

Practice Oriented Science: UAE – RUSSIA – INDIA

Materials of International University Scientific Forum
March 27, 2024

UAE, 2024

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UAE – RUSSIA – INDIA

Part 2

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UAE

Proceedings of the International University Scientific
Forum “**Practice Oriented Science: UAE – RUSSIA
– INDIA**”. Part 2.

(March 27, 2024. UAE)

ISBN 978-5-905695-87-2

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DOI 10.34660/INF.2024.14.68.082

**KEY ASPECTS OF UNIVERSITIES' ACTIVITIES CONTRIBUTING
TO THE SUSTAINABLE DEVELOPMENT GOALS
ACHIEVEMENT: DESCRIPTIVE ANALYSIS**

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Abstract. *Universities play an important and multifaceted role in preparing young people to meet complex challenges of the modern world. Interdisciplinary programs, research projects, social responsibility and international orientation implemented by universities contribute to the development of highly qualified young professionals who can make a significant contribution to achieving the Sustainable Development Goals. Involving students in educational and research projects on sustainable development creates a new generation of young leaders and professionals who are ready to solve complex problems in achieving the said goals, thereby transmitting the goals to society. Strengthening the position of universities in achieving sustainable development goals is facilitated by the development of a strategy, which must necessarily include various activities aimed at attracting young professionals and the public to issues of sustainable development.*

Keywords: *university, sustainable development goals, education center, research center, university development strategy.*

With the growing challenges of environmental, social and economic sustainability, the solution of which requires integrated and innovative approaches, the issues of determining the contribution of universities in countering such threats are increasingly relevant [3]. Universities possess highly qualified personnel with

the knowledge and skills to achieve sustainable development goals, students master educational programs that include environmental and social components, and the scientific community conducts research and initiates comprehensive innovative solutions. In turn, the desire of universities to contribute to the achievement of sustainable development goals encourages them to develop partnerships with employers, government and non-governmental organizations. The universities become centers for the formation of a culture of sustainable development, transmitting these values to young people, their behavior and habits [6]. All these aspects make universities significant in solving sustainable development problems.

The problem discussed in this article attracts the attention of many researchers and experts in the field of education. For example, the works [2, 4, 5, 7, 8] study issues of sustainable development within the framework of the work of UNESCO chairs at universities. A major contribution to the development of education from a sustainable development perspective is UNESCO's series of workshops aimed at deepening the participation of schools, colleges and universities in UNESCO's activities on the future of higher education.

A descriptive analysis of specialized literature on the participation of universities in achieving the sustainable development goals, as well as based on the authors' own professional experience, five aspects were established in the activities of the university in achieving the said goals.

The first and key aspect that defines the contribution of universities to achieving sustainable development goals is the classical role of universities as centers of education. Universities develop competencies necessary to achieve sustainable development goals, integrate knowledge, skills and abilities aimed at promoting sustainable social, economic and environmental change. In modern universities, the emphasis is on interdisciplinary learning, which encourages students to integrate knowledge from various fields and contributes to a deeper understanding of sustainable development issues and the search for innovative solutions. Educational programs cover various disciplines in sustainable development, ecology, social sciences, and innovative technologies [1]. Students are trained in critical thinking, analysis and solving problems of sustainable development, which is necessary to effectively confront the global challenges of our time.

Universities provide training for a new generation of young professionals with the knowledge, skills and abilities to develop and implement technologies and innovations that contribute to sustainable development. To this end, youth are involved in social projects that contribute to the well-being of regional communities, which allows them to develop leadership qualities and abilities for social transformation.

Educational organizations are actively developing partnerships with employers, government and non-governmental organizations to ensure that students have

access to real-life practical cases. This helps to increase the practice-oriented nature of educational programs. Students are supported in developing their own entrepreneurial ideas, start-ups and innovative projects, which contributes to the development of effective solutions to achieve sustainable development goals.

A key aspect of learning is academic mobility. Students have the opportunity to participate in exchanges, internships and joint programs with foreign educational organizations. This enriches their experience, provides a global understanding of the challenges of sustainable development and stimulates cross-cultural interaction.

An important element is also the use of modern educational distance technologies and e-learning in the educational process. Educational institutions are introducing digital platforms, virtual laboratories and artificial intelligence technologies into the educational process for more effective learning for sustainable development.

Research centers operate at educational organizations, within which work is carried out to develop new technologies, methods and strategies that promote sustainable development. This is the second aspect that determines contribution of universities to achieving sustainable development goals. Young scientists participate in research projects, gaining best practices and developing their own innovative abilities. Research centers at universities act as units of intellectual activity, where innovations in various fields of science are formed and tested: new materials, production methods, and energy technologies are developed.

Universities make a great contribution to achieving sustainable development goals by acting as “conductors” of the above mentioned goals. By actively involving youth in sustainable development projects, they have an impact on society. Young people develop a deep understanding of social and environmental issues, a sense of social responsibility and civic education, which in the long term influences public values. Students learn to analyze the challenges and threats of our time and propose practical solutions to achieve sustainable development goals. This experience shapes their ability to effectively solve sustainable development problems, which turns out to be valuable in their future professional activities. Interaction with teachers broadens their horizons, with experts from the real sector of the economy allows them to gain practical experience in implementing ideas, which provides great opportunities for a future career. Universities, by actively involving young people in sustainable development projects, help attract public attention to sustainable development issues. This is a source of new ideas and support for projects aimed at solving specific sustainability problems.

Introduction of sustainable practices into university activities represents the fourth aspect that determines the contribution of universities to achieving sustainable development goals. Universities are committed to reducing their environmen-

tal impact through the adoption of energy-saving technologies, use of renewable energy sources, and efficient use of resources. They invest in infrastructure that meets environmental standards: implementing efficient heating and cooling systems, creating public “green” spaces, influencing the mindset of employees by creating a positive example of compliance with the principles of sustainable development in the team.

Universities also act as centers for promoting collaboration and creating partnerships for sustainable development. Such interaction covers all of the above aspects that determine the contribution of universities to achieving sustainable development goals: from research to educational programs, impact on society and the introduction of sustainable practices in university management. Universities establish close ties with representatives of the real sector of the economy, exchange knowledge and resources with them, implement educational programs in a network form and joint research projects, create and test innovative technologies.

Universities collaborate with public sector institutions to assist in the development and implementation of regional government programs aimed at supporting sustainable development. Partnerships with non-governmental non-profit organizations allow universities to interact with environmental and social initiatives, implement joint projects in the field of environmental protection and volunteering. Exchange of experience, joint interdisciplinary projects and participation in international program initiatives contribute to global coordination of efforts in the field of sustainable development.

Thus, contribution of universities in achieving sustainable development goals should be considered through the prism of five main aspects of their activities: universities as centers of education, universities as research centers, universities as “conductors” of sustainable development goals, universities as centers for introducing sustainable practices into their activities and universities as centers for developing cooperation and partnerships for sustainable development (fig.). All these aspects form the basis of a modern university development strategy.

Achieving sustainable development goals must be the basis for working out a development strategy for modern universities. In this context, the strategy will help attract the attention of the public and students, increase the reputation and authority of the university in terms of compliance and familiarization of young people with the principles of sustainable development. Universities should actively use social media to reach youth audiences as fully as possible, hold events such as open days and virtual tours to draw attention to sustainability issues, establish a communication mechanism with alumni, respond to requests and engage the student community in achieving sustainable development goals. Particular attention should be paid to the content broadcast by the university through various channels to the external and internal environment. It should highlight the contribution of

the academic and scientific components of the university to achieving sustainable development goals, including through the holding of various forums and conferences.

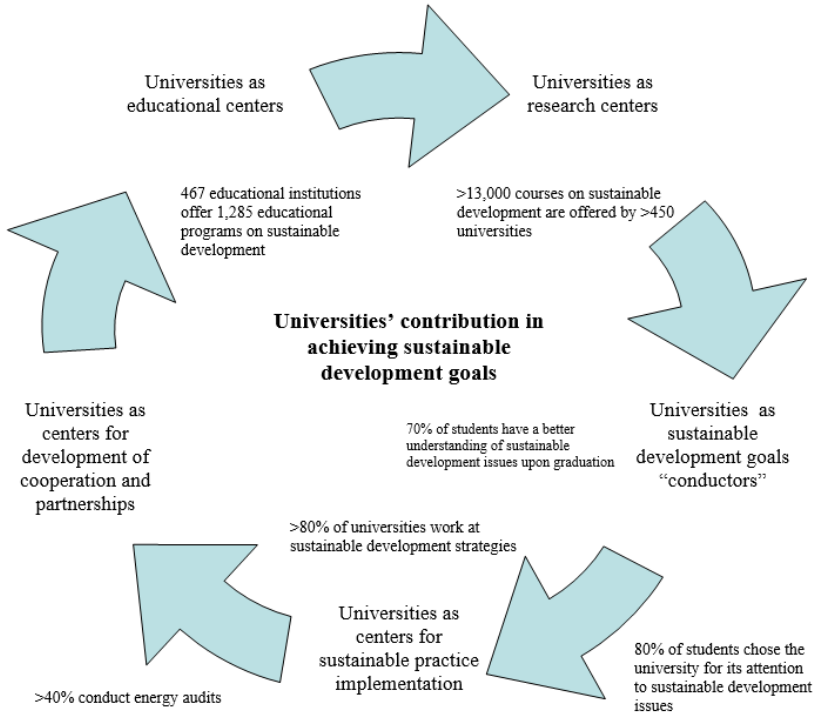


Figure. *Universities' contribution in achieving sustainable development goals*

Thus, strengthening the position of universities in achieving sustainable development goals will be possible through the implementation of the following activities aimed at attracting students and the public to issues of sustainable development:

- working out a university development strategy with an emphasis on environmental friendliness, social responsibility and economic sustainability;
- active use of the university website, press releases and social networks to inform students, teachers and the public about the goals of sustainable development and the university's achievements in this direction;
- development of educational programs, educational and methodological complexes including modules and courses on sustainable development;

- organization of educational and scientific events, forums and conferences dedicated to discussing sustainable development goals and ways to achieve them;
- regular coverage of the achievements of students, young professionals, teachers, projects and innovations in the field of sustainable development to attract the attention of employers and the public;

- development of a campaign including videos and interviews with successful alumni and students actively involved in sustainable development projects.

Such integrated approach would allow universities not only to strengthen their position in achieving sustainable development goals, but would also become a key factor in increasing competitiveness in the educational services market.

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ANALYSIS OF THE MAIN TECHNICAL AND ECONOMIC INDICATORS AND PRIORITIES FOR THE FORMATION OF THE REPRODUCTION OF THE AGRO-INDUSTRIAL COMPLEX

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Annotation. *By its objective nature, structural composition and mechanism of cluster behavior, the agro-industrial complex (AIC) is a single organism consisting of aggregate elements of technologically interconnected intersectoral systems. Based on this, the agro-industrial complex is a complex diversified technologically interconnected structure for the reproduction of capital, labor and products. Its functional efficiency is clearly expressed in the system of inter-industry “chain reaction”, characterized not only by the usefulness of the industry cluster (inter-industry behavior), but also by the possibility of increasing the efficiency of technical and economic indicators of individual sectors and enterprises, which represents the relevance of the study.*

Keywords: *technical and economic, intersectoral, optimal, reproduction, usefulness, pricing, trends.*

The effectiveness of the latter determines the objectives of the study - improving the state of technical and economic indicators, increasing the degree of exploitation of operating assets in order to meet the needs of the population and own production, fulfilling state and non-state orders, as well as orders of public organizations. In this regard, the main objective of the study is to restore the usefulness and optimal structure of the resource potential of the agro-industrial complex of the northern regions, which objectively requires comprehensive support from the state and local territorial entities [1, p. 228].

Analyzing the situation, it can be noted that for quite a long period of time, agricultural organizations in the northern regions have been occupied by disinvestment tendencies of management - systematic underfinancing of business entities

and an unfavorable atmosphere for the acquisition and use of capital resources. This circumstance is largely due to the deterioration of the condition of the main types of agricultural machinery and equipment. Statistics show that on average for 2011-2022. In the agricultural sector of the economy in the northern regions, the number of agricultural equipment in use has significantly decreased, including tractors of all brands by 1.3 times, tractor trailers - 1.3, plows - 1.7, harrows - 1.4, cultivators - 1.7, sowing machines – 1.3 times, mowers – 1.5 times. The number of combines decreased: forage harvesters by 7.0%, and potato harvesters by 27.2%. The number of solid mineral fertilizer spreaders is decreased by 22.2%, and milking installations and units increased by 3.5%.

During the analyzed period, in agricultural organizations of the northern regions, the provision of tractors and combines per 1000 hectares of cultivated land has an active downward trend. Since on average for 2011-2022. in these organizations, the provision of tractors per 1000 hectares of arable land decreased from 14 to 11 units. At the same time, the arable land load per tractor increased from 71 to 90 hectares, and the planting of potatoes per 1 potato harvester decreased from 21 to 15 hectares. The low level of provision of agricultural enterprises with the necessary machinery and equipment is explained both by the lack of investment financing and the drop in the pace of their own economic activity. Over these years, the energy power of agriculture in the northern regions has tended to decrease by almost 31.6%, including per worker from 65 to 57 hp, and per 100 hectares of sown area from 850 to 687 hp. . The current situation opposes not only the formation of resource potential, but also the restoration of expanded reproduction of the agro-industrial complex of the northern regions, and slows down the process of transition to progressive management methods.

A similar trend can be observed in livestock farming in most regions of the north. This trend is more clearly characterized in almost all agricultural categories of the Komi Republic (Table 1). Statistics show that on average for 2017-2022. in all categories of agriculture in the region, there was a decrease in livestock numbers: cattle by 15.7%, including cows by 12.7%; sheep 31.7; goats 43.1; horses 54.4; rabbits 58.3%. An increase in the number of animals is observed in the following types of animals: pigs – by 46.4%; deer 3.0 and bee colonies by 16.8.8%. As for poultry farming, its development is slow, and production in this area is limited to almost providing regional markets with poultry meat.

Table 1
Number of livestock and poultry in farms of all categories in the Komi Republic, at the end of the year; thousand heads

Indicators	2017	2018	2019	2020	2021	2022
Cattle	35.5	34.4	34.0	32.9	31.6	29.9

including: cows	15.6	15.3	14.8	14.4	14.2	13.6
pigs	23.5	29.8	37.5	40.0	37.4	39.9
Sheep	8.9	9.4	8.9	8.2	7.4	6.6
Goats	5.7	5.2	5.0	4.8	4.4	3.9
Horses	3.3	3.1	2.8	2.6	2.3	2.1
Deer	90.2	91.1	92.2	93.7	95.9	93.0
Rabbits	18.6	18.7	15.9	15.0	12.2	11.6
Bird	1626.9	1709.3	1829.8	1689.1	1614.1	1702.7
Bee colonies, pcs.	576	586	717	861	706	696

Source: Statistical collection “Agriculture in the Komi Republic”, Syktyvkar. 2019

The results of a retrospective analysis show that a sharp reduction in state financial support for regional agriculture led to an increase in its insolvency. This increased the “gap” of connections in the intersectoral trade of the agro-industrial complex and worsened economic relations with the external environment, especially with the spheres of production of means of production. Conflicting situations have emerged with procurement and processing units, as well as with numerous production and social infrastructure facilities. In total, negative trends in intersectoral pricing of the economy have accelerated, and price disparity between industrial sectors and agriculture has increased. The disorganization and disinvestment trend of intersectoral management of the region’s agro-industrial complex ended with the gradual ruin of small and medium-sized agricultural enterprises, the loss of connections not only with external, but also with internal regional financial and commodity markets.

It should be especially noted that one of the types of practical state support for the agro-industrial complex of the northern regions is budget subsidies. However, these funds received by agricultural enterprises in most cases are not used for investment purposes, but to pay off debt obligations or pay wages. Consequently, the periodic increase in the volume of subsidies does not contribute to the renewal of production - an increase in efficiency and production volume, especially in small and medium-sized agricultural enterprises [2, p. 49]. If, on the one hand, a sharp reduction in state financial and economic support for the agro-industrial complex of the northern regions has a negative impact on the growth of production volumes, then, on the other hand, a hasty transition to market economic conditions does not correspond to the use of effective methods and mechanisms for the socio-economic transformation of their spheres and enterprises. Insufficient and slow rates of financing and imperfect mechanisms for managing the economic activities of the agro-industrial complex of the northern regions result not only in a significant deterioration in their technical and economic indicators, but also in reproductive and cluster characteristics.

The above negative trend can be seen in agricultural organizations of the Komi Republic. Since a strong drop in the production activities of these organizations in the region is accompanied by deterioration in the condition of many processing enterprises and an increase in the inactivity of infrastructure and other social facilities. This accelerates the process of reducing many small and large operating agricultural entities of the agro-industrial complex, especially workshops, car parks, food storage facilities and other infrastructure buildings and structures. The duration of this trend contributes to a significant reduction in existing social service facilities in rural areas, a reduction in transport and other services, a decrease in the volume and pace of agricultural and veterinary work and services performed in both crop production and livestock production.

The impact of negative factors on the development of the region's agro-industrial complex, in particular its backward agriculture, leads to a significant decrease in food security. Since today more than 80% of the food consumed in the region is imported, and the level of self-sufficiency with local food products has an active downward trend. Let us consider some aspects of the ratio of exported and imported agricultural products by agricultural organizations in the Komi Republic (Table 2).

Table 2
Export and import of agricultural products by agricultural organizations in the Komi Republic, no micro-enterprises; tons

Indicators	2017	2018	2019	2020	2021	2022
Exported from the Komi Republic:						
potatoes	53	1.5	-	-	1.4	-
vegetables	2.5	-	-	-	73	-
livestock and poultry	872	481	377	1062	4483	-
Eggs, thousand pieces	1774	12822	36954	15521	23018	-
Imported to the Komi Republic:						
potatoes	1417	944	2298	2651	1703	-
vegetables	1451	1649	1331	810	1282	-
Livestock and poultry	3004	2302	1615	1012	11968	-
Milk and dairy products	48	54	51	23	920	-
Eggs, thousand pieces	29285	46189	38028	21072	33816	-

Source: Statistical collection "Agriculture in the Komi Republic", Syktyvkar. 2019

As can be seen from the table, for all types of products presented, the share of imported products is much higher than that of exported ones. On average for 2017-2022. the ratio of exported and imported products for their individual types is:

potatoes - 1:96.9; vegetables – 1:34.6; livestock and poultry – 1:2.7; eggs – 1:1.9. During the analyzed period, there was no export of own production of milk and dairy products outside the Republic by agricultural organizations, and the import of these products had a certain increase, i.e. from 48 (in 2017) to 920 tons (in 2022). This trend in the import and export of food is observed in almost all regions of the north. This indicates not only a significant lag in agro-industrial farming, but also a loss of incentive in entrepreneurial activity.

The study confirmed that during the years of reform, new but not yet fully established categories of economy were unable to provide a sufficient level of production efficiency. The low level of competitiveness of their commercial products slowed down the processes of transition to external food markets, the search for effective market niches and adaptation to them for a long period of time. All this suggests that the slow pace of production activities of agricultural enterprises does not allow improving the state of technical and economic indicators, applying the principles of expanded reproduction, increasing the scale of own production and improving the quality of marketable products.

It must be emphasized that the structural integrity and functional feasibility of the agro-industrial complex of the northern regions largely depends on the correct regulation of prices. The above circumstances indicate a regular analysis of the formation of prices for food products, identifying key factors affecting pricing. As a rule, correct consideration of pricing factors and their rational use makes it possible to enter the market with lower costs and high competitiveness of agricultural and food products. This suggests that, despite all the circumstances, the fate of all economic activities of the agro-industrial complex is determined by adaptation to markets with an acceptable price.

A significant increase in market competition activates the development of intellectual activity in the agro-industrial complex, stimulates the manufacturer to apply the latest achievements of scientific and technological progress, and improve the quality of manufactured products. The main task in this case is to correctly justify prices, taking into account all general business expenses, such as: the totality of material and intangible assets used, management costs; rental costs; expenses for paying off taxes and debt obligations; costs associated with transporting goods, carrying out recreational environmental work, and a variety of infrastructure and other services used.

A characteristic feature in the pricing of the agro-industrial complex is that when setting product prices, in addition to total costs, a certain addition to the price is also taken into account, calculated at the level of profitability that could ensure normal profit for the further operation and resumption of reproduction of agro-industrial enterprises. More accurate accounting of periodic changes in production costs - rising prices for acquired tangible and intangible assets, increasing

rents, increasing the tax burden and rates on debt obligations makes it possible to correctly formulate the cost and cost of goods produced. When forming the selling price of goods, the competitive mechanism must determine the level of consumer demand for a specific product and take into account the degree of influence of various market price factors, especially infrastructural ones.

The fact is that pricing of the agricultural sector plays a huge role in increasing the efficiency of technical and economic indicators. It is directly proportional to increasing the efficiency and competitiveness of economic entities in the agro-industrial complex. Pricing factors are not only “determinants” of selling prices, but also estimated indicators of improving the quality characteristics of manufactured goods. As a rule, a high price, to one degree or another, creates high competitiveness and creates a favorable atmosphere for further improving the reproductive characteristics of agricultural sectors and enterprises. Let’s consider the producer price indices of agricultural products sold by agricultural organizations in the regions of the European North-East for 2018-2022. (Table 3).

Table 3

Producer price indices of agricultural products sold by agricultural organizations of the European North-East, December versus December of the previous year; average (%)

Indicators	2018	2019	2020	2021	2022
Agricultural products	114.1	111.8	105.2		104.5
Crop products	113.5	97.5	87.5	139.3	84.2
Potato	112.1	91.4	96.5	115.3	81.9
Vegetables	113.7	98.1	85.2	142.2	84.4
tomatoes (tomatoes)	121.2	118.8	92.6	119.3	73.3
cucumbers	107.1	88.9	81.3	169.2	82.7
cabbage	140.0	107.1	86.7	76.9	220.0
Livestock products	114.1	112.7	106.1	88.9	105.7
Livestock and poultry (live weight)	118.6	110.7	106.0	85.6	102.4
cattle	108.7	113.0	102.9	103.3	101.7
poultry	119.2	110.6	106.2	85.0	100.1
Raw cattle milk	110.7	116.1	111.5	106.4	103.2
Chicken eggs	91.9	122.6	95.8	88.5	137.6

Source: Statistical collection “Agriculture in the Komi Republic”, Syktyvkar. 2019

As can be seen from the table, for the period 2018-2022. The price index for agricultural products in the Komi Republic and the Arkhangelsk region was uneven and unstable. Based on the analysis, it was revealed that, depending on various

natural, climatic, financial, economic and market circumstances, price indices for these regional agricultural products fluctuated from 91.0 to 114.1%. This fluctuation in crop production, covering a wide area, was in a strong fluctuation - from 84.2 to 139.3%, than in livestock production - from 88.9 to 114.1%. The highest range of fluctuations in product prices was in crop farming (for vegetables), and the lowest in livestock farming (for meat and milk).

It was determined that the slow pace of acquisition and use of fixed assets of production, ineffective methods of using land and labor resources in agriculture in most regions of the north were accompanied by an active decrease in production volumes, the release of workers from production and the acceleration of the process of outflow of professional specialists from rural areas to cities. The narrowing of the scale of land use reduced the scale of their own production activities and sales of goods. Most of the raw materials supplied to the food industry in the northern regions were imported or imported raw materials. The analysis shows that the rate of supply of raw materials to the food industry of these regions from outside is growing faster than the rate of renewal and development of their domestic production. The main task today is the need to formulate an agro-industrial policy that can link the interests of industry with the agrarian sector of the agro-industrial complex of the northern regions, ensuring the effectiveness of their interdependent parameters, allowing the development of appropriate programs for joint and effective interaction [3, p. 46].

A special task today is to develop intersectoral interacting agro-industrial concepts for the agro-industrial complex of the northern regions, establishing close ties with both government agencies and financial organizations (especially banking). At the same time, an important role belongs to strengthening ties with research institutes in order to introduce new production technologies. A special role belongs to regular state support for the development of agriculture in the regions of the north, the formation of their optimal sectoral structures for active participation in the cluster behavior of the agro-industrial complex. Consequently, the basis for strengthening the cluster behavior of the agro-industrial complex of the northern regions is the periodic development of their intersectoral model, which optimizes the activities of interconnected agro-industrial spheres and enterprises [4, p. 150].

We must not forget that with the development of scientific and technological progress and the expansion of the scale of production and range of products, the population's need for essential food products is growing, and new requirements for the products produced and services provided appear. Since the different needs of the population for the produced agri-food products and the actual conditions for their competitiveness force commodity producers to produce higher quality goods with high utility. A successful solution to this problem is possible only by

improving the technical and economic condition of agricultural enterprises in the northern regions, restoring their expanded reproduction - ensuring the integrity and efficiency of the main inter-industry technological chain.

It follows from this that, among all the problems, improving the structural composition of the main technological cycle of the agro-industrial complex - starting from the development of the project and its financing, as well as the conduct of production activities to completion, an effective marketing service and the full repayment of debt obligations - is of particular importance. In the broad sense of the word, an agro-industrial cluster should be understood not only as a territorial “industrial-agrarian” association, but also as an effective partnership with scientific institutions, financial organizations, and government agencies, the integration of which makes it possible to purchase high-tech industrial products and services used in the agro-industrial complex, optimal use of economic resources and strengthening competitiveness in general [5]. Consequently, the industrial cluster of the agro-industrial complex is a complex system, which may include many areas and objects (production, non-production, service, scientific, educational, environmental, infrastructure, market and others) in order to perform specific agri-food tasks - providing the population with the required volume and food quality.

In summary, we note that from the point of view of a theoretical and practical approach, improving technical and economic indicators and ensuring priorities for the formation of expanded reproduction of the agro-industrial complex should have the following qualities: a) systemic action - the creation of a reliable guarantor to ensure equal relations and incentives between interdependent areas and enterprises of the agro-industrial complex ; b) effective management of the development of the main factor components of the agro-industrial complex (capital, labor, land), improving methods and mechanisms for using operating assets of enterprises, accelerating the speed of turnover of exploited resources, achieving high returns from business projects and processes; d) an active transition to electronic document management, the creation of information systems for processing and analyzing data and their prompt transmission; e) formation of planning and forecasting systems for the strategic development of the agro-industrial complex; f) ensuring reliable analysis, accounting and control over the main areas of agricultural activity, ensuring an active transition to digitalization; g) achieving highly efficient technology for managing agriculture and livestock; h) the desire for an active transition to international standards of production and market activity.

Consequently, in order to solve the set tasks of the agro-industrial complex of the northern regions, the main emphasis should be on eliminating the systematic underfinancing of the agro-industrial spheres and achieving a high degree of technical and technological equipment of agricultural enterprises. At the same time, government support for strengthening economic relations between agriculture, the

food industry and the commodity market should be accompanied by increased rates and increased volumes of food production. This means that agricultural organizations must apply modern techniques and technologies, expand intellectual activity, and meet the requirements of processing enterprises for the required volumes and quality of raw materials. Only in such circumstances can we achieve certain successes and meet the needs of the population for the required volumes and quality of food.

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DOI 10.34660/INF.2024.50.31.084

DEVELOPMENT OF ECONOMIC CULTURE AND FINANCIAL LITERACY IN CITIZENS

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Abstract. *The main purpose of the research is to study the basic concepts in the field of economic culture, including financial literacy, as well as to substantiate the role of national economic education in the system of building a competent and conscious economic behavior of citizens, in increasing their level of knowledge in the field of economics and finance.*

To achieve the goal of the study and obtain objective results, the following tasks were set and fulfilled: the concepts of economic culture and financial literacy were studied, the requirements of national educational standards in terms of the formation of universal competencies and learning outcomes were disclosed, the important role of a higher education institution in improving economic culture and developing financial literacy of the population, problematic aspects of the education system and the formation of educational programs have been identified, a model for the formation of universal competence in the field of economic culture and financial literacy has been proposed, possible risks have been identified, a list of measures has been developed to improve the economic culture and financial education of citizens through the education system.

Keywords: *Economic culture; financial literacy; economic education; universal competence; income; expenses; saving; standard of living.*

Introduction

In order to understand the essence of economic phenomena and be able to correctly assess (analyze) specific economic situations, it is necessary to develop economic thinking, which can be achieved by obtaining economic education and universal competencies in the field of economic culture, including financial literacy.

It is very important to substantiate the role of national economic education in the system of building a competent and conscious economic behavior of Russian citizens, in raising their level of knowledge in the field of economics and finance. Disclosure of the requirements of national educational standards in terms of the formation of universal competencies and learning outcomes makes it possible to identify problematic aspects of the education system and the formation of educational programs. Assessing the problems and risks associated with this [7], it is quite possible to determine the optimal model for the formation of universal competence and ways to improve the economic culture and financial education of citizens through the education system [2].

Methodology

Economic culture is a system of values and motives of economic activity, respect for any form of ownership and commercial success as a great social achievement, success, rejection of the mood of “equalization”, creation and development of a social environment for entrepreneurship [13]. To increase the level of economic culture of a person, it is important to constantly increase knowledge in the field of economics, acquire skills and abilities as a result of making economic decisions.

Financial literacy is the ability to understand and effectively use various financial skills, including personal finance management, budgeting of income and expenses, investing free resources [6].

Economic and financial education is a continuous process of acquiring knowledge and certain competencies in the field of economics and finance at all stages of the educational process [3], the ability to make correct and informed management decisions, perform effective actions to improve financial well-being and ensure the protection of their interests, as well as the effectiveness of business processes of business entities [11]. Knowledge and ability to operate with key economic and financial concepts makes it possible to competently manage your money, for example, keep records of income and expenses [4], plan a personal budget, create savings and savings, as well as navigate the products and services offered by financial institutions [9]. That is, to be a conscious consumer. People with financial literacy tend to be less vulnerable to financial fraud [5], which has been gaining serious momentum recently and affects vulnerable groups of the population. Given the importance of finance in modern society [8], the lack of financial literacy can seriously damage a person’s long-term financial success [1].

All this allows us to conclude that the role of higher education institutions in improving the economic culture and financial literacy of the population is really high. Currently, in the educational sphere, in accordance with the adopted Federal State Educational Standards of Higher Education (hereinafter referred to as the FGOS VO), a competence-based approach is widely used in practice. In the Main Professional Educational Programs of Higher Education (hereinafter referred to as OPOP VO) in any direction (profile) of training, universal, general professional and professional competencies are provided, allowing graduates to be endowed with knowledge, abilities and skills (hereinafter KAS) in various fields and spheres of life. Thus, in the field of the formation of students' economic culture, including financial literacy, there is a universal competence of UC-10 (according to some FGOS – UC-9), which forms students' ability to make informed economic decisions in various areas of life.

In our opinion, the universal UC-10 competence should be formed by studying not one discipline, but several. The process of increasing the results of training in the UC-10 competence will occur gradually from semester to semester throughout all years of study. Moreover, at the initial stage of competence formation, basic knowledge will be given. Further, within the framework of studying the disciplines of later semesters, as well as in the process of preparing coursework in the direction (profile) and internship, it is assumed that the development of competence at an advanced level and the acquisition of skills and abilities by students is expected. We believe that the formation of the universal UC-10 competence in the framework of elective disciplines involves the acquisition of deeper knowledge, abilities and skills in the field of economic culture, including financial literacy by the students interested in economics and finance. At the same time, the requirement to include optional subjects in the curriculum of the OPOP is optional for the program developer and should not violate the unified approach to the model of formation of universal competencies within the framework of mandatory disciplines.

Results

The proposed model for the formation of universal competence in the field of economic culture, including financial literacy, on the example of the OPOP VO implemented in the IUEF KFU according to the Enlarged Group of Specialties and Directions 38.00.00 "Economics and Management", is presented in Table 1.

Table 1

Model for the formation of universal competence in the field of economic culture, including financial literacy

Field of education	Enlarged group of specialties	Direction of training	Discipline, practice	Status (mandatory, elective, optional)	Semester	Total labor intensity (hours/credits)
5 - Social Sciences	38.00.00 Economics and Management	38.03.01 Economics	Module “Economic Culture and Financial Literacy”	Mandatory	1,2,3	576/16
		38.03.02 Management	OD.1. Microeconomic theory	Mandatory	1	216/6
			OD.2. Macroeconomic theory	Mandatory	2	216/6
		38.03.03 Personnel Management	OD.3. Finance	Mandatory	3	144/4
			OD.4. Real economy: state and development trends	Mandatory	4	108/3
		38.03.04 State and municipal administration	Module «Economics and personal finance»	Optional	5,6,7	324/9
			FD.1. Management of socio-economic development	Optional	5	108/3
			FD.2. The modern financial system	Optional	6	108/3
		38.03.06 Trading business	FD.3. Management of personal savings and investments	Optional	7	108/3
			Familiarization practice	Mandatory	6	108/3
			Preparing for and passing the state exam	Mandatory	8	108/3

The main advantages of the proposed model are clearly presented in Figures 1-4. In our opinion, the following aspects are very important: a competence-based approach to the formation of any educational program, the gradual development of universal competence, the orientation of learning outcomes to the demands of time and their educational and methodological support, a multi-level point-rating system for assessing competence.

