factor in the development of the "Step into the Future" program, that has played a decisive role in transformation of the Russian educational system; theoretical development of epistemo-didactic concepts characterizing the educational activities under the program. Educational features that indentify its originality and development are explicated in the pre-history of the "Step into the Future" program founded in 1991. Humanistic missions of the program team are defined and educational strategies of the program are described. The intentions of the fundamental epistemo-didactic concepts of research education cultivated by the program are revealed. The conclusion is made that the human factor plays a decisive role in the development of modern education systems, and not only as an instrument for overcoming conservative traditions, but to a much greater extent as a creating source.

Keywords: Human factor · Non-formal education · Research
Knowledge society · Didactics · Generativity · Learning · Environment

1 Introduction

The present-day society sees the horizon of its existence through the paradigm of knowledge society, where knowledge is able to create things, technologies, global and local structures of life, human relations. But who creates this society? In fact, it is not just knowledge, but people through whom it acts and who, finally, act by means of it. The fundamental basis of this society is a human factor manifested itself through creativity of a special research type.

The knowledge society reality was becoming apparent from the mid-XXth century. A new system of labor division emerged in those days, where a knowledge worker played a key role. In 1957, Drucker talks about the development of an innovation system that includes science, as well as a pluralistic society of organizations and a society which is based on education [1]. In 1999, Bell points to powerful science-driven research universities, strong entrepreneurial culture and venture capital for small business financing as sources of the US technological leadership [2]. Science is increasingly becoming a single source of additional knowledge, and knowledge is positioned as a new axial principle of the society [3].

The knowledge society relies on cognitive abilities of a creative personality [4]. Cognitive-type professions are becoming instruments of material and spiritual growth

S. Nazir et al. (Eds.): AHFE 2018, AISC 785, pp. 249–258, 2019.
https://doi.org/10.1007/978-3-319-93882-0_25

of the society [5]. Education that trains young people with capacities for scientific creativity and innovation activities, i.e. *research education,* is playing the role of a culture-producing basis of the knowledge society [6]. The research education is aimed at complex high-level competencies and starts from school years [7]. Early engagement of promising schoolchildren in research activities at the age of 11–13 years is of key importance [8].

Formal school, olympiads and traditional project activities can't develop scientific-type research behavior, scientific methodicalness of the mind and skills of scientific-research cognition [9]. They can't develop the main thing any scientific research activity starts from - the ability to see the problem, comprehend it and identify the subject of study or development. Conditions, in which olympiads or a school project occur, form a thinking model that is not authentic to research activities in science and engineering. The formal school trains future knowledge workers in conceptual categories of Descartes, Newton and Laplace, whereas the modern scientific thinking operates in the epistemic system of Bohr, Heisenberg and Prigogine [10].

In Russia, the development of a modern schoolchildren's research education model is a result of the "Step into the Future" program - the non-governmental and non-commercial initiative of scientists, teachers and education experts.

2 Objectives, Methodology, and Research Design

Objectives of the study: (1) identification the human factor role in the development of the "Step into the Future" program, which has played a decisive role in transformation of the Russian education system; (2) theoretical development of epistemo-didactic concepts defining educational activities under the program.

The methodology of the study in its first part includes: a review of documentary sources from an archive of the "Step into the Future" program as well as a personal archive of the author, who is the founder of this program; generalization and social-epistemological analysis of the historical material in terms of the human factor. The theoretical part of the work uses methods of an epistemo-didactic analysis and generalization of cognitive situations, a cognitive psychology, a structural-functional analysis of a social action, a philosophical ontology.

The research design determines the structure of this paper. At the first stage, educational features of the "Step into the Future" program prehistory, that determines its image and development, are explicated. Further, conceptual views on the role of the human factor in the development of the "Step into the Future" program are elaborated. At the second stage, the epistemo-didactic principles the program followed in its advancement are identified and analyzed, and they are conceptualized.

