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## Agricultural sciences

### ASSESSMENT OF THE CARBON FOOTPRINT OF LEGUMES, GRASSES AND THEIR MIXTURE BIOMASS -CASE STUDY-

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#### **Methodology and Background**

The aim of the current study was to assess the carbon footprint of legumes, grasses and their mixture crops. The research activity, based on the realization of numerous analyses, determinations and studies of an economic nature, was performed in the agricultural bio base of the Research and Development Station for Bovine Arad, Romania during the year 2024. The structure of the fodder system of this farm included the following crops:

- concentrated fodder crops (585 ha-57%)
- grain wheat 335 ha-33%),
- grain corn (150 ha-14%),
- grain barley (100 ha-10%)
- green fodder crops (178 ha-18%)-
- alfalfa (79 ha-8%),
- perennial grasses (58 ha-5%),
- Sudan grass (22 ha-2%),
- autumn gorse (15 ha-2%),
- mix of alfalfa with perennial grasses (4 ha-1%)
- ensilaged fodder crops (256 ha-25%)
- corn silage (256 ha-25%)

The results of the conducted studies aimed at the following objectives:

- determination of soil organic carbon content, for each crops
- the carbon footprint according to agrotechnical works applied to carry out the germinal, fertilization, maintenance, harvesting and transport operations
- the amount of carbon CO<sub>2</sub> eq captured due to photosynthesis and fixed in the biomass of crops in the forage system
- the total amount of "net" carbon fixed through photosynthesis at the level of the forage system
- determination of the average degree of humification of organic matter (SOC) in the soil
- determining the number of carbon credits and the value of the carbon certificate

In order to determine the content of C and N in the soil, numerous samples were taken from all the soils and types of land of each sown crop, a few days before their harvest. These average soil samples were taken at different depth horizons of the soil profile-0-10 cm, 10-20 cm, 20-30 cm, where most of the total amount of roots is found. The analysis methods were as follows:

- determination of organic carbon content - wet oxidation STAS 7184/21-82, PTL 12
- determination of nitric nitrogen (N-NO<sub>3</sub>)-potentiometric-methodology ICPA (1981) vol. 1, chap. 10, PT 46
- determination of ammonia nitrogen content (N-NH<sub>4</sub>)-distillation, ICPA methodology (1981) vol.

1, chap. 10, PT 47

- determination of total nitrogen and total carbon from soil samples, plants and secondary products-SR ISO 10694/1998 and the protocol for the use of the elemental analyser VARIO MACRO CUBED-PT 162

The chemical analyses carried out led to the determination of the amount of carbon in the plant and soil according to the phytomass production of each crop, both above-ground and underground. Also, based on the calculation of the C/N ratio, the rate of decomposition of plant residues and roots was assessed, as follows:

- C/N ratio below - a very intense decomposition is achieved
- C/N ratio between 15-30 - average decomposition intensity
- C/N ratio over 30 – reduced intensity of decomposition

The distribution of plant residues on the 0-10 cm depth layer, on average, varies according to the farming system applied: 17% in the conventional system, 75% in the minimum-tillage farming system, 90% in the direct sowing system, without plowing. Since different terminology is used in the specialized literature from one author to another, regarding the names of the stages that follow from the carbon content C-CO<sub>2</sub> eq in the atmosphere to C sequestered in the soil, we have adopted the following formulas:

- C-CO<sub>2</sub>eq captured by photosynthesis
- C fixed-CO<sub>2</sub> eq in the above-ground and underground biomass
- C stored or sequestered in the soil.

For Feller et al. (2004) the notion of carbon sequestration in the soil is totally associated with that of "greenhouse gas flow" at soil-plant-atmosphere interference. Sequestration refers only to the storage of carbon in soil, derived directly or indirectly from atmospheric C or CO<sub>2</sub>. Thus, carbon storage originating from organic matter of an industrial nature, partly from the fossil reserves of urban compost, cannot be considered and associated with the notion of "sequestration". In order to determine the quantity of C and CO<sub>2</sub> eq, the conversion coefficients known in all specialized works were used, respectively: 1 kg C-3.66 Kg CO, 1 kg CO<sub>2</sub>-0.273 Kg C.

The quantitative evaluation of the C content, respectively in CO<sub>2</sub> eq equivalence, was carried out for each crop in the forage system, both for the main production (grains, fodder phytomass) and for the secondary production (straw, stalks, corn cobs). Also, the amount of carbon was determined, differentiated, for aboveground and underground biomass (roots, stubble). During the biosynthesis processes of plant organic substances (carbohydrates, cellulose, fats, proteins, etc.), as a result of photosynthetic activity, part of the carbon captured in the form of CO<sub>2</sub> returns to the atmosphere through the respiration associated with photosynthesis, through the respiration of the soil and the microorganisms involved in soil decomposition. According to the studies carried out in this regard, the return of carbon to the atmosphere is carried out within fairly wide value limits. In this sense, for the quantitative determination of the returned carbon, the proportion of 15% for above-ground biomass and 30% for underground biomass was taken into consideration. The amount of net carbon – CO<sub>2</sub> eq was determined from the difference between the amount of gross C-CO<sub>2</sub> eq produced by photosynthesis and the amount of C-CO<sub>2</sub> eq returned. Following the determinations performed, a diagram was made regarding the general distribution of carbon fixed by photosynthesis in the fodder ecosystem, with the following carbon sequestration basins, respectively:

- long-term or short-term immobilized fixed carbon in the main production, specific to the farm – grains, phytomass, silage and in the secondary production (straw)
- carbon fixed in roots, stubble, plant residues
- carbon fixed and returned to the atmosphere through plant-soil respiration

The soil quality is conferred by the amount of accumulated organic matter, which, following the processes of decomposition and mineralization, is partially transformed into humus. Previous studies carried out in this regard emphasize a wide variation in the amount of humus, the limits being between 0.34-0.48 t/humus/t net carbon sequestered in the soil. Thus, to determine this parameter, an average degree of humification was taken into consideration, namely 0.42 (42%). The high level of global atmospheric pollution with greenhouse gases has required the application of quantitative and value assessment measures of the carbon footprint, and the issuance of carbon certificates showing the degree of its storage in various fields of activity. Depending on this certificate, the number of carbon credits is determined, which is the equivalent of one ton of stored carbon. From this point of view, following the studies carried out, depending on the amounts of net carbon sequestered in the soil, both the number of credits/ha and their value were calculated. The value of the credits varies daily on the carbon market,

the values being between 30-100 euros/credit. Thus, on the EU carbon market (according to the Carbon Expert Newsletter) during 2024, 5 evaluations of carbon certificates were traded at the following prices (average of 67.94 euros/credit):

- 23.04.2024-64.21 euro/credit
- 13.08.2024-72.86 euro/credit
- 20.08.2024-72.58 euro/credit
- 11.09.2024-65.27 euro/credit
- 25.09.2024-64.21 euro/credit

### Results

*Determination of soil organic carbon content at the time of harvesting*

The organic carbon content represents soil organic matter (SOM) resulting from the decomposition of plant residues, roots, animals, substances released by soil microorganisms. The organic matter in the soil has a content of approx. 58% carbon, originating from the atmosphere through the photosynthesis activity of plants (Grant A and Michel V., 2020). The organic carbon in the soil has a very important role on its physical, chemical and biological properties, with a significant impact on fertility, through:

- sequestered carbon deposits with a role in reducing CO<sub>2</sub> from the atmosphere;
- improving the soil structure by forming aggregates that help air and water circulation and stabilize soil erosion;
- improving the water retention capacity in the soil and avoiding the phenomenon of excessive drying that leads to the occurrence of pedological drought;
- the contribution made to the retention of nutrients and the provision of food and energy for the microorganisms and insects living at this level.

The application of sustainable agricultural practices (crop rotation, use of organic fertilizers, and management of plant residues) has a very important role in conserving and improving soil carbon content.

Determinations of soil organic carbon were carried out on the 0-30 cm depth horizon, from 10 to 10 cm, a depth that includes over 70% of the plant rhizosphere. The chemical analyses regarding organic carbon, carried out on grain corn and silage corn crops, are presented in tables 1 and 2 respectively. In these species, the organic carbon content is 3.64% on the 0-10 cm depth, 3.71% on the 10-20 cm horizon and 2.91% on the 20-30 cm horizon. Relative to the hectare, the amount of carbon varies at different depths, as follows: 24 t/ha for the 0-10 cm depth, 49 t/ha for the 10-20 cm depth, respectively 58 t/ha for the 20-30 cm depth horizon.

Table 1.

*Soil organic carbon content at different depth horizons in grain corn crop (150 ha)*

| Parameters/Depth horizons            | 0-10 cm – 0.1m <sup>3</sup> | 10-20 cm– 0.2m <sup>3</sup> | 20-30 cm– 0.3m <sup>3</sup> |
|--------------------------------------|-----------------------------|-----------------------------|-----------------------------|
| Soil weight (kg/m <sup>2</sup> )     | 67                          | 134                         | 201                         |
| Organic C content (%)                | 3.64                        | 3.71                        | 2.91                        |
| C (kg/m <sup>2</sup> /depth horizon) | 2.4                         | 4.9                         | 5.8                         |
| Organic C (t/ha)                     | 24 (100%)                   | 49 (204%)                   | 58 (242%)                   |
| Organic C (t/cultivated area)        | 3600                        | 7350                        | 8700                        |

Table 2.

*Soil organic carbon content at different depth horizons in silage corn crop (256 ha)*

| Parameters/Depth horizons            | 0-10 cm – 0.1m <sup>3</sup> | 10-20 cm– 0.2m <sup>3</sup> | 20-30 cm– 0.3m <sup>3</sup> |
|--------------------------------------|-----------------------------|-----------------------------|-----------------------------|
| Soil weight (kg/m <sup>2</sup> )     | 67                          | 134                         | 201                         |
| Organic C content (%)                | 3.64                        | 3.71                        | 2.91                        |
| C (kg/m <sup>2</sup> /depth horizon) | 2.4                         | 4.9                         | 5.8                         |
| Organic C (t/ha)                     | 24 (100%)                   | 49 (204%)                   | 58 (242%)                   |
| Organic C (t/cultivated area)        | 6144                        | 12544                       | 14848                       |

As can be seen, a fact later found also in the other cultures, both the organic carbon content and the amount of organic matter of the soil increase as the soil volume increases in depth. On the soil profile, the horizons on the surface have looser soil, where the decomposition of organic matter is not complete as a result of the deposition of new organic substances, originating from plant remains, stubble, roots. Thus, the volumetric weight of the soil in the first 20 cm is lower compared to the volumetric weight associated with the horizon up to 30 cm. Here the soil is denser as a result of the decomposition of organic matter accumulated over time.

In the wheat crop, cultivated on the largest surface (335 ha) within the fodder system, the amount of organic carbon related to the three depth horizons increases proportionally from 21.3 t/ha (100%) at the depth of 0-10 cm to 42.2 t/ha (198%) for the depth of 10-20 cm and 62 t/ha (291%) for the depth

horizon 20-30 cm. The amount of organic carbon in the barley crop is lower compared to the wheat crop because the barley has a much less developed root system, the roots penetrating the depth of the studied soil horizon more difficult.

Table 3.

| <i>Soil organic carbon content at different depth horizons in wheat crop (335 ha)</i> |                                   |                                   |                                   |
|---------------------------------------------------------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| <i>Parameters/Depth horizons</i>                                                      | <i>0-10 cm – 0.1m<sup>3</sup></i> | <i>10-20 cm– 0.2m<sup>3</sup></i> | <i>20-30 cm– 0.3m<sup>3</sup></i> |
| <i>Soil weight (kg/m<sup>2</sup>)</i>                                                 | 67                                | 134                               | 201                               |
| <i>Organic C content (%)</i>                                                          | 3.19                              | 3.15                              | 3.08                              |
| <i>C (kg/m<sup>2</sup>/depth horizon)</i>                                             | 2.13                              | 4.22                              | 6.2                               |
| <i>Organic C (t/ha)</i>                                                               | 21.3 (100%)                       | 42.2 (198%)                       | 62 (291%)                         |
| <i>Organic C (t/cultivated area)</i>                                                  | 7135                              | 14137                             | 20770                             |

From the data presented in table 4, it can be seen that on the three soil depths the amount of organic carbon registered a quantitative upward trend, characterized by the following values: 17 t/ha on the 0-10 cm depth (100%), 32 t/ha (188%) on the 10-20 cm interval, respectively 47 t/ha representing a weight of 276% on the terminal horizon 20-30 cm.