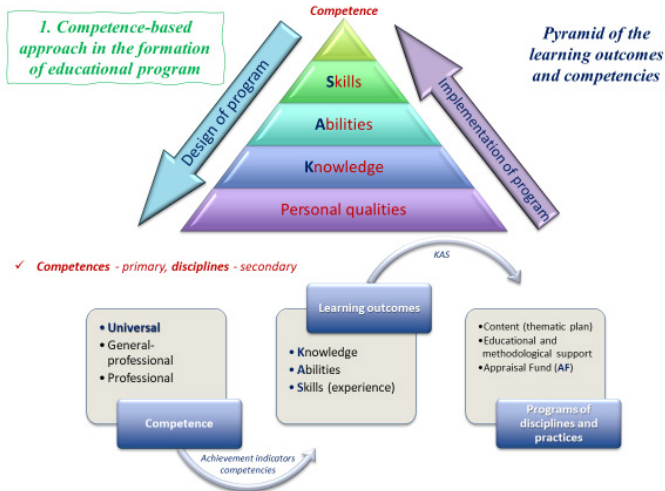


Figure 1. Advantage – Competence-based approach in the formation of OPOP VO

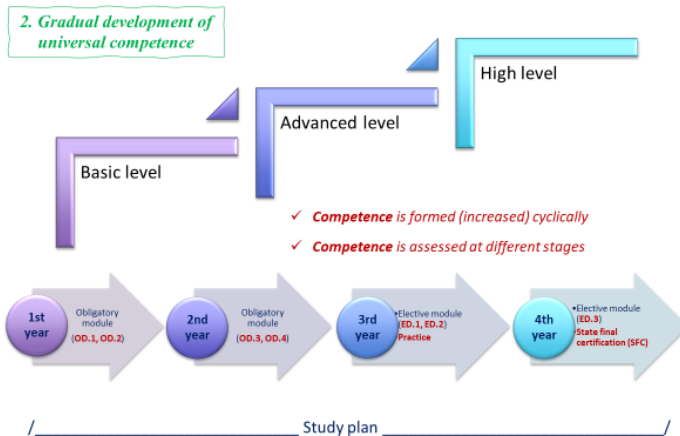


Figure 2. Advantage – Gradual development of universal competence

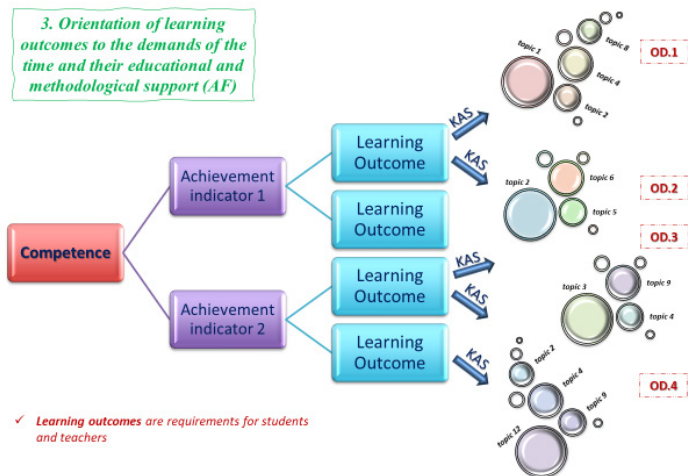


Figure 3. Advantage – Orientation of learning outcomes to the demands of the time and their educational and methodological support (assessment funds)

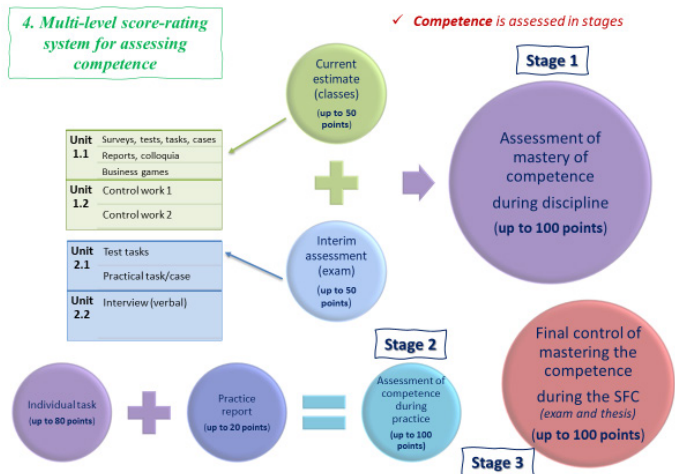


Figure 4. Advantage – Multi-level score-rating system for assessing competence

Conclusions

Despite these demonstrated advantages of the proposed model, it should be noted that any processes that affect changes in the educational block require additional labor and time costs. Such interventions in the educational process may entail certain risks. Possible risks of the model proposed for implementation and ways to solve problems are presented in Table 2.

Table 2

Problems that need to be solved in the transition to the proposed model of the formation of universal competence in the field of economic culture, including financial literacy

Problems and risks	Ways to solve problems and minimize risks
<p>At the initial stage of the implementation of the new model, the following problems may arise:</p> <ul style="list-style-type: none"> - additional costs for the coordination of curricula (labor and material costs); - additional costs for the coordination of the work of the team of teachers, the consistency of the work programs of disciplines according to the planned learning outcomes, the funds of evaluation means, the sequence of study (workload and time costs); - additional costs for professional development of teachers involved in the implementation of the new module on economic culture and financial literacy; - additional costs for attracting practitioners to improve the quality of teaching and provide practical skills in the formation of universal competence; - problems related to the optimization of educational and methodological documentation on disciplines within the module of economic culture and financial literacy; - problems related to the search for resources to perform tasks for the transition to a new model; - the risk of getting the opposite effect from the introduction of a new model. 	<p>The main ways to solve problems and minimize risks:</p> <ul style="list-style-type: none"> - using existing structures (departments, centers) that were already created earlier and that are currently functioning (for example, the center for the support of the educational process and the Educational and Methodological Commission - to coordinate the process of implementing a new model); - the use of the existing teaching staff - to ensure the educational process; - involvement of external practitioners to participate in the educational process; - creation of a unified database of organizations that can potentially accept students for practice, conclusion of long-term contracts with them and constant replenishment of the database; - preliminary forecasting of all additional costs for the implementation of the new model in order to plan expenses in advance and find sources of financing in order to avoid a negative economic effect.

To minimize risks and eliminate various types of losses, it is possible to develop a Roadmap for the transition to the proposed model for the formation of universal competence in the field of economic culture, including financial literacy. The

roadmap should reflect two aspects: organizational and methodological. This will allow you to consistently perform certain actions in order to efficiently and effectively complete all assigned tasks and achieve the final goal as quickly as possible.

Inference

As mentioned above, the key aspects of financial literacy include knowing how to make a budget, plan retirement, manage debts and track personal expenses. As the financial markets become more complex, financially educated people contribute to their effective functioning [12]. Economically savvy and financially educated people with critical thinking and the ability to compare and assess risks for certain financial products offered by financial institutions develop competition. With the increasing level of financial education among the population, the number and quality of innovations in the world of finance is increasing, thereby encouraging financial providers to develop newer products and services. Also, a low level of financial literacy leads to an increase in the number of economic crimes in financial markets. Thus, obstacles to the legal conduct of business are formed [10] and the tendency to switch to illegal increases. In this regard, the role of economic education is an undoubtedly important element in the system of formation of economic culture and financial literacy among the population.

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HISTORY OF ECONOMIC TEACHINGS OF INDIA: THREADS

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Abstract. *The article examines and analyzes the threads of economic science in India. A detailed analysis of this concept is the fundamental basis for studying the history of economic teachings in India, containing a large conceptual apparatus.*

Keywords: *threads, India, Indian economy, history of Indian economic teachings, Indian economic science.*

Threads are economics. In Indian philosophical literature, the threads are the idea of resource allocation and forecasting reserves, the dharmashastra (code) of distribution balances. Niti comes from the root *ni = to lead, guide, direct. The concept of "threads" is widely used in Sanskrit-Vedic literature, but there is enough evidence that its origin and first outbreak occur during the ancient Indus civilization.

In the Atharva Veda, niti means "to lead towards clear goals; to lead with constantly visible goals." In this book and other derivatives, the threads already give an idea of the very well collected moral and political thought on which the first Ario-Dravidian kingdoms of ancient India were founded and organized. So, for example, in this context words such as nitimat are used - "a person of impeccable behavior", and therefore "a good guide of people." Nitha - "a skilled strategist, possessing intelligence and cunning." Somewhat later, in the works of the 6th and 5th centuries BC. BC, the concept of "nityukta" was used to designate a leader who wisely leads his community, "causing goods to multiply."

At the time when Aristotle lived in Greece, in India it was well understood that the benefit of existing goods and their distribution is a matter of higher wisdom. The collection of goods, the possibility of increasing them and improving their distribution - this is what interests Threads; of course, in connection with Dharma, the Law operating at the human level within the framework of social organization (without violating or impeding the freedom and autonomy of the individual). The search for individual salvation is the great theme of India.

In classical Brahmanism, Dharma is Law. References to Dharma originate in the earliest works of Sanskrit literature. Aivankhov O.M. begins his famous study

by comparing the use of the concept of Dharma from the early Vedas to the Upanishads and testing its application in the organization of Indian kingdoms in the centuries before the Christian era [1].

Dharmasastras, Arthasastras, law and politics. Without going into the subtleties of the texts, we can say that what was achieved in India is comparable to events in China, where in moral philosophy the greatest good was considered to be the unification of the feelings of the people around a just and wise king. Any distribution of wealth not supported by such a premise was understood as a waste of goods and energy. Chinese writers have been rediscovered by modern economic strategists. Tsung Tzu is required reading in MBA courses, from Kellogg to Chilean universities; but no one still uses the Nitisastras, which are much more brilliant than the Chinese works [2].

Dharmashastras are the principles of the Law. In written form, they are collections of codices, the compilation of which began around the 6th century BC. They are written in the form of maxims and their subject is Dharma, Law, duty in the most absolute sense. The Dharmashastras are a body of Brahminical tradition, that is, they stem from the highest Hindu orthodoxy and have existed since the earliest times. In themselves they constitute a highly complex scholastic system which forms the basis of all Indian jurisprudence and, by historical expansion, of much of South Asia. The Dharmashastras are sometimes criticized as an intellectual construct invented by the Brahmins to control the lower castes. However, a careful analysis of the context and a thorough knowledge of the sources, as well as the historical process through which they were formed, allows us to see that there is a legal basis for everything in the Dharmashastra corpus.

If the Dharmasastras are the legal foundations, then the Arthasastras are the application “for the proper management of society and for achieving wealth and a blissful life in society.” Unlike the Dharma texts, the Arthasastras are more limited and even refer to a single author, Kauciliya (321 - 296 BC). Kaucilius was a famous writer who compiled all practical knowledge for the good and ideal management of a kingdom (a collective enterprise, as we would say today), the obvious goal of which is the prosperity and happiness of the participants. Kauciliya was a man of action. He was a minister and government secretary to King Chandragupta Maurya (321-297 BC), founder of the dynasty that, following his surname, ruled Northern India from its capital Pataliputra (modern Patna). For Kaucilius, the threads are the fundamental principle on which royal distributive justice is built.

Empire of good versus political empire. Chinese philosophical and moralistic thought found application in empire building. However, the events that culminated in the dominance of the Qin kingdom over all other kingdoms are precisely such a development. The empire created by Qin Shi Huang can find a good Western analogue in the tricks and machinations of Julius Caesar, who came to power and created the conditions for the empire that Caesar Augustus would later build.

In China, Qin Shi Huang achieved territorial power through constant threat; in this way he created colossal political centralization. But it was the Han Dynasty that developed and proclaimed the semi-religious basis of the “Celestial Empire,” which for this reason was able to exist for four hundred years (from 206 BC to 220 AD). In India, Kautiliya, the “ideologist” of the throne of Chandragupta Maurya, proposed ideas for the proper administration of the kingdom, but never had in mind a philosophical and political basis that would lead the king to proclaim universal power. Interestingly, his grandson, Ashoka, did this and succeeded. True, for this Ashoka relied on another political mysticism. Ashoka became a Buddhist and built the first Buddhist empire in history. Ashoka proclaimed himself a universal emperor (=Chakravartin, something like a political Buddha) and made Buddhist laws the norm for governing the empire.

For classical Brahmanism, Ashoka’s act was a political aberration because a universal law that equalizes everyone and rules the whole world without falling into great injustice will never be possible. People are inherently different and therefore creative, and this is the secret of wealth. This is why Ashoka’s empire was short-lived and fell apart after his death. India has taken the opposite path to China. No one in India tried again to build a universal empire, at least until the advent of Islam, which claimed to have the necessary concepts: a single community and a universal kingdom (Islam), under a single command (caliph) and a single religious law (Sharia). In contrast, Hindu philosophical and moral thought rarely sought application in real politics, but remained a pure abstraction.

Hindu philosophical-moral thought went deeper, and although it did not attempt to do so, it sought a universal and timeless status, not for the creation of a political empire, but for the achievement of common goods desired by all mankind. Goods, for the possession of which it is necessary to demonstrate the highest creativity. This is why Chinese thought is better suited for political purposes, while Indian thought is better suited for philosophical, psychological, economic and social purposes.

Good governance is about justice and prosperity. Daṇḍaniti is a benevolent and correct distribution that makes possible the reign of justice, which today is more or less the idea of the rule of law. However, it is very significant that for Indian thinkers considered to be the fathers of Hindu law, such as Gautama, Manu or Yajñavalkya, distribution, the proper distribution of resources, is inseparable from the idea of “rigor and severity in punishment”. Daṇḍaniti is also the power of punishment, precise and at the right time [3].

The good kingdom (Rashtra) rewards everyone according to their deserts, promotes the performance of duty (protects work), persecutes and punishes with exemplary severity those who break the rules, interfere with or interfere with the performance of duty by others. In the style characteristic of the time, it was as-

sumed that it was proper for good government to suppress with all severity and, if necessary, destroy non-holders or those who violate good morals and thereby betray the sense of social community. And in the next paragraph he adds that the king “must always be ready to give and facilitate the flow of goods, and to punish with the utmost severity.” Although this frightening aspect of the good kingdom is balanced by the protective zeal of science and art. It is fitting for Rashtra, a righteous kingdom, to invite sages (acharyas) to advise the government and help interpret the Dharmasastras correctly and competently.

Kosha, wealth that rains down. The Nityashastras agree that if politics is aimed at good governance and ensuring the happiness of the subjects of the kingdom, then the acquisition of wealth - kosha - in abundance has more subtle reasons. Kosha falls like rain from the sky when there is moral perfection, respect for the Brahmins and observance of the rules that society imposes on itself through customs and popular sanction. The study and cultivation of the thread, called “Danasastra”, “Nitisastra” or others, was the main task wherever Hinduism took root. This was the case, for example, in Thailand and throughout Southeast Asia. Notwithstanding the later tensions between the Mohammedans and the Hindus, either during the centuries of the Delhi Sultanate, or later under the Mongols, close attention to moral speculation and its application to means of increasing wealth was a constant activity in the most respected monasteries, Mahasthanas, Mathas, Brahmakulas, Vidyakulas, ashrams and other academic and scholastic institutions in India. Many respected teachers were advisors to the Mughal rulers and it is said that the great Acharya, associated with the very orthodox Jyotismatha school, made the great Emperor Akbar rich and powerful with his precise advice and creative mind.

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FAMILY LEGAL PREVENTION OF NEGLECT OF MINORS

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Currently, the situation with asocial families needs to improve the prevention of neglect of minors, taking into account the current needs of the family, society and the state. One of the socially significant tasks facing our state at the present time is to find ways to reduce the increase in crimes among the younger generation and prevent antisocial families.

In 2021, 679 thousand minors became participants in crimes in the Rostov region, and in 2023 already 856 thousand (Fig. 1).

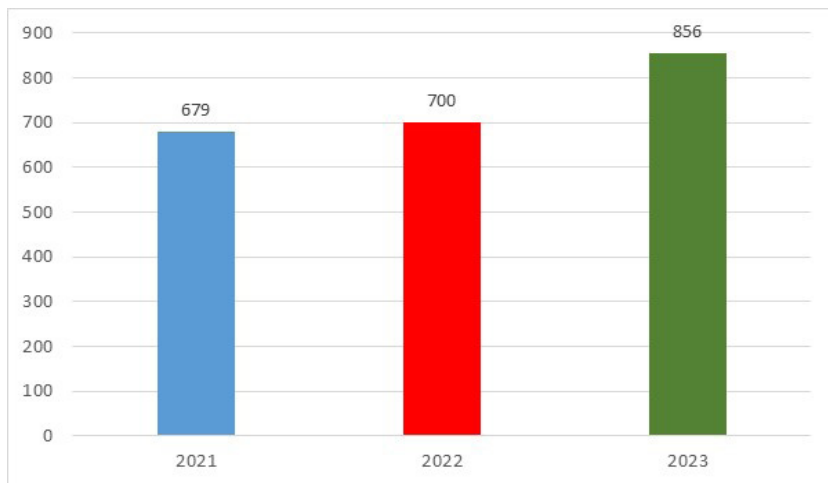


Figure 1. Number of street minors in the Russian Federation (thousand people) [4]

Thus, over several years, the number of such participants in crimes does not decrease, but increases. It should be noted that most crimes are committed by neglected children with deviant behavior, leading an antisocial lifestyle, drinking alcohol and drugs.

An analysis of the reasons for the growth of neglect among adolescents and children indicates that its origins lie primarily in the family, and parents, as legal representatives of minors, do not perform the educational functions assigned to them by legislation, Article 63 of the Family Code of the Russian Federation [1].

The state family policy of the Russian Federation is aimed primarily at supporting, strengthening and protecting the family as the fundamental basis of Russian society, creating traditional family values, increasing the role of the family in the life of society, preventing and overcoming family dysfunction [5].

As an analysis of statistical data and materials from news media sources shows, despite the measures taken by Russian legislation, the growth of asocial families has been increasing in recent years. The problem of dysfunctional families in Russian society poses a threat to children living in such a family.

The socio-psychological causes of crimes include lack of attention, love, and support for the child in the family. Absence of parents due to being immersed in work, career, solving one's problems. Deprivation of parental rights, stay in prison, increased divorce of parents, and fundamental refusal to raise a child. All this, in our opinion, negatively affects the psychological development of a child who does not receive enough attention, warmth, love, care, as a result of which children go to look for «authority» and support in other places, encounter the street, its rules, antisocial laws.

Socio-economic reasons, which include poverty, sale of housing by parents, disposal of child benefits in their own favor, as a result of which the legal rights of a minor are violated, the child «gets lost», crosses the line of the law, begins to «get» his own food, means of subsistence, thereby violating Chapter 11 of the Family Code of the Russian Federation, dedicated to the rights of children [1]. According to Article 18 of the UN Convention on the Rights of the Child, parents have general and primary responsibility for the upbringing and development of the child. They are obliged to think first of all about the interests of the child [3], but parents violate the rights of their children when they use maternity capital and benefits not for the needs of the children, but for themselves. As a result, underage children go hungry, wear torn clothes, do not receive proper medical care, quality education, and remain homeless.

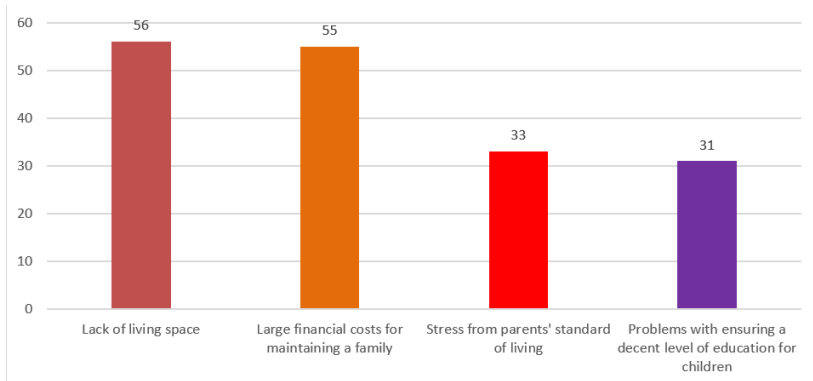


Figure 2. Problems of families in the Rostov region

Statistics show that parents are concerned about the lack of living space (56% of respondents), people are concerned about the high financial costs of maintaining a family (55% of respondents), stress from the standard of living of parents (33% of respondents), problems with providing children with a decent level of education (31% of respondents), etc. (Fig. 2).

Minors commit crimes because they want to live better than others, thinking that by crossing the line of the law, they will have money, they will be able to afford what they lack in the family. By intimidating younger children who will be afraid of them, they gain so-called «authority», gain power, and create their own antisocial «gangs».

It seems necessary to propose creating special projects at the level of state support for Russian youth, where they can realize themselves, show their skills, and create new scientific ideas for the future society. During the project, teenagers will be able to gain new knowledge, communicate with peers, they will develop common interests, and not disappear on the street and not break laws. The state will be required to provide financial assistance to minors, which can be spent not on alcohol and drugs, but invested in your project to promote your ideas.

For minors who have problems with the law, in our opinion, special organizations should be created that will not only conduct preventive conversations, but will also have the opportunity to work and earn money legally. When a person receives a salary, he understands that he earned it himself, through his own efforts, skills, and abilities. There will be an interest in gaining more knowledge, skills, and mastering a profession in order to increase earnings.

The state ensures the provision of assistance and support to victims of violence through the establishment of crisis centers. Crisis centers are not uniform in their functions. Thus, the specialization of some of them is the provision of consulta-

tions with specialists (mainly the provision of legal assistance), employment of citizens who seek help; others serve as a temporary place of residence for people who find themselves in difficult life situations [6].

In our opinion, prevention of neglected minors must begin with the family. We must save and preserve children during the demographic problem. Members of asocial families, as we indicated earlier, are often characterized by aggressiveness and hot temper; in such families, there is a high probability of an environment of domestic violence, both physical and psychological.

In accordance with Art. 4 of the Federal Law «On the basics of the system for the prevention of neglect and delinquency of minors», the system for the prevention of neglect and delinquency of minors includes: commissions for the affairs of minors and the protection of their rights; social protection authorities and social service institutions; bodies exercising management in the field of education and organizations carrying out educational activities; guardianship and trusteeship authorities; health authorities and medical organizations; and other divisions [2].

It should be noted that guardianship and trusteeship authorities practically do not prevent antisocial families and do not identify them. The chairman of the HOA or the management company must notify the guardianship and trusteeship authorities when they see street children on the streets, hear noise in apartments, or see beaten and dirty children. And until such families are registered, we do not know in what conditions the children are and live, and we cannot help them.

According to paragraph 1 of Article 2 of the Federal Law of 24 June 1999 № 120-FZ «On the fundamentals of the system for the prevention of neglect and juvenile delinquency», the main objectives of the activities for the prevention of neglect and juvenile delinquency are: prevention of neglect, homelessness, delinquency and antisocial actions of minors, identification and elimination of the causes and conditions conducive to this; ensuring the protection of the rights and legitimate interests of minors; identification and suppression of cases of involvement of minors in committing crimes, other illegal and (or) antisocial actions, as well as cases of inducing them to suicidal actions [2].

Today, asocial families live according to the following principle: the mother was deprived of parental rights according to the rules of Article 69 of the Family Code of the Russian Federation [1] due to a riotous lifestyle and inappropriate home conditions for the child's life. But she gives birth to children again and history repeats itself. The way of life does not change, children do not receive maternal love, care, upbringing, education, but are simply transferred to state education. Such children live on their own, as a result of which minors commit crimes. We live by the principle of «punishing» and not healing. Sometimes a person needs to be given a possible option so that he can improve. Even if we save one family per 100 people, this will be an achievement of the work of government agencies.

Only from high-quality state-family policy for the prevention of antisocial families will there be a healthy society.

First of all, we must start with each family that needs prevention; it is not always a good family, but there is a good one. Even in a good family, terrible situations happen. Children do not trust psychologists at school. For example, a 12-year-old girl was isolated from the class, lived in some kind of her own world, either she invented it herself, or something happened. Before this, not a single teacher was interested in the girl's problem. The young teacher went to visit, met all the family members, saw how they lived, and then after class the girl told the teacher that she had been raped by her own father since she was 5 years old.

When she talked about herself, she noted that every family probably lives according to this principle, she hated everyone. The young teacher helped contact law enforcement agencies, and the parents were prosecuted. It should be noted that no amount of time can cure this child. She will hate men; in the person of her mother, she hated a woman who could not protect her daughter from her own father. The child withdraws, does not play, and suffers every time when his mother leaves and she stays with his father.

The situation of a child who is a member of an asocial family deserves special attention. Thus, a minor who is deprived of parental care, who does not receive the necessary medical care and education, and who is brought up in a negative psychological environment, risks becoming one of the marginalized people in the future. A significant role in monitoring the implementation of the rights of minors is played by the activities of guardianship and trusteeship authorities in accordance with current legislation.

All of the above will, in our opinion, allow us to resolve problems that arise in the family, improve the health of the family, and most importantly, children will live with their parents, and the family will develop as a social institution in our society.

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TRAINING “WORKING WITH THE NOTION OF “INCLUSIVE EDUCATIONAL PROCESS”

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Abstract. *The article proposes a training option aimed at teachers formalizing their idea of an inclusive educational process based on essential features instead of external ones. The results of the evaluation of the pilot test are presented in comparison with the results of using other strategies for working with groups of teachers to formulate their ideas about inclusion.*

Keywords: *advanced training for teachers, training, work in microgroups, the process of concept formation, inclusive educational process.*

Our deep conviction is that the restructuring of education in Russia towards its humanization, orientation towards the individual needs of each participant, which is directly related to the ideas of educational integration and inclusion, is impossible without a deep understanding of the essence of the inclusive educational process. Unfortunately, in practice we observe the predominance of a superficial idea of inclusion, focused on purely external signs (the presence of children with disabilities in an educational organization, the presence of documents in the form of developed individual educational routes for children with disabilities, the presence of a ramp in an educational organization, etc.). Therefore, elaborating teachers' ideas about inclusion, forming their definition of an inclusive educational process based on its essential characteristics seems to be a significant task for us, which served as the premise for the development of the proposed training.

In developing this training, we started from the idea of the double stimulation method when forming concepts. The experimental genetic method makes it possible to artificially, in laboratory conditions, induce and create the genetic process of the psychological formation of a certain position, the formulation of a meaningful scientific concept. In the cultural-historical concept of L. S. Vygotsky, the experimental genetic method was used to study the development of attention, memory, and scientific concepts. However, the author himself and his collaborators failed

to reveal the entire path of transformation of external objective activity into a mental process itself, to unravel the mystery of the “rotation of a sign” [8]. Despite this, the strategy for the formation of mental processes outlined by L.S. Vygotsky became the basis for many developments in Russian psychology, including the method of step-by-step systematic formation of mental actions and concepts in the concept of P.Ya. Galperin. Developer of the theory of developmental training V.V. Davydov wrote: “the experimental genetic research method introduced by L. S. Vygotsky and his colleagues naturally turned into a formative experiment method or a genetic modeling method in which design plays an important role” [5].

For the first time, the double stimulation method was used in a joint study by L.S. Vygotsky and L.S. Sakharov when studying the process of concept formation. The essence of the method is that the study of higher mental functions is carried out using two series of stimuli, each of which plays a special role in relation to the activity of the subject. One row of stimuli performs the function of an object towards which the subject’s activity is directed, and the other row performs the function of signs (stimulus-means) with the help of which this activity is organized.

In some works, L. S. Vygotsky characterized the method he proposed as objectifying: “If the “stimulus-response” technique was an objective psychological technique that limited the study only to those processes that were already external in human behavior, then our technique can rightfully be called objectifying...By bringing out those auxiliary operations with the help of which the subject masters this or that task, our technique makes them available for objective study, in other words, objectifies them” [3].

At the same time, the author calls his method instrumental, since the subject of the study is the instrumental act. “... In an instrumental act,” writes L. S. Vygotsky, “the psychological properties of an external phenomenon are used, the stimulus becomes a psychological tool due to its use as a means of influencing the psyche and behavior. Therefore, every tool is necessarily a stimulus; if it were not necessarily a stimulus, that is, if it did not have the ability to influence behavior, it could not be an instrument. But not every stimulus is a tool” [1].

In the Vygotsky-Sakharov study, figures of various colors, shapes, heights and sizes were used as stimulus-objects, and as stimulus-means - words written on the back of each of the figures, which were signs of experimental concepts (they denoted a certain set of characteristics of the stimuli - objects). During the experiment, the subject gradually revealed the features included in the experimental concept, selecting figures on which, in his opinion, the same word was written, and checking each time the correctness of his choice. Thus, the use of the double stimulation method made it possible to study how the subject uses signs as a means of directing his mental operations and how, depending on the way the word is used, the entire process of concept formation proceeds and develops.

Researchers note that the genetic modeling method is a method of actively influencing the subject and promotes his mental development and personal growth [6].

“... The inclusion of symbolic functions in the operation creates conditions for a completely new nature of the connection between the elements of the present and the future (actually perceived elements of the present situation are included in one structural system with symbolically represented elements of the future), creates a completely new psychological field for action, leading to the emergence of educational functions intentions and pre-planned target action” [4]. It is also worth noting that taking into account the entire sequence of changes made to an object becomes a prerequisite for a general method in the case when it is possible to combine them into a meaningful unit of action, and this unit itself is represented in a sign-symbolic form. In this case, it becomes possible to move from a retrospective description of operations already performed to a prognostic representation of the future transformation and its expected result. Therefore, a full analysis of an object and modeling of the natural unit of its transformation is a logical and psychological condition for constructing a general method. So, in the words of L. S. Vygotsky, “thought is accomplished in the word, and is not expressed only in it” [2].

Based on the searches and positions of the founders of the method and other authors, we have developed training for teachers on mastering and discovering the concept of “inclusive educational process”. Thinking through the stages of training, we relied on the sequence of phases in the formation of the concept:

1. Natural operation phase
2. Phase of immediate transformations
3. Phase of abstraction / selection of essential features
4. Phase of sign mediation

Stages of training.

The first stage (natural operating phase) – Discovery of the participants’ ideas about inclusion:

1. The training participants are divided into groups of 4 – 6 people.
2. Discuss and formalize the definition of an inclusive educational process.
3. At the second step of the work, participants are tasked with expressing the essence of inclusion using a drawn metaphor.
4. Groups present their product (drawing) to other training participants and receive feedback: what experiences, ideas and thoughts the drawing evoked, what it is associated with. This is how authors discover that their drawing may contain meanings other than what they wanted to express. In the discussion, spontaneously formed associative complexes are problematized.

Second stage (direct transformation) – Analysis and attempts to restructure your definition:

1. Participants rethink their metaphor, adding meaning during a discussion with other participants.
2. Reformulate the verbal definition.
3. They watch the proposed series of video fragments, trying to guess where the real inclusive process is presented (children actively and with interest solve an educational problem, they are passionate and interact with each other), and which of the options is something different, although in form (there is also a child present with disabilities!) may be similar (for example, an individual lesson from a specialist with a special child who is clearly not interested in this lesson and is bored, or openly protests, which causes dissatisfaction with the specialist, which he is unable to hide), etc.
4. Having made an attempt to guess the correct connection (video fragment - assessment of the plot, qualifying it as an option “inclusion” or “non-inclusion”), participants test themselves by checking the assessment of the video fragment we proposed.

Third stage (abstraction) – Identification of essential features of the inclusive process, introduction of the second stimulus – verbal (scientific definition):

1. Identification of characteristics common to all educational processes shown in videos classified as “inclusion”.

2. Generalization and identification of indicators of inclusion.

3. Grouping indicators that are similar in meaning into larger units.

4. Working with indicators – deepening your understanding of the meanings (considering each group of indicators through the prism of at least three focuses). For example: for a selected group of indicators, we think of three different metaphors, or proverbs, or slogans that reflect the essence of this group of indicators. Then (second focus) we think through what actions of the teacher these indicators can be realized. The third focus of attention can be focused, for example, on the selection of tools for recording the parameters (indicators) of this indicator. There may be other options for focusing - there are no restrictions, the participants in the procedure themselves propose and choose them for their work.

Fourth stage (sign mediation) – Formalization of a new definition of inclusion

1. Formalization of a new definition of the inclusive process based on the identified essential features. Participants perform this part sequentially in two modes of operation. The first task is to recall, in pairs or trios, an incident from your direct experience that can be classified as an “Inclusive Process” or close to it. Describe it through the prism of the essential characteristics identified in the previous steps. A new definition of inclusion is then formalized in a group discussion.

2. Rely on the new definition of inclusion when modeling the contours of your new teaching practice. Work is done in small groups, pairs or triplets. Participants voice their professional task based on new ideas about the goals of education and

the features of inclusive pedagogy and model the general contours (principles) of their professional activity taking into account new knowledge.

Fifth stage (consolidation) – Designing elements of professional inclusive practice

At the final stage of the work, participants design elements of their inclusive educational process (classes, assignments, etc.) based on a new definition of the concept “Inclusive educational process” and using inclusion indicators.

We carried out a comparative analysis of the results of mastering the concept of “Inclusive educational process” by teachers participating in advanced training courses under the KIPK program “Supporting children with disabilities in inclusive education” (3 groups of primary school teachers, number of participants: 1 group 26 people, 2 group - 29 and group 3 22 people, respectively). Groups for training in the program were formed according to the application principle, so selection into them can be considered randomized (random). In addition, it turned out that all three groups were purely female in composition, which reduces the variability of the measured indicators, so the size of the groups can be considered acceptable for the study. The samples are also independent.