3 Results of the Analytical Study of the "Step into the Future" Program History

3.1 Pre-history of the "Step into the Future" Program

Before the beginning of the 1990s, the system of scientific work with young people was underdeveloped in Russian schools. Professional practices of schoolchildren were, as a rule, related to the sphere of blue-collar jobs and included an acquisition of simplest instrumental skills, e.g., for electricians, locksmiths, plumbers, etc. on the basis of vocational training centers. More often than not, engineering modeling was a construction of copies (dummies) of one or another technical device that gave only a net impression about an appearance of the technical object.

The "Step into the Future" program was founded in 1991 at the Bauman Moscow State Technical University (BMSTU). The program adopted traditions of the "Russian Engineering School" established at the University in the second half of the XIX century.

The history of the "Russian Engineering School" was associated with pedagogical innovations in the days of Nicholas I – the Russian Emperor, who recognized the education process organization as the most important state affair. One of specialized schools established that time was the Vocational School at the Moscow Foster Children House. Later on, it was transformed into the Imperial Moscow Technical University (IMTU), now – the Bauman Moscow State Technical University (BMSTU). The Regulations for the Vocational School (1830) set the task of making pupils useful members of the society by training skills for proficient craftsmen who possess theoretical knowledge, know the latest technical innovations, and can spread them.

In 1873, at the World Exhibition in Vienna, the "Russian method of craftsmanship training" cultivated in the IMTU awarded the Grand Gold Medal. Training of engineers by the "Russian method" gained widespread acceptance in other countries. G. Runckle, the President of the Massachusetts Institute of Technology (MIT), wrote that Russia achieved unconditioned success in solution such an important task as technical education and from then on, no other system would be used in the USA. Today, MIT is one of the best research universities in the world. The BMSTU gave many creators to the world, among them were designers of a helicopter, a diesel locomotive, a wind tunnel and a passenger jet, an automatic machine line, and a TV tube. Mankind stepped into space from inside the Bauman University.

3.2 Human Mission of the "Step into the Future" Program

In the early nineties of the last century, Russian society experienced radical sociopolitical transformations. The education system was subjected to economic repressions in conditions of total disinterest of political groups struggling for power.

In 1991, at the peak of social and economic reforms, when most residents of the country were interested only in problems of survival and subsistence, a small group of enthusiasts reflected on the role "the children of reform" would play in the forthcoming movement of Russian society toward human well-being and right forms of social life.

So the idea of the program and its name "Step into the future" were born, where an appeal not only to young generations, but to the total society could be heard.

On the vast geographical area, where more than 180 ethnic groups live, the "learning through science" educational concept was implemented that created effective social lifts for children from poor segments of population and godforsaken places. Against the backdrop of the economic downturn, voices of team members, their arguments and humanistic appeals were heard both in the country and abroad. They were able to concentrate material and financial resources and arrange new education activity in such a way that only talent and personal success became a condition for new prospects, regardless of social belonging.

Those children, whose destiny was predetermined earlier by a low social and cultural status of their families, at last have chances for education in best Russian universities; they receive scientific tutors and support from the "Step into the Future" program. The "iron curtain" that surrounded Russia falls for these children only now. For them, there are real opportunities for direct communications with their young colleagues from abroad. International scientific and educational events the program team organizes in Russia create these opportunities. Thanks to foreign partners of the program, today the best learners are able to attend scientific conferences and exhibitions in other countries, take part in scientific training at research centers. Thus, a new open youth community is formed in Russia, where children from different socio-cultural strata united by common "research" lifework become its members.

The program team gives the top priority to training young researchers from schoolchildren who are focused on creation the new in engineering, natural-scientific and social-humanitarian knowledge. Only in a decade, Russian politicians began to talk about the knowledge society and innovative economy from a practical point of view. But by this time the "Step into the Future" program has already brought up a highly professional cohort of a new generation for our country – the innovation-minded young people. For comparison: only 72 schoolchildren came to the first polytechnic colloquium, today more than 150,000 schoolchildren and students take part in the "Step into the Future" program every year.