Table 4.

| <i>Soil organic carbon content at different depth horizons in barley crop (100 ha)</i> |                                   |                                   |                                   |
|----------------------------------------------------------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| <i>Parameters/Depth horizons</i>                                                       | <i>0-10 cm – 0.1m<sup>3</sup></i> | <i>10-20 cm– 0.2m<sup>3</sup></i> | <i>20-30 cm– 0.3m<sup>3</sup></i> |
| <i>Soil weight (kg/m<sup>2</sup>)</i>                                                  | 67                                | 134                               | 201                               |
| <i>Organic C content (%)</i>                                                           | 2.49                              | 2.42                              | 2.35                              |
| <i>C (kg/m<sup>2</sup>/depth horizon)</i>                                              | 1.7                               | 3.2                               | 4.7                               |
| <i>Organic C (t/ha)</i>                                                                | 17                                | 32                                | 47                                |
| <i>Organic C (t/cultivated area)</i>                                                   | 1700                              | 3200                              | 4700                              |

Of all the crops included in the present study, alfalfa has the most deeply developed root system, consisting of a main taproot, with numerous roots on the tappet, through which it penetrates deep into the soil, sometimes at depths of more than 2 m. Thus, alfalfa accumulates a much larger amount of organic matter in the soil, including at depths greater than 30 cm, following the decomposition processes of the roots and their exudates.

Table 5.

| <i>Soil organic carbon content at different depth horizons in alfalfa crop (79 ha)</i> |                                   |                                   |                                   |
|----------------------------------------------------------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| <i>Parameters/Depth horizons</i>                                                       | <i>0-10 cm – 0.1m<sup>3</sup></i> | <i>10-20 cm– 0.2m<sup>3</sup></i> | <i>20-30 cm– 0.3m<sup>3</sup></i> |
| <i>Soil weight (kg/m<sup>2</sup>)</i>                                                  | 67                                | 134                               | 201                               |
| <i>Organic C content (%)</i>                                                           | 2.17                              | 2.52                              | 2.45                              |
| <i>C (kg/m<sup>2</sup>/depth horizon)</i>                                              | 1.4                               | 3.4                               | 4.9                               |
| <i>Organic C (t/ha)</i>                                                                | 14 (100%)                         | 34 (243%)                         | 49 (350%)                         |
| <i>Organic C (t/cultivated area)</i>                                                   | 1106                              | 2686                              | 3871                              |

Analysis of the results presented synthetically in table 5. highlights a progressive increase in the amount of organic carbon, from 14 t/ha (100%) on the 0-10 cm depth to 34 t/ha (243%) on the second horizon 10-20 cm respectively to 49 t/ha (350%) on the terminal depth horizon between 20-30 cm, so 3.5 times more compared to the first depth horizon (compared to other times culture) and 1.4 times more compared to the 10-20 cm horizon.

Sudan grass is a species of grass with a fasciculate root system, strongly branched and deep, reaching, like alfalfa, to depths of more than 2 m, which explains the 2-3 times increase in the amount of organic carbon at the depth of 20-30 cm compared to the 0-10 cm horizon. The analyzes carried out on this crop show a quantity of 9 t/ha (100%) of organic carbon at the depth of 0-10 cm, a quantity that increases progressively on the other 2 depth horizons, 18 t/ha for the 10-20 cm horizon (200%) and 27 t/ha (300%) for the 20-30 cm depth horizon.

Table 6.

| <i>Soil organic carbon content at different depth horizons in Sudan grass crop (22 ha)</i> |                                   |                                   |                                   |
|--------------------------------------------------------------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| <i>Parameters/Depth horizons</i>                                                           | <i>0-10 cm – 0.1m<sup>3</sup></i> | <i>10-20 cm– 0.2m<sup>3</sup></i> | <i>20-30 cm– 0.3m<sup>3</sup></i> |
| <i>Soil weight (kg/m<sup>2</sup>)</i>                                                      | 67                                | 134                               | 201                               |
| <i>Organic C content (%)</i>                                                               | 1.37                              | 1.37                              | 1.33                              |
| <i>C (kg/m<sup>2</sup>/depth horizon)</i>                                                  | 0.9                               | 1.8                               | 2.7                               |
| <i>Organic C (t/ha)</i>                                                                    | 9 (100%)                          | 18 (200%)                         | 27 (300%)                         |
| <i>Organic C (t/cultivated area)</i>                                                       | 198                               | 396                               | 594                               |

Table 7.

**Soil organic carbon content at different depth horizons in gramineous crop (58 ha)**

| Parameters/Depth horizons            | 0-10 cm – 0.1m <sup>3</sup> | 10-20 cm– 0.2m <sup>3</sup> | 20-30 cm– 0.3m <sup>3</sup> |
|--------------------------------------|-----------------------------|-----------------------------|-----------------------------|
| Soil weight (kg/m <sup>2</sup> )     | 67                          | 134                         | 201                         |
| Organic C content (%)                | 2.28                        | 2.45                        | 2.38                        |
| C (kg/m <sup>2</sup> /depth horizon) | 1.5                         | 3.3                         | 4.8                         |
| Organic C (t/ha)                     | 15 (100%)                   | 33 (220%)                   | 48 (320%)                   |
| Organic C (t/cultivated area)        | 870                         | 1914                        | 2784                        |

In the mixed crop consisting of perennial grasses (100%), the amount of organic carbon in the soil registers the following values: 15 t/ha (100%) for the depth of 0-10 cm, 33 t/ha (220%) for the 10-20 cm horizon, respectively 48 t/ha (320%) at the depth of 30 cm. In this case, the increase in the amount of organic carbon in the soil was 120% at a depth of 20 cm and 220% at a depth of 30 cm compared to the first horizon between 0-10 cm. These increases are largely due to the fasciolate root system, strongly developed to depths of 50-70 cm.

The mixed crop consisting of alfalfa (40%) and perennial grasses (60%), through their highly developed root system, recorded a significant increase in the amount of organic carbon at soil depths of 20-30 cm.

Table 8.

**Soil organic carbon content at different depth horizons in mixed gramineous and alfalfa crop (4 ha)**

| Parameters/Depth horizons            | 0-10 cm – 0.1m <sup>3</sup> | 10-20 cm– 0.2m <sup>3</sup> | 20-30 cm– 0.3m <sup>3</sup> |
|--------------------------------------|-----------------------------|-----------------------------|-----------------------------|
| Soil weight (kg/m <sup>2</sup> )     | 67                          | 134                         | 201                         |
| Organic C content (%)                | 2.42                        | 2.63                        | 2.35                        |
| C (kg/m <sup>2</sup> /depth horizon) | 1.6                         | 3.5                         | 4.7                         |
| Organic C (t/ha)                     | 16 (100%)                   | 35 (219%)                   | 47 (294%)                   |
| Organic C (t/cultivated area)        | 64                          | 140                         | 188                         |

Thus, at the depth of 0-10 cm, the amount of organic carbon was 16 t/ha (100%), increasing to 35 t/ha (219%) for the depth between 10-20 cm and 47 t/ha (294%) for the 20-30 cm depth horizon.

The autumn pea crop, with a participation of 75% of the autumn pea, has a significant contribution to the increase in the amount of organic carbon due to the deep and strongly developed tap root system in the surface layers of the soil.

Table 9.

**Soil organic carbon content at different depth horizons in autumn pea crop (15 ha)**

| Parameters/Depth horizons            | 0-10 cm – 0.1m <sup>3</sup> | 10-20 cm– 0.2m <sup>3</sup> | 20-30 cm– 0.3m <sup>3</sup> |
|--------------------------------------|-----------------------------|-----------------------------|-----------------------------|
| Soil weight (kg/m <sup>2</sup> )     | 67                          | 134                         | 201                         |
| Organic C content (%)                | 2.3                         | 2.49                        | 2.41                        |
| C (kg/m <sup>2</sup> /depth horizon) | 1.5                         | 3.3                         | 4.8                         |
| Organic C (t/ha)                     | 15                          | 33                          | 48                          |
| Organic C (t/cultivated area)        | 225                         | 495                         | 720                         |

In the case of this crop, the amount of soil organic carbon accumulated on the 0-30 cm depth horizon is symmetrical with that accumulated on the 20-30 cm depth (48 t/ha). The proportional increase in the amount of organic carbon on the three soil depths is determined by the 15 t/ha (100%) associated with the 0-10 cm horizon, 33 t/ha (220%) for the 10-20 cm depth, respectively 48 t/ha (320%) for the 20-30 cm horizon.

The data on the total amount of organic carbon in the soil, related to the studied depth horizons and the surface of the fodder system, is shown in table 10.

Table 10.

**The amount of soil organic carbon in relation to the depth horizons and surface of the forage system\***

| Depth horizons | Organic carbon (t/ha) | Total organic carbon /farm |            |
|----------------|-----------------------|----------------------------|------------|
|                |                       | t×10 <sup>3</sup>          | %          |
| 0-10 cm        | 17.5                  | 17.5                       | 11         |
| 10-20 cm       | 36.1                  | 36.8                       | 23         |
| 20-30 cm       | 49.3                  | 103.7                      | 66         |
| <b>Total</b>   |                       | <b>158</b>                 | <b>100</b> |

Total surface 1019 ha

**Conclusions**

The cumulative analysis of the soil organic carbon content, highlights the following conclusions:

- the average amount of organic carbon in the soil differs in relation to the depth horizon of the soil, as follows: 17.5 t/ha at a depth of 0-10 cm, 36.1 t/ha at a depth of 10-20 cm, respectively 49.3 t/ha at a depth horizon of 20-30 cm

*- the total amount of organic carbon in the soil, at the level of the total surface of 1019 ha, has the following differentiation according to the studied depths: 17.5 thousand tons (11% of the total) on the 0-10 cm depth, 36.8 thousand tons (23% of the total) on the 10-20 cm depth, respectively 103.7 thousand tons (66% of the total) on the 20-30 cm depth*

*- the total amount of organic carbon in the soil at farm level, on the total studied area, is 158 thousand tons.*

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## Biological sciences

### DIVERSITY OF ENDOPHYTIC BACTERIA ISOLATED FROM PEGANUM HARMALA

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*Peganum harmala* is a member of the Nitrariaceae family and is widely distributed throughout the world [1]. It is mainly found on dry slopes and in semi-deserts [2]. It is also widespread in arid and semi-arid regions of the deserts of North Africa and Asia, as well as in Australia, the southwestern United States, and northern Mexico. The plant has subsequently spread invasively from this region to Arizona, California, Montana, Nevada, Oregon, Texas, and Washington[3].

*Peganum harmala* contains flavonoids, anthraquinones, triterpenoids, fatty acids, essential oils, amino acids, micro and macroelements, especially alkaloids[6]. The most studied biologically active substances in *Peganum harmala* are alkaloids. This plant contains two groups of alkaloids: dikacarboline alkaloids and quinazoline alkaloids. These groups are represented by the names of the main structures (carboline and quinazoline) that make up the main structure of the alkaloids[4]. In addition, most endophytic bacteria stimulate plant growth under unfavorable conditions through the synthesis of active phytohormones (indole-3-acetic acid, ACC deaminase) [5].

To date, studies on the study of endophytic microorganisms of *Peganum harmala* are relatively rare in practice, therefore, the effect of endophytic bacteria on the growth-promoting properties of plants plays an important role in increasing the drought resistance and productivity of agricultural crops. Also, the isolation of endophytic bacteria, identification of bacteria, assessment of the diversity of endophytic bacteria in plant organs, and the study of the growth-promoting properties of endophytic bacteria in cultivated plants are of great scientific and practical importance.

Our research examined 570 segments of the stem, leaves and roots of the *Peganum harmala* plant, which is widespread in the arid, semi-arid and hilly regions of the Samarkand and Kashkadarya regions of Uzbekistan. To date, 24 endophytic bacterial isolates have been isolated from *Peganum harmala* and identified by 16SrRNA gene analysis.

The results obtained were registered in the National Center for Biotechnology Information NCBI database under the accession numbers *Pseudomonas putida* strain MsHpR103 (<https://www.ncbi.nlm.nih.gov>) OR841350.

The positive effects of 24 isolates of endophytic bacteria grown on the surface of pure culture media on the growth of agricultural crops were studied, and 5 promising bacterial strains were selected from them. In this study, comparative analysis of endophytic bacterial strains isolated from *Peganum harmala* and their sequences with the closest species in the database revealed that strain MsHpR102 was 99.79% identical to *Bacillus subtilis*, strain MsHpR103 was 99.86% identical to *Pseudomonas putida*, strain MsHpR108 was 99.79% identical to *Bacillus amyloliquefaciens*, strain MsHpS108 was 99.86% identical to *Bacillus pumilus*, and strain MsHpL103 was 99.79% identical to *Peribacillus frigoritolerans* (Table 1).

