CAREER GUIDANCE OF SCHOOLCHILDREN IN THE FIELD OF SPACE EXPLORATION

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Abstract

Space exploration in the modern world remains one of the most important trends in scientific and economic activity. Space rockets, manned orbital vehicle, satellite communications and navigation have become a common thing. Many countries have established long-term space programs for space exploration and economic use. It becomes clear that this activity requires solving complex scientific and technical problems. These problems cannot be solved without highly qualified personnel: astronomers, mathematicians, IT-specialists, engineers, cosmonauts. Many space-related organizations have drawn attention to the shortage of such personnel. “Space” professions are hardly common on the labour market. This kind of profession is unpopular with applicants and schoolchildren. This situation is due to the high requirements to mastering these professions: elitism, high requirements to the level of training, unique skills, strong physical health, psychological stability, increased responsibility. This leads to schoolchildren underestimating their potential. As a result, they do not consider such professions as a variant of choosing an individual life path. This position significantly limits the possibilities of professional choice and the outlook of modern schoolchildren. This raises the problem of broadening the professional outlook of schoolchildren and familiarizing them with various aspects of professional activities in the field of space exploration.

The objective of this article is to substantiate the career guidance technology of schoolchildren in the field of space exploration. The technology is based on methods of knowledge popularization about space and accessible practical activities.

The methodological basis of the research is the principle of the unity of consciousness and activity developed by S.L. Rubinstein. Their interaction determines the formation of the future image in a person's self-consciousness structure. The methods applied in our technology are based on modern and tested in pedagogy technologies of social partnership, educational tourism, cinema pedagogics and gaining practical experience. It is proposed to use popularization methods of knowledge about space: communication and interaction with representatives of space professions, design and implementation of excursion and educational routes to objects connected with space sphere, watching and discussing films of space subjects. The use of practices that support practical activities is recommended: conducting research that reflects the issues of space exploration; creating projects that present options for the use of space knowledge in modern life.

The technology was experimentally tested in Chelyabinsk region schools. The participants in the experiment were 246 schoolchildren. The results of the diagnostics revealed low interest of schoolchildren in space-related practical activities (21%). The experimental stage showed that the share of children interested in this activity increased to 46%.

The conclusion about the positive effect of the career guidance technology of schoolchildren in the field of space exploration was made. The proposed methods of educational and practical activities have a complex impact on the expansion of the professional outlook of schoolchildren, in the field of space exploration. And such methods can be used in the pedagogical practice of general education schools.

Keywords: space exploration, career guidance, schoolchildren, social partnership, educational tourism, cinema pedagogics, practical experience.

1 INTRODUCTION

Many famous people, who have mastered the professions of engineers and pilot-cosmonauts, admit that they made a professional choice under the influence of the space flight of Yuri Gagarin. The desire to become a cosmonaut was the subject of a game, a dream, a role model, a stimulus for development. It can be noted that the study and exploration of space has long gone beyond the

“dream” of mankind. Leading countries are establishing space programs for space exploration and economic use. These activities have resulted in the creation and operation of spacecraft. The space telescope, the planetary probes and the manned orbital station are unique scientific laboratories. The design of missiles that launch them into orbit is seen as an economic sphere. Satellite communications and navigation have become commonplace and an integral part of modern life. Humanity's interest in space exploration is evident.

This interest leads to the fact that “space” science and economics is a very promising area for the application of forces of a scientist, engineer, IT-specialist. It is necessary to make accurate mathematical calculations, create computer programs, design spacecraft, conduct research in space, etc. to solve a wide range of scientific-applied problems. New “space professions” are also emerging: space psychologist, space medicine specialist, space biologist, robotic technician, etc. The Russian space-related organizations, such as the Roscosmos State Corporation for Space Activities, suffer from a shortage of highly qualified specialists. These specialists are trained by technical universities. For example, Moscow State University (Russia) has a space research department. The faculty educates qualified specialists to conduct space research and effectively use the results of space activities in solving applied problems. Students do not take part in space projects during their studies. Many of the professional education programs implemented in Russian technical universities are aimed at training qualified engineers.