The program team completed the most difficult task as pioneers in the new education activity in view of enormous geographic sizes of Russia and its cultural diversity. The team members organized research training for schoolchildren and trained their followers in taiga jungles of the Far East, in mountain villages of the Elbrus region, in subtropics of the Black Sea region, in polar deserts of the Russian North. Schoolchildren and teachers gained practical experience in improvement of their life and life of surrounding persons with the help of science. Often, research training took place in multicultural groups with participants from different ethnic groups. In this way science instilled tolerance in children and taught how success could be achieved together.

Vast areas in Russia, where there were no universities and research centers, became frequently visited by scientists and professors to bring up worthy successors of their work. Schoolchildren were not only keen on scientific solutions of problems, they began to travel to their young colleagues and tutors. A special motivation was required for this purpose, considering that sizes of Russia from west to east were a quarter of the Equator length. Thus, the "Step into the Future" program promoted widening of ties that consolidated the country, while politicians sought to separate it.

For children from "Russian humble beginnings" (Russian poor families) – and they were the majority of the country's population – a new social lift appeared that gave a way for talents to intellectually privileged spheres of life: engineering, science, medicine, and art. Indeed, and in art too, because the program team was an initiator of the first National Festival of Young Couturiers and Designers in Russia, which has been patronizing since then the most authoritative higher education institution in this area - the Moscow Textile University.

It is surprisingly but the fact that the activity based on exclusively altruistic and ideologically not engaged principles, in conditions of economic distress, complete indifference from the party of financial tycoons and a political group that took power, had such a significant social effect that subsequently became a model for many state and public initiatives.

3.3 Educational Strategies of the "Step into the Future" Program

The "Step into the Future" program team developed and implemented an effective territorially-distributed system of research education for schoolchildren. Its main link is a scientific-educational partnership organized in the form of a coordination center. This partnership unites schools, universities, scientific institutes, high-tech enterprises, cultural organizations, and innovative development centers. The area of its geographical responsibility can be a small settlement or a big city, a small rural district or a region larger than the Europe. The initiative to create the first coordination center was announced in 1994 in Usolye-Sibirskoe, the small taiga town. By 2000, this center united enthusiasts across Siberia; the Siberian Branch of the Russian Academy of Sciences is cooperating with this center; it holds the main scientific youth forums of this huge region.

By 2005, the research type educational network created by the program covered the total territory of the country – from the Pacific coast in the east to Karelia in the west, from Murmansk in the north to Dagestan in the south. Research and development activities were organized in the form of youth scientific laboratories, design bureaus, forest ranger stations, agro-sites, startups and innovative enterprises.

Scientific-educational partnerships have become a place for diagnosing creative abilities and psychological support for young researchers. They gave opportunities for talented schoolchildren and students to carry out their works on the basis of research laboratories at universities and scientific institutes, in engineering centers and workshops of high-tech companies [11]. Thereby, problems of accessibility of an expensive scientific-technical base, advanced scientific methods, and assistance from highly professional tutors were solved. With the program support, young researchers began to apply for patents and open scientific businesses.

In 1995, the program established the Russian Youth Polytechnic Society. In 1997, it organized and successfully held the "Youth-Science-Business" innovation contest for the first time in Russia. In 1998, it developed a national network of youth scientific and engineering exhibitions. First exhibitions were held in Moscow, Lipetsk, Murmansk, Nalchik, Chelyabinsk, Usolye-Sibirskoe.

In 2010, the program launched the first large-scale project of research training in Russia for the *most promising and exceptional talented* schoolchildren. The project was

called "Scientific staff for the Future". At the territory of the country covering all nine time zones, young people at the age of 11–15 years were screened throughout the year. Robotics, ground and space transports, intellectual systems, biomedical engineering, nanotechnologies, and energy systems of the future were chosen as research training areas. Upon completion of training, participants of the "Scientific staff for the Future" project continue their research activity as members of professional teams of scientists and designers of new technologies.