The assessment of mastery of the concept was carried out on the basis of studying the products of teachers’ activities and observation, which recorded the expressed judgments reflecting the orientation towards certain indicators of the inclusive educational process. For us, the indicator of “teachers’ readiness to work in inclusive practices” was a demonstration of focus on the essential characteristics of the process (the involvement of participants in the educational process), and not on external characteristics (the presence of a child with disabilities in the class, the availability of documentation).

The starting level was characterized by analyzing the participants’ ideas about inclusion, expressed in their definitions of the inclusive educational process and illustrating metaphors. The measurement method, strictly speaking, cannot be called accurate, since the work was carried out by participants in microgroups and we cannot be sure that all teachers personally had exactly the same idea as reflected in the group product of the activity.

Having completed work on the definition and the metaphor that illustrates it, the microgroups presented their product to other participants, received feedback, which often led to problematization of the meanings embedded in the drawing, pointed out the discrepancy between the metaphor and the definition itself, and pushed the authors to develop.

Further conditions for mastering the concept were different in the three groups. In the first case, after discussion, the groups immediately moved on to formulating a new definition, the assembly and “literary design” of which was handled by the facilitator. The formalized concept was then presented to participants for use. In

the course of further work, the participants turned to it, highlighting important indicators of the inclusive educational process.

The second group worked with the meanings that were recorded in the discussion on metaphors, proposing lists of indicators of inclusion. The work continued in the same microgroups, whose task was to formulate at least 6 significant indicators of the inclusive process. Then they were put on a common board, grouped according to meaning, analyzed by participants in microgroups with different focuses of attention, and proposed for use in the further design of elements of the inclusive educational process.

The third group was then immersed in the actual training procedure we developed based on the double stimulation method. When comparing video fragments and a number of verbal stimuli (“inclusive process”, “non-inclusive process”), participants were imbued with the concept of “inclusion”. The discovery of the essential characteristics of the inclusive educational process was accompanied by manifestations of “aha experiences” (exclamations in the audience, animation in discussions in microgroups), which acted as an additional signal for us about the transformation of the participants’ ideas. The participants then drew up definitions of inclusion themselves, identified indicators of inclusion, which they worked through as in the second version of the training.

At the final stage, participants of all three groups completed the task of designing elements of an inclusive educational process. The work was structured identically in all three groups and was represented by two types of activities. First, group members sketched out options for pedagogical actions and solutions for the analyzed cases of children with special needs (from video clips and then from their own practice). At this time, by recording the proposed ideas, we noted which of the participants in the work proposed what ideas: are they focused on the essential characteristics of the inclusive educational process or not? Participants then designed and described their development of an activity or task either for a specific situation (for a specific child in their practice) or for a case situation. Then we assessed the quality of this product according to the same criteria (the extent to which the proposed activity or task reflects an orientation towards the essential characteristics of inclusion or whether it remains focused on external characteristics). A comparative analysis of the shift in understanding the essence of inclusion in all three groups of subjects can be seen in the histogram (see Fig. 1 and 2). For comparative analysis, data were converted into percentages because the number of participants in the groups varied.

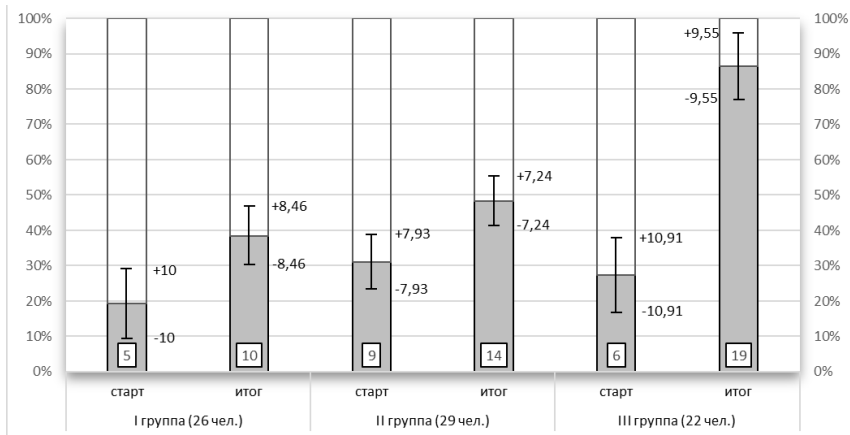


Figure 1. Comparative analysis of the shift in understanding the essence of inclusion among participants in advanced training courses

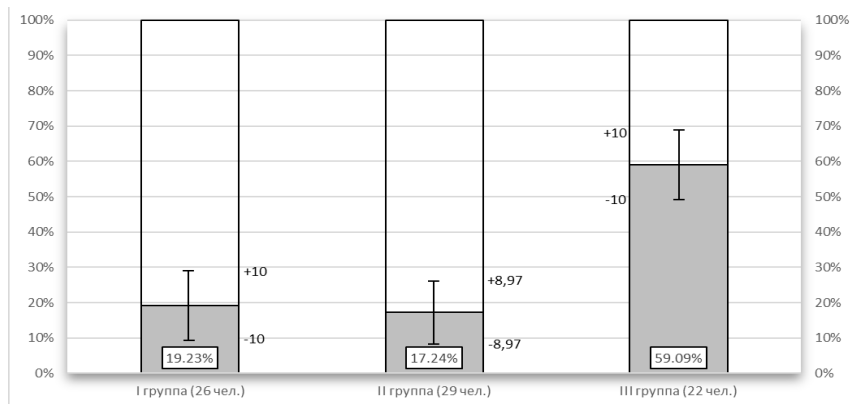


Figure 2. Comparison of shifts in the understanding of inclusion among participants in the three groups

We assessed study participants’ understanding of the essence of the inclusive process by recording the number of participants who demonstrated a high score (application of the essential characteristics of inclusion). The statistical null hypothesis was that the types of activities offered to participants would not lead to statistically significant differences between the indicators of understanding of inclusion measured at the start and at the end of the work. The alternative hypothesis (H1) was that as a result of participation in the proposed activities, statistically sig-

nificant differences will be obtained between the results of measuring the indicator of understanding of inclusion before and after the work, namely, participation in the proposed activities will allow in a significant way (towards the predominance of orientation on the essential indicators of the process) to transform teachers' understanding of the essence of inclusion. The second-order null hypothesis was that the difference in the types of activities offered to participants would not have a statistically significant effect on the increase in the indicator of understanding of inclusion measured before and after working with participants. An alternative second-order statistical hypothesis, in turn, was that the element of training associated with experiencing the “discovery” of the essential characteristics of inclusion would play a more significant role in transforming the understanding of inclusion than other options for conditions. We tested statistical hypotheses and calculated the shift in indicators of understanding of inclusion using the Wilcoxon test [7]. A comparison of the results is presented in Figure 3. The result for group 1 (26 people) can be briefly described as that changes in the understanding of inclusion among the participants in group 1 occurred, but cannot be considered significant. For group 2 (29 people), the obtained empirical value of Temp is in the zone of uncertainty. This result can be interpreted as the fact that changes in the understanding of the essence of inclusion among trainees as a result of participation in the training using a shortened scenario occurred with a probability of 95%. At the same time, if we consider the performance assessment for group 3 (22 people), we will see that the obtained empirical value of Temp is in the zone of significance. Thus, we can confidently state that a shift in participants' understanding of the essence of inclusion as a result of the full version of the training has been proven with a 99% probability.

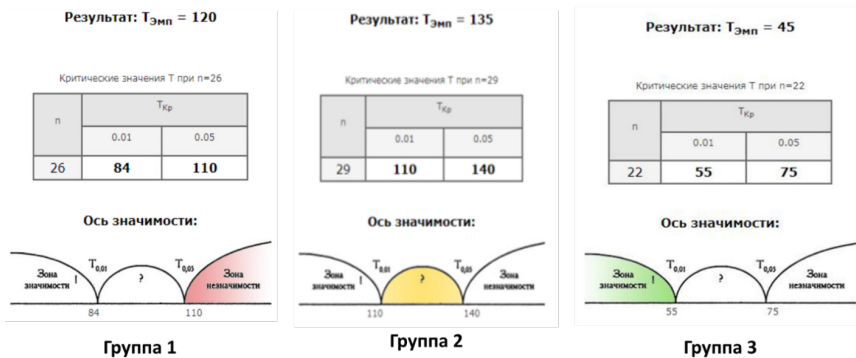


Figure 3. Comparison of assessments of the effectiveness of different strategies for working with groups of teachers to develop an understanding of inclusion using the Wilcoxon test.

Analysis of the differences obtained convinces us that changing the conditions, namely, the use of a variant of the procedure based on the participants' independent "discovery" of the essential characteristics of the inclusive educational process, significantly influenced the level of increase in the indicator of understanding of inclusion by teachers. In addition, based on statistical analysis, we can assert that the differences between the results of the shift in the understanding of the essential characteristics of the inclusive educational process, associated with differences in training conditions (and determined by recording the demonstrated use of essential indicators of inclusion by teachers when constructing the definition (at the start) and when designing classes and tasks (at completion of work)) are significant and statistically reliable. Alternative statistical hypotheses can be considered proven.

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DOI 10.34660/INF.2024.34.66.088

MODERN METHODS AND SPECIAL TECHNIQUES IN TEACHING AND CORRECTING CHILDREN WITH HEALTH AND DEVELOPMENT PROBLEMS THROUGH CREATIVE ACTIVITIES

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Annotation. *The article discusses special approaches, methods and techniques for working with students with health and development problems studying in special boarding schools. The author's program for teaching children to play musical instruments using creativity is described in detail. Possible individual routes for the development and compensation of health problems in the conditions of training and education in special educational organizations are considered.*

Keywords: *correctional work in special schools, creative implementation of students with problems of the visual analyzer, opportunities for musical activities with students in special correctional schools.*

The number of people with development and health problems, including children with vision problems, is increasing. This is due to many factors: poor ecology, chronic diseases of people of childbearing age, poor nutrition, low level of medical diagnostics, etc. Recent years have been characterized by a stable trend toward deterioration in children's health and an increase in the number of students who do not have preschool experience in artistic and aesthetic activities. First-graders of boarding schools for visually impaired children, as a rule, in addition to the underlying disease, have disorders of mental processes, emotional-volitional sphere, speech, and coordination disorders. In this regard, the correctional tasks of rehabilitation centers and correctional educational institutions are becoming increasingly relevant.

Currently, in special education serious attention is paid to the use of therapeutic, correctional and developmental opportunities of art (including music) in working with children with health problems (Belmer V.A., Zemtsova V.I., Kantor V.Z., Malshtein L.K., Plaksina L.I., Sverlov V.I., Solntseva L.I.).

Despite the obvious importance of introducing visually impaired children to musical performing activities, this area is not given due attention in the practice of additional aesthetic education in correctional educational institutions. All the numerous known musical teaching methods cannot be successfully used in special correctional schools.

Current programs for learning to play musical instruments used in children's music schools and children's art schools cannot be successfully implemented, since they do not take into account the specifics of working with visually impaired children: there is no maximally differentiated approach to teaching and aimed at the child's personality, the characteristics of his health, sanitary and hygienic standards of training and work schedule for visually impaired people are not met, short time frames for mastering skills (7-8 years), are not designed for enhanced development of creative skills within the subject, focus on narrow specialization, etc.

The current programs for children's music schools and children's art schools are based on the principle of "See-hear-play", and the program for teaching blind children to play a musical instrument is based on the principle of "Feel-hear-play", uses a special notation "combination of 6 dots" (Braille Louis) and takes into account the peculiarities of teaching the blind, not the visually impaired.

At a boarding school for students with developmental and health problems in Yekaterinburg, students have been studying according to the original program of A.D. Bunkova for several years. "Creativity and I." This program offers a fundamentally new approach to teaching visually impaired students to play musical instruments "I play-hear-see", i.e. Through creative play, students master theory, become familiar with game techniques, solve issues of coordination, emancipation of the musculoskeletal system, etc.

The inclusion of creative activity from the first lessons of education is also due to the psychological characteristics of students (not emotionality, negative assessment of personality), therefore the creative activity of students with vision problems is very important and is closely related to the acquisition and improvement of performing skills, as well as socially and personally significant abilities formation of positive relationships between a visually impaired child and the environment for successful integration into society.

The objectives of this program are special. They provide compensation for deviations in health and development, as well as correction of motor deficiencies, neutralization of negative personality traits, as well as musical ones: introduction to the art of music, development of musical abilities, education of aesthetic needs, education of artistic thinking, formation of pianistic skills, development of personal creative initiative

Lessons on an individual route contribute to the accumulation, mastery, and awareness of a large number of musical works of solo and ensemble music. In

these lessons, students become familiar with the features of styles, stylistic features of composers, thematic techniques of playing, etc. In addition, during the lessons they become familiar with the process of improvisation and composition.

Since in many cases, visual impairment develops against the background of other central nervous system anomalies caused by brain injuries and the consequences of organic diseases of the central nervous system. A characteristic feature of children with visual impairment is secondary deviations in mental and physical development. Therefore, it is very important to develop not only elementary musical abilities, but also the development of compensatory mechanisms to a greater extent. Pay special attention to the development of precisely those (abilities) that contribute to the normalization of the mental and physical development of visually impaired students, which in turn contribute to the development of musical abilities.

When students have a desire to communicate with works of painting, sculpture, decorative and applied arts, music, literature, this is a sign of the emergence and consolidation of aesthetic needs. If you start this process from an early age, you can achieve great success in developing a variety of aesthetic needs in children during the learning process.

Educational tasks aimed at nurturing artistic thinking involve involving young musicians in active creative activities from the first weeks of training. At the same time, creativity-activity, which can only arise as a result of effective mastery of the subject, requires the harmonious development of each student. Therefore, the process of nurturing artistic thinking and the process of developing practical skills must be interconnected. This necessitates a systematic construction of the educational process, in which intra- and interdisciplinary connections will actually operate.

Personal creative initiative in the process of teaching children with health and development problems is cultivated in the process of mastering educational tasks for the development of artistic thinking, and as a conscious attitude towards the issues of interpretation of a musical work and performing influence on the audience arises, the teacher needs to form in the student the need for self-expression in the creative process.

Visual impairment in such students is very diverse both in the degree of reduction in visual acuity and in its qualitative characteristics. Visually impaired people have very low visual acuity. Some children have a narrowed field of vision - this makes it difficult to navigate in space, complicates the processes of reading and writing, and disrupts the simultaneity and integrity of viewing the phenomena of the surrounding world. There are children whose visual acuity sharply decreases at dusk, sometimes to the point of complete impossibility of any distinction. Many visually impaired people have a reduced ability to distinguish colors, while others

quickly experience visual fatigue. With an increase in visual load, children experience noticeable visual fatigue (sometimes this leads to worsening vision). Most children with these vision problems need brighter lighting than those with normal vision, but some students suffer from photophobia; they do not tolerate bright light well and feel better when protecting their eyes from the light source.

All features of the state of children's vision must be taken into account in the pedagogical process. Only the creation of appropriate equipment in the lesson and the use of special methods in work can make piano training for visually impaired schoolchildren successful. All features of students' visual defects must be taken into account when organizing music classes.

Help for the visually impaired when learning to play musical instruments should include the following: creating conditions favorable to vision and using special teaching aids (special sheet music, notebooks, exercises, etc.); the use of special visual aids and a special technique for their application; maximum use and development of optical and technical aids for the visually impaired; implementing a differentiated approach to teaching visually impaired children and correcting their deficiencies depending on the qualitative characteristics of their vision and the general development of the child, etc.

The inclusion of improvisation in lessons on learning to play musical instruments with visually impaired students is necessary, since research by typhlopedagogues and typhlopsychologists indicates that visual impairment affects the brightness of individual emotions, the development of feelings and their expressed coloring. A disturbance in the visual system modifies the emotionality of experiences and increases or decreases the degree of positive and negative emotions. It is improvisation that contributes to the development of creative imagination, musical sensitivity, as well as the development of memory, musical thinking, sense of style form, compositional skill, inner hearing and the development of mental qualities such as the ability to concentrate, resourcefulness, presence of mind, which is important when solving the problem of neutralization negative personality traits of students with visual system defects.

The method of teaching improvisation is as follows: the main elements (models) are identified - rhythm, melody, harmony, form, polyphony, texture, articulation, dynamics, fingering,agogics, touch, pedalization, tempo, phrasing, etc., then students learn manipulate these variants of models, which should ultimately lead to independent searches, to the creation of your own. The main principle of the method is through the assimilation of patterns to their destruction, overcoming and release into creativity. Improvisation and composition classes require an individual form, but it is also advisable to group several students of the same level of development, approximately the same age, with the active participation of each.

The most stimulating for improvisation and composition are various kinds of rhythmic organized processes associated with movement (marching, dance, lull-

aby), with words (poems - they especially easily evoke a musical analogy), with sounds or phenomena of nature and everyday life. Drops, rain, bird calls, clocks, etc. – will easily serve as prototypes of characteristic figurative forms of musical organization.

From the very beginning of classes, students should be taught the need for musical notation (always indicating tempo, dynamics, and strokes); without this there can be no real work with musical material. Recording should be done on a large staff or using appliqués.

However, the teacher must constantly remember that a student with vision problems cannot concentrate on one task for a long time, since visually impaired students experience disruption of the functioning of other organs and systems, which are accompanied by general somatic weakness, leading to a decrease in performance and the rapid development of fatigue. Therefore, in order to maintain the student's interest and performance throughout the lesson, you need to diversify its content. Various auditory rhythmic exercises that are specifically entertaining in nature are suitable for this purpose. These exercises can also be used during ophthalmic pauses.

The program is conventionally divided into 4 stages and each stage covers various interrelated aspects of the educational process. For each stage of the program, general learning objectives are outlined, and the basic knowledge, abilities, and skills that students must acquire are determined. The division into stages allows for a differentiated approach, in which the level of mastery of piano performance is regulated individually, based on the desires and capabilities of the students, i.e. the student has the opportunity to complete training at any stage and solve for himself those tasks that the completion of this stage involves. (Mastering the last fourth stage is professional orientation to educational institutions of musical-aesthetic or other directions, which require upon admission the presence of skills in playing a musical instrument or aesthetic, aesthetic-theoretical knowledge); it is possible to increase the time frame for completing each stage (for example, mastering I and II in more than six years, if the student is not further focused on continuing musical education, or the student needs more time to master stages I and II /health condition/); compression of the training period if the student already has basic musical understanding, i.e. studied at children's music school before entering a special school, for example, in groups of early aesthetic development.

The author considers it appropriate to implement a personality-differentiated approach in individual methods of working with each student (taking into account starting capabilities, living conditions in the family), in individual selection of repertoire throughout the entire period of study, using special exercises, specific didactic means (taking into account the main and concomitant diseases), as well as drawing up individual maps and conducting monitoring studies, which trace the

development of not only special skills, abilities, abilities, but also the improvement of mental characteristics of the cause-and-effect relationships of personal and artistic development. It is advisable to have a differentiated approach to assessing the level of training at a certain stage for each student, i.e. in special attention to the degree of overcoming technical difficulties, to the level of aesthetic and creative growth, focused on pre-professional education.

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DOI 10.34660/INF.2024.46.35.089

TEXT AS THE BASIC UNIT OF A SPEECH WORK AND THE PECULIARITIES OF ITS CREATION WHEN LEARNING A FOREIGN LANGUAGE

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Abstract. *The article is addressed to linguists, psychologists, cultural experts, and all students of university humanities faculties. The article substantiates the idea that speech activity is one of the varieties of human activity, it plays a supporting role and useful for coordinating people in the process of other activities. The main function of speech activity is the transmission of information and this function is realized in speech in the form of texts. Text is the basic communicative unit of speech. In addition, the article analyzes the triad “addresser - text - addressee” is formed; it is emphasized that all three components are closely related to each other. Particular attention is paid to the process of creating texts in a foreign language, in particular in Russian. The article emphasizes that the most correct presents a communicative approach to learning Russian as a foreign language.*

Keywords: *speech activity, communicative function, text, addressee, addressee, language, speech, Russian as a foreign language.*

Each person as a member of society realizes itself in activity, a certain activity. Basically, this is a combination of various activities; this is how we achieve our goals, successes or, conversely, failures. Activities can be educational, industrial, aesthetic, literary, musical, artistic, speech, and so on. Thus, we see that speech activity is a type of human activity in general.

Speech activity plays an auxiliary role, serves to coordinate people in the process of other activities: for example, industrial, household educational and others. The definition of speech activity indicates the most important connections between speech activity and other forms of human existence in society, with other features of human

life. Specific speech aspects include: speech needs (motivation), speech intention or purpose, knowledge and experience of communicants, use of linguistic resources of the specific language being used by speakers, orientation of speech towards reality. The last aspect denotes the communication situation itself, cultural environment, presence of interlocutors or audience, characteristics of interlocutors or audience, and so on.

Undoubtedly, the main function of speech activity is to convey information to another person, a group of people, or a large audience. The most important informative function is realized in speech as an utterance or text, which can be presented in written or oral form. Text explicates information about ideas, intentions, life experiences, interests, and emotions of communicants and is the highest sphere in which the communicative function of language is realized. Of course, there are other sign systems that allow for the transmission of information: music can influence a person, painting exists, there is sign language and gestures, the language of mathematics, the language of scents, body language, and others. We believe that people live in a world of meanings, in a world of signs, and they themselves generate these meanings and signs. However, we acknowledge that people mainly communicate through language, which means they communicate through texts, as text is the primary communicative unit of speech.

The communication situation, the model of the communicative act in a simplified form is usually described as a three-component set “sender - text - receiver”. The components in this chain are presented as interacting integrated complex entities, while individual parameters of communicants and the text itself play an important role in the process of communication. The speech process, the creation of a speech work - text, is at the same time a speech-psychological activity that relies on the use of language resources, linguistic system resources, consciously or unconsciously takes into account the communicative abilities and communicative experience of the participants in the speech act, which also changes during the process of speech interaction.

Thus, the text as a specific form of practical speech activity of individuals reveals to us the internal nature, mechanisms of how, based on the psycho-physiological organization of the individual, linguistic material is structured taking into account the resources of the language system (phonetics, vocabulary, grammar, stylistics, and other systems). In simplified terms, the process of creating a speech work - a text can be characterized by presenting the main components that construct and verbalize it. The ability of a text to convey information is determined by communicants in the process of creating a message. Speakers determine a set of language resources corresponding to a specific speech activity in a specific communication sphere. At the same time, as we mentioned earlier, their communicative ability and internal lexicon (language memory) play a significant role,

which is an important component of speech activity [Human Factor in Language 1991: 8].

It is impossible to deny the fact that the speech activity of communicants, the process of creating texts depends on a whole range of individual characteristics, social factors, and circumstances, including place, motive, communicative environment, and communicative abilities. It is important to remember that the interlocutor is a reality that we perceive and analyze, obtain data about the interlocutor, and then adequately structure the speech act. Thus, in communication, we usually take into account our knowledge about the interlocutor or the listening audience; predict the expected reaction to our statement. Language, in particular the Russian language, is a complex system and a set of interaction resources, including resources of the speaker and listener. They include the ability to understand, perceive, memory capabilities, and different forms of thinking: figurative, verbal-logical, or practical.

Depending on all these linguistic, sociocultural, psycho-physiological, and other skills, we choose different language means. For example, as experience shows, we rarely express our thoughts directly; more often we hint at these thoughts. Thus, we resort to a kind of euphemism, giving the interlocutor freedom of decisions and actions. In everyday communication situations, we often say, for example: “*It will rain today,*” instead of using the phrase immediately: “*Take an umbrella!*” Most likely, the first phrase is sufficient for the listener or speech addressee to correctly interpret its prompting to action meaning.

Summarizing the above, we can conclude, what are the leading constituent factors in terms of linguistic implementation of the informative function of a speech work - text -are:

- 1) linguistic competence of the addresser and addressee of speech, reflecting knowledge of vocabulary, word formation, organization of syntactic structures, mechanism of reference, ways of expressing modality, stylistic parameters, etc.;
- 2) sociocultural competence, which provides background knowledge acquired by an individual as a result of a certain education, cultural level, social status, etc. [Kalimullina 1996: 50].

It is obvious that all of the listed characteristics of communicants, as well as factors of extra-linguistic reality, must be taken into account when creating a speech work - a text. The process of creating texts in a foreign language, in particular in Russian, deserves special attention. Here, too, all components and factors of linguistic, psycho-physiological, male cultural influence should be taken into account; it is important to pay attention to the commonality of the apperception base of the communicants, the listener or the audience.

Learning to communicate in a foreign language is a complex process, both from the perspective of psycholinguistics (the production of speech in a non-na-

tive language with the interfering influence of the native language) and from the perspective of foreign language teaching methodology. The task of teachers and learners is to learn and to be able to reproduce and understand speech in a foreign language. As we have already mentioned, during the process of speech interaction, communicants communicate through speech, more precisely - they create or understand the basic communicative units of speech - texts. The search for optimal ways of learning a foreign language continues because life and technological progress, as well as communication tools, are developing and improving. We know that new types of dictionaries based on functional-semantic areas in language are emerging, dictionaries with narrow professional focus are being created, and in the twenty-first century, there has been a breakthrough in the development of electronic translators, which greatly facilitate communication in different languages, contribute to the expansion of economic, cultural interaction between different countries, peoples, and cultures.

But as we know that man is a social being, we want to involuntarily and freely communicate in a foreign language, which stimulates the emergence of various teaching methods, including the Russian language.

In our opinion, the communicative approach to learning Russian as a foreign language seems to be the most accurate. We remember that the main functions of language are communicative and informative. Thus, the main principle of the communicative approach and the implementation of the communicative function in the theory and practice of teaching foreign languages is the creation of information gaps or communicative insufficiency, that is, the presence of the unknown within the situation and its restoration by communication participants with a specific goal and entering into specific social relationships.

Within the communicative approach, great attention is currently paid to the use of active teaching methods, in particular situational modeling games, where a specific situation is the universal form when teaching spoken language. In this case, the situation is a complex multi-dimensional phenomenon of the objective world, but it is the addressee and the recipient of the speech act who engage in dialogical communication, each having their own subjective view of the world, including their own linguistic view. Therefore, finding criteria by which a situation of speech communication can be methodically accurately modeled becomes important. First and foremost, for creating a situation of speech communication, it is significant and primary to determine the typical relationships between communicants, their individual characteristics, common perceptual base, etc. [Zemskaya 1983: 14].

If we talk about the educational process of teaching a foreign language, we note that game situations, as a rule, are widely included in the didactic part of tasks, since they are an effective means of activating spoken language. The ad-

vantage is game form before other communicative exercises is that it involves imitation of reality, and we proceed from the fact that most often communicants are immersed in the same communication environment. It is believed that it is the creative principle in speech activity that contributes to the development of mental activity and imagination, and skills are directly developed unprepared statement. In addition, experience shows that creating a game situation has a positive effect on the psychological climate in the classroom. Of course, not all students can immerse themselves in the game to the same extent and reveal all their language and speech skills, since the psycho-physiological factor plays an important role

In order for the game in Russian language classes to become a means of intensifying the learning process, ensuring the consolidation of previously covered language material and the development of spontaneous speech skills, it must be built on the laws of natural communication, have a problematic and cognitive-activity nature. At the initial stage of learning, gaming technologies are used fragmentarily, later they can cover all classes. Game tasks can be used when studying various spheres of human activity: professional, everyday, socio-cultural, artistic, aesthetic, and so on.

When organizing a game situation, the preparatory stage (phonetic, lexical, grammatical tasks), aimed at developing certain speech skills, becomes especially important. Also at this stage, the situation itself is analyzed, roles are distributed, character types of the addressee and addressee of the speech are determined, vocabulary is selected and activated, language material is studied, a mini-situation is played out, and so on. Particular attention should be paid to individual and collective independent work of students, and the teacher should act as a consultant. For less prepared students, more detailed explanations and recommendations are needed when analyzing a specific situation.

The next - creative stage - is aimed at recreating acts of real communication in educational conditions, namely texts as the main communicative units of speech. First, situations similar to real ones are created, and students act in them in different social roles, but about which they already have an idea, have experience communicating in their native language. At this stage, it is assumed that intensive techniques will be used, for example, artistic suggestion. So, for better assimilation of phrases when communicating, it is effective to use the so-called “dramatization” of mini-dialogues and situations. The topic and plot are set by the teacher, and the task of the students is to play out this situation, create a speech work - a text. The same phrases can be pronounced, for example, in the same in one case an “optimist”, in another – a “pessimist” or a “skeptic”; “lazy” and “excellent student”; “boss” and “subordinate” and the like.

We understand that there are no ideal methods for teaching spontaneous dialogues and speech in a foreign language, since native speakers of the same lan-

guage cannotChildren also face the problem of understanding the speech segments and texts they create. It is known that there is a special discipline that deals with problems of understanding - hermeneutics. When comprehending the problems that this science deals with, a paradox arose - hermeneutic circle. Several of its formulations are known, for example: understanding the text is possible only by understanding the author's personality, but it is impossible to achieve an understanding of the author's personality other than through the perception of his texts.

We understand that there are no perfect methods for teaching spontaneous dialogues, foreign language speech, as speakers of one language often also face difficulties in understanding the speech segments-texts they create. It is known that there is a special discipline dealing with understanding problems - hermeneutics. When considering the problems addressed by this science, a paradox arose - the hermeneutic circle. There are several formulations of it, for example: understanding a text is only possible with an understanding of the author's personality, but understanding the author's personality cannot be achieved except through the perception of his texts.

However, the paradox can be overcome in the practical activities of communicators. In our view, the most essential information for successful interpretation of a text is the social status of the speaker. The same phrase, depending on the social relationship between the speaker and the listener, allows for different interpretations. The speaker and the listener are equally interested in an adequate interpretation of their speech intention. And this is impossible without a clear awareness and explication by the speaker of their social role: subordinate - boss, elder - younger, colleague, buyer, client, and so on.

Thus, in the game form of teaching spoken language, we create various situations that are already familiar to students, distribute roles, and thus overcome psychological barriers; repeated repetition improves memorization without reducing interest in the lesson; student activity increases significantly. Such techniques make learning more enjoyable and stress-free; learning is carried out both at the conscious and subconscious levels.

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DOI 10.34660/INF.2024.69.25.090

PUNCTUATION OF THE ENGLISH LANGUAGE IN THE STRUCTURE OF THE UNIFIED STATE EXAM IN THE RUSSIAN FEDERATION

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Abstract. *This research work is devoted to the study of the problem of punctuation of the English language in preparation for passing the Unified State Exam in English in the Russian Federation. The author considers options for the use of punctuation marks included in the “Codifier of Verifiable Requirements for the Results of Mastering the Main Educational Programme of Secondary General Education and Content Elements for Conducting the Unified State Exam in English.” The study aims to systematize the rules for the use of English punctuation signs.*

Keywords: *apostrophe, educational activity, English, linguistics, punctuation, punctuation signs, student, teacher.*

In classes of *English as a Foreign Language* in the vast majority of educational institutions of the Russian Federation, pedagogical workers have to directly solve various tasks within the framework of teaching schoolchildren the main types of speech activities, namely, listening, speaking, reading and writing. Writing is generally recognized as the most complex aspect due to the fact that it is directly related to such sections of linguistics as grammar, lexicology, phonetics, punctuation, spelling and style. One of the difficulties of writing in the process of mastering English is punctuation. Therefore, one of the main tasks of students at the initial and subsequent stages of learning the language is to learn not only to write correctly, but also to adequately use punctuation signs. This mission is possible after a detailed consideration of the methods of using English punctuation marks, one of which is the apostrophe.

Hypothetically it was assumed, that punctuation marks in the structure of materials for preparing for the *Unified State Exam* in English can be represented not only by a comma when listing, addressing and selecting introductory words, apostrophe, period, question and exclamation marks at the end of sentences, colon and quotation marks as presented in the “*Codifier of Verifiable Requirements for the Results of Mastering the Main Educational Programme of Secondary General Education and Content Elements for Conducting the Unified State Exam in English* (hereinafter referred to as the “Codifier”) [4], but also by other signs. The seven punctuation marks, the apostrophe in particular, provided by the “Codifier” can perform other functions that are not listed in it.

The object of the research work is the English language [5], namely, the part of it called punctuation [3].

The subject of the research is the process of studying the methods of using English punctuation marks [2].

The study has covered academic printed [10] and media texts [14].

Duration of research work: January 2022 - January 2024.

The research algorithm includes four phases. Phase I (January-December 2022) – observation of the study object. The initial interpretation is based on the following parameters: gaining access to various library funds, preparing for the use of the necessary equipment (computer, multiplying equipment), providing access to the global Internet and sufficient speed of its work, searching and selecting research material, determining basic working terminology. Phase II (January-May 2023) – nomination of the working hypothesis of the study. Phase III (June-November 2023) – verification of previous observations, judgments and correctness of the hypothesis construction based on the selected and studied research material. Phase IV (December 2023 - February 2024) – discussion of empirically obtained practical results on the topic of research with colleagues, theoretical and practical justification of the studied object of the research in printed form, presentation of the results of the work to be considered by the professional community.

The material of the research work are traditional textbooks and teaching aids, electronic educational materials, materials for preparing for the IELTS [9], TOEFL [15] exams.

The methodological basis of the work was the relationship between theoretical and practical methods of research. Theoretical methods included: analysis, induction, generalization and classification. As practical methods, observation, comparison and description were applied.

The conceptual apparatus included structural punctuation, educational and methodological elements, for the designation of which basic working terminology was selected (English, apostrophe, question mark, exclamation mark, colon, comma, quotation marks, linguistics, educational activity, student, punctuation marks,

punctuation, teacher, point) based on the analysis of primary sources, specialized reference books and expert research in the field English punctuation.