However, future applicants are not in a hurry to choose these areas of professional training. This is due not only to the low awareness of students about the field of “space” professions, but also because of the high requirements for the level of training. The elitism and uniqueness of these professions is also a factor of conflict with a pragmatic approach to the choice of profession. In addition, a person who works in the field of space research needs strong physical health and psychological stability. As a result, students underestimate their potential, which significantly limits the scope of their professional interests.

In this way, the pedagogical task of broadening the professional outlook of schoolchildren, familiarizing them with various aspects of professional activities in the field of space exploration can be considered as a complex activity. Attraction of grounded psychological and pedagogical methods and emphasis on gaining practical experience make it popular and applicable in pedagogical practice.

This raises the problem of broadening the professional outlook of schoolchildren and familiarizing them with various aspects of professional activities in the field of space exploration. Stimulating interest in the field of space exploration is a significant reserve for making professional choices. Many countries around the world are creating space museums and interactive exhibitions. Films devoted to space subjects attract a wide audience. Educational programs of basic and additional education offer the study of specific sections: astronomy, history of cosmonautics. However, these measures are fragmented and do not have a targeted impact on broadening the outlook and professional choice. It is obvious that it is necessary to use the methods of popularization of knowledge about space exploration in a comprehensive manner. An important condition for achieving this purpose is the application of methods of social partnership, educational tourism, cinema pedagogics, and practical experience. This allows not only to interest schoolchildren in space research, but also to involve them in practical activities.

2 LITERATURE REVIEW

Educational practices in many countries have gained considerable experience in organizing educational and leisure activities for children of various age groups in space exploration and research.

A number of educational projects initiated by the National Aeronautics and Space Administration (NASA, USA) have attracted the interest. The organization offers various forms of participation of primary and secondary school students in educational and leisure activities: competitions, exhibitions, visiting of the space museum, games, essays, formulation of questions by scientists, etc. The purpose of these activities is to motivate schoolchildren to expand their knowledge of space.

The Memorial Museum of Cosmonautics in Moscow (Russian Federation) is an institution of social, leisure, educational and promotional activities. The museum organizes not only stationary exhibitions, but also distance learning events. "The lesson at the museum" is a broadcast of an unconventional lesson of different subjects on “space” material. "The lesson of Gagarin" is conducted by operating cosmonauts, including those on board of The International Space Station. They talk about their life

and work in space. Various quizzes and competitions contribute to the promotion of the country's achievements in manned space and the expansion of international cooperation in the field of space.

Similar projects are being implemented in countries that are not leaders in space research. “Universe in the School” (India), is a unique project implemented by Indian educators. It aims to promote astronomy and space science. The project offers the opportunity for schoolchildren to participate in an astronomy club, scientific master classes, competitions, seminars about space explorers, educational excursions and exchange programs. Methodological support is provided to teachers: it offers ways of integrating space knowledge with regular school subjects and refresher courses.

An interesting practice is presented by the JAXA Aerospace Research Center (Japan). The Centre deals with the safe use of outer space and focuses on the education and training of schoolchildren. The organization's website offers games, puzzles, pictures and videos for junior high school children. A description of the experiences that support formal and non-formal education is available. The essence of the support is to expand space knowledge through educational seminars, courses and camps. Attention is also paid to joint activities with parents: making models of aircraft, conducting experiments, launching rockets, etc.

All the proposed forms to some extent influence the formation of motivation for career guidance of schoolchildren in the field of space exploration. Their main goal is to popularize scientific knowledge. Educational tourism facilities, videos, partnership programs may be in high demand among schoolchildren and educational organizations. At the same time, the described practices are more aimed at versatile development of the individual and organization of leisure time for schoolchildren. In order to ensure the focus of educational activities not only on entertainment, but also the achievement of career guidance objectives, it appropriate to turn to the theoretical justification of the process of professional choice, including in the field of space professions.