**Table 1**

**Comparative analysis of endophytic bacterial strains isolated from *Peganum harmala* and their sequences with the closest species in the database**

| Isolated strains deposited to GenBank |                |                     | Closest match<br>(16S ribosomal RNA genes) (GenBank) |                     |                     |
|---------------------------------------|----------------|---------------------|------------------------------------------------------|---------------------|---------------------|
| Strain                                | Length<br>(bp) | Accession<br>number | Reference strains                                    | Accession<br>number | Percent<br>identity |
| MsHpR102                              | 1425           | OR841349            | <i>Bacillus subtilis</i> GEB1                        | OQ642274.1          | 99,79               |
| MsHpR103                              | 1451           | OR841350            | <i>Pseudomonas putida</i> JCM 21368                  | LC752231.1          | 99,86               |
| MsHpR108                              | 1450           | OR841351            | <i>Bacillus amyloliquefaciens</i> US573              | LN864508.1          | 99,79               |
| MsHpS108                              | 1433           | OR841352            | <i>Bacillus pumilus</i> PS3                          | LC768708.1          | 99,86               |
| MsHpL103                              | 1399           | OR841353            | <i>Peribacillus frigoritolerans</i> NASRJ18          | OL588286.1          | 99,79               |

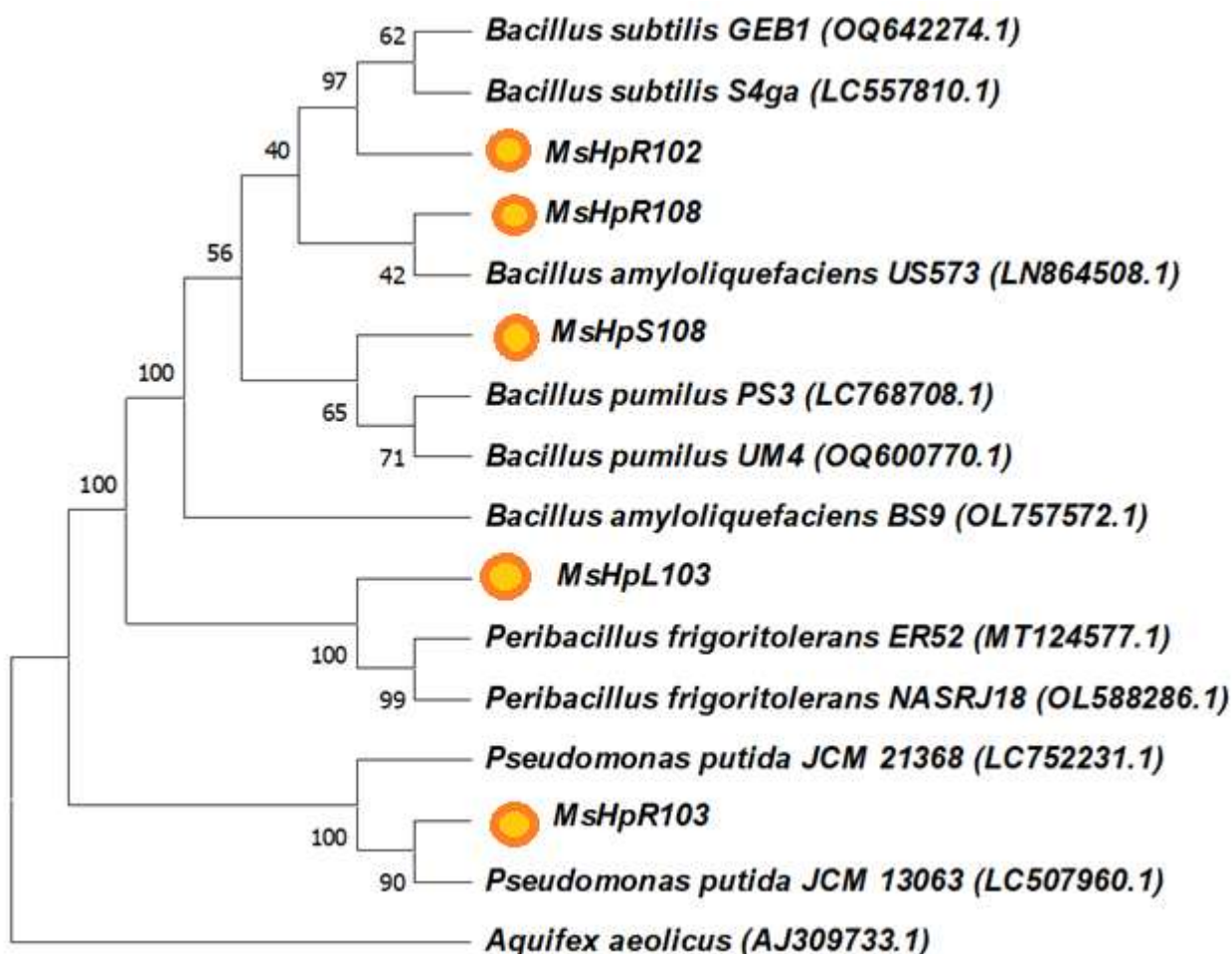


Figure 1. Phylogenetic tree of prospective endophytic bacterial strains of *Peganum harmala*

The distances between 16S rRNA fragments were calculated using the Maximum Composite Likelihood method and the number of base substitutions for each site is given in units. The phylogenetic tree of these identified strains was constructed using the evolutionary tree "Merging Closely Related Species" method in the MegaX (2011) bioinformatics program. The unit of length of the branches on the scale depicted in the phylogenetic tree is the same as the evolutionary distance used to determine phylogenetic relationships.

During the experiments, promising strains of the endophytic bacteria *Peganum harmala* were selected for further experiments. In addition, our research is aimed at improving the growth and development of agricultural crops cultivated on the basis of endophytic bacterial strains.

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## Economic sciences

### **IMPORTANT ASPECTS OF TRANSPORT AND LOGISTICS ACTIVITIES IN CURRENT CONDITIONS**

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#### **Abstract**

*The article studies important aspects of transport and logistics activities in modern conditions. The strategic functions of the transport and logistics system are studied and generalized. The important functions of the transport and logistics system in economic development and increasing the intensity of cargo turnover are analyzed. The problems of optimizing transportation are considered and the problems of improving the transport and logistics system are explained. The special role of the transport and logistics factor in the successful activities of economic entities is noted. Transport projects implemented in the post-conflict areas of Azerbaijan are analyzed. Measures for the development of the transport and logistics system in the Karabakh and East Zangezur economic regions are studied and their content is given. The strategic importance of the Zangezur International Transport and Logistics Corridor is substantiated. Proposals are made to improve the transport and logistics system of Azerbaijan in the new conditions.*

**Keywords:** *Azerbaijan, transport, logistics, transport-logistics, transport-logistics system, transport infrastructure, transport projects, directions for strengthening transport-logistics activities.*

*It should be noted that the transport and logistics infrastructure of the United States and European countries developed mainly in the 20th century. Most elements of the transport and logistics infrastructure were built in these countries in the 1950s-1970s [1]. It is known that the largest logistics network in the world was created in the United States. The transport industry of this country is a leader in terms of the length of the road and rail network and the number of airports, and in terms of maritime infrastructure it is second only to China. Intensive use of information technology in the transport and logistics sector of the United States has increased efficiency at all stages of logistics processes, optimized human resources and reduced associated costs. All logistics operations are based on simplified document flow and communication through digital technologies. Companies that manage transportation and forwarding are brokerage companies, all orders for cargo transportation are implemented online on specialized exchanges. Rail transport in the United States also has its own characteristics. 20% of all container transportation is carried out by rail. The entire US railway infrastructure is owned by numerous private companies that create healthy competition in the transport market, contribute to the constant improvement of the quality of services, automation and digitalization of all processes.*

*The efficiency of transport and logistics system management in the USA is achieved by logistics companies by following the following principles: adherence to a systematic approach; regular analysis of transport and logistics costs; continuous improvement of transport and logistics services; continuous monitoring of distribution channels. As in the rest of the world, the priority direction of development of the transport and logistics system in the European Union is the creation of transport and logistics centers. According to the definition adopted by the Commission of the European Union, a transport and logistics center is a territorial association of independent companies and enterprises engaged in the transportation of goods and related services (for example, maintenance and repair, storage). The experience of the European Union demonstrates the important role of transport and logistics centers in budget formation and reduction of logistics costs for consumers. Processing of transit cargo by transport and logistics centers allows to reduce logistics costs in the final price of the goods. In the European Union, large transport and logistics centers are usually created with the support of the state. Also, some transport and logistics centers are formed on the principle of strategic public-private cooperation. In the European Union, a general structure of transport and logistics centers has been developed, the presence*

*or absence of certain elements depends on the size of the transport and logistics centers, as well as on their location and objectives of activity.*

*The experience of countries around the world shows that the areas that successfully implement public-private cooperation in developing countries are not only transport and logistics, but also housing and communal services, energy distribution networks, etc. [2]. On the other hand, the role of the transport and logistics system in these areas is great. For example, the transport and logistics system has a significant impact on the efficient operation of the global food supply chain [3]. At the same time, one of the important conditions for the presence of strong financial mechanisms for enterprises participating in these processes is the presence of stable financial mechanisms [4]. It is also important to have balanced financial support in all regions of the country [5]. In general, transport issues are considered a serious factor in reducing costs in a reliable food supply system [6].*

*In modern times, the activity of the transport system attracts attention and more and more advanced types of it are being created. The transport system is the most important type of economic activity among the components of logistics systems. Basically, about half of the logistics costs of enterprises are accounted for by transportation. The important role of transport in logistics has led to the emergence of transport logistics, which ensures the continuous movement of material and non-material flows between the components of social systems of the territory in space and time [7]. The effective functioning of the transport system also contributes to increasing the competitiveness of the country's economic sectors [8]. Along with this, the transport and logistics system performs important functions in the dynamic development of the country's economy [9]. Diversification of the economy, in turn, forms new sources of financing and generally has a positive effect on financial stability [10]. In the classification of security indicators of the national economy, the transport factor is considered as one of the main elements [11]. Also, when organizing the country's foreign trade activities, the transport and logistics factor is considered one of the main cost-intensive activities, in connection with which more attention is paid to improving the transport and logistics mechanisms in this direction [12].*

*Some researchers, taking into account the tasks of transport logistics, highlight the following functional areas: selection of the most efficient modes of transport; design of optimal operating modes and provision of control measures; establishment of transport processes that are optimal in terms of labor intensity and duration [13]. The increasing complexity of the transport and logistics services market on a global scale leads to systemic integration of elements of the transport process, which is impossible without the use of modern logistics technologies. Based on practical activities. Virtually no mode of transport currently has all the advantages. For example, air transport has advantages in terms of the shortest delivery times, high cargo safety, as well as high transportation costs, sufficient geographic accessibility and dependence on weather conditions. The advantages of rail transport are determined by its relatively low cost, reliable compliance with the delivery schedule, the ability to transport large-sized cargo, while this mode of transport has a limited number of carriers and does not have sufficient geographic accessibility. The frequency of freight traffic depends on the density of the railway track. In this regard, multimodal transportation is used to optimize the process of cargo transportation, that is, not one, but several modes of transport are involved. Among the advantages of multimodal transportation, it is worth noting: the possibility of arranging transportation with a single document, the possibility of maximum use of the carrying capacity of a certain type of transport, saving time and financial costs [14].*

*In our opinion, the expansion of the potential of the transport and logistics system depends on the level of its financing. It is clear that investments in the creation and improvement of transport and logistics systems can act as a catalyst for the development of the economy of the region and the country as a whole. The main forms of financing transport and logistics infrastructure projects are: 1. Public-private cooperation. 2. Direct public financing. Private investment (commercial financing). The mechanism of public-private cooperation can be used in the implementation of projects for the creation and expansion of transport and logistics systems. Public-private cooperation in the transport and logistics system involves a mechanism for interaction between the public and private sectors in the planning, implementation, financing, construction and operation of the creation of transport and logistics infrastructure facilities. Such cooperation is an effective method of long-term relations and attracting investment [15].*

*Using the advantages of public-private cooperation in the transport and logistics system allows to significantly reduce the investment burden of the state budget associated with the transport industry and improve the quality of work performed. The development of the transport and logistics system, as a component of the general strategy for the development of the country's socio-economic system, is aimed*

at improving the quality of life of the population and promoting economic growth [16]. Considering the advantages of the transport and logistics system, improving its organizational and economic mechanism is one of the main conditions. In this case, it is possible to use the transport and logistics system more effectively in the strategic areas of the country. For example, the transport and logistics factor is of great importance in the processes of expanding the export structure and effectively bringing export products to more promising world markets [17]. The transport and logistics system is considered one of the decisive factors in increasing the export potential of competitive and export-oriented sectors of the economy, including the petrochemical industry, which is especially prominent in our country [18]. Along with this, there is a serious need to improve the transport and logistics infrastructure as part of measures to diversify the country's economy, expand new financial and tax sources [19]. At the same time, the transport factor is one of the decisive elements in the productive use of the capabilities of economic sectors and the formation of sources of economic growth [20]. Along with this, the effectiveness of an optimally organized transport and logistics system in improving the business environment and implementing business projects is high [21].

It should be noted that the organizational and economic mechanism of the transport and logistics system is based on the coordination of the economic interests of all participants in the process of movement of material flows. The main principles of interaction are full satisfaction of consumer demand, equal economic efficiency and financial responsibility for the final results of the movement of material flows. The organizational and economic mechanism of the transport and logistics system can be considered at different levels. Thus, the organizational and economic mechanism for increasing the efficiency of the transport and logistics system has a number of features: it mediates the initiation of the economic process between entities; regardless of its level, it has a common basis and its elements are built and operate on this basis; it is considered a regulated system, and a regulatory body is needed for the operation of the mechanism [22]. The experience of widespread use of transport hubs with the status of free economic zones in the formation of a transport and logistics network attracts attention all over the world [23]. In such zones, it is possible to organize a multifunctional transport and logistics system, reduce the duration of cargo transportation and optimize costs.

