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Research Laboratory in Russian Education System: Experience and Prospects

Gennady Sergeyevich Aikashev,
Magamed Nasib Ogly Samedov and Viktor Mikhailovich Shibanov

Elabuga Institute of Kazan Federal University, 89 Kazanskaya st., Elabuga 423600,
Republic of Tatarstan, Russia

Abstract: The article describes the main types and nature of the research laboratories and particularities of scientific management in Russian educational institutions, training students of high schools and universities in research; it highlights the main types, organizational forms and bases of their operation and shows the main directions of improving the quality of research that involves high school and university students. The effectiveness of the laboratories (its innovative component), in the authors' opinion, must enhance, on the one hand, the development of theoretical and methodological foundations of research organization. On the other hand, there is a need to raise the overall level of research culture (cognitive, methodological and special practical training) of all participants: from managers, young and experienced scientists to schoolchildren, students and graduate students. Moreover, it is necessary to develop special programs (and introduce relevant sections into the available ones) to engage talented children and young people in research and implementation of socially significant projects.

Key words: Research laboratory and experimental research work · A young researcher, research student · Teacher and researcher · Bachelor · Master · PhD student and scholar · teacher training · Diagnostic and technological equipment: "L-micro" · "Archimedes" · Research programs and development programs of Elabuga Institute of Kazan Federal University · "Intel Summer" · "Children's University" · "Laboratory for Gifted Children" · Work with children in the associations "Young Physicist" · "Radio Electronics".

INTRODUCTION

Research laboratories (research groups, clubs and associations) and research centers are established in schools and higher schools of the Russian Federation to enhance the students' cognitive, developmental, research, scientific and creative abilities.

As a rule, school research laboratory includes teachers-subject specialists, additional education teachers, school psychologists, social pedagogues, class teachers, representatives of school administration and even university teachers.

In higher education establishments among the research team members one can find senior high school students and university students of different groups and departments, young scientists and graduate students, teachers, preschool teachers, after-school and secondary educational institution teachers, representatives of various forms of ownership, small, medium-sized businesses, banking sector and large enterprises.

As the analysis of foreign authors' scientific publications shows, the topical problem can be considered one of the most important ones in the field of XXI century education, as well as assessment of the scientific validity of youth research laboratory effectiveness [1].

Taking into consideration the fact that the scientific interest in this problem will continue to grow in our country as well, we systematically raise this issue in the teaching and methodical manuals, including those for the students of Elabuga Institute of Kazan Federal University (EI KFU), research publications, which offer rationale for the necessity to work with different categories of students in their spare time. Work of this kind can be carried out at

Corresponding Author: Aikashev, Elabuga Institute of Kazan Federal University, 89 Kazanskaya st., Elabuga 423600, Republic of Tatarstan, Russia.

any educational or health institution, including summer camps, provided with programs for children's and young people's creative development and enhancing their interest in the subject and research work [2].

Main: Retrospective analysis of the research laboratories in educational institutions of the Russian Federation shows that they can be divided into the following types.

The first type is mostly a scientific leader's personal office. The activities of such a research laboratory are usually hidden from curious and prying eyes, but the results of its work and academic achievement are important. Besides, this type includes creative innovators', inventors', artists', composers' and other bright and talented individuals' workshops. All these varieties can be called classical or academic types of the research laboratory.

The second type is an open research laboratory. Most often, it represents an office-studio in the humanities, social and applied sciences, natural sciences, physics and mathematics and other work areas of the educational establishment. A teaching creative laboratory can be considered a variation of this type, being organized on the initiative of the teacher-researcher, or a teacher of additional education program in a school classroom or at a university department, children's (youth's) association, the activities of which do not contradict the legal framework of the Russian Federation.

The third type is a laboratory of the dynamic type. In school it includes a room for activities with children, teenagers and young people in their leisure time. It presupposes that the students regularly work in the library, are engaged in sports and go to the gym, swimming pool, participate in various sporting events, outdoor activities and some indoor sports and tourism, which serve as a basis for research.

The fourth type is a multifunction laboratory. It includes school and university museums, specialized classrooms, technical laboratories in schools, universities and institutions of further education, psychological relief rooms, social development and diagnostics offices.

As history shows, genuine scientific glory is achieved by the leaders of a new type of thinking and way of life-humanists, democrats and teachers-researchers. Their activity is organized on the basis of research laboratories of the second and the following types and all the creative work with young researchers is aimed at encouraging individuality, introducing innovations, diagnostic techniques, pedagogical and psychological testing [3].

Our studies show that an open research laboratory (the second type) is often a technical classroom or a psychosocial room. These may include, for example, a laboratory in physics, chemistry, biology, astronomy, archeology and other subjects. A special place among them can be occupied by a laboratory in history, social science, economics and law, physics and information technology, as well as by interdisciplinary research laboratories (of intellectual or technical talent) that explore aspects of life processes of different age groups, especially those of children and youth.