In 2011, the "Innovative Future of Russia" project was launched. The project was aimed at developing skills of scientific entrepreneurship for schoolchildren and students of introductory courses having inventions in the field of science and technology. The project received support from the Ministry of Economic Development of Russia. In 2015–2016, the methodology of scientific training for talented children from needy families, children with disabilities, and children in extreme circumstances was developed and tested.

Today, the "Step into the Future" program is a joint work for many people and various organizations. It is an authoritative nationwide movement that unites scientists, teachers, lecturers, specialists and forward-looking politicians in matters of education of innovation-minded young people focused on creation of scientific innovations, advanced engineering, and high technologies. The program acts as an inter- and transdisciplinary research site, where a huge fund of knowledge, talent and energy is concentrated and which is a strategic resource of the Russian society in its movement towards human well-being and right forms of social life.

4 Results of Theoretical Conceptualization of Educational Activities Under the "Step into the Future" Program

4.1 Basic Conceptual Statements

The analysis of the more than 25-year educational activity under the "Step into the Future" program made it possible to formulate the following conceptual statements.

In modern society, research education acquires its methods, environment and forms of institutionalization, becoming a *special* part of the educational system responsible for upbringing a group of technological progress. It requests scientific-cognitive continuity between secondary and higher schools. For secondary education, this means that it becomes *non-general and non-universal*. For research universities and innovative science, this shows their growing dependence on cognitive ability of a schoolchild to master complex systems of *modern* scientific knowledge [12].

Research education becomes an instrument of research-type socialization, that makes young people ready for life in the knowledge society [13]. This new type of socialization, first described by me, achieves a global cultural importance. Research education gives a dynamic competence to a growing personality that enables to foresee a direction of changes in the content and configurations of professional knowledge, predict in-depth cognitive transformations of the paradigmatic type [14]. A new type of ascending mobility or cognitive mobility as I call it is being formed by means of research education. It performs the function of social distribution of learners according

to their cognitive vocation in the epistemic structure of the knowledge society, i.e. it provides an ascending movement towards the professional cognitive-type environment depending on abilities of thinking and mental structure of a personality [15].

4.2 Generative Training, Environment, and Generative Didactics

The fundamental epistemo-didactic characteristic of research education is its *generativity*, which I define as an active source creatively stimulating to cognition, creation of new knowledge and its social-economic application. The generativity property extends to both education and learning environment.

Generative training is aimed at developing capacities for discovery new knowledge and methods of its transformation [16]. It involves not only processes leading to scientific creativity, but also formation of a special value system, peculiar to epistemic communities (e.g., in respect to search for the truth, partnership, and competition), scientific-type research behavior [17], scientific cognitive trajectories of personality development (problem-cognitive programs) [18]. The generative training, cultivated by the "Step into the Future" program, is based on method of scientific researches [19].

The generative nature of education manifests itself in the approach to on-going appraisal of a learner. Conventional appraisal based on a correlation between learner's outcomes and established standards can't be a measure, to a large extent, for products the learner created independently. In generative (not just summing up) estimations, a special focus is made on *what* the learner can make with the acquired knowledge, and not how well acquired knowledge match with the boundary set by others [20]. It is worth noting that competencies answer the question "*how* does a learner operate with knowledge?"

The generative learning environment is a combination of cognitively active forms of cognition organization and a special cognitive operationalism they contribute to learning practices. The generative learning environment contains uncertainties that stimulate imagination. They are contained in those problems that are solved or can be set in it. The problematic situations it offers give a material for a choice of a cognition object and its comprehension. Thereby, they structure cognitive activity. Collectives of people engaged in professional work with knowledge demonstrate patterns of search activity. Along with the fact that this environment "leads" into researches and developments, it contains authoritative truths and rigid epistemic models to be overcome in the process of searching for new knowledge. In this way the generative environment teaches to strive for scientific truth.