We have already expressed the view that a conscious choice of future professions, including space, is based on self-determination. The problem of self-determination as an activity of one's own free will, not imposed from outside, occupies a leading place in foreign literature. It was reflected in many publications (A.E. Black, E.L. Deci, Ch.P. Niemiec, R. Ryan, Sh. Field, etc.) [1],[2],[3]. Initially, the problem of self-determination was addressed by philosophers (J. Locke, B. Skinner). They have established that all events (as well as a person's behavior and actions) are the consequences of the previous reasons. These ideas were further disseminated in the works of psychologists. It was about human behavior as a result of external and internal influences (Michael L. Wehmeyer, Brian H. Abery, Dennis E. Mithaug, Roger J. Stancliffe) [4].

The results of the work of the most influential foreign scientific school in the field of professional self-determination are reflected in the publications of Edward L. Deci and Richard M. Ryan [5]. The authors have developed and promoted the Theory of Determination, including in education within the framework of professional self-determination. This theory mainly focuses on the presence of interest in learning. According to the authors, this factor actually leads to the improvement of the quality of education, facilitates the choice of profession. Articles supporting the thesis that the choice of profession is conditioned not only by the interest in training, but also by participation in practical activities are aroused interest. The paper “Self-determination in action in the classroom” (L.A. Price, D. Wolensky, R. Mulligan) proposed practical mechanisms of pedagogical support of professional self-determination: implementation of thematic research, implementation of the action algorithm and reproduction of best practices [6]. Developing these views, A.E. Black, J. Ryan, L. Reeve, etc. express the opinion that the support of independence, autonomy of the child, removal of the teacher from the attempts of total control of educational activity will contribute to the development of competence and professional self-determination of schoolchildren [1; 7]. Geoffrey C. Williams and Edward L. Deci have tested the theory of self-determination on medical university students. They revealed an important dependence: the more teachers maintain their independence in learning, the higher and faster they can observe competence in many areas, and the formation of beliefs [8]. The same problem is addressed in the joint of USA and Korean study (H. Jang, J. Reeve, A. Kim) [9]. Scientists have conducted several experiments with South Korean high school students and found that competence and motivation, satisfaction with learning are acquired through the means of granting autonomy to students at the classroom. Attention is drawn to studies that focus on the development of organizational skills among students: goal-setting, measures to achieve results, and changes in outcomes. These skills work effectively, including the formation of professional self-determination. According to studies conducted in this segment (M. Agran, M.L. Wehmeyer), students trained in technologies to achieve the goal have shown significant increases in independence in learning [10].

The most significant results of the study are conclusions about the readiness for self-determination and career guidance.

Drawing attention to the fact that engineering and technical specialties occupy a significant place in the space industry, it is worth summarizing the results of research on the subject of professional self-determination in the field of science and technology. In this regard, it is worth noting the work "Development of the educational and career interest scale in science, technology, and mathematics for high school students" by American scientists (Y.J. Oh, Y. Jia, Mh. Lorentson, F. LaBanca) [11]. They have developed a scale of educational and career interests of high school children in science, technology and mathematics. This scale is convenient and allows to determine with a high degree of accuracy the steady interest of schoolchildren-teenagers.

The description of the experience of Greek scientists (A. Emvalotis, A. Koutsianou) is quite interesting in the studied segment [12]. They proposed successful technologies for building a positive attitude towards scientists, scientific knowledge and careers in science. It is noteworthy that the study involved junior schoolchildren. The subject of research of individual authors is the intention of high school children to study physics to master subjects of technical direction. It is necessary for the further mastering of a profession in the field of engineering specialties.

Representatives of the Czech scientific school (J. Cincera, M. Medek, P. Cincera, M. Lupac, I. Ticha) addressed the study of the influence of pedagogical factors on professional self-determination [13]. They point to the essential role of forms and methods of teaching in the successful understanding of scientific knowledge by students and the development of their willingness to make choices in favor of engineering professions. One of the most effective forms is extracurricular activities. These findings are supported by research of Chinese scientists (Ch. K. Ming, L.K. Fong) [14]. They demonstrate the need to use the resources of extracurricular activities in professional orientation. Exhibitions, lectures on popularization of scientific knowledge, competitions, summer scientific and technological practices in the camps, modeling of spacecraft and other vehicles provide better chances to communicate with science, and interesting unobtrusive events cause interest in knowledge in the field of engineering knowledge. The Finnish researchers (K. Juuti, J. Lavonen) experimentally established that a number of techniques and methods of activity implemented in the class have a positive effect on the formation of interest during career guidance of schoolchildren in the field of technical specialties in the future [15]. Such techniques include scientific experimentation, social construction of knowledge, discussion and demonstration with the participation of the educator. The most significant results in this segment were achieved by American researchers. According to Gary H. Kitmacher, the National Research Institute, the National Association of Teachers of Science, the American Association for the Advancement of Science created and published scientific standards in 2013 [16]. The essence of these standards is to provide science education to all students in three subject areas: physical sciences, life sciences and Earth and space sciences. The main tools for implementing the standards include scientific content, scientific practices and large-format scientific topics.