The relevance of the research topic is due to the need to comprehensively study modern academic printed and media texts in order to identify ways to use English punctuation signs. Various aspects of the English language are thoroughly studied and developed, but its punctuation nuances still pose a problem for researchers to solve. In addition, there are punctuation signs that are not included in the “Codifier,” but are found in the structure of materials for preparing for the *Unified State Exam* in English [1]. Undoubtedly, the fact of responsibility for misunderstanding and incorrect use of these punctuation signs is not removed from students. However, the competence of teachers to assess the ability/inability of students to understand and use punctuation signs in writing that were not included in the “Codifier” is in doubt.

The aim of the research work is an attempt to identify ways of using English punctuation marks and classify ways of using them in written practice.

To achieve this goal, the following tasks were set:

A) to study theoretical literature:

- to study approaches to the description of punctuation marks in Russian and foreign literature;
- to consider ways to use punctuation marks;

B) to study academic texts [13]:

- to search for punctuation marks in the structure of texts in English [17];
- to identify and describe the most common methods of using punctuation marks contained in target texts [6].

The result of the research work was the creation of a classification of ways to use English punctuation signs, one of which is the apostrophe.

The apostrophe is used in writing contractions, that is, shortened forms of words from which one or more letters have been omitted. In standard English, this generally happens only with a small number of conventional items, mostly involving verbs. Here are some of the commonest examples, with their uncontracted equivalents: it's - it is or it has; we'll - we will or we shall; they've - they have; can't - cannot; he'd - he would or he had; aren't - are not; she'd've - she would have; won't - will not. In each case, the apostrophe appears precisely in the position of the omitted letters.

It is not wrong to use such contractions in formal writing, but they should be used sparingly, since they tend to make our writing appear less than fully formal. Such contractions represent the most useful job the apostrophe does for both the writer and the reader, since, without it, we would have no way of expressing in writing the difference between *she'll* and *shell*, *he'll* and *hell*, *can't* and *cant*, *I'll* and *ill*, *we're* and *were*, *she'd* and *shed*, *we'll* and *well*.

A few words which were contractions long ago are still conventionally written with apostrophes, even though the longer forms have more or less dropped out of use. Here are the commonest ones, with their original longer forms: *o'clock* – *of the clock*; *Hallowe'en* – *Halloweven*; *fo'c's'le* – *forecastle*; *cat-o'-nine-tails* – *cat-of-nine-tails*; *ne'er-do-well* – *never-do-well*; *will-o'-the-wisp* – *will-of-the-wisp*.

Some generations ago, there were rather more contractions in regular use in English; these other contractions are now archaic, and you wouldn't normally use any of them except in direct quotations from older written work. Here are a few of them, with their longer forms: *'tis* – *it is*; *'twas* – *it was*; *o'er* – *over*; *e'en* – *even*. There are other contractions which are often heard in speech. Here are a few: *'Fraid so*. *'Nother drink? Is'pose so*. *'S not funny*. It is, of course, never appropriate to use such colloquial forms in formal writing, except when you are explicitly writing about colloquial English. If you do have occasion to cite or use these things, you should use apostrophes in the normal way to mark the elided material.

In contemporary usage, there are a few unusual phrases in which the word *and* is written as *'n'*, with two apostrophes; the commonest of these is *rock 'n' roll*, which is always so written, even in formal writing. One or two more of these are perhaps acceptable in formal writing, such as *pick 'n' mix* and possibly *surf 'n' turf*. But it is advised to write *fish and chips*, even though you may see *fish 'n' chips* on takeaway shop signs or even on restaurant menus.

Contractions must be carefully distinguished from clipped forms. A clipped form is a full word which happens to be derived by chopping a piece off a longer word, usually one with the same meaning. Clipped forms are very common in English; here are a few, with their related longer forms: *gym* – *gymnasium*; *ad* – *advertisement*; *pro* – *professional*; *deli* – *delicatessen*; *hippo* – *hippotamus*; *bra* – *brassiere*; *tec* – *detective*; *flu* – *influenza*; *phone* – *telephone*; *copter* – *helicopter*; *cello* – *violoncello*; *gator* – *alligator*; *quake* – *earthquake*. Such clipped forms are not regarded as contractions, and they should not be written with apostrophes. Writing things like *hippo'*, *bra'*, *'cello* and *'phone* is not correct in modern English. Of course, some of these clipped forms are still rather colloquial, and in formal writing you would normally prefer to write *detective* and *alligator*, rather than *tec* and *gator*.

Contractions must also be carefully distinguished from abbreviations, which are things like *Mr* for *Mister*, *Ib.* for *pound(s)*, *BC* for *before Christ* and *e.g.* for *for example*. There are also a few circumstances in which apostrophes are used to represent the omission of some material in cases which are not exactly contractions. First, certain surnames of non-English origin are written with apostrophes: *O'Leary* (Irish), *d'Abbadie* (French), *D'Angela* (Italian), *M'Tavish* (Scots Gaelic). These are not really contractions because there is no alternative way of writing them. Second, apostrophes are sometimes used in representing words in non-stan-

dard forms of English: thus the Scots poet Robert Burns writes *gi'* for *give* and *a'* for *all*. Third, a year is occasionally written in an abbreviated form with an apostrophe: *Pio Baroja was a distinctive member of the generation of '98*.

In British usage, they do not use an apostrophe in pluralizing dates: *This research was carried out in the 1970s*. American usage, however, does put an apostrophe here: *This research was carried out in the 1970's*. One should not adopt this practice unless they are specifically writing for an American audience.

An apostrophe is indispensable, however, in the rare case in which you need to pluralize a letter of the alphabet or some other unusual form which would become unrecognizable with a plural ending stuck on it: *Mind your p's and q's*. *How many s's are there in Mississippi?* It is considered to be very bad style to spatter e.g. 's and i.e. 's through the writing.

An apostrophe is used in a possessive form, like *Esther's family* or *Janet's cigarettes*. The basic rule is simple enough: a possessive form is spelled with 's at the end. Hence: *Lisa's essay; my brother's girlfriend; children's shoes; the aircraft's black box; a week's work; England's navy; Wittgenstein's last book; women's clothing; somebody's umbrella; my money's worth*. This rule applies in most cases even with a name ending in s: *Thomas's job; James's fiancée; the bus's arrival; Steve Davis's victory*.

There are three types of exception. First, a plural noun which already ends in s takes only a following apostrophe: *the girls' excitement; my parents' wedding; both players' injuries; the Klingons' attack; the ladies' room; two weeks' work*. They do not pronounce these words with two esses, and so they do not write two esses: nobody says *the girls's excitement*, but plurals that do not end in s take the ordinary form: see the cases of *children* and *women* above. Second, a name ending in s takes only an apostrophe if the possessive form is not pronounced with an extra s. Hence: *Socrates' philosophy; Saint Saeins' music; Ulysses' companions; Aristophanes' plays*. The final class of exceptions is pronouns: *He lost his book; Which seats are ours?; The bull lowered its head; Whose are these spectacles?*

The possessive *its* never takes an apostrophe. The same goes for possessive *whose*: this cannot be spelled as *who's*, though there is a word *who's*, a contraction of *who is* or of *who has*, as in *Who's your friend?* or *Who's got a corkscrew?* However, the indefinite pronoun *one* forms an ordinary possessive *one's*, as in *One must choose one's words carefully*.

There is a further point about writing possessives: when they add an apostrophe-s or an apostrophe alone to form a possessive, the thing that comes before the apostrophe must be a real English word, and it must also be the right English word. Thus, for example, something like *ladle's shoes* is impossible, because there is no such word as *ladie*. Moreover, a department in a shoeshop could not be called *lady's shoes*, because what the shop is selling is *shoes for ladies*, and not *shoes for lady*, which is meaningless. The correct form is *ladies' shoes*.

It is permissible to say that the hypothesis of the research work that punctuation signs in the structure of materials for preparing for the *Unified State Exam* in English can be represented not only by commas when listing, addressing and highlighting introductory words, apostrophe, period, question and exclamation marks at the end of sentences, colon and quotes, as presented in the “Codifier”, but also other signs, is confirmed. The apostrophe actually performs other functions that are not listed in the “Codifier”.

Summing up, it should be noted that the solution to the problem of the use of punctuation marks, the apostrophe in particular, has a degree of uncertainty for students due to the reasons of the difference between the British and American versions of the English language and the imperfection of the Unified State Exam regulating documents in terms of punctuation of the English language. However, the methods of applying the apostrophe (‘) identified and described in a systematic way can to some extent simplify the process of learning English in the field of punctuation for students not only in educational institutions of additional education, but also in secondary educational institutions of the Russian Federation. We admit that the conclusions presented are not exhaustive due to the inability to cover the entire textual spectrum of the English language due to its constant development. For this reason, we invite all interested parties to join us in a further, more thorough study of this issue.

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CENTRAL ASIAN COUNTRIES IN THE IMPLEMENTATION OF THE MEGA PROJECT “ONE BELT, ONE ROAD”

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Annotation. *The article is devoted to the consideration of plans for the implementation of the Chinese mega-project “One Belt, One Road”, it is noted that the most important place is given to the countries of Central Asia. It is emphasized that since ancient times, Central Asia has been a meeting place between the civilizations of East and West, a connecting link between different peoples and cultures of Eurasia. It is concluded that the “One Belt, One Road” megaproject is open to all countries, international and regional organizations, and also creates the basis for economic cooperation between China and interested countries and the Central Asian countries play a key role in its implementation.*

Keywords: *One Belt One Road, Central Asia, countries, cooperation.*

The ancient Silk Road opened a new window of friendly relations between countries and wrote a new chapter in the development of mankind [1]. “Xi Jinping’s initiative was not the first Chinese attempt at a foreign economic offensive. Its forerunners were the strategies of “external opening” by Deng Xiaoping, “peaceful rise” by Hu Jintao, and “going outward” by Jiang Zemin. They created the ideological and economic foundation on which China’s current strategic leap is taking place...”[2]. China’s concept of “One Belt, One Road” - OBOR (for the joint creation of the Silk Road Economic Belt and the Maritime Silk Road (MSR) of the 21st century) - has an international scale and is aimed at improving existing and creating new trade routes, transport, as well as economic corridors connecting more than 60 countries of Central Asia (CA), Europe and Africa, which will contribute to the development of trade relations between them and the People’s Republic of China (PRC).

For the first time, the idea of forming the “Silk Road Economic Belt (SREB)” was voiced by Chinese President Xi Jinping during his keynote speech at Nazarbayev University, in Astana, as part of his state visit to Kazakhstan in September

2013, as a new form of deepening cooperation between China, states of Central Asia. In his speech in Astana, Xing Jinping emphasized: “China and the countries of Central Asia are good neighbors, connected by common rivers and mountains. This is the reason why China attaches so much importance to relations with Central Asian countries and why Central Asia occupies one of the priority areas in Chinese foreign policy. Since ancient times, the territory of Central Asia has been a bridge that connects the East and the West, i.e. crossroads of civilization.

Currently, the topic related to the implementation of the project, as well as the participation of various countries and regions in it, is one of the most pressing and discussed problems in various fields, from politicians, diplomats to scientific experts. To create a designated system project, joint consultations with the participation of many states are required to determine all the issues directly related to joint construction, and then to use it effectively after the implementation of a large-scale project of global significance. The project is focused on thirty years.

Kazakhstan has the greatest opportunities to participate in the SREB in the Central Asian space, which sets its priority task to develop transit potential by attracting part of the cargo flow in the China-Europe direction. To achieve this goal, a cooperation plan was signed in 2016 to link the SREB with the Kazakh national program “Nurly Zhol”. Chinese President Xi Jinping called this act one of the most significant results of the BRI in the political sphere. We also note that trade and economic relations between the Republic of Kazakhstan and the People’s Republic of China are actively developing [5]. Kazakhstan became China’s largest trading partner in 2023, with bilateral trade reaching \$41 billion, up 32% from the previous year. Kazakh exports to China amounted to \$16.3 billion, imports - \$24.7 billion[6].

One of the primary tasks facing the countries of the Central Asian region (CAR) is the coordination and promotion of national development strategies of states located along the SREB on the basis of mutual understanding and dialogue, relying, first of all, on the historical experience of the Great Silk Road (GSR). This is necessary in order to advance the implementation of the initiative, revive the ancient GSR in a new form, establish closer ties between countries and continents, and raise the mutually beneficial cooperation of these countries to a new level to a new historical height. Over the past time, the initiative put forward gradually began to turn not just into a concept, but into a major international project of great economic interest not only for China itself, but also for all countries located along the GSR, including all the Central Asian republics. As is known, previously similar projects aimed at reviving the Central Asian region were put forward by countries such as Russia, the USA, the EU, Japan and now China. The Chinese initiative received a wide response and this is explained by the fact that China today is the largest producer and investor in the global economy, which, despite

some decline, maintains high rates of economic development in comparison with other countries of the world. Accordingly, it is not surprising that the new Chinese initiative for the Central Asian states, aimed at reviving the GSR in modern conditions, is of great interest.

This keen interest is primarily explained by the fact that the CAR region is a crossroads where various routes of the Great Silk Road intersected since ancient times. As is known, the GSR as a trade route arose in the 3rd century. BC. and existed until the 16th century. And at the suggestion of the German geologist Ferdinand von Richthofen, from the end of the 19th century, the extensive network of roads received the name Seidenstrassen - Silk Road, which has survived to this day. The GSR was a system of caravan roads leading from China to the countries of the Middle East and Europe. A significant part of this route ran through the territory of the Central Asian states. Therefore, the countries of the Central Asian region are, without a doubt, the most important link in the large-scale international SREB project. Three out of five Central Asian states share a common border with China. The total length of the state border between Kazakhstan and China is 1,782.75 km, between Kyrgyzstan and China is 858 km, and between Tajikistan and China is 494.95 km.[6].

Central Asia is a region where the interests of both great powers and regional forces intertwine, including the USA, Russia, Europe, China, India, Iran, Turkey, and Arab countries. Many of these countries view Central Asia as a single, integral enclave. In reality, of course, this is not the case at all. Firstly, in the Central Asian region, various cultural and civilizational streams intersect, or rather converge (Turkic, Mongolian, Persian, Arabic, Chinese). In ancient times and the Middle Ages, as a rule, one or two of them were dominant for some period of time. Because of this, the countries and peoples of Central Asia have their own characteristics (traditions, mentality). Secondly, all world religions have spread in Central Asia. As Peter Frankopan, the author of a book called “The Silk Road,” notes: “This is the very place where Judaism, Christianity, Islam, Buddhism and Hinduism literally rubbed sides” [4, p. 12]. As the famous Kazakh scientist Karl Baipakov states: “Religious ideas were spread through (the GSP), various missionaries “carried” their faith to overseas countries. Buddhism came from India to Central Asia and East Turkestan to China, Korea and Japan; Christianity and then Islam spread from Syria, Iran and Arabia. However, Islam, which spread not only “by fire and sword,” but also by the sweet tongue of a Muslim merchant, gradually replaced Christianity, Buddhism, Zoroastrianism, and local cults in Central Asia” [7, p. 27]. Although, after the collapse of the USSR, religious beliefs and movements that were not traditional for the CAR appeared. Thirdly, “This is a cauldron in which a brew from various language groups was prepared - Indo-European, Semitic and Sino-Tibetan languages could be heard along with Altai, Turkic and

Caucasian” [4, p. 13]. And now there are several ethnolinguistic bands here: Turkic-speaking, Persian-speaking and Russian-speaking.

During the period of the Soviet Union, the Russian language dominated in a number of republics, primarily Kazakhstan, and it is no coincidence that this republic was called a “laboratory of peoples.” And currently there are many different forecasts about which language will take the leading place in 20-30 years. Fourthly, the Central African Republic is a place of interaction between agricultural and nomadic farming with its own characteristics in the cultural and social sphere, so there is no need to talk about sociocultural homogeneity. Fifthly, until the second half of the 19th century there was the Turkestan region, and then autonomous and then union republics within the USSR. And also the designation of the region “Central Asia and Kazakhstan” appeared, based on economic specialization. Let us recall that after the declaration of sovereignty in 1992. Kazakh President Nursultan Nazarbayev at the summit of Central Asian states proposed to abandon the definition of “Central Asia and Kazakhstan” in favor of the concept of “Central Asia,” covering all post-Soviet states of this region.

All of these above-mentioned features of each country must be taken into account during the preparatory work, as well as at the implementation stage of the SREB project, but despite the above differences, by and large, the Chinese concept of the SREB is a unifying project, taking into account the fact that both China and the countries of Central Asia were the main points along which the routes of the Great Silk Road passed. The importance of Kazakhstan for the implementation of the SREB project is most obvious and understandable. Once upon a time, one of the VSR routes originated from Kazakhstani soil. (to which is the historical reference of his modern project). The main part of the route passed through the territory of Semirechye and Southern Kazakhstan and it is quite natural that this contributed to the development of trade and economic ties and the growth of cities. According to the first President of the Republic of Kazakhstan Nazarbayev: “Roads are lifelines for Kazakhstan. In our vast expanses around the roads, life has always arisen and developed.”[8]. At least three GSR routes passed through the territory of neighboring Kyrgyzstan in the Middle Ages. These are the Pamir-Alai road, Fergana and Chui highways. Trade and craft settlements and cities appeared along these routes, such as Borskoon, Tash-Rabat, Osh, Uzgen, etc. It can be stated that it was thanks to the GSR that during the Middle Ages Kyrgyzstan became one of the cultural centers of the Turkic peoples. It is important to note that to date, on the territory of the Kyrgyz Republic, important historical monuments have been preserved from those times: the caravanserai “Tash-Rabat” (IX), Mount Suleiman (Suleiman-Too), the Uzgen architectural complex, the mausoleum “Shah-Fazil” and etc. Part of the GSR route, which ran through the territory of modern Tajikistan, played an important role in the development of international trade and

served as a link between Bakrtiya, Tokharistan, Sogdiana and Fergana with India, Afghanistan and China. The following routes passed through Tajik territory: Sogdian, Karteginsky, Khatlon, and Pamir. Among the cities known on the leading VSR routes are: Penjikent, Ura-Tyube, Khujand. The ancient Turkmen city of Merv (Mary) was called the gateway to Central Asia. On the territory of modern Turkmenistan you can find traces of the HSP. The ancient complex of Merv is included in the UNESCO list of world historical heritage as one of the centers of the Great Silk Road, which also includes such settlements as Meshed-Mesrian in Dehistan, Shakhislam in the Bakhard region, Nisa, Anau, Abiverd, Altyn-Tepe near Ashgabat, ancient Merv, Margush , Amul near Turkmenabat, etc. The territory of modern Uzbekistan is located in the center of the Great Silk Road. The cities of Samarkand, Bukhara, Tashkent, Fergana and others served as important transshipment points on the GSR, which contributed to their development and prosperity. In many cities, monuments from those times have been preserved to ours. So, “Central Asia was especially crisscrossed with caravan routes. Its cities - Merv, Samarkand, Bukhara, Khiva, Otrar, Turkestan, Taraz, Ispidzhab, Suyab, Balasagun, Osh, Uzgen and others - were centers not only of trade, but also science and culture”[9]. According to professor from Uzbekistan O.P. Kobzeva: “Among the many achievements of human civilization, the Great Silk Road has a special place” [10, p. 155]. Kazakhstan demonstrates interest in connecting the EAEU and the SREB. According to N. Nazarbayev, “The SREB can profitably link the platforms of the SCO, the EAEU and the European Union into a single regional territory of prosperity”[11]. President of Uzbekistan Shavkat Mirziyoyev noted that he hopes to integrate the China-Kyrgyzstan-Uzbekistan railway network (including Afghanistan) into the One Belt, One Road program through connections with ports in Pakistan and Iran. He also stated that “the overall priority should be the creation of interconnected industrial technology parks, scientific and innovation clusters and free economic zones along the Silk Road Economic Belt”[12]. Then-President of Kyrgyzstan Almazbek Atambayev also praised the Belt and Road Initiative for opening up new opportunities in the region, noting the importance of expanding fiber optic transmission lines from China to Europe through Kyrgyzstan, e-commerce and the creation of logistics centers, saying that the construction project The China-Kyrgyzstan-Uzbekistan railway is promising [13]. The leaders noted the role of cultural and humanitarian ties in the development of the tourism potential of the GSR states, and also expressed interest in the construction of a railway that connects China - Kyrgyzstan - Uzbekistan, and outlined the importance of creating joint high-tech production, free economic zones and technology parks on the Silk Road.

At the end of 2023, Turkmen exports to China amounted to \$9.6 billion of the total annual volume. However, this figure was 6.6% lower than in 2022. Chi-

na's exports to Turkmenistan amounted to a billion dollars, an increase of 11.3% compared to the previous year. Kyrgyzstan increased trade turnover with China by 28.8%, to \$19.8 billion. As in Tajikistan, Kyrgyzstan's trade balance was completely one-sided. Bishkek's exports to China amounted to a paltry \$80 million. China's annual trade turnover with Uzbekistan grew by 45% in 2023 to \$14 billion, with the balance heavily tilted toward Beijing. Uzbekistan's exports, according to the GACC, amounted to \$1.6 billion of the total volume. At the same time, the Statistics Agency of Uzbekistan reported bilateral Uzbek-Chinese trade turnover for 2023 at \$13.7 billion. According to Uzbek data, exports to China are estimated at \$2.5 billion, and imports at 11.2 billion \$[6].

Thus, the presidents of the Central Asian countries expressed their readiness to participate in the One Belt, One Road megaproject. Unlike the American project "Greater Central Asia", "New Silk Road", which assumed the "democratization" of the region, the Chinese project does not put forward any political requirements for the participants. Central Asia as a whole occupy an extremely important geostrategic position in Central Eurasia, and Kazakhstan stands out as an outpost for expanding trade and economic ties with Europe, Russia, Turkey and Iran. Of course, the One Belt, One Road megaproject is of particular importance for the Central Asian states themselves due to the region's geographic proximity to the Middle Kingdom and close economic ties with Beijing. Banking on the unique geopolitical position of Central Asia and its historical role in the trade route of the Great Silk Road, the republics of the region are trying to use Chinese investments to solve their own infrastructure problems and "build" national development strategies into the overall outline of the global Chinese project [14, p. 30].

One of the most important suppliers of energy resources to the Celestial Empire is Turkmenistan, where, since 2009, a bilateral contract has been in force, according to which the supply of 30 billion cubic meters is provided. m of Turkmen gas per year with an increase in supply volumes to 65 billion cubic meters. m by 2020. To ensure the import of hydrocarbon raw materials, in 2009 Beijing allocated funds for the development of a group of super-giant gas and oil fields Galkanysh, located in Mary velayat, becoming the only country that gained access to the development of Turkmen resources on land, and also ensured the construction of three gas pipelines to transport resources to its territory [15].

Thus, the "One Belt, One Road" megaproject is open to all countries, international and regional organizations, and also creates the basis for economic cooperation between China and interested countries. Today, Beijing's global initiatives resonate with the countries of Central Asia. Beijing is interested in investing and expanding its economic influence, while the countries of the region need external investment and the development of their own infrastructure. Mutual interest dictates the high dynamics of cooperation between the Central Asian republics and the Middle Kingdom. It is worth noting that for the practical implementation of

its initiative, China is creating new financial development institutions such as the Asian Infrastructure Investment Bank and the Silk Road Fund, the capital of which will be directed to the implementation of large-scale infrastructure projects within the framework of the “One Belt, One Road” megaproject.

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DOI 10.34660/INF.2024.44.77.092

FEATURES OF NUTRITIONAL STATUS OF PATIENTS WITH OBESITY AFTER SEVERE COVID-19

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Annotation. *Obesity and COVID-19 mutually aggravate each other. Losses of vitamins and minerals during COVID-19 indicate the need for their compensation at all stages of the disease and recovery. The nutritional status and nutrition of post-COVID-19 patients is one of the main factors influencing recovery and maintenance of health. Dietary components with immunomodulatory and antioxidant effects have benefits in infectious diseases and play a potential role in the stages of prevention, treatment and recovery from COVID-19.*

Keywords: *obesity, COVID-19, microelements, vitamins, diet therapy.*

Introduction. Obesity is a modifiable risk factor that aggravates the course and affects the prognosis in patients who have had COVID-19 [1]. Against the background of the disease, hyperthermia and shortness of breath are accompanied by an increase in the need for nutrients and energy. At the same time, due to disturbance or loss of smell/taste, obsessive cough, shortness of breath, increased fatigue, and psychological difficulties associated with the perception of the course of the disease, there is a decrease in the consumption of macro- and micronutrients [2]. Nutritional status may be affected by medications, which may have side effects such as changes in appetite and poor nutrient intake. Losses of vitamins and minerals during COVID-19, as with any other infectious disease, indicate the need for their compensation at all stages of the disease and recovery.

Deficiency in the body of microelements, vitamins, in particular folic acid, disruption of the folate cycle and the associated decrease in the utilization of homocysteine in cells and an increase in its level in plasma, disruption of the synthesis of amino and nucleic acids can affect the ability to rehabilitate patients who have had COVID-19. 19.

Severe COVID-19 is noted against the background of vitamin D and vitamin C deficiency due to their antioxidant, anti-inflammatory and immunomodulatory ef-

fects; vitamin E and selenium due to their ability to influence resistance to respiratory infections. Magnesium deficiency is associated with decreased immune cell activity and increased inflammation, including that associated with COVID-19. Zinc deficiency worsens the course of the disease, its immunomodulatory and antiviral effects are disrupted, which affects the outcome of COVID-19 [3].

Thus, there is no doubt that the nutritional status and nutrition of patients who have had COVID-19 is one of the main factors influencing the recovery and maintenance of health. Dietary components with immunomodulatory and antioxidant effects have benefits in infectious diseases and play a potential role in the stages of prevention, treatment and recovery from COVID-19.

Purpose of the study is to diagnose the nature of nutrition and assess disturbances in micronutrient status in patients who have suffered a severe new coronavirus infection COVID-19.

Materials and methods

This study included 40 patients with COVID-19 (main group). Patient selection criteria: patients aged 18-75 years who suffered severe COVID-19 no more than 1.5-2 years ago. The main group included 28 women and 12 men. COVID-19 is confirmed by the presence of clinical signs, laboratory tests and computed tomography data (viral pneumonia CT 3-4). The average age of the patients was 57.2 ± 1.9 years - from 30 to 75 years ($M \pm m$), the average body mass index (BMI) was 39.8 ± 1.8 kg/m². When analyzing the group, grade 3 obesity was detected in 25%, grade 2 in 37.5%, and grade 1 in 37.5% of patients. The control group included 40 patients, average age 60.4 ± 1.8 years, average BMI 36.7 ± 1.4 kg/m².

The condition was assessed initially upon admission to the clinic and after 14-18 days. To assess nutritional status, resting energy expenditure and metabolic substrates (proteins, fats, carbohydrates), all patients underwent initial (before) and dynamic (after) anthropometric studies, assessment of body composition using bioimpedance analysis, and study of resting energy expenditure using indirect respiratory calorimetry with determination of daily nitrogen excretion, assessment of nutrition at home using a computer method, standard and specialized laboratory tests, instrumental studies - according to indications. Exercise tolerance was assessed using a 6-minute walk test at the beginning and at the end of treatment.

Statistical analysis was carried out using the statistics program StatTech v. 3.1.10.

Results

Analysis of anthropometric data showed that in both groups, almost all subjects as a result of complex treatment experienced a statistically significant decrease in body weight and BMI.

Index	Observation phase	Control group (CG)	Main group (MG)
Body mass Me (Q ₁ – Q ₃) kg	1	111.6 (89.3 – 117.6)	102.4 (88.2 – 129.5)
	2	106.0 (88.3 – 115.0)	97.4 (86.7 – 126.6)
	R	0.002*	<0.001*
BMI M±SD kg/m ²	1	38.7 ± 7.7	40.2 ± 10.2
	2	38.1 ± 7.4	39.3 ± 9.8
	R	0.001*	<0.001*
Fat mass M±SD kg	1	47.0 (36.8 – 63.5)	48.9 (37.9 – 69.7)
	2	46.6 (36.6 – 62.3)	47.1 (37.3 – 68.2)
	R	0.293	<0.001*
Muscle mass Me (Q ₁ – Q ₃) kg	1	33.6 (31.1 – 39.8)	31.2 (26.5 – 34.6)
	2	33.2 (31.0 – 38.1)	30.2 (25.9 – 33.1)
	R	0.004*	0.004*

* – differences in indicators are statistically significant ($p < 0.05$)

As can be seen from the presented data, only in the main group there was a statistically significant decrease in body fat mass. At the same time, a statistically significant decrease in muscle mass was observed in both groups.

In patients of both groups, it was not possible to identify statistically significant changes in the amount of resting energy expenditure. At the same time, the rate of carbohydrate oxidation (CO) in patients in the control group as a result of the course of treatment increased statistically significantly, against the background of a decrease in the rate of fat oxidation (CO), which may be responsible for the worse reduction in fat mass in this group. The rate of protein oxidation (POR) did not change significantly in both groups.

Analysis of the dynamics of resting energy expenditure during treatment

Index	Observation phase	Control group (CG)	Main group (MG)
Carbohydrate oxidation Me (Q ₁ – Q ₃) g/day	1	21 (15 – 26)	302 (35 – 340)
	2	47 (41 – 73)	111 (79 – 294)
	R	<0.001*	0.910
Fat oxidation Me (Q ₁ – Q ₃) g/day	1	200 (186 – 234)	118 (30 – 205)
	2	182 (152 – 218)	124 (50 – 198)
	R	0.049*	0.634
Protein oxidation Me (Q ₁ – Q ₃) g/day	1	77 (71 – 85)	64 (58 – 72)
	2	76 (70 – 86)	68 (66 – 70)
	R	0.670	0.641

Energy expenditure at rest Me (Q ₁ – Q ₃) kcal/day	1	2042 (1882 – 2260)	1915 (1487 – 2343)
	2	2037 (1859 – 2281)	1904 (1574 – 2233)
	R	0.670	0.845

Exercise tolerance was assessed using a 6-minute walk test performed at the beginning and end of treatment. In dynamics, an increase in the distance traveled was noted in both groups: in the main group by 15.9%, in the control group – by 19.2%.

Using a specialized computer program, the nutrition that patients followed during prehospital nutrition was assessed.

It was found that the most characteristic violations of the actual nutrition of patients in both groups are excessive consumption of total cholesterol (+79.4%), simple carbohydrates (+37%), lack of dietary fiber consumption (-30.1%), omega-3 PUFAs (- 21.9%), vitamin D (- 74%). A detailed analysis of the nutrition of patients who had a severe course of COVID-19 revealed an excess calorie intake (+23.9%), primarily due to simple carbohydrates (an increase in the consumption of simple carbohydrates by 53%). Cholesterol consumption increased by 89%, sodium by 263%, potassium by 119.5%. At the same time, there was a decrease in the intake of vitamin D from food by 88.7%, folic acid by 11.8%, biotin by 87%, zinc by 8.3%, iodine by 6.7%, chromium by 56.5%, silicon by 97%, dietary fiber by 32.8%, omega-3 PUFA by -36.2%. The intake of fat-soluble vitamins from food corresponded to the daily requirement.

Conclusions

1. An assessment was made of changes in anthropometric parameters during complex treatment in patients who had a severe new coronavirus infection COVID-19. A statistically significant decrease in body weight, BMI, fat mass, and muscle mass was revealed.

2. Diagnosis of the nutritional pattern and assessment of the nutritional status of patients who have suffered a severe new coronavirus infection COVID-19 were carried out.

3. An assessment was made of the initial metabolic processes and their dynamics against the background of complex treatment in patients who have suffered a severe new coronavirus infection COVID-19. There was no statistically significant reduction in resting energy expenditure (positive effect of diet therapy).

4. A statistically significant increase in exercise tolerance was demonstrated against the background of complex treatment in patients who had a severe new coronavirus infection COVID-19 according to the 6-minute walk test performed during the treatment.