The research training theory developed by me is called *generative didactics*. It proceeds from foundations of the education structure in the knowledge society and analyses the method, environment, knowledge, and cognition from the viewpoint of education and upbringing a personality capable for creation and materialization of knowledge, i.e. for transformation of knowledge into technical and social objects and technologies.

4.3 Method of Scientific Research

The method of scientific research was conceptually developed by me as an instrumental core of the research training system under the "Step into the Future" program. From the mid-nineties, the method of scientific research in various forms is used in Russian secondary and higher educational institutions cooperating with the program.

The method of scientific research is a cognitive tool of research training that didactically uses the methods of scientific search with the aim of personality becoming through the study of oneself, the world around and oneself in the world. The essence of the method of scientific research is social and existential training in formation a person engaged into the scientific-cognitive attitude to the world. The method of scientific research solves the following key tasks: *pedagogical task* – upbringing a researcher; *epistemic task* - formation of a scientific-research complex of knowledge and competences; *ontological task* – development a special attitude to the truth that determines the scientific-type research behavior.

The method of scientific research builds up learning as a *continuous* research "project" forming a knowledge complex of personality in the spirit of research that creates a problem-cognitive program for an individual. The method is not so much used for verification of class-lesson knowledge and their social "revival" as it is aimed at mastering the scientific methodology. This "methodological" training is focused, first of all, on present-day and future professional interests of an individual. It is from this perspective the methods of knowledge acquisition are mastered, and general and special competencies are generated.

4.4 Innovative Environment and Creative Space

In general, the generative learning environment is defined by me as an educational system that stimulates and shapes the creative function of thinking, and possesses required socially active cognitive components. This very general theoretical construct sets a framework description.

Analysis of the generative environment as a structurally intricate epistemic *surrounding* leads to cognitively constructional concepts. Thus, the "learning and scientific innovative environment" model developed by me for Russian schools and universities can be interpreted as an epistemic mega-kit containing such components as research groups, business incubators, small innovative enterprises, scientific societies of learners, technological consortia, generalized knowledge funds, etc., distributed and classified at a structural-functional level and a meta-level [21].

By making an emphasis on the ability of the generative environment to be a creativity initiator, i.e. making accent on the cognitive-operational function, I arrived at theoretical vision of this environment as a creative space and defined it as follows.

The creative space is a cognitive-generative system stimulating creativity and development processes of the creative thinking function via a link of cognitive activity with an epistemically active (generative) environment. This definition assumes that creative spaces should be socially-saturated and creatively stimulating for cognition; they should actively operate as a factor in creation of scientific and technological innovations, as well as take an active part in processes of their practical application

promotion; i.e. be generative in their structure and functions. They should function as a single epistemo-didactic complex, whereby the education becomes a direct actor of a social action aimed at the knowledge society development [22].

5 Conclusions

The human factor plays a decisive role in the development of modern education systems, and not only as an instrument for overcoming conservative traditions, but, to a much greater extent, as a creativity initiator. The public initiative has advantages over formal directives and, above all, in attitude toward matters, which is expressed in unconditional pursuing the truth both in creation of new organizational forms of education and in pedagogical practices. As a result of searching for the truth, theoretical developments describing non-formal social activity give an option to take a look into the future of education, and thereby create beacons for its authentic transformations.

The "Step into the Future" program provides an example of this social and theoretical effectiveness. At the World Innovation Education Summit (WISE, Doha, 2011), the "Step into the Future" program was recognized by the international community as one of two primary innovation projects in Russia. As a result of independent monitoring, only two Russian projects were invited to the summit – the "Step into the Future" program and the Skolkovo center. In such a way the initiative public project ranks alongside with the financial empire with the amount of investments making a sizable part in the country's budget.