It should be noted that in the near future, the opening of the Zangezur corridor may become one of the most important projects in terms of expanding the potential of the transport and logistics system of Azerbaijan. Currently, negotiations are ongoing with the countries of the region regarding the implementation of this project. The new economic situation that will be formed as a result of the implementation of the Zangezur corridor will play an important role in the transport infrastructure of not only Azerbaijan, but also the countries of the region, as well as Europe and Asia, and the international integration of the economic regions of Karabakh and Eastern Zangezur will be more intense. In addition, the formation of diversified transport and logistics capabilities can create additional opportunities to accelerate the revival of these economic regions. These processes will have a multiplier effect on all sectors of the economy, including banking, will expand infrastructure, develop financial markets, etc. It should be noted that many transport projects are being implemented in the region. For example, the Ahmedbeyli-Fizuli-Shusha-Zafar highway and the Barda-Agdam railway will be commissioned in the near future. High-quality transport infrastructure is being created in the cities of Shusha and Khankendi.

Thus, we believe that in the coming years, important projects related to the expansion of the potential of the transport and logistics system will be implemented in Azerbaijan, and in this regard, we have identified a group of key trends that are more noticeable in this direction:

- unification of all modes of transport, as well as participants forming the transport and logistics market;
- concentration of powers in the field of management of the expansion of opportunities and development of the management system;
- expansion of the system's potential, as a rule, on the initiative of republican or local authorities;
- expansion of the system's potential through interaction with local and foreign private investors, as well as with financial institutions on the basis of the public-private cooperation mechanism. Such cooperation is useful for the development of effective goals for the development of the transport and logistics system, as well as for the selection of appropriate projects in terms of the greatest social effect, etc.

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## WAYS OF DEVELOPMENT OF PETROCHEMICAL ENTERPRISES OF AZERBAIJAN IN THE VALUE ADDED CHAIN IN MODERN CONDITIONS

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### **Abstract**

*The article examines the development paths of petrochemical enterprises in Azerbaijan along the value-added chain in modern times. The strategic role of petrochemicals in diversifying the economy in the face of new challenges is explained. The importance of the petrochemical sector in reducing the dependence of the economy on the oil and gas factor in Azerbaijan is substantiated. The problems of increasing the competitiveness of petrochemical enterprises and their modernization based on high technologies are considered. The importance of improving the activity strategies of petrochemical enterprises in the conditions of a modern market economy is stated. It is noted that there is a need to commission new competitive petrochemical enterprises along the value-added chain. Taking into account modern challenges, proposals have been prepared for the development of Azerbaijani petrochemical enterprises along the value-added chain.*

**Keywords:** *Azerbaijan, petrochemicals, petrochemical enterprises, added value chain, development problems, development prospects of petrochemical enterprises.*

*In the context of globalization, ensuring national security of any country, economic growth and technological development can be enhanced by intensive development of the chemical and petrochemical industry [1]. Chemical and petrochemical complex - this industrial sphere is the basis for the production of various types of products and materials, has a significant impact on the main industries, agriculture, construction and other industries. A characteristic feature of this industry from other areas is the high level of automation of labor and technological development, which is associated with the intensification of the use of chemical and petrochemical products in all sectors of the economy [2]. It should be noted that Heydar Aliyev played a historic role in the development of the chemical and petrochemical complex of Azerbaijan. Thus, in the 1970-1980s, under his leadership, the country's chemical industry was updated [3]. Heydar Aliyev, who came to power for the second time after the collapse of the former USSR, managed to solve the problems of modernizing the country's chemical and petrochemical complex in a market economy [4]. The problems of improving and modernizing existing mechanisms to ensure the sustainability of our country's economic development should be considered and resolved. The solution of these problems can make a significant contribution to the development of the chemical and petrochemical industry of Azerbaijan [5]. Chemical and petrochemical enterprises are highly intellectual industries that are attractive for investment, contribute to qualitative changes in the structure of the economy, and are open to the application of new ideas and developments [6]. The role of the chemical and petrochemical industry in accelerating the development of the country is expressed in the contribution to the growth of GDP, employment of the working population, an increase in tax revenues to the budget, industrial production volumes. and innovative activity, investment attractiveness. One of the main strategic goals of the development of this industry in the country is to achieve an increase in added value per capita [7]. The production of competitive science-intensive products with a high share of added value is an indicator of the efficiency of these industrial enterprises. It should be noted that measuring the efficiency of production activities is inextricably linked with determining the direction of its further modernization [8]. It should be noted that the chemical and petrochemical industries are interconnected industrial complexes in Azerbaijan and are of great importance as a processing industry with strong potential and the ability to create added value [9]. The bulk of this potential is located in the city of Sumgait [10; 11]. The possibilities of using the existing potential of this industrial region should be substantiated from a scientific and technical point of view, constantly seriously assessed, taking into account the issues of full and efficient use of the production capacities of these industrial regions [12].*

*Modern development of the chemical and petrochemical industry should be based on new principles and approaches: integration and clustering of production chains; development of new sales markets, as well as raw material supplies, differentiation of supplier countries of chemical and petrochemical products; minimization of production costs by improving the quality characteristics of products, the depth of oil refining. To implement these approaches and principles, it is advisable to consider the entire value chain of the industry, and not individual enterprises. This concept is already widespread in world theory and practice. However, the application of the value chain concept in the chemical and petrochemical sector of Azerbaijan is associated with the need to adapt it to the industry specifics of the national economic system as a whole. In modern times, ensuring the continuity of economic development, accelerating the development of areas that create added value in the economy, achieving the development of export-oriented and competitive industries are among the strategic goals [13]. When implementing strategic roadmaps for the development of the chemical and petrochemical industry in Azerbaijan, the main tasks are to model the development of these industries, ensure the effective use of their production potential, and diversify their structure [14].*

*In the near future, it is planned to build and commission new huge enterprises in the chemical and petrochemical sector, which is associated with the modernization of existing large manufacturing enterprises in Azerbaijan, the creation of high-tech production, diversification and expansion of the processing network of valuable oil and gas raw materials. Due to the diversification and expansion of the production network of these industrial enterprises in Azerbaijan, the production of various types of products in this area can create additional value, give a powerful impetus to the development of entrepreneurship in all regions of our country, and create additional incentives for business [15].*

*It should be emphasized that the concept of value chains is widespread in scientific and practical literature and is used to determine the competitive advantages of enterprises and assess the effectiveness of their activities in the global market. The term "value chain" was first proposed in the 1960s and 1970s. This issue was examined in detail by M. Porter in his work "Competitive Advantage" and, in his opinion, "value chain" means: "A set of various types of enterprise activities aimed at the development, production, supply, sale and servicing of its products" [16]. This system allows you to track how the cost of goods changes at different stages of production in the chemical and petrochemical sector, identify the most costly stages and look for ways to minimize them. At the same time, this system covers all stages of the product life cycle and is used by chemical and petrochemical enterprises to assess the effectiveness of the selected business model or search for a new one [17]. In general, today the most relevant are integration processes at different levels of the value creation system; there are two types of integration: direct and reverse. In forward integration, the enterprise develops product distribution channels, and in reverse integration, the production base. In this case, when choosing an integration strategy, the enterprise should initially analyze its activities, which includes: determining the enterprise's place in the value chain and possible areas of integration; assessing the economic efficiency of integration; calculating the performance indicators of the integrated structure [18].*

*Any value chain has a core that links chain participants, simplifies the decision-making process, and involves other enterprises in production and commercial processes. Such value chains are more competitive if their core is built on innovations or scientific and technical developments [19]. The assessment of the effectiveness of the value chain should be scenario-based and take into account possible risks and instability of weak links, optimistic and pessimistic forecasts. It is necessary to assess the effectiveness of this process in order to create a value chain at these industrial enterprises or integrate it as a link in an existing chain. The following main approaches to the formation of value chains are distinguished: process, system, situational, comprehensive, combined, normative. In recent decades, interesting trends have been observed in the chemical and petrochemical sector. Thus, the share of this industry in the total volume of industry is increasing, as scientific and technical innovations and innovative technologies are applied, the role of science-intensive and innovative products in the value chain increases [20].*

*It is known that during the period after the approval of strategic roadmaps for the development of the national economy and the main sectors of the economy, the issues of developing adequate mechanisms for economic development and finding optimal solutions to the problems of choosing an effective model become relevant. clearly defined [21]. One of the main issues is the development of chemical and petrochemical enterprises capable of creating added value, and the diversification of production in this area [22]. The development of chemical and petrochemical enterprises in terms of added value and the diversification of production at these enterprises require the creation of the necessary infrastructure, the attraction and use of qualified personnel, and the expansion of the domestic*

market for the products of these industries. which also require the implementation of government support measures as a priority task.

Of interest is the methodology for assessing the diversification of the chemical and petrochemical industries, taking into account the synergistic effect, considering not only economic effects, but also the possibilities of strengthening the relationships between the elements of the system. The experience of considering such a relationship will undoubtedly be useful for assessing the effectiveness of creating value chains at these enterprises or for developing a methodology for their restructuring. To assess the effectiveness of forming value chains at these industrial enterprises, it is possible to apply a process approach and take into account the efficiency of managing raw materials, production relations and sales stages. Diversification of production in the chemical and petrochemical sector largely depends on investments [23]. To diversify production at these industrial enterprises, it is necessary to form an optimal capital structure and determine the amount of borrowed funds. The use of borrowed funds will allow the enterprise to increase the profitability of its capital. As a result, the implementation of multidimensional calculations using these indicators allows you to build an optimal capital structure, leading to the maximum increase in its net profitability. Investment policy plays an important role in the effective management of existing fixed assets. The process of reproduction of these funds includes constant investments. Diversification of production in the chemical and petrochemical sector should be based on innovation.

In order to achieve high competitiveness of the chemical and petrochemical industry, which is one of the main sectors of the economy of Azerbaijan, it is necessary to develop it in an innovative way. This will ensure an increase in the production volumes of enterprises in this sector, as well as lead to the opening of new jobs in the country and can become the basis for the development of the country's economy as a whole.

Currently, the main priorities for the development of this industry in Azerbaijan are:

- modernization of existing facilities for the production of industrial products in demand on the market, creation of new and innovative production capacities;
- stable provision of enterprises of the field with hydrocarbon raw materials;
- development of technologies for processing of fields, diversification of the raw material base of the industry due to the development of processing of polymeric materials;
- development of infrastructure for providing enterprises of the field with raw materials and transportation of finished products to consumers;
- development of infrastructure of entrepreneurship with the aim of forming industries of deep processing of hydrocarbon resources;
- Development of interregional cooperation to solve complex problems typical for most enterprises of the chemical and petrochemical industry of Azerbaijan, etc. chemical and petrochemical industry of Azerbaijan, etc.

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**THE ROLE OF FOREIGN INVESTMENT IN THE DEVELOPMENT OF SELF-GOVERNING ENTITIES****Maia Gelashvili**

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**Abstract**

Investments are an integral part of the Modern Economy and represent a long-term investment of capital in order to achieve economic activity and a social-innovative effect, which is expressed in the form of cash, deposits, intellectual property, shares and securities. Georgia is not limited to a high interest in attracting foreign investment, which is due to both its economic and political situation. However, the geographical location creates favorable conditions for the movement of foreign capital in the transport sector. A necessary condition for attracting foreign investment is a stable macroeconomic environment, which is expressed in low taxes and regulations, cheap labor, free trade and much more. It is very important for the state to control investment flows, since diversification is possible, which is a prerequisite for the loss of economic sovereignty. Therefore, the state must attract investments and investors who will be focused on both the introduction of technological innovations and the social protection of the working personnel. Foreign direct investment in Georgia is calculated based on the methodology developed by the International Monetary Fund (IMF), which takes into account the ownership of shares of an enterprise located in another country by a resident of one country and the implementation of various economic transactions related to this enterprise. The determining factors of foreign direct investment are: equity capital, reinvestment, debt obligations. The role of portfolio investments in a municipality is insignificant, since they are multidirectional and, accordingly, the municipality may not have all the necessary resources for their implementation. However, one can understand the investor's motivation, which can be divided into the following areas:

- Free trade zone and market research;
- Access to natural resources and their efficient use;
- Cheap labor, low tax rates;
- Increased efficiency by taking into account the marketing strategy and competitive advantages.

Thus, attracting investment depends on many internal and external factors, which requires great effort. In particular, the position and decision of the government to create an attractive business environment, low taxes, a stable and legal environment, and to establish new priorities. When implementing this approach, it is advisable to define priority areas that will ensure municipal development in the economic context. In particular:

- What area is a priority for the development of the region?
- What investment sector is growing in the municipality?
- What specific advantages does the municipality have?

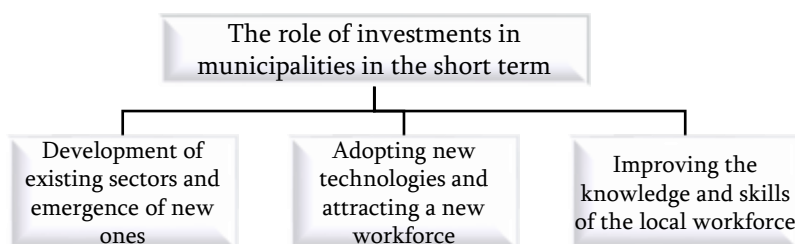
**Keywords:** Investor, Investment, Stabilization, Municipality, Taxes, Fund, Tariffs.