In this way, in connection with the development of global practice and popularization of knowledge about space, it can be stated that it is concentrated around social and leisure projects. Such projects are implemented by social and leisure institutions: museums, space agencies. Participation in the proposed events is easily accessible from a distance. However, they cover a small circle of highly motivated children and perform only the functions of popularization. Such organizations can be seen as social partners and use the resources they provide. Pedagogical activity of the development of sustainable interest in science, scientific ideas about space and space research should be based on the ideas of professional self-determination of a schoolchild. It can be considered scientifically sound that professional self-determination is conditioned by the results of internal and external influences. The content of pedagogical influence on professional self-determination may include scientific knowledge about space, integration with regular school subjects and extra-curricular activities. This content can be mastered in the course of diagnosing the interests of schoolchildren, mastering the basics of science in general education, inclusion in additional education programs. Among the effective methods, the promotion of interest in scientific knowledge and technological sphere, development of independence in training, implementation of practical scientific-applied projects are singled out. All this gives grounds to use these conclusions for designing scientifically grounded technology of career guidance of schoolchildren in the field of space exploration.

3 METHODOLOGY

The authors of the article propose the technology of career guidance of schoolchildren in the field of space exploration. The chosen methodology is based on the principle of unity of consciousness and activity developed by S.L. Rubinstein [17]. It consists in the fact that in the consciousness of man is represented “the image of the future”. This image is related to the perceptions of oneself, one's needs and the possibilities of achieving the desired future. The result of such correlation can be considered an element of human self-determination. In turn, the perception of one's needs and opportunities is significantly influenced by the activities undertaken: obtaining information about the sphere of life, applying this knowledge in practice. For example, the learner's success in educational activities arouses interest in continuing education at a higher level. The schoolchildren's educational activity is the leading one. It is carried out on the basis of the proposed samples. These samples are perceived and transformed in the minds of schoolchildren into goals, objectives and ways to achieve them. Certain goals, objectives and ways of achieving them allow us to realize the interest in space issues in the form of organized activities. It is assumed that this relationship should be taken into account in the process of career guidance of schoolchildren in the field of space exploration. This is quite consistent with the results of the studies we analyzed. A prospect is being built that ensures the continuity of the process of career guidance of schoolchildren in the field of space exploration.

It is also necessary to take advantage of the opportunities offered by organizations that promote space research. This makes it possible for us to take into account the principle of cooperation with social partners by sharing available resources. This cooperation can be carried out at the organizational level by entering into a cooperation agreement and making mutual payments for the provision of educational services, or by using the terms of a public offer. For example, there are educational events and educational tourism. There are also resources that highlight the potential for the application of space knowledge in educational activities, with free access. Among other things, representatives of educational organizations involved in space exploration, organizations engaged in the field of economics of space exploration, and representatives of “space” professions are often interested in such cooperation.

The purpose of technology implementation is to assist schoolchildren in their professional self-determination, including professions related to space exploration. The pedagogical objectives of this task can be defined as the inclusion of schoolchildren in activities that contribute to: (a) broadening the children' professional horizons; (b) popularizing knowledge about space exploration; (c) demonstrating the social significance of the "space" professions; and (d) applying knowledge in accessible activities. These activities are proposed to be deployed in two areas: 1) popularization of professions in the field of space exploration and research; 2) gaining practical experience. On the one hand, this activity will influence the schoolchildren's consciousness, forming a positive image of the "space" professions, arousing interest in knowledge about space. On the other hand, it is possible to implement activities that will demonstrate the availability of such professions.