References

1. Drucker, P.F.: Landmarks of Tomorrow. A Report on the New « Post-Modern » World. p. xi, 114, 129. Harper, N.Y. (1996)
2. Bell, D.: The Axial Age of Technology Foreword: 1999. In: Bell, D. (ed.) The Coming of Post-Industrial Society: A Venture of Social Forecasting. p. xl, xliii. Basic Books, N.Y. (2008)
3. Stehr, N.: Knowledge Societies. p. 103, 92. SAGE, London (1994)
4. Etzkowitz, H.: The Triple Helix: University – Industry – Government. Innovation in Action. Routledge, N.Y. and London. p. 35 (2008)
5. Peters, A., Besley, T.: Introduction: The Creative University. The Creative University, p. 1. Sense Publishers, Rotterdam (2013)
6. Karpov, A.O.: The ancient episteme of activity as ontological horizon of modern education development. Procedia – Soc. Behav. Sci. **214**, 453 (2015)
7. Simons, M.: «Education through research» at European universities: notes on the orientation of academic re-search. J. Philos. Educ. **40**(1), 36 (2006). Oxford: Blackwell Publishing
8. Karpov, A.O.: Early engagement of schoolchildren in research activities: the human factor. In: Advances in Human Factors in Training, Education, and Learning Sciences. Series: Advances in Intelligent Systems and Computing, vol. 596, p. 86. Springer International Publishing AG, Basel (2018)
9. Karpov, A.O.: Formation of the modern concept of research education: from new age to a knowledge society. Procedia – Soc. Behav. Sci. **214**, 443–445 (2015). Amsterdam: Elsevier

10. Doll, W.E.: A Post-modern Perspective on Curriculum, p. 158. Teacher College Press, Columbia University, London (1993)
11. Karpov, A.O.: Integrated and network systems of research education in the knowledge society (by example of the Russian educational system). Mediterr. J. Soc. Sci. **6**(6), 531–532 (2015). Rome: MCSER Publishing
12. Karpov, A.O.: University 3.0 as a corporate entity of knowledge economy: models and missions. Int. J. Econ. Finan. **6**(S8), 357 (2016). Mersin: EconJournals
13. Karpov, A.O.: Socialization for the knowledge society. Int. J. Environ. Sci. Educ. **11**(10), 3490–3492 (2016). Den Haag: Look Academic Publishers
14. Karpov, A.O.: Education in the knowledge society: genesis of concept and reality. Int. J. Environ. Sci. Educ. **11**(17), 9955 (2016). Den Haag: Look academic publishers
15. Карпов, А.О.: Когнитивная мобильность // Народное образование. М.: ИД « Народное образование », № 2, С. 37–45 (2008)
16. Karpov, A.O.: Generative Learning in Research Education for the Knowledge Society. IEJME - Math. Educ. **11**(6), 1627–1629 (2016). Den Haag: Look academic publishers
17. Karpov, A.O.: Early Engagement of Schoolchildren in Research Activities: The Human Factor, pp. 90–91
18. Karpov, A.O.: Problem-cognitive program: a model of socio-cognitive self-making of learners-researchers in cultural reality of knowledge society. In: The European Proceedings of Social & Behavioral Sciences (EpSBS), vol. XXVII, p. 337. Future Academy, Nicosia (2017)
19. Карпов, А.О.: Метод научных исследований vs метод проектов // Педагогика. М. № 7, С. 14–25 (2012)
20. Doll, W.E.: A Post-modern Perspective on Curriculum. p. 172, 175, 127
21. Karpov, A.O.: Education for knowledge society: learning-scientific innovation environment. J. Soc. Stud. Educ. Res. **8**(3), 201–214 (2017)
22. Karpov, A.O.: University 3.0 as a corporate entity of knowledge economy: models and missions. pp. 356–359