One of the most active topics for discussion in political and public circles of any country is economic development, social situation, devaluation and stabilization of the national currency, inflation. The role of foreign investment is especially important, since Georgia is a developing country and, accordingly, domestic investment is in deficit. The unstable financial situation is a factor holding back the country's economic growth and the standard of living of the population. Investments are an integral part of the modern economy and represent a long-term investment of capital in order to achieve economic activity and a socially innovative effect, which is expressed in the form of cash, deposits, intellectual property, shares and securities. All economic categories, including investments, are divided into the following groups: direct or real (capital investments used to create fixed assets) and portfolio (financial capital investments used to purchase securities). At first glance, both types of investments are similar in content, but they differ in the way they are implemented. Investments are divided into: tangible, intangible and

financial, but the financial side is important for every investor so that he does not lose a cent and receives high profits, so he must be able to identify all the expected risks. Georgia is not limited to high interest in attracting foreign investment, which is due to both its economic and political situation. However, the geographical location creates favorable conditions for the movement of foreign capital in the transport sector. A necessary condition for attracting foreign investment is a stable macroeconomic environment, which is expressed in low taxes and regulations, cheap labor, free trade and much more. Foreign direct investment is an important factor in the country's economic growth. Before making a decision, the investor studies the economic investment environment of the country, as he is focused on making a profit, while the economic situation in the country receiving the investment is changing. It is very important for the state to control investment flows, as diversification is possible, which is a prerequisite for the loss of economic sovereignty. Therefore, the state should attract investments and investors that will be focused on both the introduction of technological innovations and the social protection of the working personnel.

The most important direction of economic growth and development is investment, which depends on such a key factor as the savings rate. Highly developed countries have a high level of both foreign and domestic investment. Accordingly, there is a free formation of monetary resources. On the other hand, developing countries have to make great efforts for economic development, having relatively small resources at their disposal. Investments play a significant role in all developed and developing countries.

According to Article 16, paragraph 4 of the Organic Law of Georgia "Code on Local Self-Government", local governments (municipalities) of Georgia are authorized to implement a policy to attract investments on the territory of the municipality. Investments at the local government level are an opportunity for long-term development (see Scheme N1) namely:



**Scheme N1**

Based on the above-mentioned positive results, the municipality is given the opportunity to achieve a competitive advantage in the long term, increase its own financial income and economic growth, introduce high-tech services and create jobs. This whole process presents the image of the municipality in a completely new way.

Foreign direct investment in Georgia is calculated based on the methodology developed by the International Monetary Fund (IMF). Foreign direct investment - FDI International investment activity A category that involves the ownership by a resident of one country of a share in an enterprise located in the territory of another country and the implementation of various economic transactions related to this enterprise. The determining factors of foreign direct investment are: equity capital, reinvestment, debt obligations. Where debt obligations include loans and trade credits, reinvestment is the difference between dividends and profit / loss, as well as the receipt or repayment of statutory debt.

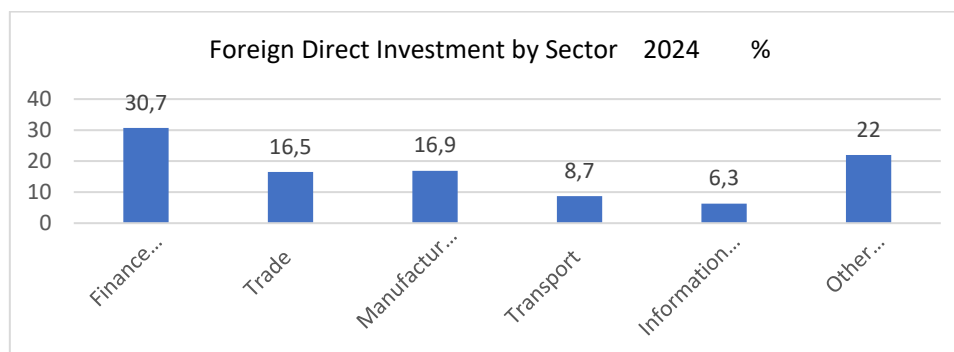
An investor can be an individual, a corporate or unincorporated legal entity, as well as a government organization. Direct investment is aimed at acquiring production or expanding a business of a foreign enterprise in the country, while portfolio investment manages financial and other resources in order to make a profit. Portfolio investment does not play a significant role in the municipality, since it is multi-directional and, accordingly, the municipality may not have all the necessary resources for their implementation, although it is possible to understand what the investor wants. The motivation of investors can be divided into:

- Free trade zone and market research;
- Access to natural resources and their efficient use;
- Cheap labor, low tax rates;
- Increased efficiency by taking into account the marketing strategy and competitive advantages.

Before making an investment, the investor takes into account the relationship between two types of institutional and personal factors at the municipal level, such as the influence of the government on the process of choosing an investment location. Although the investment is made in a specific municipality, the rate of economic growth and stability are important for them. Namely: GDP, GDP per

capita, savings, GDP per capita, gross public debt and, most importantly, the indicators and indices developed by international organizations that determine the country's rating. In recent years, the Georgian government has been actively improving communication with investors in the context of the effective use of indices and indicators. Georgia's investment environment by FDI sectors in 2024 (see Diagram N2) is as follows

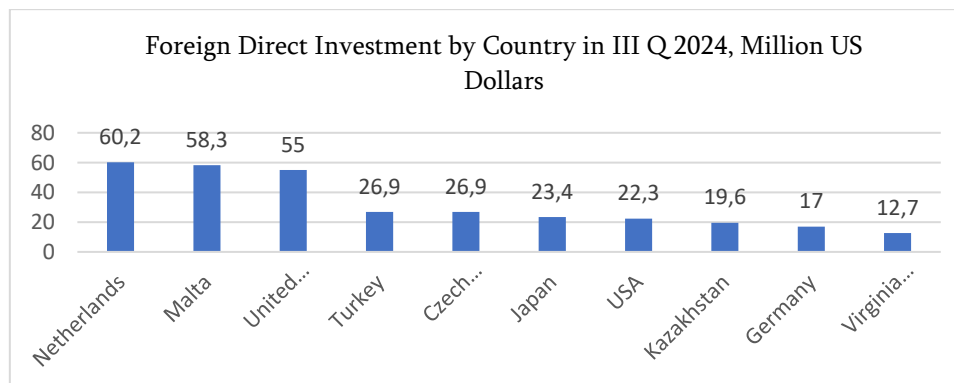
Diagram N2



Source: National Bureau of Statistics of Georgia 2024

If we compare the dynamics of foreign direct investment in the third quarter of 2022 with the same indicator for 2024, we will see that the volume of investments has almost halved, and the first quarter of 2024 of the financial sector is estimated with a negative indicator, although it is the financial sector that should develop the most. This is why capital is of paramount importance for the region, as it allows mitigating the current difficult economic situation, since foreign direct investment changes the demand in the consumer market, increases the budget and improves the standard of living of the population. However, it is also worth noting that investors in Georgia are reluctant to invest in high-tech industries due to political and economic instability, as well as low qualification of personnel. Accordingly, the difficult economic situation is a direct blow to the business sector. The volume of foreign investment in Georgia in 2023 amounted to 1902.2 thousand US dollars, while in 2022 investments amounted to 2253.4 thousand US dollars. It was fixed in dollars and amounted to 966.3 according to the data for the first nine months of 2024. Based on the above data, it can be assumed that the volume of investments in 2024 will decrease. The reason may be reinvestment. According to the Georgian Statistics Service, the largest countries issuing foreign investments in Georgia in the third quarter of 2024 (see diagram N3) are:

Diagram N3



Source: National Bureau of Statistics of Georgia 2024

In terms of foreign direct investment in Georgia in the third quarter of 2024, the Netherlands is leading with 60.2 million US dollars, Malta is in second place with 58.3 million US dollars, and Great Britain is in third place with 55 million US dollars. There are also approximately equal volumes of investments come from Turkey, the Czech Republic, Japan and the USA. Investments came approximately from seventy-five countries. By sector, the highest percentage was realized in the financial and insurance sector and amounted to 300.1 million. USA. US dollars, which is 52.3% of the total volume of direct foreign investments. The following spheres include: real estate, communication, transport, art, education and administrative activities. It is also interesting to note that investments increase the gross domestic product of the country, while GDP does not increase in Georgia. At the current stage, it still remains low, which is aggravated by the violation of the macro-economic parameter called public debt, namely it should not exceed 60% of GDP. It is also noteworthy that Georgia is distinguished by low tax rates, and foreign investments in free industrial zones on its territory do not bring profit, but rather represent a

heavy burden for the population. In particular, the consumption of electricity and taxes are growing, because a huge number of consumers are companies with technological innovations. Accordingly, it would be expedient to attract foreign investments to Georgia, which would be focused on the transport sector, since the country is a regional corridor. Developing countries are a favorable environment for investors, as they have cheap resources and are labor-intensive, however, when incoming foreign currency increases wages, the market demand increases and, accordingly, this type of investment for investors decreases or disappears. At this time, the government should focus on attracting capital-intensive investments that will not cause negative expectations on the market.

Thus, attracting investments depends on many external factors and requires a lot of effort. In particular, the creation of an attractive business environment, low taxes, the establishment of a stable and legal environment, as well as the establishment of new priorities that can be achieved through the position and decisions of the government.

When investing in a Georgian municipality, the asset may exist, but only a part of it can be used. That is why the government must plan and prepare a concept for large-scale infrastructure activities. By sector, the largest share of foreign investment in 2023 was in financial and insurance activities (30.7%), followed by trade (16.5%), manufacturing (16.9%), transport (8.7%), information and communication (6.3%) and other sectors (22%). Investments in the region's municipalities were distributed as needed. In particular, new buses were launched to serve the population, roads connecting internal villages were repaired, and schools and kindergartens were restored. However, much remains to be done.

In 2023, the European Union and FAO (Food and Agriculture Organization of the United Nations) will provide 1 hectare of land to two hundred farmers in the regions of Georgia. They provided assistance in introducing zero-tillage methodology for growing grain crops on the land, which is a new technology not only for the region but also for Georgia. This method of soil cultivation involves cultivating the soil without plowing and cultivating it. This is beneficial for farmers, as it saves time and money on processing. The ENPARD (Enhancing Agricultural Competitiveness and Poverty Reduction) program has been operating in the region since 2013. The goal of this program is to help farmers in rural areas adapt to climate change and support them in responding to environmental risks.

In 2023, \$537,090 thousand in foreign direct investment was invested in the region, mainly in the mining and processing industries. However, it would be advisable to provide financial support for the improvement of outdated technologies and infrastructure, as ineffective strategies have a negative impact on both economic development and employment. According to the Ministry of Infrastructure, works worth 300 million GEL are underway in twenty-four settlements of the region, which will be completed by 2027 and will provide 24-hour uninterrupted water supply to up to 55,500 beneficiaries. In accordance with the decree of the Government of Georgia, the Ministry of Economy and Sustainable Development announced that the priority is the development of the electric power sector, where the main investors are the Czech Republic, Turkey and the Netherlands. In particular, in 2023-2025 it is planned to build 40 stations with a capacity of 477 MW, including the following categories:

- Hydroelectric power plants (in reserve) 150 MW;
- Wind power plants 70 MW;
- Solar power plants MW;
- Power plants operating on various renewable energy sources 10 MW.

In recent years, tourism, as well as the development and provision of tourism infrastructure services, have become very relevant for attracting investors. According to the investment bank Galt Taggart, in January 2025, Georgia received \$ 290 million in tourism revenue, which is 1.4% more than in the same period last year. Revenue is expected to reach \$ 4.5 billion by the end of 2025.

To implement this approach in municipalities in the context of regional economic development, it is necessary to identify areas that will answer the questions:

- Which area is a priority for regional development?
- Which investment sector is growing in the municipality?
- What specific advantages does the municipality have?

**Conclusion:** Accordingly, the Municipal Economic Development Policy should be oriented and adapted to local specific conditions. To use the potential of local resources as much as possible, which will ensure the solution of social and economic problems. In addition, when attracting foreign investment, it is necessary to identify and use the strengths and capabilities of the municipality, since the future of the country depends on its decision.

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## TAX SYSTEM AND FISCAL POLICY OF GEORGIA

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**Abstract**

The article examines the role of taxes in the development of the state economy. The essence of the regulatory function of these taxes and its role in fiscal policy. The tax system provided for by the new Tax Code of Georgia, which includes 5 national taxes and one local tax, is analyzed. In conclusion, it was noted that the goal of the country's tax policy is to create an attractive and favorable tax environment for the private sector and foreign investors, as well as for opening and developing a business.

**Keywords:** taxes, tax policy, fiscal policy, tax code, tax systems.

The modern tax system has come a long and difficult way. Humanity does not remember that a state can exist without taxes. As states and nations developed, tax systems developed and improved. A significant part of the economy of each country is its tax system, which determines the size of the budget, the degree of freedom of the economy and the ease of investing in this country.