Within the framework of the first direction it is supposed to use the methods of popularization of scientific knowledge about space, the method of educational tourism, the method of cinema pedagogics, which are well established in educational practice.

Popularization of scientific knowledge about space is organized on the basis of real communication of schoolchildren with representatives of the space industry and modern forms of presentation of educational information. Educational tourism implies building excursion and educational routes associated with the study of professional activities of specialists working in the space industry. The cinema pedagogics affects both the intellectual and emotional spheres of children.

Popularization of knowledge about space can be effectively carried out in communication with the participants involved in space research, ensuring flights into space, production of rockets and spacecraft. They can be pilots-cosmonauts, members of the search and rescue team, engineers, science fiction writers. Such communication can be organized in different formats: in real mode; by means of "Skype" and "You Tube" videoconferencing systems; using recorded video materials; in written form, etc. In this case, schoolchildren receive information directly. When the source of popularization of science is a representative of a particular profession, this person leaves an impression that space exploration can be devoted to life. This representative tells about complex and funny cases from professional life, which are not described in the scientific literature. Information is presented more vividly, convincingly and emotionally. Such direct communication influences the formation of a positive attitude to the professions in the field of space exploration.

Another direction of knowledge popularization can be determined by using the resources of leisure and educational organizations that pay attention to the popularization of cosmonautics: specialized museums, planetariums, libraries. Profile museums, such as the “Memorial Museum of Cosmonautics” in Moscow, planetariums present expositions devoted to space subjects. The exhibitions give a clear picture of natural and man-made space objects. Schoolchildren can study three-dynamic models of the universe, planets, and spacecraft; hear the sounds of space; touch the elements of space equipment; and simulate the actions of astronauts in conditions of increased gravity using technical devices or virtual reality.

Educational resources available remotely can be integrated with classroom and extra-curricular activities. At physics, chemistry and geography lessons, it is advisable to watch TV space lessons from the International Space Station, "The lesson of Gagarin " and "the lesson at the Museum". In the same way are useful for watching a multi-part film of the special project “Year in orbit”. The authors of such projects are real cosmonauts. It is possible to study the “Atlas of Space Professions” in extracurricular activities. Another element of popularization is the activities of librarians. They can select interesting literature; organize exhibitions dedicated to the Day of Cosmonautics and other important dates.

Educational tourism implies the formation of excursion and educational routes associated with the study of professional activities of specialists working in the space industry. Such routes, of course, should take into account the interests of children and the capacity of the school in their organization. Schoolchildren can visit: specialized museums of "space" subjects; the center of cosmonaut training; objects of cosmodromes; scientific observatories; industrial enterprises where products for space sphere are made; organizations using satellite communication technologies. Interesting excursions can be organized without leaving the region. For example, one of the central exhibits of the exposition is the largest fragment of the meteorite "Chelyabinsk" in the Chelyabinsk State Museum of Local Lore. We believe that such excursions can be useful for schoolchildren.

Of course, for some schools they may be labor-intensive and expensive, because they are intended to travel. Therefore, it is necessary to envisage the use of methods that will make it possible to explore space and learn about the "space" professions while at school. Recently, the method of cinema pedagogics has gained popularity as one of the tools to popularize science. It allows to mention not only intellectual, but also emotional sphere of the person at perception of the information. This contributes to a qualitatively different assimilation of knowledge, formation of interest in the scientific side of life.