A very specific role is played by the laboratories in pedagogy, psychology, social pedagogy, sociology, philosophy that deal with problem children and intellectually gifted children and study the organization of a healthy lifestyle for various categories of the population.

Best practice shows that the majority of psycho-pedagogical laboratories are either regular classrooms or specialized diagnostic centers: sensory rooms, psychological relief offices, vocation counseling, or professional retraining offices.

Laboratories of this type can include offices either equipped with the latest technology, or "retro-labs", where one can see instruments, equipment of different brands and manufacture year, both of domestic and foreign production, on the desktops.

A scientist's close look will not disregard the fact that the technical office of the research laboratory in educational institutions of the Russian Federation is not even one room, but a few of their species. One can find the following among them: a classroom or a study in information technology, a workshop for repairing and manufacturing of training equipment, a laboratory in the open terrain (a geographical area, a weather station, a planetarium, a botanical garden, clinics and hospitals), museums and many others. Scientific laboratories equipped with modern technique include classrooms for biology, chemistry, electrical engineering, robotics, computer science, offices for psychological diagnostics and pedagogical correction.

There are scientific and technical laboratories, service centers, specialized high schools and colleges in large educational establishments, which prepare a new generation of researchers, providing opportunities for different students to take various kinds of field study and practices.

Currently, the number of technical offices and specialized research laboratories is growing steadily in all types of educational institutions of the Russian

Federation. Enormous funds, of which national scientists and educators have only dreamt until recently are spent on the laboratory equipment and specialist training.

For example, the currently manufactured standard equipment of the brand "L-micro ®" represents a single experimental environment of the educational institution or individual laboratory that combines demonstration equipment, sets of physical sensors for organizing research, laboratory activities and practical work. The core of this equipment is a personal computer with a measuring unit and various sensors of physical quantities and software, which allows the teacher and the students themselves to assemble a demonstration plant during the class in the research association [4].

Among the teachers of chemistry, biology and ecology as an elective course, "Archimedes" has become a widespread laboratory in Russian schools since 2004. Its constituent digital educational resources and laboratory facilities allow the teacher to move smoothly from reproductive forms of educational activities to independent, search and research types of work, to develop students' information and communication culture and improve skills in teaching and research [5] as well as substantially enrich educational activities in secondary schools [6].

The higher education system in recent years has also significantly enriched its scientific technical equipment of classrooms and research laboratories [7].

For example, the training equipment "3-Lab" is an automated, programmable device that can be used to perform experiments, organize students', graduates' or scientific community representatives' experimental and research work [8].

MATERIALS AND METHODS

The analysis of the research laboratories' activities shows that their effectiveness is determined by the staff competence and skills, the nature of relationships within the team members and the management style. Especially important is the university administration support of technical, material and financial provision of the research and every researcher's interest stimulation.

So, while organizing a scientific research related to the development of students' technical creativity it is necessary to pay special attention to such areas of work as organization of all pedagogical process participants' scientific and theoretical training that would include methodological, regulatory, didactic and practical activities. It is also of major importance to intensify the research participants' psychological and pedagogical training to develop their creative abilities (e.g., organizational, communication, social), which would enable them to organize team experiments or their own individual ones.

Moreover, highlighting the specific development of students' scientific knowledge research abilities while organizing research in various fields of science, it is necessary to expand significantly the opportunities of the research laboratory in such areas as planning the researchers' activities and design that would ensure understanding the connection between science, technology and social development processes.

In educational institutions such work can be carried out in subject classrooms, museums and educational workshops. To do this one needs to create research laboratories like "Young Historian", "Young Polyglot", "Young Physicist and Information Technology", "Young Mathematician, Chemist and Biologist", "Radio Electronics and Computer Modeling".

In supplementary education institutions and leisure facilities this work can be organized in clubs and interest groups, in children and youth associations under the guidance of an experienced scientist, such laboratories as "School Leader and Leader's Skills" or "Robotics" can work.

In higher education institutions opportunities for pupils and students are significantly expanded. There may be research laboratories both of the traditional type and experimental centers, such as, for example, "Intel Summer", "Children's University", "Work with Gifted Children"-projects that are implemented in Elabuga Institute of Kazan Federal University [9].

A philosophical rationale for the organization of classes during the school holidays and leisure time and the need to include every child, student, teacher-researcher in the development of science, country and the international community may be a link to all this work.