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INTEGRATIVE VIEW ON CONNECTIVE TISSUE: THE PATH FROM INFLAMMATION TO EPITHELIAL-MESENCHYMAL TRANSITION, INNOVATION IN REGENERATIVE MEDICINE AND TISSUE ENGINEERING

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Annotation. *Connective tissue has a critical impact on the functioning of the human body, going beyond a simple support structure. It plays a central role in mechanical support, organ protection, transport of important substances, regulation of metabolism, and maintenance of body temperature. Connective tissue is also key in wound healing, tissue regeneration and immune defense, due to its content of immune system components and participation in the formation of the lymphatic system. In addition, the text highlights the importance of connective tissue in the development and progression of many diseases, including various forms of fibrosis, highlighting its complex role in both inflammatory and non-inflammatory processes. Despite extensive study, many aspects of connective tissue function and pathology remain poorly understood, supporting the need for further research in this area. The text also notes the historical development of scientific views on connective tissue, starting with the work of A.N. Chernogubov and ending with modern research, emphasizing its significance in medicine and biology.*

Keywords: *connective tissue, connective tissue functions, tissue regeneration, fibrosis, non-inflammatory processes, connective tissue pathology, epithelial-mesenchymal transformation (EMT), and sclerosis.*

Connective tissue (CT) plays a vital role in the body, performing many functions due to its unique structure and components. It includes not only ligaments,

tendons and fatty tissue, but also more specialized forms such as blood and bone tissue. Connective tissue performs vital functions in the human body, going beyond a simple “supporting frame” for organs and systems. The main and primary functions of connective tissue are mechanical support and protection, while connective tissue provides shape and support to organs and the body as a whole. Connective tissue also serves as a barrier, protecting organs and tissues from damage. Around important organs there is a connective tissue capsule that protects them from mechanical damage. Blood, which is also a special type of connective tissue, plays a key role in transporting oxygen, nutrients, hormones and other important molecules to tissues and organs throughout the body. Adipose tissue, a form of connective tissue, serves as an important source of energy by storing fats. It also plays a role in metabolism, regulating body temperature and protecting organs from mechanical damage. Connective tissue plays an important role in the process of wound healing and tissue regeneration, forming a new matrix that serves as the basis for the growth of new cells. In addition, connective tissue contains components of the immune system, such as white blood cells, which fight infections and participate in inflammatory responses. The lymphatic system, another type of connective tissue, plays a key role in maintaining the body’s immune defenses. Thus, connective tissue plays a multifunctional role in the body, providing its structure, protection, regulation and support of various vital functions. Connective tissue, performing diverse and complex functions in its essence, is an integrative tissue that maintains homeostasis [1]. Connective tissue is the completion of almost all final stages of general pathological processes. Any diffuse or focal sclerosis of parenchymal organs, a skin wound or adhesive process in the body cavity occurs with the obligatory participation of connective tissue (CT). The final stages of diseases with a predominance of CT over specialized, that is, parenchymal tissue do not have a generally satisfactory explanation and, for the most part, are simply stated as inevitable. These processes are also controlled by ST elements, being a dynamic living process for which it is necessary to come up with an appropriate reason - the extent of the damage, the virulence of the infection, hypoxia, etc. The significant role of connective tissue pathology in the development of many multisystem disorders is confirmed by the presence of hundreds of congenital and acquired symptoms and syndromes. In the subsequent course of life, they determine the development of compensatory reactions in their many pathological manifestations and create the supernosology “connective tissue failure” [2]. In modern literature, there are indications of increased susceptibility of patients with connective tissue pathology (CT) to pneumonia, tuberculosis and other diseases. Among them: cystic and simple hypoplasia, solitary lung cyst, malformation and branching with hypoplasia of the bronchial wall of segmental and subsegmental bronchi, bronchiectasis and bronchial diverticulosis, bullous emphysema [3].

The problem of connective tissue development is expressed in clinical confusion that arises when interpreting the nature of fibrous transformation of parenchymal organs - inflammatory or non-inflammatory - as the inevitable outcome of their chronic diseases. Inflammation and the subsequent development of connective tissue are more or less clear. The problem of inflammatory development of connective tissue in the context of fibrous transformation of parenchymal organs is a complex and multifaceted issue in medicine. Parenchymal organs, such as the liver, kidneys, and lungs, contain functional tissues that perform organ-specific functions. Fibrosis is a process in which normal tissue in an organ is replaced by connective tissue, resulting in decreased functionality of the organ. Inflammation is the body's defense response to tissue damage caused by infection, injury, toxic substances, or autoimmune activity. The inflammatory process involves activation of the immune system and can lead to proliferation of connective tissue in an attempt to isolate and eliminate the damaging agent and repair damaged tissue.

The non-inflammatory process of fibrosis can result from chronic tissue damage without overt inflammation. Such damage can be caused by environmental factors, metabolic disorders, hereditary predisposition or other non-infectious mechanisms, including occupational factors. In this case, fibrosis develops as a result of the constant stimulation of fibroblasts to synthesize collagen and other components of the extracellular matrix, which leads to thickening and compaction of tissue without an obvious inflammatory response.

Clinical uncertainty arises when it is difficult to determine whether the primary driver of fibrosis is inflammatory or non-inflammatory. This distinction is critical because treatment approaches can vary significantly. In the case of inflammatory fibrosis, the goal of treatment will be to control the inflammation and its causes. In the case of non-inflammatory fibrosis, efforts may focus on reducing fibrogenic stimulation of fibroblasts and modulating extracellular matrix formation.

Prophetic were the words about the possibility of a non-inflammatory nature of the sclerosing process, which originated in pulmonology - "anthracosis" (Stratton, 1837.), "pneumoconiosis" (Zinker, 1867.), "silicosis" (Visconti, 1870.) and coincided with the formation in biology and natural science of scientific ideas about connective tissue. Possible beliefs about the non-inflammatory nature of sclerosis were based only on clinical observations and practically ran counter to the understanding of sclerosis in other areas of medicine as inflammatory in nature, as a banal, completely nonspecific, stereotypical, etiologically already impersonal and pathogenetically already pronounced phenomenon. Nevertheless, this belief sooner or later, to one degree or another, made its way into various branches of medical science. Interstitial lung diseases, some forms that are not inferior to anti-inflammatory therapy; idiopathic fibrosis (cirrhosis) of the liver; Ormond's disease; systemic diseases of collagenosis, rigid to anti-inflammatory therapy; tubulointersti-

tial fibrosis in the kidneys (TIC), as a nonspecific predictor of the development of chronic renal failure, standing outside the etiology of nephropathies, is not the entire list of the most demonstrative clinical manifestations of the non-inflammatory nature of the sclerosing process and the pathology of TS.

A detailed study of connective tissue represents many years of torment in the scientific thought of many scientists. Medicine in its essence was unable to solve numerous problems generated by the forms of participation of ST in pathology. Over time, new ones were added to those indicated above, leading A.N. Chernogubova (1891) – to the idea of connective tissue dysplasia as a result of CT failure during the period of embryonic development. As part of his research, Chernogubov came to the conclusion that some forms of CT dysplasia may be associated with primary tissue failure during embryonic development. This assumption was based on observations of developmental anomalies, when disturbances in the structure and function of the CT lead to defects in the formation of organs and systems of the body. Although specific works by A.N. Chernogubov may not be fully available for wide analysis due to the limitations of time and technology of that period, his contribution to the understanding of connective tissue as a key element in the development and functioning of the body remains extremely important in understanding the problem of the formation of TS. Chernogubov was one of the first to point out the importance of the early embryonic period for the formation of healthy connective tissue and the possibility of the development of pathological conditions due to disturbances in this process. Modern medicine and biology use these concepts in the study of genetic and congenital diseases, as well as to develop methods for diagnosing, preventing and treating conditions associated with connective tissue dysplasia. Research in this area includes genetic testing, molecular biological methods to identify mutations and abnormalities in genes responsible for the development and functioning of TS, as well as the development of new approaches to therapy aimed at correcting identified disorders.

Scientific views of A.A. Bogomolets on ST as the “root of man”, the morphological heterogeneity of which he used to classify constitutional polymorphism; V.G. Garshin – to the concept of the role of disorders of epithelial-mesenchymal (stromal-parenchymal) interactions in the development of pathology. Thoughts by I.I. Swordsman were defined by ST as “ignoble”. A.A. Zavarzin, an active supporter of evolutionary histology and the author of the doctrine of phylogenetic divergent development of tissues, considered the intercellular matrix to be a “dead” substance, waste material that has no functional significance.

The diversity of scientific views on ST did not allow us to come to a common idea about its most important role in the body. Over the past decades, in-depth and detailed aspects in the study of ST have belonged to such sciences as biochemistry, histology and electronic research methods. All these methods made it possible

to obtain fundamentally new information about ST, its constituent elements and the complex mechanisms of intertissue interactions.

The systemic essence of life itself is largely based on the restructuring of connective tissue, starting from stem cells, which underlies the development of almost all tissues of the body. During a certain life cycle, lasting 4-5 years, multiple changes in various cellular structures occur: blood cells and macrophages are renewed 1825 times, the gastric mucosa - 365 times, the intestinal mucosa - 261 times, and adipose tissue - 87 times. The blood is completely replaced 61 times, the skin epithelium - 182 times, all layers of the skin - 52 times, and the skeletal structure is renewed 20 times [4]. The structure of a living system is a specific organization of its constituent elements (subsystems), among which connective tissue acts as the main subsystem. Recursion of a living system, that is, repeated repetition of its functions, helps to increase the level of adaptation due to the self-organization of connective tissue, which is the basis for the life of the system as a whole. Almost any disease or pathological reaction is largely associated with connective tissue and occurs through “typical” pathological mechanisms, such as regeneration, proliferation, granulomatosis, inflammation, necrosis, etc.

In the context of the development of our knowledge about connective tissue (CT), the need for new approaches to the diagnosis of CT becomes obvious. The history of the study of TS shows that in recent decades it and its cells have become key objects of research in immunohistochemistry, immunoenzymeology, cell therapy, as well as in the study of mediators of intercellular interactions and mechanisms of intracellular signal transduction and transcription, focused on cellular and tissue trans- and dedifferentiation.

Today, the possibility of reprogramming cells from a differentiated state to a less differentiated state, up to a stage resembling multi- or pluripotent embryonic stem cells, has been confirmed. Epithelial-mesenchymal transformation (EMT) is one example of such dedifferentiation, but with an understanding of the biological essence inherent in this concept, which was introduced into medicine at the end of the 20th century and is actively used in oncology to explain the invasiveness of tumors and the process of transformation of specialized cells into tumor cells, resembling stems.

The EMT phenomenon offers a solution to the problems of development and transformation of TS, indicating the possibility of a non-inflammatory nature of sclerosis [5, 6, 7]. This is confirmed by studies explaining the development of pneumosclerosis and tubulointerstitial syndrome through EMT.

The participation of ST in the reparative process emphasizes its role in intertissue correlations, which I.I. Schmalhausen defined it as an evolutionary and obligate pattern. Under normal conditions, epithelial and mesenchymal tissues are separated during histogenesis, reducing the possibilities of ST for adequate

morphogenetic effects, although in renewing structures, such as bone marrow, ST remains active [8]. In non-renewing tissues, excessive formation of CT is a consequence of historical development, and not degeneration of its functions. CT does not tend to separate from the parenchyma and does not aim to maintain the shape of the organ at the expense of its function, indicating that sclerosis is not a replacement process.

The EMT phenomenon demonstrates that, under pathological conditions, molecular and biochemical mechanisms regulating cellular renewal obey evolutionary laws, forming adaptive ensembles. This supports the idea that under conditions of stress, inflammation or injury, cells can activate programs that return them to more primitive, but flexible and adaptive states, capable of tissue regeneration and remodeling. In the context of various diseases, including cancer, cardiovascular, and connective tissue diseases, understanding the processes of EMT and mesenchymal to epithelial transition (MET) opens new perspectives for the development of treatments aimed at correcting abnormal cellular differentiation and stimulating regenerative processes.

It becomes fundamentally important to study the molecular pathways that regulate EMT, including signaling molecules, transcription factors, microRNAs and other molecular mechanisms involved in this transition. Such in-depth understanding may facilitate the identification of new treatment targets, allowing the development of drugs and biological agents capable of manipulating the EMT process to restore normal tissue architecture and function.

As a result, the EMT phenomenon not only represents a key element in understanding the mechanisms of disease development and tissue remodeling, but also opens up new opportunities for regenerative medicine and therapeutic approaches aimed at restoring damaged tissues and organs. This highlights the importance of further research in this area aimed at expanding our understanding of the morphogenetic processes of cell dynamics and their role in health and disease.

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DOI 10.34660/INF.2024.69.83.094

THE PROBLEM OF POPULATION AGING AND THE INCREASING INCIDENCE OF ACHONDROPLASIA AND OTHER CONGENITAL ANOMALIES IN OFFSPRING

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Summary. *The article discusses the problems of declining birth rates, late marriage and aging of the population and their connection with the increase in mutational damage in the gametes of the father and mother, and the incidence of congenital anomalies in the offspring. Numerous studies show that after 35 years, the number of de novo mutations in sperm and oocytes increases sharply. Research has found that every year of a father's life adds an average of 1,5 de novo mutations to the sperm genome, and a year of a mother's life adds 0,37 mutations per year, that is, about one mutation per three years. All this leads to the development of a number of congenital malformations and hereditary diseases in the offspring of late-parous parents, such as achondroplasia, Apert syndrome, Crouzon syndrome, Pfeiffer syndrome, thanatophore dysplasia, multiple endocrine neoplasia type 2 and many others. The conclusion suggests itself that the birth of children at the optimal age of 20-34 years is a biological and social necessity for the birth of healthy offspring and the reproduction of the human population*

Keywords: *declining birth rate, aging population, mutations in gametes, congenital diseases.*

The problem of fertility is more acute than ever in modern Russia. The geopolitical situation is developing in such a way that the preservation of Russia as an independent sovereign state directly depends on the birth rate in the coming decades. The collapse of the Soviet Union and huge human losses in the 90s of the 20th century led to the loss of vast territories and a sharp decline in the population of the Russian Federation. It has still not been possible to reverse the negative trends in population decline, and this is one of the most alarming factors calling into question the further development of Russian territories. Modern priorities of family life also do not add optimism in changing the situation. The birth of children in a modern family is relegated to the background in the list of priorities. Building a career and material well-being are put in first place, as a result of which having children occurs too late, when a woman's ability to give birth is approaching the critical age for this task. Late-bearing mothers over 35 have become a common feature of modern life. However, the majority of the population does not have the understanding that the late age of birth of offspring leads to the emergence of a huge number of small families, leaves no chance for simple reproduction of the population and greatly increases the risk of having children with various types of pathologies.

The sharp aging of the population increases the burden on social services and reduces the number of active population employed in the national economy.

One of the extremely negative effects of late first birth is a sharp increase in chromosomal and gene mutations in gametes in parents over 35 years of age, which leads to congenital malformations in the offspring, chromosomal and gene diseases.

Congenital malformations are the most common pathology in the structure of causes of stillbirth, infant mortality, infant and child morbidity. This is due to both the absolute and relative growth of this group of diseases. The increase in their number may be facilitated by the current changes in the demographic characteristics of the population. Thus, over the past two decades, the profile of maternal age in Europe has changed markedly, with the average age of motherhood increasing every year. It is well known that a woman's age carries a risk of developing certain diseases in her children. Older women have a higher risk of having children with chromosomal abnormalities such as Down syndrome.

In order to analyze changes in the age profile of mothers over time, a comparison was made of the age structure of women in 2011 and 2018 [1]. It was shown that over the 8-year period the proportion of mothers over 35 years of age increased: in 2011, they totaled 10,03%, and in 2018 – 17,79%. Similar trends can be traced in countries of both Europe and Asia. Thus, according to data from the International Clearinghouse for Birth Defects Surveillance and Research (ICBDSR), in European countries the proportion of mothers over 35 years of age

increased from 10,9% in 1993 to 18,8% in 2004. [2]. In South Korea, the percentage of older women who are pregnant more than doubled over a 10-year period, from 6,2% in 1999 to 15,4% in 2009 [3]. At the same time, it is well known that older maternal age is associated with an increased risk of chromosomal abnormalities; This applies primarily to chromosomal disorders such as trisomy of chromosomes 13, 18 and 21.

Based on the combined database of monitoring congenital malformations, the frequency of chromosomal diseases was assessed for the group of trisomies 13, 18, 21, depending on the age of the mother. In total, from 2011 to 2018, there were 7675 cases of trisomies of chromosomes 13, 18 and 21 in newborns and fetuses out of 5047468 births. The cumulative incidence was 1,52 per 1000 births. At the same time, in different age groups of mothers, the frequencies of these trisomies varied significantly. If in the age interval from 20 to 34 years their frequency was 0,9 per 1000 births, then after 40 years this figure increased to 13,34 per 1000 births, and after 45 years – to 23,32 per 1000 births [1].

In general, a pronounced trend of increasing the frequency of chromosomal abnormalities is observed after 35 years, which confirms the well-known pattern. Thus, the age of a woman over 35 years is considered as an unconditional risk factor for the development of aneuploidy, which is explained by the direct association of maternal age with the frequency of meiotic chromosome nondisjunction during oogenesis. For women over 35 years of age, a number of studies have shown an increased risk of having children with neural tube defects and facial clefts [4].

Analysis of the frequency distribution of congenital malformations of non-chromosomal etiology in different age groups of mothers showed that in the group of mothers 35-39 years old, the frequency of such malformations was 4,64%, the maximum frequency was observed in the group of women over 45 years old (7,98%). Thus, starting from the age of 35 years, there is a significant increase in the incidence of congenital malformations.

In turn, older paternal age may be associated with a higher risk of developing certain monogenic disorders caused by mutations in the FGFR2, FGFR3, and RET genes.[5] These conditions are Apert syndrome, Crouzon syndrome, Pfeiffer syndrome, achondroplasia, thanatophoric dysplasia, multiple endocrine neoplasia type 2 and multiple endocrine neoplasia type 2b [5]. The most significant effect concerns achondroplasia, which can occur in approximately 1 in 1875 children fathered by men over 50 years of age, compared with 1 in 15,000 in the general population [6]. FGFR genes may be particularly affected by paternal age due to selfish spermatogonial selection, in which the impact of spermatogonial mutations in older men is enhanced because cells with certain mutations have a selective advantage over other cells.

Unlike oogenesis, spermatogenesis is a lifelong process [7]. Each year after puberty, spermatogonia (sperm precursors) divide meiotically approximately 23

times [8]. By age 40, spermatogonia have undergone about 660 such divisions, compared to 200 at age 20 [8]. Copying errors can sometimes occur during DNA replication preceding these cell divisions, which can lead to de novo mutations in sperm DNA [9].

The selfish spermatogonial selection hypothesis suggests that the impact of spermatogonial mutations in older men is further amplified because cells with certain mutations have a selective advantage over other cells.[8,10]. Such an advantage would allow the mutated cells to increase in number through clonal expansion [8,10]. In particular, mutations that affect the RAS pathway, which regulates spermatogonial proliferation, appear to confer a competitive advantage on spermatogonial cells and also lead to diseases associated with paternal age [10].

Over the past two decades, evidence has also accumulated that spontaneous miscarriages, as well as a decrease in the success of assisted reproductive technologies, are associated with impaired sperm chromosome integrity and DNA fragmentation [11]. A recent systematic review found that advanced paternal age was associated with a significant increase in DNA fragmentation (with 17 of 19 studies reviewed showing such an association) [12].

Spermatogenesis is accompanied by DNA methylation, an epigenetic process that regulates gene expression [8]. Incorrect genomic imprinting and other errors sometimes occur during this process, which can affect the expression of genes associated with certain disorders, increasing the susceptibility of offspring. The frequency of these errors appears to increase with age. This could explain the association between paternal age and schizophrenia [13]. Paternal age influences offspring behavior, possibly through epigenetic mechanisms affecting transcriptional repressors [14].

Icelandic geneticists conducted an unprecedented study of mutagenesis in modern humans, analyzing the complete genomes of 1548 “triples”, including a pair of parents and their offspring [15]. Direct comparison of the complete genomes of an offspring and both its parents is labor-intensive, but the most reliable way to determine the number of new mutations. In 225 cases out of 1548, the researchers had at their disposal, in addition to the genomes of two parents and a descendant, also the genome of a representative of the next (third) generation, that is, a descendant of a descendant. Such data make it possible to more reliably establish the origin (paternal or maternal) of new mutations in a representative of the second generation, because these mutations are inherited by a grandson or granddaughter as part of a chromosome fragment that matches one of the chromosomes of either the grandfather or grandmother. It turned out that each newborn receives on average 70 new mutations that the parents did not have, of which 80% are brought by the sperm, and only 20% by the egg. The rapid increase in the number of new mutations with the age of the father was confirmed: each year of a father’s

life adds an average of 1.5 mutations to his offspring. The age of the mother also affects the number of mutations in the offspring, but not so much: each year of the mother's life costs the offspring 0.37 additional mutations. The distribution of "maternal" mutations throughout the genome turned out to be uneven: in several areas the frequency of their occurrence was sharply increased. Apparently, this is due to the fact that chromosomes in aging oocytes most often break in these areas. A similar pattern of distribution of maternal mutations is characteristic of chimpanzees and gorillas, but not of orangutans. We appear to have inherited this pattern from early African great apes.

The authors discovered a total of 108778 new mutations (of which 101377 were single nucleotide polymorphisms, the rest were indels). Thus, the result was an average of $108778/1548 = 70,3$ new mutations per person, which coincides with previous estimates.

It was possible to establish paternal or maternal origin with maximum accuracy for 15746 mutations registered in those triplets where there was data on "descendants of descendants." It turned out that 80,4% of new mutations are of paternal origin, that is, people receive them with the sperm genome. The number of "paternal" mutations increases rapidly with the age of the father. Each year of a father's life adds an average of 1,47 new mutations to his descendants. This is less than previous estimates (about two). The number of mutations of maternal origin also increases with the mother's age, but four times slower - by 0,37 per year of the mother's life.

It was previously noted that paternal and maternal mutations differ in their nature and distribution throughout the genome. A new study has confirmed this. Thus, C>T mutations (replacement of cytosine with thymine) are 1.3 times more common among maternal mutations than among paternal ones. Mutations T>G and C>A are approximately the same number of times more common among paternal than maternal ones. Some differences were also found in the rates of change in the frequency of different types of mutations with the age of the parent.

One of the most unexpected results is that the distribution of maternal mutations across the genome turned out to be extremely uneven (this is less true for paternal mutations). In some regions of the genome, the frequency of occurrence of maternal mutations is sharply increased. Particularly notable is a section of the eighth chromosome, 20 million base pairs long, where maternal mutations occur 4,5 times more often than the genome average. The frequency of maternal mutations of type C>G is especially strongly increased (12,8 times) in this area. In some other regions of the genome, the frequency of such mutations is also noticeably increased. Both the number of C>G mutations and the number of clusters ("condensations") of such mutations grow rapidly with maternal age.

If these features of the occurrence of maternal mutations did not appear yesterday, but exist for a long time, then in these regions of the genome in people

there should be an increased frequency of the corresponding single nucleotide polymorphisms (that is, variable nucleotide positions, where in some people there is nucleotide C, and in others - G). The authors tested this assumption using the available genomic data (not only Icelandic), and it was completely confirmed. This means that an increased frequency of C>G mutations in these regions of the genome has been characteristic of our species for a long time. But how long ago? To find out, the researchers turned to the genomes of various monkeys. It turned out that chimpanzees and gorillas are similar to humans in the distribution of C>G polymorphisms, but orangutans and other apes are not. Apparently, this means that the identified feature - an increased frequency of C>G mutations in several strictly defined regions of the genome - appeared in our ancestors after their separation from the ancestors of orangutans, but before their separation from the ancestors of gorillas. In other words, it appeared in the early representatives of the African great apes

Some indirect signs (such as the frequent location of adjacent maternal C>G mutations on the same DNA strand, as well as the coincidence of regions with an increased frequency of such mutations with regions of frequent gene conversion not associated with crossing over) indicate that the increased probability maternal mutations C>G are characteristic of those areas where DNA double helix breaks often occur in aging oocytes. For some reason, these areas are torn more often than others, and C>G mutations appear during the repair of double breaks. Recall that sperm precursor cells are constantly dividing, and most mutations in them are DNA replication errors. On the contrary, the precursor cells of eggs (oocytes) do not divide, but “freeze” in prophase I of meiosis for years and decades. Therefore, most mutations in them are the result of DNA damage not associated with replication. Perhaps this is due to the peculiarities of the configuration of chromosomes in prophase I of meiosis, the strength of different sections of chromosomes, the “structural stress” to which oocyte chromosomes are exposed in the chiasmata, as well as the decrease in the amount of cohesin in aging oocytes.

From the results obtained, it follows that the rate of accumulation of genetic differences between divergent species (which must be constant for the ideal functioning of the “molecular clock”) depends, among other things, on the age at which fathers and mothers have children. Obviously, an increase in the average age of paternity by 10 years would lead to an acceleration of mutagenesis (in mutations per year) by 4.7%.

Based on the foregoing, it becomes obvious that late birth of children has an extremely negative impact on the quality of the human population and its reproduction. The birth of children with a fertility rate of at least 2.1 at the optimal age of 20-34 years is a biological and social necessity for healthy offspring and solving the problem of population decline in our country.

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DOI 10.34660/INF.2024.19.35.095

UDC 616-036.22

MAIN DIRECTIONS OF EPIDEMIOLOGY OF INFECTIOUS DISEASES

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Abstract. *The article is devoted to the study of the basic concepts of epidemiology of infectious diseases. The author substantiates the relevance and significance of the research topic. A brief justification of epidemiological infectious diseases is given. The author notes that the epidemiology of infectious diseases studies the circumstances under which both infection and disease occur in the population, and the factors affecting their frequency and spread. This concept distinguishes between infection and disease, because the factors determining their occurrence may be different, and also because infection without disease is characteristic of many viruses. Infection indicates the reproduction of the pathogen inside the host organism and is determined to a large extent by factors that determine the effect of the pathogen and the susceptibility of the host organism. A disease is a reaction of the host organism to an infection when it is severe enough to cause a recognizable set of clinical symptoms. The factors influencing the occurrence and severity of this response vary depending on the specific viruses involved and their path of entry, but the most important determinants for many common infections lie within the focus itself. Of these, the age at the time of infection is the most important. Also, in the work, the COVID-19 pandemic is investigated as an example.*

Keywords: *epidemiology, epidemiology of infectious diseases, infectious disease, unified health, SARS-CoV-2, COVID-19, intervention, PHC, WHO.*

Introduction

As is known, the epidemiology of infectious diseases is concerned with the circumstances under which both infection and disease occur in a population and the factors influencing their frequency, distribution and dispersal. This concept distinguishes between infection and disease because the factors that determine their occurrence may be different and because infection without disease is common to many viruses. Infection indicates the proliferation of a pathogen within a host and is determined largely by factors determining pathogen exposure and host susceptibility. Illness is the body's response to an infection when it is severe

enough to cause a recognizable set of clinical symptoms. Factors influencing the occurrence and severity of this reaction vary depending on the specific viruses involved and their route of entry, but the most important determinants of many common infections lie within the host itself. Of these, the most important is age at the time of infection. This article will outline the concepts, methods, and techniques of infectious disease control.

Epidemiology is the study of the distribution and determinants of health conditions or events in specific populations and the application of the results of this research to control health problems. It is the quantitative science of infectious diseases, studying the circumstances under which disease processes occur, factors influencing their prevalence, and the host's response to an infectious agent, and the use of this knowledge for control and prevention. It includes the pathogenesis of disease both in the community and in the individual. With regard to infectious diseases, it is necessary to study the circumstances under which both the infection and the disease occur, since they can be different. Infection results from the encounter of a potentially pathogenic microorganism with a susceptible human host through an appropriate portal of entry and usually involves an obvious host response to the pathogen. [1] Exposure is a key factor, and sources of infection are primarily outside the individual human host, in the environment or in other infected hosts. Disease is one of the possible consequences of infection, and the factors important for its development are mainly inherent in the host, although the dosage and virulence of the infecting microbe play a role. These intrinsic factors include age at the time of infection, portal of entry, presence or absence of immunity, strength of the primary defense system, effectiveness and nature of humoral and cell-mediated immune responses, genetic makeup of the host, nutritional status, presence of other diseases, and psychosocial influences. These factors that lead to the occurrence of clinical disease among those infected have been called "clinical disease promoting factors," and many of them remain unknown. Host responses may include death, classic clinical signs of disease, mild or atypical forms, subclinical and non-obvious infections, and a carrier state, which can exist in the absence of a detectable host response. While the clinician is primarily concerned with the disease, the epidemiologist is interested in both the infection and the disease itself. Infection without disease is common, so a study limited to clinical disease alone would provide an incomplete epidemiological picture and provide a poor basis for control and prevention. A complete understanding includes the pathogenesis of the process leading to clinical disease, both in the community and in the individual.

Research methods

Epidemiology can be divided into descriptive, analytical, experimental and serological epidemiology. The main analytical methods used are cohort (prospective) and case-control (retrospective).

Before conducting epidemiological studies, you should read a textbook on epidemiological methods, which includes discussions and examples on infectious diseases. It should be noted that the World Health Organization (WHO) has produced a concise book on all aspects of epidemiological research.

Epidemiological studies can be descriptive or analytical. Descriptive studies are based on available data sources and describe disease patterns in populations as a function of time, place, and individual factors. Epidemic investigations begin with descriptive research. These findings often provide clues to the etiology of the disease or associated risk factors. Analytical studies are then designed to test the causal hypotheses developed from the descriptive studies, usually requiring new data. There are three common analytical methods used in epidemiological studies.

Results and discussions

Concepts in the epidemiology of bacterial infections are very similar to those in the epidemiology of viral infections. Some differences between viral and bacterial infection include the intracellular location of all viruses, their smaller size, the requirement of living tissue for viral replication, the ease with which many viruses are spread by respiratory or insect vectors, the relatively high level of immunity following viral infection, the usefulness of serological tests for the diagnosis of most viral infections and the inability of viral infections to respond to antibiotic therapy [2]. Highly sensitive and specific molecular techniques are increasingly used to identify the pathogen and the host response to it.

Many of the concepts and methods of epidemiology are applicable to both infectious and noncommunicable diseases, and there should not be a significant dichotomy between them.

In general, epidemiology can be viewed as the development, pathogenesis and expression of infection and disease in a community in much the same way that clinical medicine deals with the development, pathogenesis and expression in an individual. The emergence of new diseases such as Lyme disease, toxic shock syndrome and the development of antibiotic-resistant pneumococci and tuberculosis bacilli, the emergence of erythrogenic streptococci (“flesh-eating” streptococci) and a new cholera strain called 0139, outbreaks of foodborne *E. coli*, an outbreak of cryptosporidiosis transmitted through water are among the emerging infections that continue to pose challenges for epidemiologists and for which preventive strategies are being developed. It is becoming clear that the continued, and in some cases increasing, importance of infectious diseases is a public health concern in many countries.

In developing countries, infectious diseases continue to be a leading cause of morbidity and mortality, and efforts are being made to develop training programs in epidemiology and surveillance in such areas.

Public health authorities often monitor the severity and status of an epidemic by assessing transmission activity and/or intensity (i.e., transmissibility) through-

out the epidemic. For example, health measures such as contact tracing, case isolation, hand hygiene, face coverings, and social distancing can influence people’s behavior and change the transmission activity or transmissibility of a circulating virus in a community. Estimates of epidemiological parameters, including generation interval, effective reproductive number (R_t), and superspreading potential (k), can reflect transmission activity or transmissibility of an epidemic and are used to determine the impact of these factors (Figure 1).

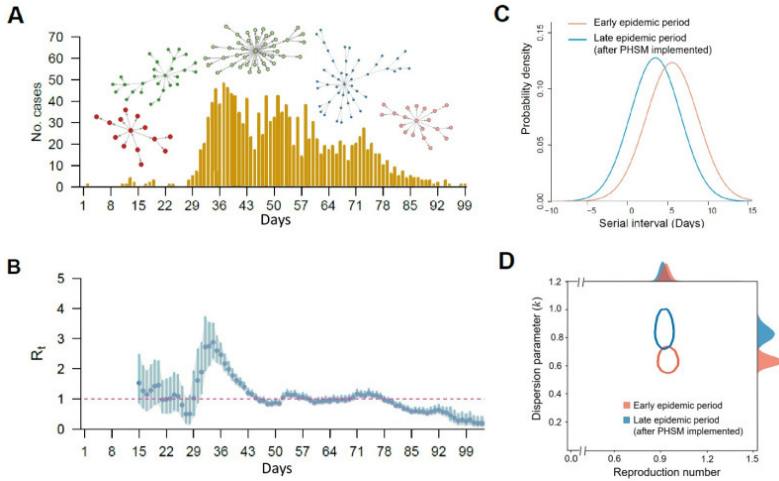


Figure 1. Determination of epidemiological parameters

Note: COVID-19 results in South Korea are presented here, modified from materials. (A) Epidemic curve with chain of transmission of infectious diseases (indicator of transmission activity). (B) Daily effective reproductive number (R_t) of infectious diseases (a measure of transmissibility). (C) Distribution of infectious diseases over successive intervals in two different epidemic periods. (D) Risk of over-prevalence of infectious diseases during two different epidemic periods.

For example, after COVID, many countries are relaxing the provision of primary health care (hereinafter referred to as PHC). However, a significant knowledge gap remains regarding the relationship between weakening PHC and changes in these epidemiological parameters. Some studies have reported that these parameters could potentially be modified for COVID-19 variants and subvariants and have an impact on the dynamics of other infectious diseases. [3] This may increase the infectious burden of future infectious diseases in different countries and settings.

During the COVID-19 pandemic, the potential for pre-symptomatic transmission of SARS-CoV-2 has hampered effective PHC delivery. It is difficult to determine when transmission began because it is difficult to pinpoint who is infected and when. However, detailed contact tracing exercises allow transmission chains to be reconstructed based on start time information, perhaps using timing of infection with known dates of potential exposure. Combining these data with known information about the onset of symptoms in the infector and the infected person, it is possible to draw a conclusion about the incubation period and the distribution of successive intervals

Transmission of infectious diseases depends on the number of infectious and susceptible individuals in a population and their effective contacts. For example, the stochastic susceptible-infectious-recovered compartmental model assumes population homogeneity and indicates a high probability of effective contact between similar age groups. Not all people in a population are equally susceptible to infection. Thus, information about age-specific infection, infection probability, and contact matrix could be used to develop an age-structured compartment model. For example, at the beginning of the COVID-19 pandemic in 2020, few cases were reported among children, and an age-varying transmission matrix of infector-infected pairs was observed (i.e., children had a higher likelihood of transmission from adults). Since public health authorities in many countries report age-stratified numbers of COVID-19 cases daily, age-specific prevalence of infection (i.e., age-specific susceptibility to infection) can be estimated using Bayesian inference using Markov chain Monte Carlo [4].