There are many domestic and foreign cartoons and films about the theme of space. During the use of this method it is important to take into account age specifics. Cartoons may be suitable for junior schoolchildren. Scientific films, feature films, based on both real events and fantastic ones may be suitable for teenagers. The animated series “Space Jura and Nura”, the creation of which was supervised by Russian cosmonauts, is valuable for junior schoolchildren. Also popular with schoolchildren is the animated film “Star Dogs: Belka and Strelka” in two parts. It tells with humor about an important historical event in the history of space. Based on the example of these cartoons it is possible to form the children' initial ideas about cosmodromes (Baikonur and Vostochny), the Solar System and cosmonaut training. Among the fantastic stories about space theme shot cartoon series “Alice knows what to do”. It shows the distant future, connected with the development of new planets and communication with representatives of extraterrestrial civilizations. Popular feature films include “Gravity” (2013, UK, USA) and “The Martian” (2015, UK, USA). Their examples show not only scientific but also anti-scientific information. At the physics lesson, based on the example of the film "Gravity" can be parsed mistakes in demonstrating the laws of interaction between bodies in weightlessness. It is useful to look at the behavior of the hero of the movie "The Martian" at health lesson. His knowledge of biology and first aid helped him survive on another planet. It is worth analyzing Russian films as “Gagarin: First in Space” (2013, Russia), “The Age of Pioneers” (2017, Russia) and “Salyut-7” (2017, Russia) with high school children. Such films can be useful not only in the natural science cycle, but also in the humanities. For example, the history lesson can examine the behavior of heroes, the value aspects of the behavior of Soviet citizens of the twentieth century, their patriotism and self-sacrifice. It is advisable to form and constantly update the archive of media resources about space in order to ensure that films can be used in career guidance activities.

Selection of video material to popularize knowledge about space and expand professional horizons should be guided by moral, cognitive and emotional criteria for selection of material. Moral criterion is manifested in the absence of scenes of violence, sexual relations, etc. The cognitive criterion is expressed by the availability, interest and usefulness of the video material presented. Emotional

criterion presupposes the presence of subtle humor, emotional experiences, and the possibility of empathy for the characters. The application of cinema pedagogics involves four stages: 1) selection of appropriate videos, 2) watching them, 3) discussion of heroes' behavior, 4) conclusions. It is necessary to watch the film in terms of meeting its criteria, prepare the necessary fragments, and prepare questions, a discussion plan or other options for the schoolchildren. Small video clips are recommended to be shown at the lesson or as part of extracurricular activities. This will awaken the interest of the children while meeting the health requirements. After such a demonstration, it is necessary to hold a discussion in accordance with the stated topic of the lesson or activity and draw appropriate conclusions.

The second direction of implementation of our technology is the organization of practical activities. The value of this element of the technology is that it will demonstrate the availability of professions related to the study and exploration of space. Examples of such activities may be educational projects carried out on space-related topics. In terms of increasing interest in space studies and exploration, schoolchildren may be offered interesting educational tasks. The experiments will clearly demonstrate the possibilities of studying the parameters of gravity, the principles of satellite communications, and simulate the conditions of space.

Project activities will be also interesting for schoolchildren. The project can not only study individual physical phenomena and technologies, but also find applications for scientific knowledge. For example, it is possible to implement a project to study the Earth using satellite images. It is no secret that the geographical outlines of continents and islands are changing. With the help of satellite technologies, it is possible to study these phenomena, establish facts and predict trends. Many "space" technologies are changing our lives. The study of their practical applications could also be the subject of a scientific application project. Creating an atlas of "space professions" could be another topic that needs to be studied and colorfully designed. It is possible to think up how conventional "earth" technologies can make life easier for space explorers. The study of the history of space exploration, the awareness of its importance as a moral example, can also serve as an object of study. To ensure that these projects are not a one-off event, it is worthwhile to hold thematic conferences where schoolchildren can present the results of their research.

Another area of practical activity can be the design of models, layouts and operating prototypes of aircraft. It is important that these activities are carried out in a team. First of all, in this case it is possible to involve children with different interests in the same project. Furthermore, the demonstration of a model or a successful launch of a missile will encourage all team members to continue their experiments. It is a good opportunity to present your designs in space-related contests. This will make it possible to compare the results of their work with the achievements of other schoolchildren, to feel like a participant in a common cause.

In this way, the use of these methods in a complex allows schoolchildren to get an image of the “space” professions and to assess their potential for mastering them. This opportunity will provide a vision for cognitive and possibly professional development.

4 RESULTS

The proposed technology was tested in 7 educational organizations of the Chelyabinsk region (Russian Federation). One of the areas of their educational practice was the promotion of career guidance of schoolchildren in the field of space exploration. The study covered 246 schoolchildren.