In any country, regardless of the level of economic development, the problem of financial resources, their sufficiency and distribution has always been on the agenda, in the regulation of which tax policy plays a crucial role. Tax policy is implemented on the basis of legislative and other regulatory acts establishing taxes and their types, subjects of taxation, objects of taxation, tax rates, tax benefits, rules for transferring taxes to the budget of the appropriate level, as well as legal norms concerning tax offenses.

The tax system of the country should be a regulator of economic processes in the country, it is necessary to ensure the implementation and coordination of fiscal and regulatory functions inherent in tax policy.

The fiscal function implements the main social purpose of taxes - the formation of financial resources of the state. The fiscal function is manifested in providing the state with financial resources necessary to solve state problems. This is typical for all states. At all stages of its development, through which a centralized monetary fund is created in the form of a state budget or centralized funds and material conditions for the functioning of the state are ensured. Through the fiscal function of taxes, the government ensures that the state budget achieves a balance between income and expenditure. Uniform distribution of tax revenues between various links in the budget system. Solve the political, economic and social problems facing it.

The regulatory function is carried out by: regulating supply and demand, stimulating scientific and technological progress, stimulating savings by the population, promoting the development of entrepreneurship, regulating export-import activities, influencing the exchange rate of the national currency - by withdrawing money supply and reserves from the economy. Taxes as a specific form of production relations through the regulatory function affect the factors of production - labor and capital. The tax system and tax policy of Georgia are built taking into account the experience of foreign countries with developed market economies and are aimed at promoting the socio-economic development of our country and improving its fiscal policy.

The tax system of Georgia was largely formed in the first decade of the 21st century based on the economic reforms carried out and the experience of developed countries in this area.

"The tax system of Georgia includes the principles, forms and methods of establishing, changing, canceling and paying taxes provided for by the Tax Code of Georgia, tax authorities and tax control, as well as types of liability for violating tax legislation."

The Tax Code of Georgia simultaneously defines local and national (centralized) taxes in force in Georgia, defines national taxes the rules for calculating and paying taxes, as well as the procedure for introducing these taxes throughout the territory of Georgia. As for local taxes, the supreme

*representative bodies of the autonomous republics and local self-government bodies have the right to independently decide on the introduction of the relevant taxes on their territory, as provided for by the Tax Code of Georgia. The tax system defined and in effect by the Tax Code of Georgia includes national and local taxes.*

*The tax system provided for by the Tax Code of Georgia includes 5 national taxes and 1 local tax.*

*Income taxpayers are resident and non-resident individuals receiving income from sources in Georgia. The object of taxation for a resident individual is taxable income, which is calculated as the difference between the total income received during the calendar year and the deductions provided for by the Tax Code for this period. When taxing the income of individuals, income is taxed at a rate of 20%.*

*Payers of the profit tax are Georgian enterprises and foreign enterprises operating in Georgia through a permanent establishment and/or receiving income from a source in Georgia. The object of taxation is profit, which is defined as the difference between the gross income and the amount of the deduction provided for by the Tax Code, while the Tax Code takes into account both income and expenses. Gross income includes income received in any form or kind from employment, wages, economic benefits or other income in cash or in kind. Taxable profit of an enterprise is taxed at a rate of 15%.*

*The new reporting period for corporate income tax is a calendar month, which is a new practice, since until now, as is known, the reporting period was a calendar year. The monthly income tax return is submitted by the taxpayer to the tax authority every month (in electronic form) no later than the 15th day of the month following the reporting month, and the income tax is paid within the same period.*

*The new model of corporate income tax became relevant in Georgia on January 1, 2017, since new corporate income tax rules came into force, which differ from the approaches of IAS 12 and are called the "Estonian model". Supporters of the Estonian model believe that business will develop and expand in Georgia as well, which in itself will contribute to economic growth and employment growth. It is also supported by entrepreneurs who believe that the introduction of this model will reduce the tax burden on the private sector and about 400-500 million lari will remain in the private sector. On the other hand, tax administration will be simplified.*

*The peculiarity of the new model of profit tax is that if profit remains in the enterprise, it is reinvested and this profit is not taxed. As a result, the main positive aspect is that companies have an incentive to use profit for business activities within the enterprise, which, in turn, will contribute to the growth of wages and employment. The disadvantage is that budget revenues will decrease in the first two years.*

*To avoid a reduction in budget revenues, it is necessary to increase the current tax on dividends. In this case, the budget will be filled to such an extent that public expenditure (including public investment) is not significantly reduced (this will be especially necessary if private investment does not pay off).*

*Value Added Tax (VAT) - this tax is levied on taxable turnover, which is the amount of taxable transactions and taxable imports carried out during the reporting period. The amount of a taxable transaction is determined based on the market price of the goods (services) excluding value added tax. The amount of taxable import is equal to the customs value of goods determined by the tax legislation of Georgia and the sum of taxes and fees payable upon import of goods into Georgia, excluding VAT payable in Georgia. The VAT rate is 18% of the taxable turnover or taxable amount of import.*

*Payers of excise tax are persons who produce excisable goods in Georgia, import excisable goods and/or export ferrous and non-ferrous metals. Excise tax rates are differentiated. This tax does not apply to the export of excisable goods, with the exception of the export of ferrous and non-ferrous metals.*

*Import tax is levied on any person moving cargo across the border of Georgia, with the exception of the export of goods. The taxable base of import tax is determined by the tariff value of the goods when crossing the economic border of Georgia. Currently, its rates, according to the Tax Code of Georgia, are 0%; 5% and 12%.*

*As for the local property tax, this tax is levied on property owned (possessed, used) by individuals and legal entities.*

*The object of property tax is the right of ownership of various types of property (land, vehicles, intangible assets, other real estate, fixed assets). Property tax rates are differentiated for resident and non-resident enterprises, as well as for individuals and legal entities with different incomes.*

*The Tax Code provides for strict tax control over the correctness of tax calculation and timely payment by taxpayers, as well as the administration and collection of taxes. The Ministry of Finance of Georgia and its local bodies are responsible for monitoring compliance with and implementation of the tax legislation of Georgia. In particular, the right of tax control is granted to the tax authority, and partly to customs posts located in the Revenue Service. The issue of liability for violation of tax legislation is*

*mainly for fiscal purposes and does not imply criminal prosecution of a person. The goal of the country's tax policy is to create an attractive and favorable tax environment for the private sector and foreign investment, as well as for starting and developing a business.*

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## THE IMPACT OF THE ECONOMY ON ENVIRONMENTAL POLICY: ON AZERBAIJAN'S ENERGY AND AGRICULTURE SECTORS

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### ***İQTİSADİYYATIN EKOLOJİ SİYASƏTƏ TƏSİRİ: AZƏRBAYCANIN ENERGETİKA VƏ KƏND TƏSƏRRÜFATI SEKTORLARI ÜZRƏ***

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#### **Abstract**

*This article investigates the impact of Azerbaijan's economy on environmental policy through the energy and agricultural sectors. It highlights the environmental damage caused by the oil and gas industry and the transition to renewable energy sources. The ecological challenges related to the use of chemical fertilizers in agriculture are discussed. The importance of environmental policies for sustainable development is emphasized. The Azerbaijani government is investing in green technologies. The sustainable development model is essential for future generations.*

#### **Xülasə**

*Bu məqalədə Azərbaycanın iqtisadiyyatının ekoloji siyasətə təsiri, energetika və kənd təsərrüfatı sektorları üzrə araşdırılır. Neft-qaz sektorunun ətraf mühitə mənfi təsirləri və bərpa olunan enerji mənbələrinə keçid müzakirə olunur. Kənd təsərrüfatında kimyəvi gübrələrin istifadəsi ilə bağlı ekoloji problemlər araşdırılır. Ekoloji siyasətlərin davamlı inkişaf üçün vacibliyi vurğulanır. Azərbaycan hökuməti yaşıl texnologiyalara sərmayələr yatırır. Davamlı inkişaf modeli gələcək nəsillər üçün vacibdir.*

#### **Аннотация**

*В статье рассматривается влияние экономики Азербайджана на экологическую политику через секторы энергетики и сельского хозяйства. Обсуждается вред, наносимый окружающей среде нефтегазовой отраслью, и переход на возобновляемые источники энергии. Изучаются экологические проблемы, связанные с использованием химических удобрений в сельском хозяйстве. Подчеркивается важность экологической политики для устойчивого развития. Правительство Азербайджана вкладывает средства в зеленые технологии. Модель устойчивого развития необходима для будущих поколений.*

**Keywords:** oil and gas, renewable energy, agriculture, environmental policy, sustainable development, ecosystem.

**Açar sözlər:** neft-qaz, bərpa olunan enerji, kənd təsərrüfatı, ekoloji siyasət, davamlı inkişaf, ekosistem.

**Ключевые слова:** нефть и газ, возобновляемая энергия, сельское хозяйство, экологическая политика, устойчивое развитие, экосистема.

*İqtisadi inkişaf əksər ölkələr üçün vacib bir prioritetdir. Lakin iqtisadiyyatın sürətli inkişafı ətraf mühitə mənfi təsir göstərir. Hazırda iqtisadiyyatın qarşısında duran əsas problemlərdən biri, davamlı inkişafın təmin edilməsi və təbii resursların səmərəli istifadəsidir. Ekoloji siyasətin əsas məqsədi iqtisadi fəaliyyətlərin ətraf mühitə vurduğu zərərləri minimuma endirməkdir. Azərbaycan, neft-qaz hasilatçısı bir ölkə olaraq, bu məsələdə xüsusilə həssasdır. Bu məqalədə Azərbaycanın iki əsas sektoru - energetika və kənd təsərrüfatı sahələri üzrə iqtisadiyyatın ekoloji təsirləri və bu sahələrdə ekoloji siyasətin rolu araşdırılacaq.*

*Azərbaycan iqtisadiyyatının dayaq nöqtələrindən biri olan neft-qaz sektoru, ölkəyə böyük gəlir gətirir. Lakin bu sektorun ətraf mühitə mənfi təsirləri də mövcuddur və bunu müzakirə etmək zəruridir.*

*Neft Sənayesinin Ekoloji Təsirləri Azərbaycanın neft-qaz sənayesi iqtisadi inkişafın mühüm hissəsini təşkil etsə də, bu sektorun ətraf mühitə göstərdiyi təsirlər daha çox diqqət tələb edir. Xəzər dənizindəki neft sızmaları torpaq və suyun çirklənməsinə səbəb olur. Məsələn, 2021-ci ildə Dövlət Statistika Komitəsinin məlumatına görə, sənaye sektorundan atmosfərə atılan karbon dioksit (CO<sub>2</sub>) emissiyaları 35 milyon tona çatıb. Bu göstərici əsasən neft-qaz sənayesinin fəaliyyəti ilə bağlıdır. SOCAR-ın 2020-ci il hesabatına görə, neft hasilatı və emalı zamanı ətraf mühitə atılan tullantılar torpaqdakı bioloji müxtəlifliyi ciddi şəkildə məhv edir. Bu isə kənd təsərrüfatı sahələrində məhsuldarlığın azalmasına səbəb olur. Xəzər dənizində aparılan neft hasilatı isə su ekosistemlərinə ciddi təhlükə yaradır və bu təsirlərin qarşısını almaq üçün daha güclü tədbirlər görülməlidir.*

*Azərbaycanın iqtisadi inkişafının mühüm dayaqlarından biri olan neft-qaz sektoru, ölkəyə böyük miqdarda gəlir gətirir və dövlət büdcəsinin əsasını təşkil edir. Bununla belə, bu sektorun ətraf mühitə mənfi təsirləri də çox ciddidir və mütləq müzakirə olunmalıdır. Neft və qaz sənayesinin ekoloji təsirləri yalnız Azərbaycan üçün deyil, həm də bütün Xəzər regionu üçün böyük narahatlıq doğurur. İqtisadiyyatın bu əsas sahəsində fəaliyyətin davam etdirilməsi ölkənin iqtisadi rifahını artırırsa da, ətraf mühitə vurduğu zərərin miqyası dayanıqlı inkişafı təmin etmək üçün ciddi tədbirlər görülməsini zəruri edir.*

**Neft Sənayesinin Ekoloji Təsirləri-** Neft və qaz sənayesi Azərbaycanda iqtisadiyyatın əsas tərkib hissəsidir və bu sahə milli gəlirin, ixracatın və məşğulluğun əsas mənbəyidir. Lakin, bu sənayenin fəaliyyətləri nəticəsində yaranan ətraf mühitə mənfi təsirləri daha çox diqqət tələb edir. Aşağıda neft sənayesinin ekoloji təsirlərini daha dərinlən araşdırıram:

**Torpaq və suyun çirklənməsi-** Xəzər dənizində həyata keçirilən neft hasilatı və nəqli torpaq və su resurslarının çirklənməsinə səbəb olur. Xəzər dənizi Azərbaycanın neft hasilatı sahəsində əsas mərkəzlərdən biridir. Lakin bu neft yataqlarında baş verən sızmalar dəniz suyu və sahilyanı torpaqların çirklənməsi ilə nəticələnir. Neft sızmaları torpağın üzərində yığılan neft və kimyəvi tullantılarla torpağın məhsuldarlığını azaldır. Torpaqda mikrofloranın məhvi ilə yanaşı, bu çirklənmə kənd təsərrüfatında məhsuldarlığın kəskin azalmasına səbəb olur. Belə ki, çirklənmiş torpaqlarda becərilən məhsulların keyfiyyəti aşağı düşür, bu isə insan sağlamlığına mənfi təsir göstərir. Xüsusilə kənd təsərrüfatı üçün yararlı torpaqlarda neftin və digər kimyəvi tullantıların miqdarının artması əkin sahələrinin məhsuldarlığını təhlükə altına alır.