Thus, age-specific COVID-19 vaccination coverage and vaccination efficacy can be applied to the susceptible population within an age-structured compartment model for COVID-19. In addition, many countries have changed their COVID-19 surveillance design from active to passive, and many COVID-19 cases have gone unreported due to changes in health-seeking behavior and lack of contact tracing (Figure 1). Consequently, seroprevalence studies were conducted to identify age-related susceptibility to SARS-CoV-2 infection in many communities during the SARS-CoV-2 omicron wave. Additionally, a longitudinal study of community seroprevalence may improve epidemic modeling and pharmaceutical intervention strategies by elucidating the immune dynamics of SARS-CoV-2 at the individual and population levels [5].

Results

The co-circulation of multiple viruses in a community post-COVID-19 may address several critical questions regarding cross-protection from natural infections caused by similar viruses, the seasonality of multiple pathogens, and their complex burden and impact on health care settings. This creates opportunities to develop a holistic quantitative approach.

Nowadays, developing optimal intervention strategies is critical to respond to epidemics or pandemics in real time. Optimization theory in optimal control problems has proven itself well. However, optimization theory for individual models (or network models) has a relatively short history and is currently under development. Game theory can provide good methods for optimizing individual models, while dynamic or geometric programming can optimize network models. Optimization problems (optimal control or dynamic programming) often require predetermined information (priors), and optimization systems using artificial intelligence (AI) provide an alternative approach to answering epidemiological questions. For example, it can be used to determine when to screen or treat infected individuals in resource-limited settings with a variety of infectious diseases.

Artificial intelligence-based research is a growing field and is applied to many sequential decision-making problems. An AI-based amplification system consists of two main actors: a policy maker (or actor) and a dynamic model of disease transmission (or the environment). The subject makes a decision based on the structure of the contact network and information about the dynamically changing epidemiological characteristics of the population (susceptible–exposed–infectious–recovered). Reinforcement learning uses past-present-future states and identifies inherited or embedded information. These features may provide an innovative and alternative framework for understanding the dynamics of infectious disease transmission.

It is worth saying that over the past decade, two coronavirus diseases, Middle East respiratory syndrome coronavirus and SARS-CoV-2, have affected the world's population. These zoonotic infectious diseases are documented to be transmitted from animal populations (e.g., wildlife and livestock) to susceptible humans or vice versa through direct or indirect contact. This contact is becoming more frequent due to the violent encroachment of humans into natural spaces due to population explosions and travel. Moreover, changes in climate and landscape have altered the relationships between animals and people, causing either competition for natural resources or their distribution. These kinds of changes in relationships occur constantly between wild and farmed animals, as livestock rely heavily on humans for breeding and feeding. For example, in South Korea, many domestic ducks were infected with avian influenza from wild birds. Animal health authorities have conducted proactive surveillance of avian influenza in both wild and farmed birds. In addition, early identification and reduction of infected poultry flocks and serosurveillance of farm workers were carried out to prevent the possible spread of viruses from animals to humans (i.e. secondary spread). Thus, an integrated and holistic approach such as One Health could improve public health decision-making regarding community-level mitigation and intervention strategies against these infectious diseases.

Conclusions

The above allows us to draw an objective conclusion that knowledge in the field of epidemiology of infectious diseases is expanding. Basic epidemiological methods and principles are used today, however, improved laboratory diagnostic methods help confirm cases faster, see how they are related to each other, and therefore can help prevent the spread of a particular disease. Better computers can improve data analysis, and the Internet provides access to detailed information about specific diseases. Computer connectivity improves disease reporting for surveillance purposes, allowing the epidemiologist to take preventive action more quickly when needed, as well as identify disease clusters and outbreaks early.

With all these changes, infectious disease epidemiology has received increased attention, making it a challenging area to work on. Thus, to mitigate or control future infectious disease epidemics and pandemics, a critical strategic breakthrough in primary health care from a unified health perspective is needed. Continued improvements in community-based epidemiological modeling and applied computational methods are needed to generate scientific evidence to improve public health decision-making.

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CARDIAC ARREST DURING LAPAROSCOPY. REVIEW OF A CLINICAL CASE. DISCUSSION OF THE ALGORITHM OF ACTIONS

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List of abbreviations:

CPR - cardiopulmonary resuscitation

NBP – non-invasive blood pressure

ALV - artificial lung ventilation

RR – respiratory rate

HR – heart rate

SpO₂ – oxygen saturation

Mm Hg Art. – mm Hg

cm H₂O – cm water column

Pin–Inspiratory pressure

I:E – inhalation to exhalation ratio during mechanical ventilation

i.v. – intravenously

vol % – volume percentage of inhalational anesthetic on the evaporator

AV – atrioventricular

Keywords: *“laparoscopy”, “cardiac arrest”, “carrying out CPR under laparoscopy”.*

Relevance: More than 80% of emergency abdominal surgeries in our hospital alone are performed laparoscopically. This method of surgical intervention offers many advantages compared to traditional open operations. However, despite its minimally invasive and effective nature, this type of surgical intervention, according to the literature, can be complicated by damage to the abdominal organs and great vessels of the abdominal cavity. Pneumoperitoneum, necessary for laparoscopy, can lead to bradycardia with subsequent cardiac arrest. These complications may lead to the need for cardiopulmonary resuscitation. To date, in policy documents - medical treatment standards, guidelines, scientific publications - there are no specific recommendations, standards and guidelines for the prevention of damage to the abdominal organs and great vessels during CPR during laparoscopy.

Purpose of the study: To determine the sequence of actions for CPR during laparoscopy; prevent damage to internal organs during CPR during laparoscopy.

Materials and methods: On 08/17/2021 at 15:13, a 4-year-old, 18 kg, male child was admitted to the emergency department with complaints of acute pain in the right iliac region. After examination by a surgeon, a preliminary diagnosis of “Acute appendicitis” was made. Laboratory studies were consistent with the nature of the disease; ECG changes in the ventricular myocardium were not sharp. At 16:00, the child was admitted to the operating room with a functioning 22 G peripheral venous catheter in the left antecubital vein with NBP of 104/62 mmHg. Art., heart rate – 122 beats/min, respiratory rate – 22 per minute, SpO₂ – 98%. After introductory inhalation mask anesthesia Sevoflurane + O₂ step by step 0.0 – 8.0 vol%, a naso-gastric tube was installed, the following was injected intravenously: 0.005% Fentanyl 1.0 ml, 1% Rocuronium 1.0 ml - by direct laryngoscopy without technical difficulties, tracheal intubation was performed with a 4.0 endotracheal tube with a cuff, the cuff was inflated, artificial ventilation was started in the “Pressure Control” mode with the parameters: RR – 18 per minute, RV – 15 cm H₂O, I:E ratio – 1:2, oxygen concentration in the inhaled mixture is 30%, Sevoflurane concentration is 2.0 vol%, auscultation of breathing is bilaterally symmetrical and clear, the course of anesthesia is smooth. At 16:20, catheterization of the bladder was carried out and after standard treatment of the surgical field with an antiseptic solution, paraumbilical laparocentesis was performed, pneumoperitoneum was applied, a laparoscope and a clamp for single access were inserted into the abdominal cavity, the anatomical atraumatic grasper, the course of anesthesia was smooth. At 16:30, during an examination of the abdominal organs, the patient experiences rapid bradycardia with complete cardiac arrest, a drop in blood pressure to 68/28 mm Hg. Art., the laparoscope and clamp with trocar were removed from the abdominal cavity, the laparoscope trocar was not removed from the abdominal cavity. The following was injected intravenously: 0.1% Adrenaline hydrochloride 0.1 ml, 0.1% Atropine sulfate 0.1 ml, chest compressions were started. After 30

seconds, cardiac activity was restored; heart rate was 134 beats/min, NBP was 92/54 mm Hg. Art. Saturation by transcutaneous pulse oximetry did not decrease below 92%. It was decided to return to laparoscopy. At 16:45, during the re-application of pneumoperitoneum, a repeated episode of bradycardia is noted with a drop in heart rate to 82 beats/min and a drop in blood pressure to 76/43 mm Hg. Art.. A decision was made to complete laparoscopy and proceed with surgical intervention through laparotomy. After desufflation of the abdominal cavity and removal of all surgical instruments from the abdominal cavity, the heart rate was restored to 104–116 beats/min and blood pressure was restored to 97/71 mmHg. Art.. At 17:20 laparotomy was performed. During the inspection of the abdominal organs, in addition to signs of acute gangrenous-perforated appendicitis and diffuse peritonitis, a rounded hematoma of the mesentery root with a diameter of 1.5 - 1.8 cm and a deserosed area of the jejunum not requiring surgical correction of 1.0 cm by 3 were discovered. 5 cm most likely received by the patient leaving the laparoscope trocar in the paraumbilical area during chest compressions. After appendectomy and lavage of the abdominal cavity with warm 0.9% NaCl until signs of diffuse peritonitis were eliminated, the abdominal cavity was drained in two places, the laparotomy wound was sutured at 18:50, the patient was transferred to spontaneous breathing mode. At 19:00 a CVC was installed in the right subclavian vein. At 19:20 the patient was extubated and with RR – 24/min, HR – 112 beats/min, NBP – 105/63 mmHg. Art. , SpO₂ – 98% transferred to the ICU for further observation. When performing combined endotracheal anesthesia under mechanical ventilation during laparotomy, no hemodynamic disturbances were noted. Therefore, we can be sure that the bradycardia followed by cardiac arrest was caused solely by the action of pneumoperitoneum. During observation in the ICU, only positive dynamics were noted. 08/18/2021, i.e. the next day, the patient in a stable, moderate condition was transferred to the surgical department. On August 24, 2021, drains were removed from the abdominal cavity. On August 30, 2021, the patient was discharged in satisfactory condition for outpatient observation at his place of residence.

Discussions: A review of the freely available Internet literature confirmed the pathological effect of pneumoperitoneum on the cardiovascular system. Pneumoperitoneum can cause AV dissipation, AV junctional rhythm, sinus bradycardia, and asystole (1). In elective laparoscopic surgery, there are 16 cases of bradycardia followed by cardiac arrest in 11,000 adult patients (2). However, none of the authors provides even an approximate algorithm of actions for performing CPR in laparoscopic surgery. Indirect cardiac massage, which is an integral part of CPR, is also unsafe for the patient and can lead to ruptures of the liver and spleen, ruptures of hollow organs: the stomach and various parts of the intestines; massive hematomas caused by rib fractures. Thus, the totality of risks associated with laparoscopy and chest compressions obliges you to act as follows:

1. remove the manipulators from the abdominal cavity;
2. remove the metal and plastic sleeves of the manipulators, immediately installing latex atraumatic sleeves instead;
3. perform CPR;
4. quickly and atraumatically reinstall the sleeves with manipulators and laparoscope through latex sleeves
5. continue or terminate laparoscopic surgery.

Results: Considering the risk of trauma to the abdominal organs during laparoscopy (injuries to the liver and spleen, stomach and intestines, great vessels (3)) (4), the possibility of trauma to the abdominal organs and chest during CPR (ruptures of the stomach and intestines, blunt liver injury, massive hematomas caused by rib fractures) (5), there is a need to remove all instruments from the abdominal cavity for CPR, and the high probability of returning to continue or end the surgical intervention makes it necessary to install latex sleeves, through which everything is quickly and atraumatically instruments can be returned to the abdominal cavity (6).

Conclusions: With increasing bradycardia during laparoscopy, it is necessary to remove all manipulators and their metal and plastic sleeves from the abdominal cavity, and in their place, immediately install atraumatic latex sleeves, through which, with successful restoration and stabilization of the patient's vital functions, rapid and atraumatic reverse installation of a video port and manipulators to continue and complete the surgical intervention.

This method eliminates the possibility of damage to internal organs during CPR in case of complications of laparoscopy and ensures a quick return to the continuation or completion of surgery when restoring the patient's vital functions after successful resuscitation measures.

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DOI 10.34660/INF.2024.70.95.097

DEVICE FOR ADAPTIVE SAMPLING OF ANALOG SIGNALS

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Annotation. *In digital instruments, to obtain the digital equivalent of a continuous measurand, it is subjected to time discretization and level quantization. Discretization is the sampling of samples of a continuous quantity at small time intervals, which are called sampling steps. The sampling step can be constant or variable.*

With a constant step (uniform sampling) the interval between samples is selected based on a priori information or assumptions about the characteristics of the signal.

With variable pitch (non-uniform sampling) the interval between samples is changed in real time taking into account the change of continuous measured value. The step increases on horizontal sections of the signal and decreases on steep sections of the signal. This variable pitch sampling is called adaptive sampling.

In turn, adaptive discretization can be with continuously varying intervals between samples or with multiple intervals between samples.

In this paper we consider the principles of construction of a device for adaptive discretization with continuous intervals.

Keywords: *Discretization, adaptive discretization, sampling interval, noncontinuous value, discrete value, criterion of the largest deviation, controlled generator, precision rectifier, sampling-storage device, analog-to-digital pre-converter, digital-to-analog converter.*

1. The structural diagram of the adaptive sampler is shown in Figure 1.

The input analog signal V_{in} enters the input amplifier (repeater), which is simultaneously an impedance converter.

The output signal of the repeater is fed to the difference amplifier and to the sampling-storage device.

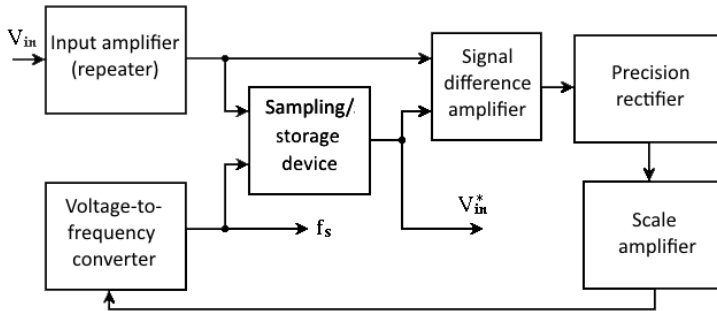


Figure 1. Structural diagram of the adaptive sampling device

The output of the sampling-storage device is connected to the second input of the difference amplifier. At the output of the difference amplifier a bipolar signal of the analog signal sampling error is formed. The bipolar signal with the help of a precision rectifier is transformed into a signal of one polarity, the amplitude of which is an indicator of the sampling error. The signal of the precision rectifier is fed to the scaling amplifier.

The scale amplifier performs the following functions.

1. Produces a voltage-to-frequency converter control signal over the entire operating range of the sampler.
2. Determines the criterion by which adaptive sampling takes place.
3. Provides the necessary control law and alignment of the precision rectifier with the rest of the discretizer devices.

When the discretizer error increases (when the signal at the output of the precision rectifier increases), the signal at the output of the scaling amplifier increases. This leads to an increase in the sampling frequency and, consequently, to stabilization and limitation of the sampler error.

When the sampler error decreases below the set limit, the signal at the output of the scaling amplifier also decreases, which leads to a decrease in the sampling frequency and, consequently, to stabilization of the sampler error at the set level.

2. The functional diagram of the discretizer is shown in Figure 2. The functional circuit is performed in the EWB simulator, and it is possible to trace the operation of the adaptive discretizer and observe oscillograms at various points of the functional circuit. For this purpose, an oscilloscope, a function generator, an analog-to-digital converter ADC and a digital-to-analog converter DAC are added to the circuit. Functional generator simulates the input analog signal, its output is

connected to the input repeater (impedance pre-transformer), made on the operational amplifier A1. The output of the repeater is connected to the non-inverting input of the difference amplifier A3 and to the input of the sampling-storage device (key S, capacitor C1, repeater on operational amplifier A2).

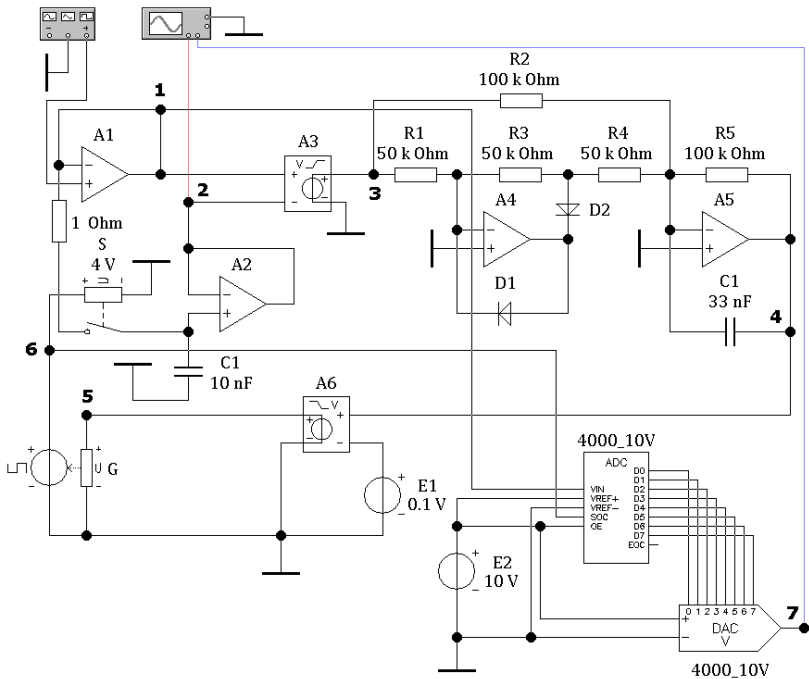


Figure 2. Functional diagram of the adaptive sampling device

The sampling-storage device [1] under the control of the voltage-frequency converter G performs sampling of the input analog signal. The output of the sampling-storage device is connected to the second difference amplifier A3. A time sampling error signal is generated at the output of A3. Oscillograms of voltages at the corresponding points of the circuit are shown in Figure 3 and Figure 4. Figure 3 shows the oscillograms of the input analog signal (point 1 of the circuit) and the sampled signal (point 2 of the circuit). Figure 4 shows the oscillograms of the sampled signal (point 2 of the diagram) and the sampling error signal (point 3 of the diagram).

The error signal is greater than zero if the input signal increases and less than zero if it decreases. The error signal is fed to the rectifier made on operational amplifiers A4, A5, diodes D1, D2, capacitor C1 and resistors R1,..., R5. The rectifier

is assembled according to the standard scheme [1]. Capacitor C1 is intended for smoothing ripples at the rectifier output.

The signal from the rectifier output goes to the non-inverting input of the scaling amplifier. The other input of the scaling amplifier is connected to the reference voltage source E1.

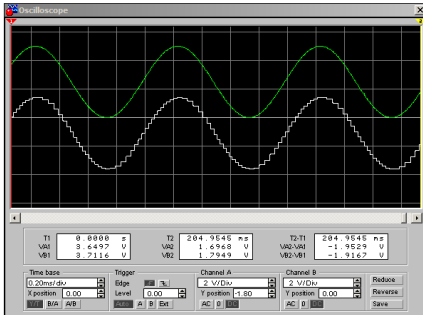


Figure 3. Oscillograms of voltages at points 1 and 2 of the circuit

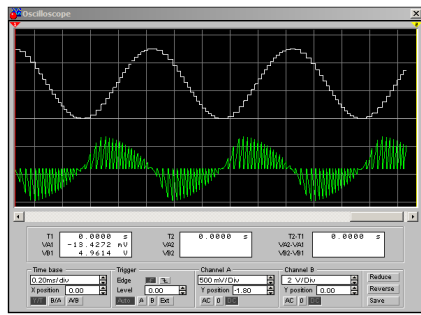


Figure 4. Oscillograms of voltages at points 2 and 3 of the circuit

The scaling amplifier controls the voltage-frequency converter. Oscillograms of voltages at the corresponding points of the circuit are shown in Figure 5 and Figure 6.

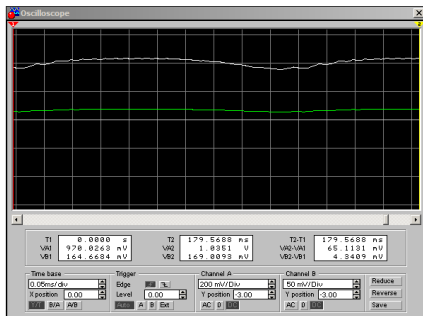


Figure 5. Voltage waveforms at points 4 and 5 of the circuit

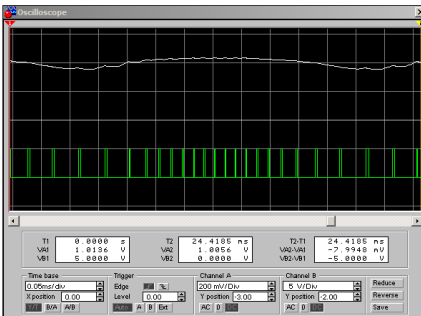


Figure 6. Voltage waveforms at points 5 and 6 of the circuit

The top oscillogram in Figure 4 and Figure 5 is the output of the scaling amplifier. The average value of this output voltage is one volt, which corresponds to a sampling frequency of 25 kHz. The lower oscillogram in Figure 5 is the output of the rectifier (input of the scaling amplifier). The lower oscillogram in Figure 6 is the output of the voltage-to-frequency converter.

The analog-to-digital converter (ADC) [2], [3] receives discrete pulses of the pe-temporal frequency and the input signal to be converted. The digital signal codes at the output of the analog-to-digital converter are unevenly spaced along the time axis, according to the selected adaptive sampling algorithm.

The digital-to-analog converter (DAC) [2], [3] connected to the ADC outputs reconstructs the analog signal and thus shows the correctness of the adaptive sampler. Figure 7 and Figure 8 shows the input analog signal and the signal after ADC and DAC conversion for 1 kHz and 100 Hz.

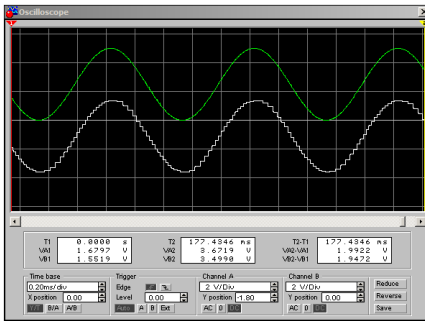


Figure 7. Oscillograms of voltages at points 1 and 7 of the circuit ($f=1$ kHz, $f_s=25$ kHz)

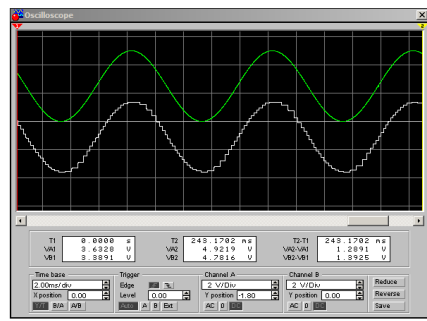


Figure 8. Oscillograms of voltages at points 1 and 7 of the circuit ($f=100$ Hz, $f_s=2.5$ kHz)

3. Schemotechnical realization of the discretizer should not present special problems. Devices containing elements A1, A3..., A6 can be implemented on operational amplifiers. The sampling-storage devices (A2, C1, key S) are available in integrated design [1]. Voltage-frequency converters (G) are also available in integrated design. The ADVFC32, AD654 microcircuits with a wide frequency range (up to 500 kHz), high linearity and low error [2], [3] are quite suitable for the sampler under consideration.

4. The sampling interval Δt depends on the maximum modulo value of the input analog signal, on the maximum frequency component f_m . of the signal spectrum, as well as on the selected method of signal reconstruction and the allowable error at the sampling interval [4], [5], [6].

Suppose x'_m is the maximum modulo value of the derivative of the input analog signal at the sampling interval Δt . Then the maximum deviation of the approximated signal from the discrete copy will be approximately equal to

$$\Delta x_m \approx x'_m \cdot \Delta t. \tag{1}$$

When the signal is represented by trigonometric series, the maximum value of the derivative will be determined by the harmonic component with frequency f_m [4].

$$x(t) = X_m \cdot \sin(2\pi f_m t).$$

The modulus of the derivative in this case will be equal to

$$x'_m = 2 \cdot X_m \cdot \pi \cdot f_m. \tag{2}$$

Using (1) and (2) we obtain

$$\frac{\Delta x_m}{\Delta t} \approx 2 \cdot X_m \cdot \pi \cdot f_m, \quad \Delta t \approx \frac{\Delta x_m}{2 \cdot X_m \cdot \pi \cdot f_m}. \tag{3}$$

Let us introduce the notation:

$$\delta X_m = \frac{\Delta x_m}{X_m},$$

where δX_m is the maximum relative sampling error.

We obtain finally

$$\Delta t = \frac{\delta X_m}{2 \cdot \pi \cdot f_m}. \tag{4}$$

Figure 9 and Figure 10 show the oscillograms of the triangular signal at the same frequencies as in Figures 7, 8.

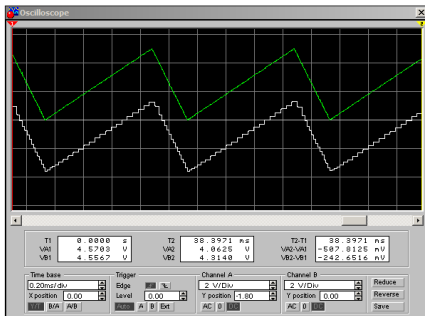


Figure 9. Triangular signal at points 1 and 7 of the circuit ($f=1$ kHz, $f_s=25$ kHz)

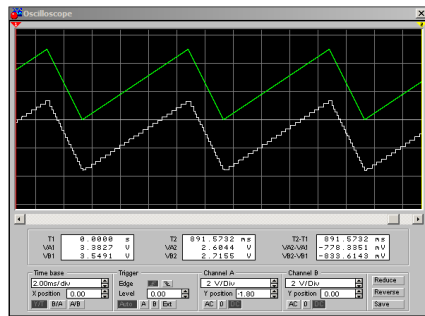


Figure 10. Triangular signal at points 1 and 7 of the circuit ($f=100$ Hz, $f_s=2.5$ kHz)

As can be seen from the oscillograms, the sampling rate increases at steep signal sections and decreases at gentle sections. Indeed, if the rise or fall of the signal has increased, Δx_m may increase. To keep Δx_m within predetermined limits it is necessary to decrease Δt or increase the sampling rate [7]. This is what the adaptive discretizer considered in this paper automatically does.

5. Conclusions

1. The device of adaptive sampling of analog signals will allow to convert analog signals into discrete signals in a large range of frequencies of analog signals. The sampling period is continuously adjusted to the frequency of the input signal, leaving the sampling error at a given level.

2. A working model of the discretizer in an electronic simulator is obtained. The model allows to check the performance of the discretizer, to obtain experimentally its characteristics, as well as to compare analytical calculations of the discretizer parameters with the experiment.

3 The technical realization of the discretizer is not difficult. It mainly consists of operational amplifiers, as well as integrated circuits of pulse action. All these elements are widespread and are produced by many firms.

4. Simple calculation dependencies for determining the sampling interval depending on the allowable sampling error are obtained.

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PARSING IN THE MODERN WORLD

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Abstract. *The purpose of this article is to reveal the concept of parsing as a process of automated information collection, to explain why and who uses parsing in their work, as well as to identify the advantages of this process. The study has given a number of examples of parsing application in the modern world. Besides, there has been shown a real example of a Python program, which automatically collects a large amount of information to structure it. In the course of the work, the main technologies and tools for parsing data from web resources have been considered.*

Keywords: *parsing, web scraping, data collection, data processing, information, API, XHR, Python, queries.*

Introduction

Nowadays, the Internet is the largest source of information, which is usually used by people of different professions for their own purposes. You can easily get confused in such a huge amount of unstructured information, but there is such a process as parsing, which allows you to speed up routine work, precisely to collect a large amount of data from web sources and structure it. The concept of parsing is a process of automated collection and systematization of data from open sources using special algorithms. The parsing process is also called web scraping. This technology has found wide application in many areas including information retrieval, market analytics, and social media monitoring. However, it should be borne in mind that not all web resources treat parsing positively and resort to using various methods of protection. This leads to the fact that for each site, you have to develop your own scraping algorithm, taking into account the circumvention of such protection systems.

Research methods

The parsing process can be divided into two stages:

1. Getting information from a web resource;
2. Analysis of the received information, that is, the allocation of useful data.

In the vastness of the Internet, you can find many different sites from single-page sites to large online stores. However, for parsing, it does not matter what type of site is to be processed, it is more important what method the processing will be performed.

Next, let's take a closer look at the parsing methods:

1. *Using the official API* [3]. Many websites provide an API (Application Programming Interface) to access their data. This approach allows you to obtain structured information corresponding to the specified parameters and constraints, which facilitates the parsing process. The API provides developers with a programming interface for interacting with a web resource and receiving data in a convenient format, often in JSON or XML format. When using the official APIs, developers need to read the documentation provided by the website and get the available methods and parameters to get the necessary information. But the target web resource does not always have its own API, or there are certain paid tariffs for accessing it.

2. *Parsing HTML documents*. This parsing method involves obtaining HTML documents using HTTP requests, such as GET and POST [4], to web resources. Then the data is analyzed to extract the necessary information. Various tools and libraries can be used to make HTTP requests, such as requests in Python. The resulting HTML code is analyzed using special HTML parsing tools such as BeautifulSoup or lxml [5]. Using these tools, you can find the necessary elements on the page, extract text, attributes, links and other information [6]. But using this method, as a rule, it is quite difficult or even impossible to circumvent the protection that uses Javascript functions built into pages, the execution of which is mandatory to display any data. The disadvantage of this method is the cost of a lot of time for the parsing process, since it is necessary first to get an HTML document, which can sometimes have a lot of weight, and then find the necessary information.

3. *Parsing of XHR queries*. Some web applications load data dynamically using XHR (XMLHttpRequest) technology [2]. XHR requests are used to exchange data between the web browser and the server without reloading the page. Parsing such queries allows you to extract information that is not displayed directly on the web page.

For what purposes is parsing used? There may be any option that requires collecting a large amount of data, but I will highlight several tasks that are relevant nowadays, in my opinion, the implementation of which can be simplified by applying parsing:

1. Data collection for aggregator sites. These can be news sites, movie sites, and reference sites.;
2. Data processing before use in machine learning models;
3. Comparison of competitors’ prices;
4. Generating reports for sellers on marketplaces, they may include data on the number of daily sales, product ratings, and reviews.

The parser development process

Site analysis. As an object for parsing, it was decided to choose an online store popular in Russia. As a result of the analysis before writing the program, it was revealed that the site allows you to parse XHR queries. This makes the task easier, because in this case you will not need to work with an HTML document, which is not always a convenient method.

Using the developer’s tool in the browser, we look at which of the XHR queries is useful, that is it should contain information about products. Figure 1 highlights a request to the server that responds with product data. In Figure 2, the server’s response in JSON format to the request from Figure 1.

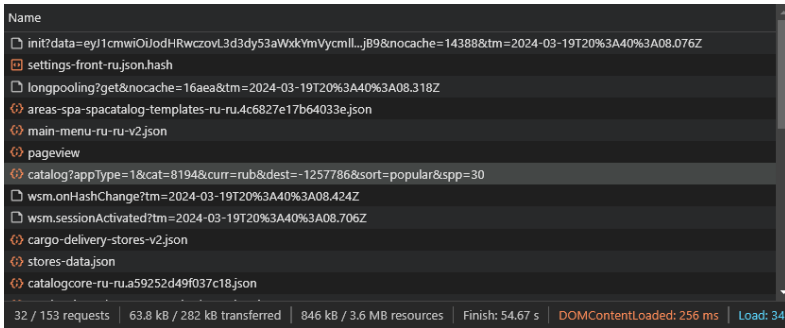


Figure 1. XHR requests

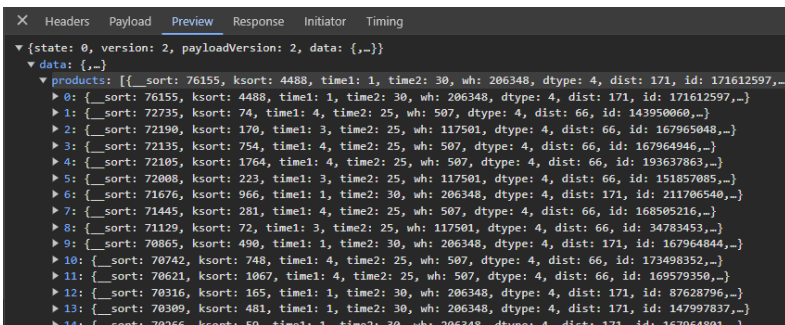


Figure 2. Response with product information in JSON format

Development of the parser. The parser will be written in the Python programming language and the requests library. There are many other libraries and technologies for parsing, but since we will only work with queries, these technologies will be enough.