Taking into account the fact that a number of problems of psycho-pedagogical nature of research in various fields of knowledge in different years of the late XIX-early XXI centuries received an adequate coverage in the works of Russian and foreign scientists, such as V.M. Bekhterev, L.S. Vygotsky, V.I. Andreyev, V.I. Zvonnikov, F. Galton, A. Binet, A. Maslow, K. Rogers and others, it is necessary to provide opportunities for the research laboratory staff and research participants to become familiar with their basic concepts and scientific works.

For example, A. Maslow, to understand the inner mechanisms of human mental qualities put forward the idea "of the essence of the theory of satisfaction" as a hypothesis, which includes such components as "position, interests, tastes and values; boredom and interest; happiness, joy, contentment, delight and ecstasy; social consequences". Besides, he distinguishes "level of frustration; random, aimless behavior and behavior with the aim of entertainment" [10. PP. 90-92].

It should be mentioned that novice researchers can test this hypothesis, not only in theory but also in practice. Thus it is known that the organizers' research and special methodological training to guide students' technical creativity (in such youth research laboratories as "Young Physicist", "Young Astronomer", "Young Journalist and Broadcaster", "Radio Electronics" or "Computer Simulation") consists of theoretical and practical training when studying physics and mathematics and general technical cycle disciplines.

On the other hand, pupils' or students' psychological and pedagogical preparation to organize classes in research creativity in the laboratory, presupposes that all participants in the pedagogical process have specific knowledge about research organization and knowledge of teaching and educational problems that can be solved in the classroom or during their own laboratory research. This training includes knowledge about the methodology and technology of organization, carrying out various kinds of creative activities, methods of the research participants' motivation, the ability to apply this knowledge in practice, as well as the formation of competence in economic issues and their solutions [11].

CONCLUSION

Among the activities of research laboratories created in Russian educational establishments, forming young researchers' positive motivation should be a priority and personal need of every creative person: a teacher, specializing in a certain subject, a university teacher, a scientist and head of the educational institution.

Such motivation includes the development of constructive, organizational, technological and research skills, which can be regarded as a system of personal creative traits, aimed to solve design, educational and social problems, to develop mental abilities and all other skills are treated as operating (executive) ones aimed at fulfilling practical activities by young researchers and their mentors. Work aimed to form the future researcher's productive activity included in the cycle of scientific knowledge can be arranged within the framework of the research laboratory direction areas.

Consequently, it is necessary to intensify the ideological and philosophical training of the members of research groups and their scientific advisers in a particular scientific discipline, such as physics and its related areas of research, which is carried out not only on a theoretical, but on an experimental, practical level. It is necessary to form technical skills on the same basis, which is an integral part of training aimed at the formation of a person's scientific, technical, creative and constructive thinking. It is also important to form the ability to solve design and research tasks to develop creative thinking of all the participants of the pedagogical process.

The need to form all these abilities, knowledge and skills ensues from the Federal State Education Standard for high school students and, consequently, teachers and researchers in physics, chemistry, biology and other subjects in all types of educational institutions of the country, for whom their main functions (informative, research, social and etc.) are thereby highlighted [12].

Moreover, these functions, in our opinion, remain the main psychological and pedagogical functions in research, teaching and organizing students' field work and practices as well as activities of school self-government bodies and public associations.

It is natural that for their implementation specific tasks should be set to form the person's specific knowledge, skills and creativity. Taking into account the new requirements of the Federal State Education Standard and the New Education Law in the Russian Federation their implementation should be not only of the personal, subject-oriented, but also of research-oriented nature [13].

For example, the information function of the physics teacher as leader in students' physical and technical creativity in a research laboratory envisages that all the participants of the pedagogical process should master theoretical knowledge about the structure of various instruments, tools, software, materials and the teacher possesses the skills to impart his knowledge to the students using appropriate training and education methods and techniques (interviews, observation, experimentation, experiment, etc.). This function provides for the development of forming skills, which can be correlated with psychological foundations of any teaching and research activities.

Output: While conducting classes in research laboratories to the students participating in the projects "Intel Summer", "Children's University" and "Work with Gifted

Children" we found out that the leader's activity is of certain specificity that is to be reflected in the structure of knowledge, skills and implementation ways of the creative abilities of each of the pedagogical process members. Along with the structural, organizational, gnostic and communicative skills, a modern researcher, for example, a physics teacher must possess the performing (operating) skills and abilities, as the pupils' and students' activities in the scientific association are linked to the creation of material objects.

Thus, regardless of the type of the research laboratory, the innovative training of organizers of children's and young people's research in the humanities, natural sciences as well as other activities contains a multitude of components of theoretical, organizational, structural, psychological and educational activities. It includes knowledge of the theoretical foundations of school and university subjects and related disciplines, the specifics of work with various categories of people (pupils, students, post-graduates) in research laboratories. This includes the choice of research technology, ways of research organizing, options of its description, scientific production presentation character or its public assertion in a business or educational institution under the leadership of a young or experienced scientist.

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