*Xəzər dənizindəki neft sızmaları su ekosistemlərini də ciddi şəkildə təhlükə altına alır. Dəniz suyu ilə neftin qarışması balıqların və digər su canlılarının həyatı fəaliyyətinə mənfi təsir göstərir. Suyu qarışan neft yalnız dəniz həyatını zərərli hala gətirmir, həm də çirklənmə nəticəsində balıqçılıq sənayesi ciddi zərərlə üzləşir. Xəzər dənizinin ekosistemi, suyun üzərində yığılan neft layları səbəbindən məhv olmaq təhlükəsi ilə üz-üzədir.*

**Karbon emissiyaları və iqlim dəyişikliyi-** Neft və qaz sənayesinin ətraf mühitə vurduğu zərərlərdən biri də karbon emissiyaları ilə bağlıdır. Bu sənaye fəaliyyətləri nəticəsində atmosfərə atılan karbon dioksit (CO<sub>2</sub>) və digər zərərli qazlar iqlim dəyişikliyinə sürətləndirir. Dövlət Statistika Komitəsinin 2021-ci il məlumatlarına görə, sənaye sektorundan atmosfərə buraxılan karbon qazı (CO<sub>2</sub>) emissiyaları 35 milyon tona çatmışdır. Bu rəqəm əsasən neft və qaz sənayesinin fəaliyyətindən qaynaqlanır və Azərbaycanın iqlim dəyişikliyinə qarşı mübarizəsində böyük bir maneə yaradır.

*SOCAR-ın (Azərbaycan Respublikası Dövlət Neft Şirkəti) 2020-ci il hesabatında qeyd olunur ki, neft hasilatı zamanı ətraf mühitə atılan tullantılar və tullantı qazlar yalnız torpaq və su resurslarına deyil, həm də atmosfərə ciddi ziyan vurur. Atmosfərə buraxılan zərərli qazlar havanın keyfiyyətini aşağı salır və həm ekoloji, həm də ictimai sağlamlıq problemləri yaradır. Bu isə tənəffüs yolları xəstəliklərinin artmasına, yerli əhalinin sağlamlığının pisləşməsinə səbəb olur.*

*Atmosfərə buraxılan CO<sub>2</sub> və metan qazları (CH<sub>4</sub>) global iqlim dəyişikliyinə başlıca səbəblərdən biridir. Neft hasilatı zamanı metan qazının sərbəst buraxılması istixana effektinə səbəb olur və iqlim dəyişikliyinə sürətlənməsinə gətirib çıxarır. Bu təsirlər uzunmüddətli perspektivdə yerli və global ekosistemlərə mənfi təsir göstərir və iqlim dəyişiklikləri ilə əlaqəli təbii fəlakətlərin artmasına şərait yaradır.*

**Su ekosistemlərinə təsir-** Xəzər dənizində neft hasilatının artması yalnız suyun çirklənməsinə səbəb olmaqla qalmır, həm də su ekosistemlərini məhv edir. Xəzər dənizi neft hasilatında strateji əhəmiyyət daşıyan bir sahə olsa da, orada yaşayan dəniz canlılarının həyatı təhlükə altındadır. Neft sızmaları balıq populyasiyalarının azalmasına, balıqların kütləvi ölməsinə səbəb olur. Bu vəziyyət balıqçılıq sənayesinə də mənfi təsir göstərir. Balıq ehtiyatlarının azalması nəticəsində sahil bölgələrində balıqçılıqla məşğul olan əhalinin gəlir mənbələri təhlükə altına düşür. Eyni zamanda, Xəzər dənizindəki su ekosistemlərinin məhv olması bioloji müxtəlifliyin azalmasına gətirib çıxarır.

Neft sızmalarının yaratdığı ən böyük problemlərdən biri də su ekosistemlərində zərərli kimyəvi maddələrin toplanmasıdır. Bu maddələr dəniz canlılarının həyat dövrlərini pozur və onların inkişafını ləngidir. Uzun müddətli sızmalar nəticəsində balıq və digər dəniz canlılarının populyasiyaları tükənmə təhlükəsi ilə üzləşir, bu da regionun ekoloji balansına ciddi təsir edir.

Xəzər dənizi regionda neft hasilatı üzrə strateji əhəmiyyətə malikdir və burada həyata keçirilən hasilat əməliyyatları ölkə iqtisadiyyatı üçün böyük gəlir mənbəyi təşkil edir. Ancaq bu strateji əhəmiyyətə malik iqtisadi fəaliyyətin dəniz ekosistemlərinə vurduğu zərərlər həm qısamüddətli, həm də uzunmüddətli ekoloji problemlərə yol açır.

#### **Neft sızmalarının balıq populyasiyalarına təsiri**

Xəzər dənizində baş verən neft sızmaları nəticəsində balıqların həyati fəaliyyəti ciddi şəkildə pozulur. Neftin su səthində yığılması və ya suyun içinə qarışması suyun oksigen səviyyəsinin azalmasına səbəb olur, bu isə balıq növlərinin kütləvi ölməsinə gətirib çıxarır. Suyun oksigen tərkibi azaldıqca, balıqlar və digər dəniz canlıları boğularaq məhv olur. Xüsusilə Xəzər dənizinə xas olan nərə balığı kimi nadir növlərin populyasiyası ciddi şəkildə azalır. Nərə balığının kürü istehsalı və balıqçılıq sənayesində vacib rolu olduğu üçün bu itkilər yalnız ekosistemə deyil, iqtisadi sektora da mənfi təsir göstərir. Nərə balığının kürüsündən alınan kürü (qara kürü) dəyərli bir ixrac məhsulu olsa da, populyasiyanın azalması nəticəsində bu sahədə fəaliyyət göstərən sənaye də təhlükə altındadır.

#### **Balıqçılıq sənayesinə təsir**

Xəzər dənizində neft sızmaları və ekosistemlərin məhv edilməsi sahil ərazilərində balıqçılıq sənayesinə ciddi zərbə vurur. Balıqçılıq sektoru bu bölgədə çoxsaylı insanların əsas dolanışiq mənbəyidir. Suyun çirkənlənməsi və balıq populyasiyasının azalması nəticəsində sahil bölgələrində balıqçılıqla məşğul olan əhəlinin gəlir mənbələri azalmağa başlayır. Balıq ehtiyatlarının azalması, balıq ovunun azalmasına səbəb olur və nəticədə balıqçılar üçün daha az gəlir gətirir. Bu proses uzun müddət davam etdikdə, sahil bölgələrindəki balıqçılıq sənayesi tənəzzülə uğrayır və yerli iqtisadiyyata mənfi təsir edir. Balıq populyasiyalarının bərpası üçün uzun müddət və çoxlu resurs tələb olunduğu üçün bu sənayedə itkilərin geri qayıdışı çətin olur.

Bundan əlavə, balıqçılıq sənayesində fəaliyyət göstərən insanlar yalnız iqtisadi çətinliklərlə qarşılaşmır, həm də sosial-mədəni itkilərlə üzləşir. Bir çox sahil əhalisi nəsillər boyu balıqçılıqla məşğul olub və bu fəaliyyət onların həyat tərzinin ayrılmaz bir hissəsidir. Balıqçılığın azalması onların sosial-mədəni identifikasiyalarına da təsir göstərir.

**Bioloji müxtəlifliyin azalması-** Neft hasilatı yalnız su və torpaq ekosistemlərinə təsir etməklə kifayətlənmir, həm də bioloji müxtəlifliyi ciddi şəkildə məhv edir. SOCAR-ın apardığı tədqiqatlara görə, neft hasilatı zamanı ətraf mühitə buraxılan tullantılar torpaqdakı bioloji müxtəlifliyi azaldır. Bu təsir, xüsusilə kənd təsərrüfatı sahələrində daha aydın görünür. Torpaq məhv olduqca, torpağın məhsuldarlığı azalır və kənd təsərrüfatı məhsullarının keyfiyyəti pisləşir. Uzunmüddətli perspektivdə bu, Azərbaycanın kənd təsərrüfatı sektoruna mənfi təsir edir və ekoloji dayanıqlığı zəiflədir.

Bioloji müxtəlifliyin azalması yalnız kənd təsərrüfatı üçün deyil, həm də təbii ekosistemlərin dayanıqlığı üçün böyük təhlükə yaradır. Torpaq və su ehtiyatlarının məhvi yerli flora və faunanın tükənməsinə səbəb olur. Bu, global miqyasda Azərbaycanın ekoloji vəziyyətinə və təbii resurslarının davamlı istifadəsinə mənfi təsir göstərir.

#### **Nəticə**

Azərbaycanın neft-qaz sənayesi iqtisadiyyatın inkişafında mühüm rol oynasa da, bu sektorun ətraf mühitə vurduğu zərərlər dayanıqlı inkişaf modelinə keçidin vacibliyini göstərir. Neft sızmalarının, karbon emissiyalarının və digər ekoloji təsirlərin qarşısını almaq üçün daha güclü ekoloji siyasətlər həyata keçirilməli və təmiz enerji mənbələrinə keçid sürətləndirilməlidir. Azərbaycanın gələcək iqtisadi inkişafı yalnız ətraf mühitin qorunması və davamlı texnologiyaların tətbiqi ilə mümkün olacaqdır.

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## SOURCES AND DIRECTIONS OF FINANCING NATIONAL ECONOMIC DEVELOPMENT

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## MİLLİ İQTİSADI İNKİŞAFIN MALİYYƏLƏŞDİRMƏ MƏNBƏLƏRİ VƏ İSTİQAMƏTLƏRİ

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**Abstract**

**The purpose of the study** is to determine the sources and directions of financing of national economic development, to determine the impact of the implemented long-term economic development strategy on the sustainable and balanced development of the country's regions.

**The methodology of the study** is mainly formed from methods such as scientific abstraction, analysis, synthesis, comparison and generalization. At the same time, attention is also paid to the approaches in the scientific works of various researchers regarding the determination of sources and directions of financing of economic development.

**The practical significance of the research** – from the point of view of the applied significance of the study, the scientific and practical innovations taken in the article are related to the determination of sources and directions of financing of national economic development in the context of global challenges in the modern era.

**The results of the research** the sources and directions of financing of economic development were investigated and proposals were made to increase development.

**The originality and scientific novelty of the research** – that the development agenda is based on the acceleration of economic development in the socio-economic life of the country, especially in the regions and rural areas, the transition to a new qualitative stage of work in the direction of decent employment of the population and further improvement of social welfare, and the strengthening of ecological safety. The formation and implementation of a national economic development model from fundamental economic concepts is the main basis for the sustainable and growth development of the national economy, and recommendations and proposals have been prepared in this regard.

**Xülasə**

**Tədqiqatın məqsədi** milli iqtisadi inkişafın maliyyələşdirmə mənbələri və istiqamətlərinin müəyyən edilməsi, həyata keçirilən uzunmüddətli iqtisadi inkişaf strategiyasının ölkənin regionlarının davamlı və tarazlı inkişafına təsirinin müəyyən edilməsidir.

**Tədqiqatın metodologiyası** əsas etibarilə elmi abstraksiya, analiz, sintez, müqayisə və ümumiləşdirmə kimi metodlardan formalaşdırılmışdır. Eyni zamanda, iqtisadi inkişafın maliyyələşdirmə mənbələri və istiqamətlərinin müəyyən edilməsi ilə bağlı müxtəlif tədqiqatçıların elmi əsərlərindəki yanaşmalara da diqqət göstərilmişdir.

**Tədqiqatın tətbiqi əhəmiyyəti** nöqteyi-nəzərindən məqalədə alınmış elmi-praktiki yeniliklərdən müasir dövrdə global çağırışlar kontekstində milli iqtisadi inkişafın maliyyələşdirmə mənbələri və istiqamətlərinin müəyyən edilməsi ilə bağlıdır.

**Tədqiqatın nəticəsində isə** iqtisadi inkişafın maliyyələşdirmə mənbələri və istiqamətləri araşdırılmışdır və inkişafın yüksəldilməsinə dair təkliflər verilmişdir.