Writing a program begins with connecting the requests library.

```
import requests
```

Figure 3. *Importing the library*

Next, a function is declared designed to collect data from the site and variables of the request link and the dictionary of request headers are also declared.

```
def get_data(page):
    url = f"https://catalog.wb.ru/catalog/men_shoes/v2/catalog?appType=1&cat=8194&curr=rub&dest=-1257786&sort=popular&spp=30&page={page}"
    headers = {
        'Accept': '*/.*',
        'Accept-Language': 'ru,en;q=0.9',
        'Connection': 'keep-alive',
        'Origin': 'https://www.wildberries.ru',
        'Referer': 'https://www.wildberries.ru/catalog/obuv/muzhskaya/kedy-i-krossovki',
        'Sec-Fetch-Dest': 'empty',
        'Sec-Fetch-Mode': 'cors',
        'Sec-Fetch-Site': 'cross-site',
        'User-Agent': 'Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/120.0.0.0 YaBrowser/24.1.0.0 Safari/537.36',
        'sec-ch-ua': '"Not_A_Brand";v="8", "Chromium";v="120", "YaBrowser";v="24.1", "Yowser";v="2.5"',
        'sec-ch-ua-mobile': '?0',
        'sec-ch-ua-platform': "Windows"
    }
}
```

Figure 4. *Function declaration*

We send a request to the server, which will return the data from Figure 2.

```
response = requests.get(url, headers=headers).json()
```

Figure 5. *Sending a GET request*

We work with the response in JSON format, select the necessary data and add them to the list for ease of working with the data in the future.

```
products = response['data']['products']
result_products = list()
for product in products:
    result_products.append(
        f"{product['name']} – {str(product['sizes'][0]['price']['total'][:-2])} P")
return result_products
```

Figure 6. *Working with the response to the request*

At this stage, the main function for data parsing has already been implemented, it remains to prescribe a small logic for entering the number of pages that the program will parse and convenient data output.

```
def main():
    pages = input('Specify the number of pages to parse: ')

    final_product_list = list()

    for page in range(1, int(pages) + 1):
        final_product_list += get_data(page)

    for i in range(len(final_product_list)):
        print(f"{i}. {final_product_list[i]}", sep='\n')

if __name__ == '__main__':
    main()
```

Figure 7. Logic of data input and output

```
Specify the number of pages to parse: 1
0. Кроссовки демисезонные спортивные – 2831 ₺
1. Кроссовки демисезонные спортивные – 2831 ₺
2. Кроссовки осенние – 2820 ₺
3. Кроссовки демисезонные спортивные – 2831 ₺
4. Кроссовки демисезонные спортивные – 2831 ₺
5. Кроссовки текстильные замшевые – 5446 ₺
6. Кроссовки зимние – 1470 ₺
7. Кроссовки демисезонные – 1759 ₺
8. Кроссовки демисезонные спортивные – 1826 ₺
9. Кроссовки демисезонные – 1474 ₺
10. Кроссовки кожаные демисезонные – 2379 ₺
11. Кроссовки Strutter – 3669 ₺
12. ектильные слипоны – 1484 ₺
13. Кроссовки весна текстильные – 1574 ₺
14. Кроссовки демисезонные – 1220 ₺
15. Кроссовки демисезонные – 1215 ₺
16. Кроссовки демисезонные спортивные – 1346 ₺
17. Кроссовки зимние – 1479 ₺
18. Кроссовки демисезонные – 1623 ₺
19. Кроссовки демисезонные – 1652 ₺
```

Figure 8. Data output

Figure 8 shows the data obtained by parsing. This completes the development of the parser.

Conclusion

This article deals with the main aspects of parsing, which is a process of automated collection and systematization of data from open sources. Moreover, there are also many applications of parsing, including information retrieval, market analytics, social media monitoring, price comparison, data collection for machine learning and reporting. Another important point in the development of a parser is the analysis of the structure and protective measures of a web resource in order to determine an effective scraping method.

Thus, parsing remains an actual and in-demand tool in the modern world, providing the opportunity to collect and process large amounts of data.

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KINEMATICS OF POINT MOTION ALONG CURVES OF THE SECOND ORDER

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Abstract. *In the scientific literature, the differential equation of an ellipse is derived through dynamic quantities and laws. Kepler's laws are then derived. However, Kepler's laws are kinematic. This article examines the kinematic equation of an ellipse. The equation is derived through the oscillations of a parametric pendulum. It is shown that Kepler's laws are properties of kinematic equations of motion of a point along second-order curves. The motion of a material point along second-order curves is represented by kinematic equation (1.10). The kinematics of second-order curves is studied on an ellipse. Formulas for the dependence of acceleration and radius, speed and radius are derived. The direction of the velocity and acceleration vectors is determined. The conditions for the conservation of Kepler's laws when a material point moves along an ellipse are shown.*

Keywords: *Kepler's laws, ellipse, speed, acceleration, radius.*

Content

- I. Formulas for the dependence of acceleration and radius, speed and radius
- II. Velocity and acceleration vectors
- III. Trammel of Archimedes
- IV. Kepler's laws as properties of kinematic equations of motion of a point along curves of the second order

If simple equations of speed and acceleration are sufficient to describe rectilinear motion: $V = S/t$, $a = S/t^2$, then differential equations of motion are needed to solve problems on the curvilinear motion of material points and their systems. "The way we derive these equations doesn't matter": [1, §11, п.3].

I. Formulas for the dependence of acceleration and radius, speed and radius

Point C moves in an ellipse relative to the focus, Figure 1.

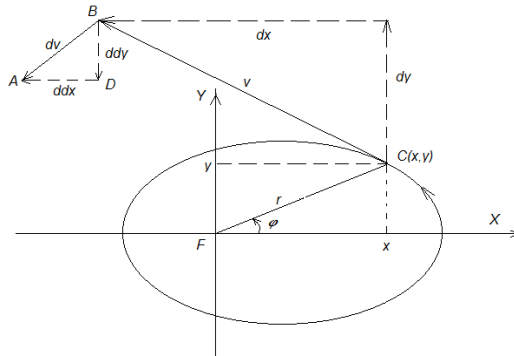


Figure 1

There is a system of equations for a parametric pendulum (1)
 The parameter is time (t).

$$\begin{cases} x = r(\varphi(t)) \cdot \cos(\varphi(t)) \\ y = r(\varphi(t)) \cdot \sin(\varphi(t)) \end{cases} \quad (1.1)$$

Let us substitute into system (1) the radius of the ellipse with respect to the focus:

$$r(\varphi(t)) = \frac{b^2}{a(1 - \varepsilon \cdot \cos(\varphi(t)))} \quad (1.2)$$

$$\begin{cases} x = \frac{b^2}{a(1 - \varepsilon \cdot \cos(\varphi(t)))} \cdot \cos(\varphi(t)) \\ y = \frac{b^2}{a(1 - \varepsilon \cdot \cos(\varphi(t)))} \cdot \sin(\varphi(t)) \end{cases} \quad (1.3)$$

Let's differentiate twice. We get the coordinates of speed and acceleration:

$$\dot{x} = \frac{d}{dt} \left(r(\varphi(t)) \cos(\varphi(t)) \right) = -\frac{b^2 \cdot \dot{\varphi} \cdot \sin(\varphi(t))}{a(\varepsilon \cdot \cos(\varphi(t)) - 1)^2} = \frac{r^2 \cdot \dot{\varphi} \cdot \sin(\varphi(t))}{\varepsilon \cdot \cos(\varphi(t)) - 1} \quad (1.4)$$

$$\dot{y} = \frac{d}{dt} \left(\frac{b^2}{a(1 - \varepsilon \cdot \cos(\varphi(t)))} \sin(\varphi(t)) \right) = \frac{b^2 \cdot \dot{\varphi} \cdot (-\varepsilon + \cos(\varphi(t)))}{a(\varepsilon \cdot \cos(\varphi(t)) - 1)^2} = \frac{r^2 \cdot \dot{\varphi} \cdot (-\varepsilon + \cos(\varphi(t)))}{1 - \varepsilon \cdot \cos(\varphi(t))} \quad (1.5)$$

$$\ddot{x} = \frac{b^2 \left((-\varepsilon \cdot \cos(\varphi(t)) \cdot \sin(\varphi(t)) + \sin(\varphi(t))) \ddot{\varphi} + \dot{\varphi}^2 (\varepsilon \cdot \cos(\varphi(t))^2 - 2\varepsilon + \cos(\varphi(t))) \right)}{a(\varepsilon \cdot \cos(\varphi(t)) - 1)^3} \quad (1.6)$$

$$\ddot{y} = \frac{-b^2 \left((-\cos(\varphi(t))(\varepsilon \cdot \cos(\varphi(t)) - 1) + \varepsilon) \ddot{\varphi} + 2\dot{\varphi}^2 \left(\varepsilon^2 - \frac{\varepsilon \cdot \cos(\varphi(t)) + 1}{2} \right) \sin(\varphi(t)) \right)}{a(\varepsilon \cdot \cos(\varphi(t)) - 1)^3} \quad (1.7)$$

$$\text{Velocity } v = \sqrt{\dot{x}^2 + \dot{y}^2} = \frac{b^2 * \dot{\varphi} * \sqrt{1 + \varepsilon^2 - 2\varepsilon * \cos \varphi(t)}}{a(1 + \varepsilon * \cos \varphi(t))^2} = \frac{r * \dot{\varphi} * \sqrt{1 + \varepsilon^2 - 2\varepsilon * \cos \varphi(t)}}{(1 - \varepsilon * \cos \varphi(t))} \quad (1.8)$$

$$\text{Acceleration } \dot{v} = \sqrt{\ddot{x}^2 + \ddot{y}^2} =$$

$$b^2 \left(\begin{aligned} & \frac{\sqrt{(\varepsilon^2 - 2\varepsilon * \cos(\varphi(t)) + 1)(\varepsilon * \cos(\varphi(t)) - 1)^2 * \dot{\varphi}^2}}{a(\varepsilon * \cos(\varphi(t)) - 1)^3} + \\ & \frac{\sqrt{4(\varepsilon^2 - \frac{3 + \varepsilon * \cos(\varphi(t)) + 1}{2})\dot{\varphi}^2(\varepsilon * \cos(\varphi(t)) \sin(\varphi(t)) - 1)\dot{\varphi}}}{a(\varepsilon * \cos(\varphi(t)) - 1)^3} - \\ & \frac{\sqrt{4\dot{\varphi}^4(-\cos(\varphi(t))^3 \varepsilon^2 + (\varepsilon^4 - \frac{\varepsilon^2}{4})\cos(\varphi(t))^2 + (\varepsilon^2 + \frac{\varepsilon}{2})\cos(\varphi(t)) - \varepsilon^4 - \frac{1}{4})}}{a(\varepsilon * \cos(\varphi(t)) - 1)^3} \end{aligned} \right) \quad (1.9)$$

We form a system of equations from (1.6), (1.7) and solve for φ . We obtain the kinematic equation of motion of a point relative to the focus along second-order curves:

$$\ddot{\varphi} = \frac{2 + \varepsilon * \sin(\varphi) * \dot{\varphi}^2}{1 - \varepsilon * \cos(\varphi)} \quad (1.10)$$

At different values of eccentricity, the shape of the curve will change.

We substitute (1.10) into (1.9), and simplify:

$$\dot{v} = \frac{b^2 * \dot{\varphi}^2}{a(1 - \varepsilon * \cos(\varphi))^2} = \frac{r * \dot{\varphi}^2}{1 - \varepsilon * \cos(\varphi)} \quad (1.11)$$

The sector speed is constant:

$$k = r_p^2 * \dot{\varphi}_p = r_i^2 * \dot{\varphi}_i = r_a^2 * \dot{\varphi}_a = \text{const}, \quad (1.12)$$

$$\dot{\varphi} = \frac{k}{r^2} \quad (1.13)$$

where r_p is the perifocal distance, r_a is the apofocal distance

We substitute (1.13) into (1.11):

$$\dot{v} = \frac{k^2}{r^2(1 - \varepsilon * \cos(\varphi))} \quad (1.14)$$

The acceleration v is recalculated using formula (14). Results (9) and (14) are compared, Figure 2.

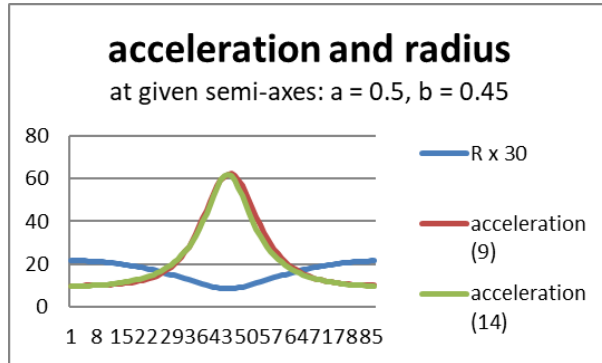


Figure 2

We substitute (1.13) into (1.8):

$$v = \frac{r * k * \sqrt{1 + e^2 - 2e * \cos \varphi(t)}}{r^2 (1 - e * \cos \varphi(t))} = \frac{k * \sqrt{1 + e^2 - 2e * \cos \varphi(t)}}{r * (1 - e * \cos \varphi(t))} \quad (1.15)$$

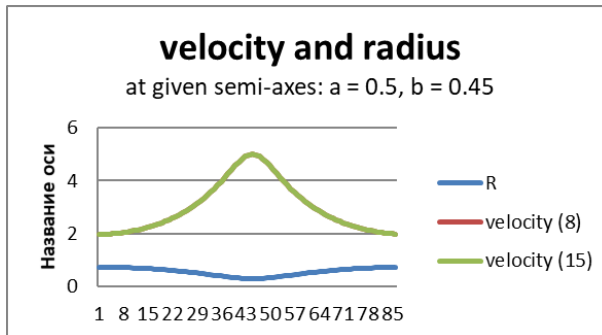
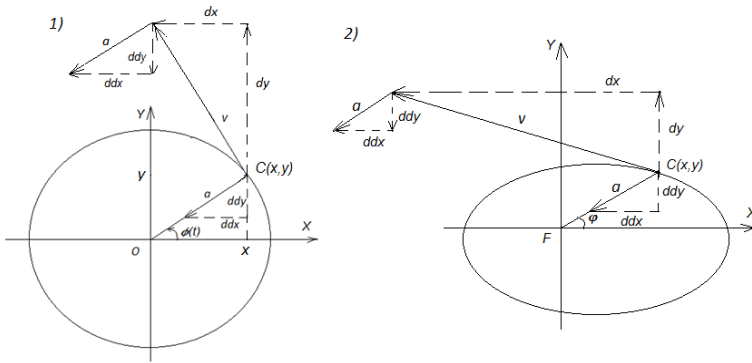


Figure 3

Formulas (1.14, 1.15) do not give any advantage for calculating the modulus of speed and acceleration. First, to calculate the sector constant k , you need to calculate the angular velocity once. Secondly, in order for the motion of a point to comply with Kepler's laws, the angle must change according to elliptic equations. The value of these formulas is in the logical definition of the dependence of speed and acceleration on the radius.

II. Velocity and acceleration vectors

Let's consider two variants of point movement, Figure 4: 1) - movement relative to the center 2) - movement relative to the focus.



v - speed, *a* - acceleration, *dx*, *dy*, *ddx*, *ddy* - first and second derivatives along the coordinate axes.

Figure 4

Note the property of collinear vectors on the plane - rectangles built on vectors, Figure 5, should be similar:

$$\frac{BD}{AD} = \frac{B_1 D_1}{A_1 D_1} \tag{2.1}$$

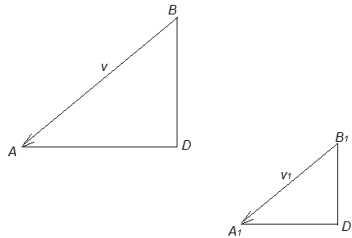


Figure 5

1. movement relative to focus

Let's compare the ratio of the coordinates of the radius and acceleration:

$$\frac{x}{y} = \frac{\cos \varphi}{\sin \varphi} \tag{2.2}$$

$$\frac{\ddot{x}}{\ddot{y}} = \frac{(-2e^2 \cos^2 \varphi + 3e^2 - 1) \cos(\varphi)}{\sin(\varphi)(e^2 - 1)(2e^2 \cos^2 \varphi + 1)} \tag{2.3}$$

If $e = 0$ we get a circle and $\frac{\ddot{x}}{\ddot{y}} = \frac{x}{y}$, (2.4)
 a special case of an ellipse, figure 5.

In Figures 5 – 7 they are marked with red lines for speed, green for acceleration.

$$\frac{d^2}{dt^2} \varphi(t) = 0, \text{ рисунок 6} \quad (2.5)$$

Coordinates of the beginning of the velocity and acceleration vectors, points of the initial ellipse (x, y) . The coordinates of the end of the velocity vector $(dx+x, dy+y)$. Acceleration vector end coordinates $(ddx+x, ddy+y)$.

Velocity, Acceleration, a = 0.5000, b = 0.5000, days = 80.00

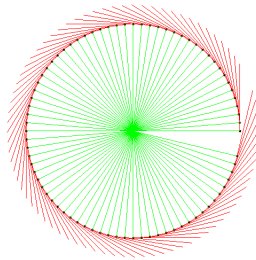


Figure 6

If $e \neq 0$, then $\frac{\ddot{x}}{\ddot{y}} \neq \frac{x}{y}$, Figure 7 (2.6)

Velocity, Acceleration, a = 0.5000, b = 0.4500, days = 80.00

☐ ☒

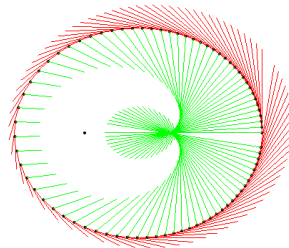


Figure 7

2. movement relative to the center, figure 4.1)

$$r(\varphi(t)) = \frac{b}{\sqrt{1-e^2 \cos^2 \varphi(t)}} \tag{2.7}$$

To derive the kinematic equation of motion of a point relative to the center, we will replace the radius formula (2) with (13) in the system of equations (1.1).

Let's differentiate twice. We get the coordinates of speed and acceleration:

$$\dot{x} = \frac{d}{dt} \left(\frac{b \cdot \cos(\varphi(t))}{\sqrt{1-e^2 \cdot \cos(\varphi(t))^2}} \right) = - \frac{b \cdot \sin(\varphi)}{(1-e^2 \cdot \cos^2 \varphi)^{3/2}} \tag{2.8}$$

$$\dot{y} = \frac{d}{dt} \left(\frac{b \cdot \sin(\varphi(t))}{\sqrt{1-e^2 \cdot \cos(\varphi(t))^2}} \right) = \frac{b(1-e^2) \cos(\varphi)}{(1-e^2 \cdot \cos^2 \varphi)^{3/2}} \tag{2.9}$$

$$\ddot{x} = \frac{d^2}{dt^2} \left(\frac{b \cdot \cos(\varphi(t))}{\sqrt{1-e^2 \cdot \cos(\varphi(t))^2}} \right) = - \frac{b \cdot \cos(\varphi) (2e^2 \cos^2 \varphi - 3e^2 + 1)}{(1-e^2 \cdot \cos^2 \varphi)^{5/2}} \tag{2.10}$$

$$\ddot{y} = \frac{d^2}{dt^2} \left(\frac{b \cdot \sin(\varphi(t))}{\sqrt{1-e^2 \cdot \cos(\varphi(t))^2}} \right) = \frac{b \cdot \sin(\varphi) (e^2 - 1) (2e^2 \cos^2 \varphi + 1)}{(1-e^2 \cdot \cos^2 \varphi)^{5/2}} \tag{2.11}$$

$$v = \sqrt{\dot{x}^2 + \dot{y}^2} = \sqrt{\frac{b^2 \varphi^2 (1 - 2e^2 \cos^2(\varphi(t))^2 + e^4 \cos^4(\varphi(t))^2)}{(1-e^2 \cos^2(\varphi(t)))^3}} \tag{2.12}$$

We solve for $\ddot{\varphi}$. We obtain the kinematic equation of motion of a point relative to the center along second-order curves:

$$\ddot{\varphi} = \frac{2+e^2 \cdot \cos(\varphi) \cdot \sin(\varphi) \cdot \varphi^2}{1-e^2 \cdot \cos(\varphi)^2} \tag{2.13}$$

Let's compare the ratio of the coordinates of the radius and acceleration:

$$\frac{x}{y} = \frac{\cos \varphi}{\sin \varphi} \tag{2.14}$$

$$\frac{\ddot{x}}{\ddot{y}} = \frac{(-2e^2 \cos^2 \varphi + 3e^2 - 1) \cos(\varphi)}{\sin(\varphi) (e^2 - 1) (2e^2 \cos^2 \varphi + 1)} \tag{2.15}$$

If $e = 0$ we get a circle and $\frac{\ddot{x}}{\ddot{y}} = \frac{x}{y}$, (2.16)

a special case of an ellipse, Figure 5.

Eccentricity $e = 0$. Substitute in equation (2.15)

$$\frac{d^2}{dt^2} \varphi(t) = 0, \text{ Figure 6}$$

$$\text{If } e \neq 0, \text{ then } \frac{\ddot{x}}{\dot{y}} \neq \frac{\ddot{x}}{\dot{y}}, \text{ Figure 8} \tag{2.17}$$

Velocity, Acceleration, $\alpha = 0.0000$, $\beta = 0.7000$, days = 80.00

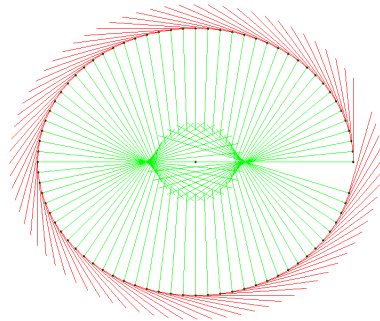


Figure 8

V. Trammel of Archimedes

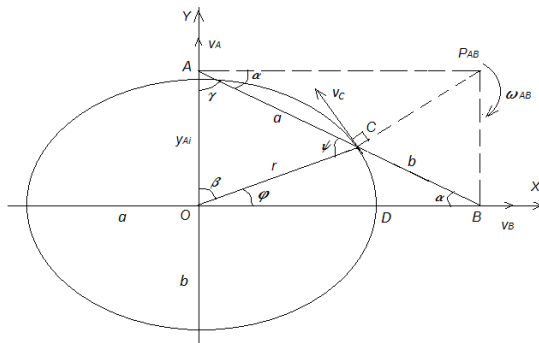


Figure 9

Any point on the ellipsograph ruler moves along an elliptical path around the center.

In order not to refer the reader to the sources, we present the derivation of the formulas necessary for calculating velocities, accelerations, and rotation angles.

Ruler AB moves from horizontal to vertical position, Figure 9. Point C describes $1/4$ of the ellipse. The direction of the instantaneous rotation of the ruler AB

around P_{AB} is clockwise in accordance with the direction of the known velocity vector of point A .

Speeds of points B and C :

$$\omega_{AB} = \frac{v_A}{AP_{AB}} \tag{3.1}$$

$$v_B = \omega_{AB} * BP_{AB} = v_A \frac{BP_{AB}}{AP_{AB}} \tag{3.2}$$

Vector v_C is directed perpendicular to CP .

$$v_C = \omega_{AB} * CP_{AB} = v_A \frac{CP_{AB}}{AP_{AB}} \tag{3.3}$$

The directions of the velocities of the points \vec{v}_B and \vec{v}_C are determined by the instantaneous rotation of the ruler AB around the instantaneous center of velocities P_{AB} .

Determination of accelerations of points B and C

Let's use the theorem - acceleration of points of a flat figure. Point A will be a pole, since the acceleration of point A is known.

The vector equation for the acceleration of point B has the form:

$$\vec{a}_B = \vec{a}_A + \vec{a}_{BA}^r + \vec{a}_{BA}^c \tag{3.4}$$

where \vec{a}_A – is the acceleration of the pole A (given);

\vec{a}_{BA}^r and \vec{a}_{BA}^c – are the rotational and centripetal accelerations of the point B in the rotation of the ruler around the pole A . In this case:

$$a_{BA}^c = \omega_{AB}^2 * BA \tag{3.5}$$

The vector \vec{a}_B is located perpendicular to the ruler AB , its direction is unknown, since the direction of the angular acceleration ϵ_{AB} is unknown.

In equation (3.4) there are two unknowns: accelerations \vec{a}_A and \vec{a}_{BA}^r , which can be determined from the equations of vector equality projections onto the directions of axes AX and AY :

$$\begin{cases} a_{Bx} = a_{Ax} + a_{BAx}^r + a_{BAx}^c \\ a_{By} = a_{Ay} + a_{BAy}^r + a_{BAy}^c \end{cases} \tag{3.7}$$

The direction of the vectors \vec{a}_B and \vec{a}_{BA}^r is chosen arbitrarily. The solution of system (3.7) allows one to find the numerical value \vec{a}_B and \vec{a}_{BA}^r with a plus or minus sign. A positive value indicates the correctness of the chosen direction of the vectors \vec{a}_B and \vec{a}_{BA}^r a negative value indicates the need to change their direction.

$$a_A = \sqrt{(a_{Ax})^2 + (a_{Ay})^2}, \quad a_{AB}^r = \sqrt{(a_{ABx}^r)^2 + (a_{ABy}^r)^2} \tag{3.8}$$

Ruler angular acceleration:

$$\epsilon_{AB} = \frac{a_{BA}^r}{BA} \tag{3.9}$$

The acceleration of point C is determined by the equation:

$$\vec{a}_C = \vec{a}_A + \vec{a}_{CA}^r + \vec{a}_{CA}^c \tag{3.10}$$

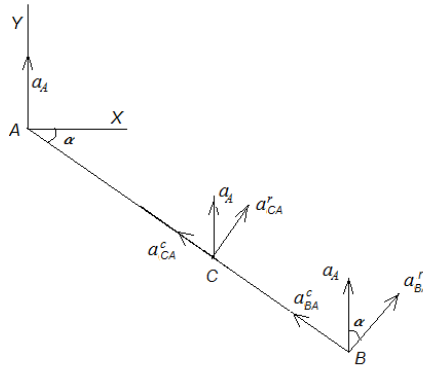


Figure 10

where \vec{a}_{CA}^r and \vec{a}_{CA}^c are, respectively, the rotational and centripetal accelerations of the point C relative to the pole A:

$$\vec{a}_{CA}^c = \omega_{AB}^2 * AC \tag{3.11}$$

$$\vec{a}_{CB}^r = \varepsilon_{AB} * AC \tag{3.12}$$

Vector \vec{a}_{CA}^c is located on CA and is directed from point C to pole A. Vector \vec{a}_{CA}^r is perpendicular to CA and directed in the same direction as \vec{a}_{BA}^r , Figure 10.

Equation (3.10) can be represented in projections on the axes Ax and Ay:

$$\begin{cases} a_{Cx} = a_{Ax} + a_{CAx}^c + a_{CAx}^r \\ a_{Cy} = a_{Ay} + a_{CAy}^c + a_{CAy}^r \end{cases} \tag{3.13}$$

The acceleration projections of point C are determined from (3.10). The direction of the vector \vec{a}_C is determined by the signs of the projections a_{Cx} and a_{Cy} .

Vector modulus:

$$a_c = \sqrt{(a_{Cx})^2 + (a_{Cy})^2} \tag{3.14}$$

Let’s take a look at the different travel options

T is the period specified by arbitrary units of time. $AB = a + b$, $A(0, y_A)$, $B(x_B, 0)$. Initial coordinates of points: $A(0, 0)$, $B(a + b, 0)$, $C(a, 0)$. Initial speed $v_{A0} = 0$.

Uniform movement

Given: point C divides AB into segments a and b, $A(0, y_A)$, $B(x_B, 0)$, initial $A(0, 0)$, $B(a, 0)$. A moves uniformly from $O \rightarrow Y$. Accelerations $a_A = 0$, $a_B = 0$, speed

$$v_A = \frac{AB \cdot \omega}{T} \tag{3.15}$$

Find: $y_{A_i}, x_{C_i}, y_{C_i}, v_{C_i}, a_{C_i}, \Phi_i$

Solution

Coordinates $A(0, y_{A_i})$:

$$y_{A_i} = v_A \cdot t \tag{3.16}$$

Further, according to equations (3.4) – (3.14)

Coordinates $B(x_{B_i}, 0)$:

$$\sin \alpha = \frac{y_{A_i}}{AB}, \alpha = \arcsin \frac{y_{A_i}}{AB} \tag{3.17}$$

$$x_{B_i} = \cos \alpha \cdot AB, y_{B_i} = 0 \tag{3.18}$$

$$\omega_{AB} = \frac{v_A}{AP_{AB}} = \frac{v_A}{x_{B_i}} \tag{3.19}$$

$$v_B = \omega_{AB} \cdot BP_{AB} = \omega_{AB} \cdot y_{A_i} \tag{3.20}$$

From equation (5) $a_{BA}^c = \omega_{AB}^2 \cdot BA$

$$\begin{cases} a_{Bx} = a_{BA}^c \cdot \cos \alpha + a_{BA}^r \cdot \sin \alpha \\ 0 = a_{Ay} + a_{BA}^c \cdot \sin \alpha + a_{BA}^r \cdot \cos \alpha \end{cases} \tag{3.21}$$

Solving the resulting equations, we find a_B ,

$$a_{BA}^r = \frac{-a_{Ay} - a_{BA}^c \cdot \sin \alpha}{\cos \alpha} = \frac{-a_{BA}^c \cdot \sin \alpha}{\cos \alpha} \tag{3.22}$$

$$\varepsilon_{AB} = \frac{a_{BA}^r}{AB} \tag{3.23}$$

Coordinates $P_{AB}(x_{B_i}, y_{A_i})$

Coordinates $C(x_{C_i}, y_{C_i})$

$$\frac{a}{AB} = \frac{x_{C_i}}{x_{B_i}}, \frac{b}{AB} = \frac{y_{C_i}}{y_{A_i}} \tag{3.24}$$

$$x_{C_i} = \frac{a}{AB} \cdot x_{B_i}, y_{C_i} = \frac{b}{AB} \cdot y_{A_i} \tag{3.25}$$

$$CP_{AB} = \sqrt{x_{B_i}^2 + a^2 - 2(a \cdot x_{B_i}) \cos \alpha} \tag{3.26}$$

$$v_C = \omega_{AB} \cdot CP_{AB} = \omega_{AB} \cdot \sqrt{x_{B_i}^2 + a^2 - 2(a \cdot x_{B_i}) \cos \alpha} \tag{3.27}$$

$$\varphi = \arctan \frac{y_{C_i}}{x_{C_i}} \tag{3.28}$$

The acceleration of point C is determined by equation (3.10):
 $\vec{a}_C = \vec{a}_A + \vec{a}_{CA}^r + \vec{a}_{CA}^c$

$$a_{CA}^c = \omega_{AB}^2 \cdot AC = \omega_{AB}^2 \cdot a \tag{3.29}$$

$$a_{CA}^r = \varepsilon_{AB} \cdot AC = \varepsilon_{AB} \cdot a \tag{3.30}$$

$$\begin{cases} \mathbf{a}_{Cx} = \mathbf{a}_{Ax} + \mathbf{a}_{CAx}^r + \mathbf{a}_{CAx}^c \\ \mathbf{a}_{Cy} = \mathbf{a}_{Ay} + \mathbf{a}_{CAy}^r + \mathbf{a}_{CAy}^c \end{cases} \quad (3.31)$$

$$\begin{cases} \mathbf{a}_{Cx} = 0 + \mathbf{a}_{CA}^r * \sin \alpha + \mathbf{a}_{CA}^c * \cos \alpha \\ \mathbf{a}_{Cy} = 0 + \mathbf{a}_{CA}^r * \cos \alpha + \mathbf{a}_{CA}^c * \sin \alpha \end{cases} \quad (3.32)$$

$$\mathbf{a}_C = \sqrt{\mathbf{a}_{Cx}^2 + \mathbf{a}_{Cy}^2} \quad (3.33)$$

Uniformly accelerated motion

Given: point C divides AB into segments a and b , A moves uniformly accelerated from $O \rightarrow Y$, $A(0, y_A)$ $B(x_B, 0)$, initial $A(0, 0)$, $B(AB, 0)$, $\mathbf{a}_{Ai} = \text{const}$, $\mathbf{v}_{A0} = 0$.

Find: y_{Ai} , (x_{Ci}, y_{Ci}) , v_{Ci} , \mathbf{a}_{Ci} , φ_i

Solution

$$\mathbf{v}_{Ai} = \frac{\mathbf{a}_A * i^2}{2}; \quad i = 1 \dots n = \frac{T}{4} \quad (3.34)$$

$$AB = \mathbf{v}_{An} = \frac{\mathbf{a}_A * n^2}{2} \quad (3.35)$$

$$\mathbf{a}_{Ai} = \mathbf{a}_A = \frac{2AB}{n^2} \quad (3.36)$$

Coordinates $A(0, y_{Ai})$

$$y_{Ai} = \frac{\mathbf{a}_A * i^2}{2} \quad (3.37)$$

Further, according to equations (3.4) – (3.14)

Coordinates $B(x_{Bi}, 0)$:

$$x_{Bi} = \sqrt{AB^2 - y_{Ai}^2} \quad (3.38)$$

Coordinates $C(x_{Ci}, y_{Ci})$:

$$\frac{a}{AB} = \frac{x_{Ci}}{x_{Bi}}, \quad \frac{b}{AB} = \frac{y_{Ci}}{y_{Ai}} \quad (3.39)$$

$$x_{Ci} = \frac{a}{AB} * x_{Bi}, \quad y_{Ci} = \frac{b}{AB} * y_{Ai} \quad (3.40)$$

$$\omega_{AB} = \frac{v_{Ai}}{AP_{AB}} = \frac{v_{Ai}}{x_{Bi}} \quad (3.41)$$

$$\mathbf{a}_{BA}^c = \omega_{AB}^2 * AB \quad (3.42)$$

$$\mathbf{a}_{BA}^r = \boldsymbol{\varepsilon}_{AB} * BA \quad (3.43)$$

The vector $\overrightarrow{\mathbf{a}_{BA}^r}$ is located perpendicular to the ruler AB , its direction is unknown, since the direction of the angular acceleration $\boldsymbol{\varepsilon}_{AB}$ is unknown.