The efficiency of the developed technology was measured according to 4 criteria: (1) Awareness of space-related professions; (2) attitude towards space-related professions; (3) understanding of the role of such professions in modern society and in the future development of the country's economy; (4) percentage of schoolchildren involved in practical space-related activities. The results of the research on these criteria are presented in Tables 1-4.

Table 1. Awareness of space-related professions

Criteria levels of manifestation	Primary diagnostics data	Final diagnostic data
Non-informed	21 %	2 %
Part-informed	56 %	70 %
Whole-informed	13 %	28 %

Table 2. Attitudes towards the space professions

Criteria levels of manifestation	Primary diagnostics data	Final diagnostic data
Indifferent	68 %	24 %
Unsustainable interest	21 %	46 %
Sustainable interest	11%	30 %

Table 3. Understanding the role of the space professions for modern society and for the future development of the Russian economy

Criteria levels of manifestation	Primary diagnostics data	Final diagnostic data
Lack of understanding	77 %	31 %
Fragmentary understanding	22 %	60 %
Systematic understanding	1 %	9 %

Table 4. Percentage of schoolchildren participating in space-related activities

Criteria levels of manifestation	Primary diagnostics data	Final diagnostic data
Percentage of schoolchildren participating in space-related activities	24%	67 %

As a result of the approbation, it has been established:

- the number of schoolchildren who are part or whole informed of space-related professions increased by 29%;
- the number of schoolchildren showing sustainable interest in the professions in space increased by 19%;
- the number of children who have a systematic understanding of the role of professions in the sphere of space for modern society and for the future development of the Russian economy has increased by 8%;
- the number of students has changed significantly in a positive way, wishing to engage in practical activities involving the application of space knowledge and exploration to human activities.

The data obtained allow to state that the developed technology of career guidance of schoolchildren in the field of space exploration is effective. The used methods have proved their effectiveness, which means that they can be used by pedagogical staff of various educational organizations.

5 DISCUSSION

The proposed technology is inexpensive. It can be implemented by the specialists of the educational organization, which implements various directions of career guidance work. The proposed methods may be relevant for the popularization of professions related to science, technology, and exploration of space. During the implementation of such technologies, possible limitations should be taken into account. Incorrect interpretation of the method of cinema pedagogics can offset its positive aspects. The use of this method requires the teacher to be able to work with videos, follow the algorithm and be reflective. The resource potential of the educational organization should be taken into account. The lack of experience of an educational organization in interacting with specialists involved in space research significantly limits its capabilities in this type of activity. Conversely, the presence of social partners in the form of organizations involved in space exploration makes it possible to develop practical activities in a more diverse manner.

6 CONCLUSIONS

The problem of space exploration and its use for economic purposes is a complex scientific and technical task that is relevant for any country. This task requires highly qualified personnel with unique skills. The formation of the elitist image of the "space" professions leads to the fact that schoolchildren do not consider many technical professions as a variant of choosing an individual life path. We have focused our research on the problem of popularizing knowledge about professional activities in space exploration. There is interest in the problem of popularization of knowledge about space, which is implemented in the framework of social and leisure activities aimed at highly motivated schoolchildren. During the substantiation of the technology of career guidance of schoolchildren in the field of space exploration, it is necessary to rely on the theoretical conclusions of scientists and the results of research of teachers with practical experience. The principle of the unity of consciousness and activity, the principle of cooperation with social partners allows to clarify the nature of the pedagogical impacts on the professional self-determination of the schoolchildren. Complex activity implies the use of methods of popularization of knowledge about space, educational tourism, cinema pedagogics, gaining practical experience. These methods are implemented in a wide range of forms: communication and interaction with representatives of space professions, design and implementation of excursion and educational routes, watching and discussing films on space subjects, implementation of projects reflecting the study and use of knowledge about space, creation of models of aircraft, etc. The technology was tested in 7 educational institutions of the Chelyabinsk Region. The criteria were: awareness of space-related professions; attitude towards space-related professions; understanding the role of space-related professions in modern society and in the future development of the Russian economy; percentage of schoolchildren involved in practical space-related activities. The obtained data on the positive dynamics of these criteria indicate the practical applicability and positive effect of the technology developed by us. The restrictions of application of the developed technology in educational practice of schools are shown.

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