We project the vector equation (3.4) on the coordinate axis:

$$\begin{cases} \mathbf{a}_{Bx} = \mathbf{a}_{BA}^c * \cos \alpha + \mathbf{a}_{BA}^r * \sin \alpha \\ 0 = \mathbf{a}_{By} + \mathbf{a}_{BA}^c * \sin \alpha + \mathbf{a}_{BA}^r * \cos \alpha \end{cases} \quad (3.44)$$

Solving the resulting equations, we find \mathbf{a}_B :

$$\mathbf{a}_{BA}^r = \frac{-a_{Ay} - a_{BA}^c \sin \alpha}{\cos \alpha} \tag{3.45}$$

$$\varepsilon_{AB} = \frac{a_{BA}^r}{AB} \tag{3.46}$$

Equation (10) can be represented in projections on the axes Ax and Ay :

$$\begin{cases} a_{Cx} = a_{Ax} + a_{CAx}^r + a_{CAx}^c \\ a_{Cy} = a_{Ay} + a_{CAy}^r + a_{CAy}^c \end{cases} \tag{3.49}$$

$$\begin{cases} a_{Cx} = 0 + a_{CA}^r \sin \alpha + a_{CA}^c \cos \alpha \\ a_{Cy} = a_A + a_{CA}^r \cos \alpha + a_{CA}^c \sin \alpha \end{cases} \tag{3.50}$$

$$a_C = \sqrt{a_{Cx}^2 + a_{Cy}^2} \tag{3.51}$$

Elliptical

The movement of the points of the ruler along the ellipse relative to the center,

$$\ddot{\varphi} = \frac{2 * e^2 * \cos(\varphi) * \sin(\varphi) * \dot{\varphi}^2}{1 - e^2 * \cos(\varphi)^2} \tag{2.13}$$

Given: point C divides AB into segments a and b , A moves elliptically according to the formula (2.13), from $O \rightarrow Y$, $A(0, \mathbf{y}_A)$, $B(x_B, 0)$, initial $A(0, 0)$, $B(AB, 0)$, $\mathbf{v}_{A0} = 0$.

Find: \mathbf{y}_{A_i} , \mathbf{x}_{C_i} , \mathbf{y}_{C_i} , \mathbf{v}_{C_i} , \mathbf{a}_{C_i}

Solution

Equation (2.13) calculates $\varphi_i, \mathbf{x}_{C_i}, \mathbf{y}_{C_i}$

$$\alpha = \arcsin \frac{y_C}{b} \tag{3.52}$$

$$\beta = \frac{\pi}{2} - \varphi_i \tag{3.53}$$

$$\gamma = \arcsin \left(\frac{r_i \sin \beta}{a} \right) \tag{3.54}$$

$$\psi = \pi - \gamma - \beta \tag{3.55}$$

$$\mathbf{y}_{A_i} = \frac{y_{C_i} + a \sin \alpha}{b} \tag{3.60}$$

$$\mathbf{v}_{A_i} = \mathbf{y}_{A_i} - \mathbf{y}_{A_{i-1}} \tag{3.61}$$

$$\mathbf{a}_{A_i} = \mathbf{v}_{A_i} - \mathbf{v}_{A_{i-1}} \tag{3.62}$$

Further, according to equations (3.4) – (3.14)

Coordinates $B(x_{B_i}, 0)$:

$$x_{B_i} = \sqrt{AB^2 - y_{A_i}^2} \tag{3.63}$$

Find the coordinates $C(x_{C_i}, y_{C_i})$ again:

$$\frac{a}{AB} = \frac{x_{C_i}}{x_{B_i}}, \frac{b}{AB} = \frac{y_{C_i}}{y_{A_i}} \tag{3.64}$$

$$x_{C_i} = \frac{a}{AB} * x_{B_i}, y_{C_i} = \frac{b}{AB} * y_{A_i} \quad (3.65)$$

$$\omega_{AB} = \frac{v_{A_i}}{AP_{AB}} = \frac{v_{A_i}}{x_{B_i}} \quad (3.66)$$

$$\mathbf{a}_{BA}^c = \omega_{AB}^2 * AB \quad (3.67)$$

$$\mathbf{a}_{BA}^r = \varepsilon_{AB} * BA \quad (3.68)$$

The vector $\vec{\mathbf{a}}_{BA}^r$ is located perpendicular to the ruler AB , its direction is unknown, since the direction of the angular acceleration ε_{AB} is unknown.

We project the vector equation (3.4) on the coordinate axis:

$$\begin{cases} \mathbf{a}_{Bx} = \mathbf{a}_{BA}^c * \cos \alpha + \mathbf{a}_{BA}^r * \sin \alpha \\ 0 = \mathbf{a}_{Ay} + \mathbf{a}_{BA}^c * \sin \alpha + \mathbf{a}_{BA}^r * \cos \alpha \end{cases} \quad (3.69)$$

Solving the resulting equations, we find \mathbf{a}_B ,

$$\mathbf{a}_{BA}^r = \frac{-\mathbf{a}_{Ay} - \mathbf{a}_{BA}^c * \sin \alpha}{\cos \alpha} \quad (3.70)$$

$$\varepsilon_{AB} = \frac{\mathbf{a}_{BA}^r}{AB} \quad (3.71)$$

The acceleration of point C is determined by equation (3.10): $\vec{\mathbf{a}}_C = \vec{\mathbf{a}}_A + \vec{\mathbf{a}}_{CA}^r + \vec{\mathbf{a}}_{CA}^c$

$$\mathbf{a}_{CA}^c = \omega_{AB}^2 * AC = \omega_{AB}^2 * a \quad (3.72)$$

$$\mathbf{a}_{CA}^r = \varepsilon_{AB} * AC = \varepsilon_{AB} * a \quad (3.73)$$

Equation (3.10) can be represented in projections on the axes Ax and Ay :

$$\begin{cases} \mathbf{a}_{Cx} = \mathbf{a}_{Ax} + \mathbf{a}_{CAx}^r + \mathbf{a}_{CAx}^c \\ \mathbf{a}_{Cy} = \mathbf{a}_{Ay} + \mathbf{a}_{CAy}^r + \mathbf{a}_{CAy}^c \end{cases} \quad (3.74)$$

$$\begin{cases} \mathbf{a}_{Cx} = 0 + \mathbf{a}_{CA}^r * \sin \alpha + \mathbf{a}_{CA}^c * \cos \alpha \\ \mathbf{a}_{Cy} = \mathbf{a}_A + \mathbf{a}_{CA}^r * \cos \alpha + \mathbf{a}_{CA}^c * \sin \alpha \end{cases} \quad (3.75)$$

$$a_C = \sqrt{a_{Cx}^2 + a_{Cy}^2} \quad (3.76)$$

The obtained motion parameters allow checking the fulfillment of Kepler's laws.

Kepler's second law

Uniform movement

```

Enter char =
if char = "y" then the source data is specified:
y
a = 0.500; b = 0.450; T = 360

Second law of Kepler
Point bypasses 1/4 ellipse counterclockwise in 89 time units
Input 0 - uniform motion OR
Input 1-uniformly accelerated motion OR,
Input 2- elliptical motion):
0
UNIFORM MOTION
Set the start of the first sector (1,..., 89): 3
Set the end of the first sector ( 3<end < 89):17
Set the start of the second sector (1,..., 89): 55
first sector: angle(start)= 0.03; angle(end)= 0.17
second sector: angle(start)= 0.61; angle(end)= 0.82
intervals of time t1= 14; t2= 14
Area of the first sector: 0.1767757E-01
IERR: 0
Area of the second sector: 0.2445188E-01
IERR: 0
    
```

Figure 11

Uniformly accelerated motion

```

Enter char =
if char = "y" then the source data is specified:
y
a = 0.500; b = 0.450; T = 360

Second law of Kepler
Point bypasses 1/4 ellipse counterclockwise in 89 time units
Input 0 - uniform motion OR
Input 1-uniformly accelerated motion OR,
Input 2- elliptical motion):
1
UNIFORMLY ACCELERATEM MOTION
Set the start of the first sector (1,..., 89): 3
Set the end of the first sector ( 3<end < 89):17
Set the start of the second sector (1,..., 89): 55
first sector: angle(start)= 0.00; angle(end)= 0.03
second sector: angle(start)= 0.35; angle(end)= 0.59
intervals of time t1= 14; t2= 14
Area of the first sector: 0.3933465E-02
IERR: 0
Area of the second sector: 0.2803914E-01
IERR: 0
    
```

Figure 12

Elliptical movement

```

Enter char =
if char = "y" then the source data is specified:
y
a = 0.500; b = 0.450; T = 360

Second law of Kepler
Point bypasses 1/4 ellipse counterclockwise in 89 time units
Input 0 - uniform motion OR
Input 1-uniformly accelerated motion OR,
Input 2- elliptical motion):
2
EELLIPTICAL MOTION
Set the start of the first sector (1,..., 89): 3
Set the end of the first sector ( 3<end < 89):17
Set the start of the second sector (1,..., 89): 55
first sector: angle(start)= 0.03; angle(end)= 0.25
second sector: angle(start)= 0.89; angle(end)= 1.15
intervals of time t1= 14; t2= 14
Area of the first sector: 0.2748870E-01
IERR: 0
Area of the second sector: 0.2748918E-01
IERR: 0
    
```

Figure 13

Equality of the areas of sectors is carried out only with elliptical motion.
Graphical results of moving a point along an ellipse at different speeds.
Uniform movement, Figure 14

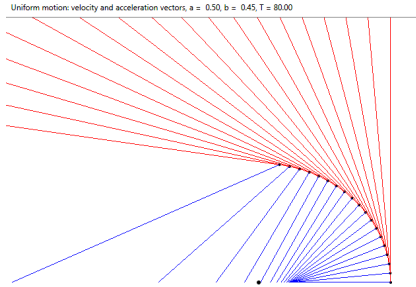


Figure 14

Uniformly accelerated motion, Figure 15.

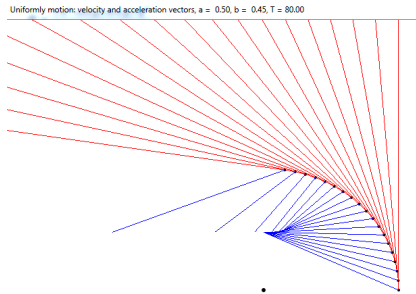


Figure 15

Elliptical movement, Figure 16

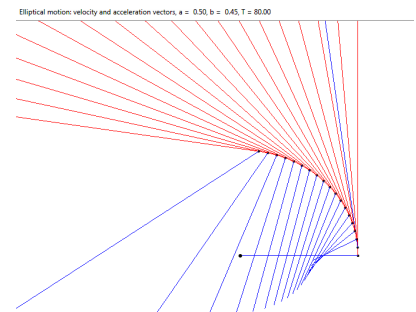


Figure 16

VI. Kepler’s laws as properties of kinematic equations of motion of a point along curves of the second order

The equations are solved by computer programs. The calculation results are compared with Kepler’s laws. The uniqueness of the orbital velocity for the given parameters of the curve is noted. The orbital velocity is calculated from the kinematic equation and compared with the values of astronomical tables

The sector velocity modulus is a constant for a given ellipse.

$$|v_{\sigma}| = \frac{1}{2} |r| * |v| * \sin(r^{\wedge}v) = const \tag{4.1}$$

If a point moves along a flat curve and its position is determined by the polar coordinates r and φ , then

$$|v_{\sigma}| = \frac{1}{2} |r|^2 \frac{d\varphi}{dt} = const \tag{4.2}$$

To illustrate the constancy of the sectoral velocity, a program was written to calculate the sector area in a given time interval. The program, TygeBraheKepler2_focal [A.1], calculates the parameters of the point movement according to equation (8) and shows the equality of the areas of the sectors at equal time intervals, fig. 17 – 19.

```

4-angular velocity, 5-polar radius, 6-linear velocity
Enter char =
if char = "y" then the source data is specified:
y
a = 9.00 b = 7.00
dpi = 0.0000000 H = 1.00000005E-03
Second law of Kepler H= 1.00000005E-03
The point bypasses the ellipse in 1/H time units (0 < H < 1), counterclockwise.
1/H = 999
Set the start of the first sector (i0=1,..., 999) i0 =
1
Set the end of the first sector (i0<i1<1/H) i1 =
999
Set the start of the second sector (0<i02<1/H-i1+i0) i02 =
1
angle(i0) 0.00: angle(i1) 6.28
angle(i02)= 0.00: angle(i12) 6.28
Area of the first sector: 0.1975210E+03
IERR: 0
Area of the second sector: 0.1975210E+03
IERR: 0
    
```

Figure 17

Figure 17 shows the program test. The area of the ellipse is πab . $3.14159*9*7 = 197.92017$

Figure 18 shows equal time intervals at different points in the period.

```

4-angular velocity, 5-polar radius, 6-linear velocity
Enter char =
if char = "y" then the source data is specified:
y
a = 9.00 b = 7.00
dpi = 0.0000000 H = 1.00000005E-03
Second law of Kepler H= 1.00000005E-03
The point bypasses the ellipse in 1/H time units (0 < H < 1), counterclockwise.
1/H = 999
Set the start of the first sector (i0=1,..., 999) i0 =
22
Set the end of the first sector (i0<i1<1/H) i1 =
333
Set the start of the second sector (0<i02<1/H-i1+i0) i02 =
555
angle(i0) 0.04; angle(i1) 0.81
angle(i02)= 4.57; angle(i12) 6.03
Area of the first sector: 0.6155315E+02
IERR: 0
Area of the second sector: 0.6155347E+02
IERR: 0

```

Figure 18

On fig. 19 added precession (dpi = 0.1) to the parameters of fig. eighteen.

```

7
a = 9.00 b = 7.00
(precession 0<=dpi<=pi/10) dpi=
0.1
0.10000000
(period = 1, 0 < H < 1 ) H =
0.001
Second law of Kepler H= 1.00000005E-03
The point bypasses the ellipse in 1/H time units (0 < H < 1), counterclockwise.
1/H = 999
Set the start of the first sector (i0=1,..., 999) i0 =
22
Set the end of the first sector (i0<i1<1/H) i1 =
333
Set the start of the second sector (0<i02<1/H-i1+i0) i02 =
555
angle(i0) 0.04; angle(i1) 0.89
angle(i02)= 4.94; angle(i12) 6.12
Area of the first sector: 0.6487499E+02
IERR: 0
Area of the second sector: 0.6487521E+02
IERR: 0

```

Figure 19

Kepler's third law

At perihelion and aphelion, $\sin(\varphi) = 0$, so the acceleration at these points is zero, and the modulo velocity difference is a constant:

$$v_p - v_a = \delta \quad (4.3)$$

Sector velocity according to the law of conservation of momentum is a constant value:

$$v_s = 1/2 \mathbf{vr} \quad (4.4)$$

Let us express the sector velocity modulo the linear velocity.

Since $\sin(v_p \wedge r_p) = \sin(v_a \wedge r_a) = 1$, then

$$v_s = 1/2 v_p r_p = 1/2 r_p (v_a + \delta) \tag{4.5}$$

$$v_s = 1/2 v_a r_a \tag{4.6}$$

$$1/2 r_p (v_a + \delta) = 1/2 r_a v_a \tag{4.7}$$

$$v_a = \frac{r_p \delta}{r_a - r_p} \tag{4.8}$$

We substitute (4.8) into (4.6):

$$v_s = \frac{\delta r_p r_a}{2(r_a - r_p)} \tag{4.9}$$

Calculate the area of the ellipse. One side:

$$S_{\text{ellipse}} = \pi ab \tag{4.10}$$

where a is the length of the major semiaxis, b is the length of the minor semiaxis of the orbit.

On the other hand

$$S_{\text{ellipse}} = v_s T = T \frac{\delta r_p r_a}{2(r_a - r_p)} \tag{4.11}$$

Consequently,

$$T \frac{\delta r_p r_a}{2(r_a - r_p)} = \pi ab \tag{4.12}$$

For further transformations, we use the geometric properties of the ellipse. We have ratios: $r_a - r_p = 2c$, $c = ae$, $r_p r_a = a^2 - c^2 = b^2$.

Substitute into (4.12):

$$T \frac{\delta b^2}{4ae} = \pi ab \tag{4.13}$$

$$T \frac{\delta b}{a^2 e} = 4\pi ; \text{ где } T = 1; \tag{4.14}$$

$$\frac{\delta b}{4\pi a^2 e} = 1 \tag{4.15}$$

Kepler's third law: $\frac{T^2}{a^3} = 1$ (4.16)

$$\frac{\delta b}{4\pi a^2 e} = \frac{T^2}{a^3}; \frac{\delta b}{4\pi e} = \frac{T^2}{a}; T = \frac{1}{2} \sqrt{\frac{\delta b a}{\pi e}} = \frac{1}{2} \sqrt{\frac{(v_p - v_a) b a}{\pi e}} \tag{4.17}$$

The program Movement of a mat point along an ellipse [A.2], using formulas (4.16) and (4.17), calculates the periods. $\delta = v_p - v_a$ [au/planet year]

```

The differential equation of the second order curves
with respect to the focus is calculated.
The data table is displayed in the file ellpi.txt.
Table columns:1-number, 2 - time, 3 - angle,
4-angular speed, 5-polar radius, 6-linear speed
7-angular acceleration, 8-linear acceleration

Enter 0 or 1 or 2 or 3 or 4
0 - enter a, b. Select planet 1 - Mercury, 2 -Uenus, 3 - Earth, 4 - Mars:
8
a =
9
b =
7
a = 9.00 b = 7.00
orbital points (N):          999
period(Kepler3 sqrt(a**3)=  27.000000
period(sqrt(((v1-u2)*b*a)/(pi*ex))/2) =  26.999981
PAUSE
To resume execution, type go. Other input will terminate the job.

```

Figure 20

```

The differential equation of the second order curves
with respect to the focus is calculated.
The data table is displayed in the file ellpi.txt.
Table columns:1-number, 2 - time, 3 - angle,
4-angular speed, 5-polar radius, 6-linear speed
7-angular acceleration, 8-linear acceleration

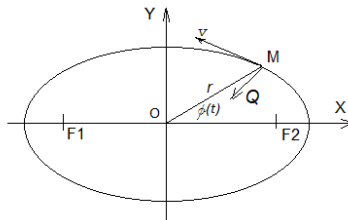
Enter 0 or 1 or 2 or 3 or 4
0 - enter a, b. Select planet 1 - Mercury, 2 -Uenus, 3 - Earth, 4 - Mars:
1
a = 0.39 b = 0.38
orbital points (N):          999
period(Kepler3 sqrt(a**3)=  0.24084271
period(sqrt(((v1-u2)*b*a)/(pi*ex))/2) =  0.24084280
PAUSE
To resume execution, type go. Other input will terminate the job.

```

Figure 21

2. Differential equation of motion of a point along an ellipse with respect to the center

Let's move the origin of coordinates to the center of the ellipse, Fig. 22. The radius function (2.7) will change.



M - material point. Q is a generalized force acting on a point. O - center.
 v - linear speed of the point. $\varphi(t)$ is the angle between the X -axis and the point, counterclockwise.

Figure 22

Kepler’s second law

The TygeBraheKepler2_center [A.1] program calculates the parameters of the point movement according to equations (2.7–2.13), and shows the equality of the areas of the sectors at equal time intervals. Figures 23–25.

```

4-angular velocity, 5-polar radius, 6-linear velocity
Enter char =
if char = "y" then the source data is specified:
y
a = 9.00 b = 7.00
dpi = 0.0000000 H = 1.00000005E-03
Second law of Kepler H= 1.00000005E-03
The point bypasses the ellipse in 1/H time units (0 < H < 1), counterclockwise.
1/H = 999
Set the start of the first sector (i0=1,...., 999) i0 =
1
Set the end of the first sector (i0<i1<1/H) i1 =
999
Set the start of the second sector (0<i02<1/H-i1+i0) i02 =
1
angle(i0) 0.00; angle(i1) 6.28
angle(i02)= 0.00; angle(i12) 6.28
Area of the first sector: 0.1976214E+03
IERR: 0
Area of the second sector: 0.1976214E+03
IERR: 0
    
```

Figure 23

Figure 23 shows the program test. The area of the ellipse is $\pi ab. 2*3.14159*9*7 = 197.92017$

```

4-angular velocity, 5-polar radius, 6-linear velocity
Enter char =
if char = "y" then the source data is specified:
y
a = 9.00 b = 7.00
dpi = 0.0000000 H = 1.00000005E-03
Second law of Kepler H= 1.00000005E-03
The point bypasses the ellipse in 1/H time units (0 < H < 1), counterclockwise.
1/H = 999
Set the start of the first sector (i0=1,...., 999) i0 =
22
Set the end of the first sector (i0<i1<1/H) i1 =
333
Set the start of the second sector (0<i02<1/H-i1+i0) i02 =
555
angle(i0) 0.10; angle(i1) 2.20
angle(i02)= 3.41; angle(i12) 5.56
Area of the first sector: 0.6155317E+02
IERR: 0
Area of the second sector: 0.6155319E+02
IERR: 0
    
```

Figure 24

On fig. 24 equal time intervals are given at different moments of the period.

```

9 semimajor axis b =
7 a = 9.00 b = 7.00
  (precession 0<=dpi<=pi/10) dpi=
0.1
0.10000000
  (period = 1, 0 < H < 1 ) H =
0.091

Second law of Kepler H= 1.00000005E-03
The point bypasses the ellipse in 1/H time units (0 < H < 1), counterclockwise.
1/H = 999

Set the start of the first sector (i0=i1,..., 999 ) i0 =
22
Set the end of the first sector (i0<i1<1/H) i1 =
333
Set the start of the second sector (0<i02<1/H-1+i0) i02 =
555
angle(i0) 0.10; angle(i1) 2.25
angle(i02)= 3.47; angle(i12) 5.67
Area of the first sector: 0.6280998E+02
IERR: 0
Area of the second sector: 0.6280998E+02
IERR: 0

```

Figure 25

On fig. 25 added precession ($dpi = 0.1$) to the parameters of fig. 23.

Kepler's third law

The program Movement of a mat point along an ellipse center [A.2], using formulas (4.16 – 4.17), calculates the periods. $\delta = v1 - v2$ [au/planet year].

In Figures 25 - 27 we see that with an increase in the eccentricity, the difference between the periods increases.

```

The differential equation of the second order curves
with respect to the focus is calculated.
The data table is displayed in the file ellpi.txt.
Table columns:1-number, 2 - time, 3 - angle,
4-angular speed, 5-polar radius, 6-linear speed
7-angular acceleration, 8-linear acceleration

Enter 0 or 1 or 2 or 3 or 4
0 - enter a, b. Select planet 1 - Mercury, 2 -Uenus, 3 - Earth, 4 - Mars:
0
a =
9
b =
7
a = 9.00 b = 7.00
orbital points (N): 999
period(Kepler3 sqrt(a*x3)= 27.000000
period(sqrt(((v1-v2)*b*a)/(pi*ex))/2) = 21.000002
PAUSE
To resume execution, type go. Other input will terminate the job.

```

Figure 26

```

The differential equation of the second order curves
with respect to the focus is calculated.
The data table is displayed in the file ellpi.txt.
Table columns:1-number, 2 - time, 3 - angle.
4-angular speed, 5-polar radius, 6-linear speed
7-angular acceleration, 8-linear acceleration

Enter 0 or 1 or 2 or 3 or 4
0 - enter a, b. Select planet 1 - Mercury, 2 -Uenus, 3 - Earth, 4 - Mars:
1
a = 0.39 b = 0.38
orbital points (N):          999
period(Kepler3 sqrt(a**3)= 0.24084271
period(sqrt(((v1-v2)*b*a)/(pi*ex))/2) = 0.23569536
PAUSE
To resume execution, type go. Other input will terminate the job.
    
```

Figure 27

```

The differential equation of the second order curves
with respect to the focus is calculated.
The data table is displayed in the file ellpi.txt.
Table columns:1-number, 2 - time, 3 - angle.
4-angular speed, 5-polar radius, 6-linear speed
7-angular acceleration, 8-linear acceleration

Enter 0 or 1 or 2 or 3 or 4
0 - enter a, b. Select planet 1 - Mercury, 2 -Uenus, 3 - Earth, 4 - Mars:
2
a = 0.73 b = 0.73
orbital points (N):          999
period(Kepler3 sqrt(a**3)= 0.62144679
period(sqrt(((v1-v2)*b*a)/(pi*ex))/2) = 0.62116992
PAUSE
To resume execution, type go. Other input will terminate the job.
    
```

Figure 28

Conclusion

The kinematic equation (1.10) accurately describes the motion along ideal second-order curves. The real orbits of cosmic bodies have deviations from the ideal curve: precession, periodic asymmetry of the lengths of the radii, and other types of deviation.

Equation (1.10) and the center of mass theorem make it possible to simulate the motion of three or more bodies along second-order curves. Example [A.5], fig. 29, 30.

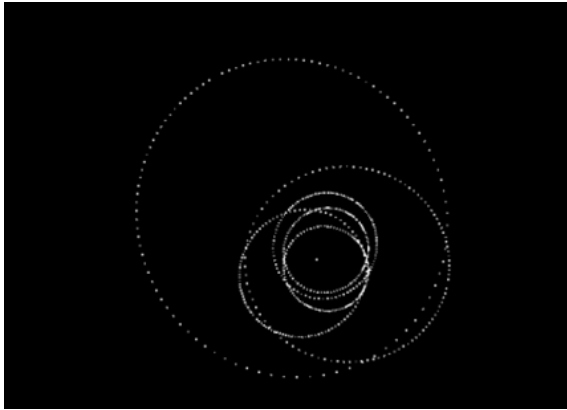


Figure 29



Figure 30

The kinematic equation (2.13) is applicable for modeling streamlines of liquid and gas particles.

The article used materials from textbooks on mechanics.

List of reference

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Applications

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2. *V.Strohm, programm, Movement of a mat point along an ellipse, <https://drive.google.com/file/d/1hM8KQL1bX627L2xhWzXjK45IX47wiVnS/view?usp=sharing>*
3. *V.Strohm, programm, TygeBraheKepler2_center, https://drive.google.com/file/d/1ZkYySXqB3lzJxESI3xRK9TdYR5BNjcpQ/view?usp=share_link*
4. *V.Strohm, programm, Movement of a mat point along an ellipse center, <https://drive.google.com/file/d/1hM8KQL1bX627L2xhWzXjK45IX47wiVnS/view?usp=sharing>*
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DOI 10.34660/INF.2024.64.35.100

RESEARCH OF SELECTION AND GENETIC PARAMETERS OF THE SIMMENTAL BREED

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Annotation. *For effective breeding, systematic control of animals is necessary. In practice, two types of reproduction are used: expanded, with an annual increase in the number of cows, and simple reproduction-without increasing the number of herds. With simple reproduction, 50-60% are allocated to the breeding core, and with extended reproduction – up to 70% of cows or born heifers. It is determined by planned tasks to increase the production of milk and beef, as well as increase the productivity of animals. The intensity of reproduction is characterized by the size of the annual cull of cows or the number (%) introduced to the herd relative to the number of cows at the beginning of the year. In recent years, it ranges from 14 to 18% on the farm, and the average age of productive use of cows has decreased. The main means of quantitative and qualitative improvement of herd reproduction is the widespread use of artificial insemination of cows and heifers.*

Keywords: *herd, reproduction, Simmental breed, correlation, cow productivity.*

In recent years, our country has seen a steady growth trend in the breeding base of such a branch of livestock farming as dairy cattle breeding.

The volume of sales of pedigree young animals has increased significantly due to the development of the dairy cattle breeding base. In the near future, it is planned to increase the volume of sales of breeding young animals using our own resources to at least eighty percent of the need [3].

Implementation of the industry program “Development of dairy cattle breeding and increase in milk production in the Russian Federation by 2020-2025” provides for the acceleration of the formation of a competitive breeding base, which will increase the share of breeding cows to fifteen percent of the total number of dairy cows, and the volume of sales of domestic breeding young animals should be at least one hundred thousand heads.

To create a competitive domestic livestock breeding it is necessary to significantly reform the breeding business and introduce the most effective selection

methods that allow the use of information technology, new systems for identifying and tagging animals.

The Ministry of Agriculture of Russia is carrying out work aimed at improving legislative acts in the field of livestock breeding in accordance with current legislation and international standards [1, 2].

To carry out effective selection, systematic monitoring of animals is necessary. In practice, two types of reproduction are used: expanded, with an annual increase in the number of cows, and simple reproduction - without increasing the size of the herd. With simple reproduction, 50-60% is allocated to the breeding core, and with extended reproduction - up to 70% of cows or born heifers. It is determined by planned targets to increase the production of milk and beef, as well as the growth of animal productivity.

The intensity of reproduction is characterized by the size of the annual culling of cows or the number (%) introduced into the herd relative to the number of cows at the beginning of the year. In recent years, it has fluctuated across the farm from 14 to 18%; the average age of productive use of cows has decreased.

The main means of quantitative and qualitative improvement of herd reproduction is the widespread use of artificial insemination of cows and heifers.

One of the main indicators affecting the yield of calves per 100 cows is the duration of the intercalving period, the norm of which should be considered 365 days in 95-98% of the dairy herd. The yield of calves per 100 cows largely depends on the duration of the service and dry periods. The duration of the service period for the herd is 80 days, which is within normal limits. The dry period for cows is 60-75 days, which also corresponds to the norm.

The offspring of heifers in the farm are used for their own reproduction. Heifers reach sexual maturity at 17 months, when they reach a live weight of 350-370 kg. In the future, it is planned to inseminate heifers with a live weight of 400-430 kg.

During the study, biometric processing of average milk yield per lactation and fat content in milk from 2 groups of Simmental breed cows of dairy and dairy-meat productivity

Cows of the Simmental breed of the dairy direction of productivity gave 4760 kg of milk during lactation or 1020 kg more than cows of the Simmental breed of the dairy-meat direction of productivity (3740 kg).

The difference in milk yield is statistically significant ($t = 8.15$) and can be transferred to the entire population with a probability level of $P > 0.999$.

Consequently, animals of the Simmental breed of the dairy direction of productivity give more milk per lactation than their peers of the Simmental breed of the dairy-meat direction of productivity.

The variability in milk yield per lactation in the Simmental breed of dairy productivity is large ($\sigma = \pm 533$ kg; $C = 12\%$), and in the Simmental breed of

dairy-meat direction productivity is small ($\partial = +/-172$ kg; $C = 5.5\%$). Therefore, selection for milk yield per lactation will be more effective in the group of Simmental dairy cows.

The biometric indicators obtained by comparing the two groups allow us to draw the following conclusion.

In cows of the Simmental breed of the dairy-meat direction of productivity, the fat content in milk is 3.86% or 0.02% more than in the milk of cows of the dairy direction of productivity.

Consequently, the milk of Simmental cows of the dairy-meat production direction contains more fat than the milk of cows of the dairy production direction.

The variability in fat content in milk in cows of the Simmental breed of the dairy direction of productivity is higher ($\partial = +/- 0.18\%$; $C = 5.1\%$) than in cows of the Simmental breed of the dairy-meat direction of productivity ($\partial = +/- 0.09\%$; $MS = 2.4\%$). Therefore, selection based on the level of fat content in milk will be more effective in the group of dairy cows.

Cows of the Simmental breed of the dairy-meat direction of productivity have a greater live weight (575 kg) than cows of the Simmental breed of the dairy direction of productivity (517 kg).

The difference in live weight indicators is statistically significant ($td = 3.96$) and can be transferred to the entire population.

Consequently, cows of the Simmental breed of the dairy-meat type of productivity have a greater live weight than cows of the Simmental breed of the dairy type of productivity.

The variability in live weight in Simmental cows of the dairy-meat direction of productivity is greater ($\partial = +/-17.6$ kg; $C = 3.8\%$) than in cows of the Simmental breed of dairy productivity ($\partial = +/-13.4$ kg; $C = 3.1\%$). Therefore, selection based on live weight will be more effective in the group of Simmental cows of the dairy-meat direction of productivity.

Calculation of the correlation coefficient between the amount of milk yield and the fat content in milk showed that in the group of cows of the Simmental breed of dairy productivity, there is a negative correlation between the amount of milk yield and fat content ($r = - 0.48$)

This relationship is statistically significant ($tr = 2.4$) and can be transferred to the entire population at a probability level of $P = 0.95$.

Consequently, in this group, when selected to increase milk yield in dairy cows, the fat content in milk will decrease (and vice versa).

In the group of cows of the Simmental breed of dairy-meat productivity, according to the results of calculations, a negative correlation was also established between the amount of milk yield and fat content ($r = - 0.45$).

This relationship is statistically significant ($tr = 2.25$) and can be transferred to the entire population at a probability level of $P = 0.95$.

Consequently, in this group, also when selecting to increase milk yield in Simmental cows of the dairy breed, the fat content in milk will decrease (and vice versa).

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1. *Statsev A., Polukhin A. Economic efficiency of using technical potential in dairy cattle breeding/Dairy and meat cattle breeding//Statsev A., Polukhin A./No. 1-2012, P.7.*
2. *Ulimbashev M. Influence of genetic and paratypic factors on the productive qualities of cows/Ulimbashev M.// Dairy and beef cattle breeding/No. 8-2009.P.9.*
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Proceedings of International University Scientific Forum

Practice Oriented Science:
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March 27, 2024

Signed in print 27.03.2024 r. 60x84/16.
Ed. No. 1. Circulation of 500 copies.
UAE, 2024.
Infinity publishing, 2024