**Tədqiqatın orijinallığı və elmi yeniliyi** baxımından qeyd etməliyik ki, ölkənin sosial-iqtisadi həyatında, xüsusilə regionlarda, kənd yerlərində iqtisadi inkişafın sürətləndirilməsi, əhalinin layiqli məşğulluğu və sosial rifah halının daha da yüksəldilməsi və ekoloji təhlükəsizliyin gücləndirilməsi istiqamətlərində işlərin yeni keyfiyyət mərhələsinə keçməsi inkişaf gündəliyində əsaslandırılmışdır. Milli iqtisadi inkişaf modelinin fundamental iqtisadi konsepsiyalardan formalaşdırılması və reallaşdırılması milli iqtisadiyyatın davamlı və artımla inkişafının əsas

*zəminidir və bunlarla bağlı tövsiyələr və təkliflər hazırlanmışdır.*

**Keywords:** *economic development, oil strategy, economic model, national economy, GDP, state program, investments.*

**Açar sözlər:** *iqtisadi inkişaf, neft strategiyası, iqtisadi model, milli iqtisadiyyat, ÜDM, dövlət proqramı, investisiyalar.*

### **Giriş**

Milli iqtisadi inkişaf modellərinin formalaşdırılması və hər bir ölkənin iqtisadi inkişaf prioritetlərinə, milli maraqlarına və milli iqtisadi strateji hədəflərinə adekvatlığının təmin edilməsi mürəkkəb problemlərin və məsələlərin baxılmasını, dərinlən öyrənilməsinə şərtləndirir və bütün bunlar müxtəlif aspektlərdən ciddi arqumentlərlə, uzunmüddətli proqnozlarla və obyektiv reallıqlara söykənmiş hesabatlarla əsaslandırılmalıdır. Bundan əlavə, milli iqtisadi inkişaf modelinin daha güclü və dayanıqlı olması üçün hər bir ölkə özünün iqtisadi inkişaf səviyyəsini real qiymətləndirməli, iqtisadi inkişaf resurslarının potensialı, iqtisadi inkişaf indikatorlarının manevrliyi və artım dinamikası, sosial-iqtisadi inkişafın səviyyəsi və s. vacib göstəricilər, şərtlər diqqətlə öyrənilməli və nəzərə alınmalıdır.

Hər bir ölkə üçün milli iqtisadi inkişaf modelinin əsasında, bu ölkədə yaşayan insanların, xalqların tarixi və mədəni irsi, adət və ənənələri, sahibkarlıq fəaliyyətinin xüsusiyyətləri, ənənəvi məşğulluq sahələri və iqtisadiyyat sektorları, geoiqtisadi üstünlüklər və s. dayanır. Məsələn, Amerika iqtisadi modeli liberal bazar iqtisadiyyatı xüsusiyyətləri ilə kifayət qədər fərqləndiyi halda, İsveç iqtisadi modeli isə dövlətin iqtisadi sabitlik və gəlirlərin bölüşdürülməsində iştirakı ilə daha çox diqqət cəhətdir. Və yaxud, Yapon iqtisadi modeli korporativ kapitalizm tənzimlənməsi və bununla bərabər sosial meyarlara üstünlük verilməsi ilə seçilsə, Alman iqtisadi modelinin əsasında sosial yönümlü bazar iqtisadiyyatının gücləndirilməsi dayanır. Amerika iqtisadi modeli ilk növbədə sahibkarlıq fəaliyyətinin stimullaşdırılmasına, sahibkarların sərbəstliyinə, yüksək texnologiyaların işlənməsinə və tətbiqinin genişləndirilməsinə, təhsil və mədəniyyətin inkişafına daha çox önəm verir. İsveç iqtisadi modeli məşğulluğun yüksəldilməsi və əhalinin həyat səviyyəsinin artırılması ilə bağlı fərqlənir. Yapon iqtisadi modeli "dövlət və özəl sektor" əməkdaşlığını önə çəkir. Alman iqtisadi modeli isə iqtisadi təşəbbüslərin inkişafına daha çox üstünlük verir. Qeyd edək ki, hər bir milli iqtisadi inkişaf modelinin əsasında sistemli yanaşma və kompleks meyarlar dayanır. Bu onunla bağlıdır ki, milli iqtisadiyyatın inkişafı, ilk növbədə təsərrüfat xüsusiyyətlərinin müxtəlifliyi ilə seçilir və onların milli iqtisadiyyata adekvatlığı, milli iqtisadi inkişaf proseslərinin səmərəliliyi, əhalinin iqtisadi fəallıq səviyyəsi, dövlətin iqtisadi inkişaf prosesləri ilə bağlı iqtisadi siyasətinin optimallığı və işləkliyi sistemli yanaşmaya, eyni zamanda milli iqtisadi maraqları, milli iqtisadi təhlükəsizliyi təmin etməyə qadir olan kompleks meyarlara söykənməlidirlər [3].

### **Milli iqtisadiyyatın davamlı inkişafı**

Milli iqtisadi inkişaf modelinin fundamental iqtisadi konsepsiyalardan formalaşdırılması və reallaşdırılması milli iqtisadiyyatın davamlı və artımla inkişafının əsas zəmini ola bilər. Son dövrlərdə, xüsusilə neftin qiymətinin dünya bazarında qeyri-sabitliyi ilə bağlı, başqa sözlə neftdən sonrakı dövr təmayüllü və yönümlü iqtisadi siyasət mexanizmləri formalaşdırılmaqdadır. Bunlarla əlaqədar olaraq, milli iqtisadi inkişaf modelinin yenilənməsi və müasir dövrdə milli iqtisadi inkişaf modelinin prioritet vəzifələrinin, yaxın və uzunmüddətli dövr nəzərə alınmaqla strateji hədəflərin müəyyənləşdirilməsi, mühüm tədbirlərin görülməsi istiqamətində real addımlar atılmaqdadır. Dövlətin iqtisadi siyasətinin təkmilləşdirilməsi, davamlı iqtisadi islahatların dərinləşdirilməsi, global iqtisadi çağırışlara adekvat və müasir konseptual yanaşmaların təmin edilməsi, milli iqtisadiyyatın səmərəli formada diversifikasiyalaşdırılması istiqamətlərinin müəyyənləşdirilməsi, milli iqtisadiyyatın davamlı artımının formalaşdırılması və bunlarla bağlı prioritet qeyri-neft sahələrinin inkişafının sürətləndirilməsi, global çətinliklər şəraitində və dünyada qeyri-sabit maliyyə mühitinin hökm sürdüyü dövrdə ölkə əhalisinin sosial rifahının davamlı olaraq yaxşılaşdırılmasına nail olması kimi mürəkkəb vəzifələr və problemlər həllini gözləyir. Bütün bunlar 2016-2020-ci illər üçün strateji inkişaf strategiyasını və tədbirlər planını, 2025-ci ilədək olan dövr üçün və 2025-ci ildən sonrakı dövrə hədəf baxışı ehtiva edir.

Strateji Yol Xəritəsi 12 istiqamət üzrə təsdiq edilmişdir, bunların sırasında milli iqtisadiyyat perspektivi, neft və qaz sənayesinin inkişafı, kənd təsərrüfatı məhsullarının istehsalı və emalı, kiçik və orta sahibkarlıq səviyyəsində istehlak mallarının istehsalı, ağır sənaye və maşınqayırmanın inkişafı, ixtisaslaşmış turizm sənayesinin inkişafı, logistika və ticarətin inkişafı, maliyyə xidmətlərinin inkişafı, telekommunikasiya və informasiya texnologiyalarının inkişafı, xüsusilə əhəmiyyətli və perspektivlidir.

Göründüyü kimi, yaxın perspektivdə ölkəmizin milli iqtisadiyyatının inkişaf modelinin əsaslı şəkildə yenilənməsi və təkmilləşdirilməsi imkanları vardır [1].

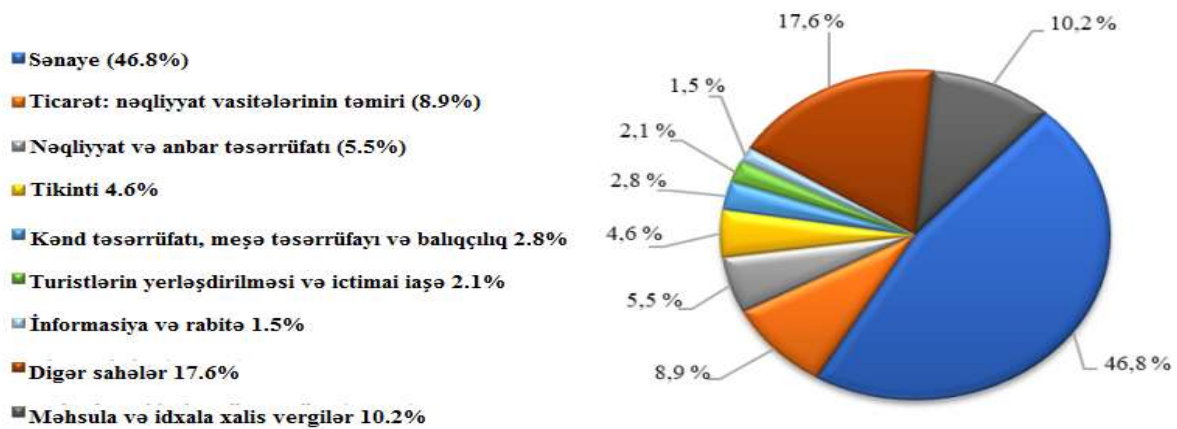
Azərbaycanda milli iqtisadiyyatın inkişaf modelinin möhkəmləndirilməsi və müasir iqtisadi global çağırışlar nəzərə alınmaqla təkmilləşdirilməsi problemləri diqqət mərkəzindədir. Ölkəmizin regional və beynəlxalq iqtisadi inkişaf proseslərində, global iqtisadi layihələrdə, o cümlədən beynəlxalq nəqliyyat və enerji layihələrində əldə etdiyi tarixi uğurlara baxmayaraq, iqtisadiyyatımızın rəqabət qabiliyyətinin gücləndirilməsi, antiböhran xarakterli məhsuldar iqtisadi mexanizmlərin iqtisadi sistemə daxil edilməsi problemlərinin həll edilməsi məsələləri ortaya çıxır. Milli iqtisadi inkişaf modelinin hazırkı mexanizmlərinin təkmilləşdirilməsi və yenilənməsi problemləri ölkəmizin davamlı iqtisadi inkişafına imkan verən adekvat iqtisadi inkişaf hədəfləri və prioritetləri əsas götürülməklə baxılmalı və həll olunmalıdır.

Azərbaycan Respublikası Prezidentinin həyata keçirdiyi uzunmüddətli iqtisadi inkişaf strategiyası ölkənin regionlarının davamlı və tarazlı inkişafının təmin olunmasını, o cümlədən yerlərdə dayanıqlı inkişaf prinsiplərinə əsaslanan rəqabətqabiliyyətli iqtisadiyyat, yüksək standartlara cavab verən sosial rifah, təbii resursların səmərəli istifadəsini və ətraf mühitin etibarlı mühafizəsini təmin edən ekoloji təhlükəsizlik sisteminin formalaşdırılmasına imkan verən əlverişli mühit yaratmaq məqsədini daşıyır.

Azərbaycan iqtisadiyyatı hazırda özünün ən mürəkkəb dövrlərindən birinə daxil olmuşdur. Belə ki, uğurlu neft strategiyasının reallaşdırılması və bir neçə illər ərzində dünya bazarında neftin qiymətinin daim artan dinamika ilə müşayiət olunması hesabına ölkəmiz dünyada sabit inkişaf edən milli iqtisadi inkişaf modelinin formalaşdırılmasına nail olmuşdur. Ölkə iqtisadiyyatı bir neçə dəfə artmış, ixrac potensialı yüksəlmiş, milli iqtisadiyyatın genişləndirilməsi potensialı yaranmışdır. Amma, obyektiv reallıqlar içərisində uzun müddət ciddi diskussiyalara məruz qalan bir sualın cavabının hazırkı dövrə qədər ciddi arqumentlərlə əsaslandırılması və onların real mexanizmlər, real praktiki fəaliyyət istiqamətləri və fəaliyyət alətləri ilə təmin edilməsi tam mənada mümkün olmamışdır. Bu məsələ, şübhəsiz milli iqtisadiyyatın neftdən asılılığının, eyni zamanda ixracın da əsasən xam neft və təbii qazdan, başqa sözlə mineral xammal resurslarından asılılığının əhəmiyyətli şəkildə azalması ilə bağlı olmuşdur və hazırda da xeyli aktual olaraq qalmaqdadır. Düzdür, dövlətimizin iqtisadi siyasəti tam gücü ilə milli iqtisadiyyatın strukturunun təkmilləşdirilməsinə, ayrı-ayrı qeyri-neft sektoru sahələrinin inkişafının gücləndirilməsinə, sahibkarlığın inkişafı ilə bağlı kompleks tədbirlərin görülməsinə və biznes mühitinin yaxşılaşdırılmasına, ölkəyə xarici investisiyaların gətirilməsinin stimullaşdırılması məqsədilə əlverişli şəraitin yaradılmasına, bir sözlə milli iqtisadiyyatın inkişafının dinamikliyinin təmin edilməsi ilə bağlı tədbirlərin ardıcıl sürətdə həyata keçirilməsinə yönəldilmişdir. Bu məqsədlərlə çoxlu sayda dövlət proqramları, tədbirlər işlənib hazırlanmış, həyata keçirilmiş və bir çox istiqamətlər üzrə hazırda bu proseslərin sürətləndirilməsi üçün işlər görülməkdədir. Digər tərəfdən, milli iqtisadiyyatın inkişafının əsas mexanizmlərinin və indikatorlarının yenilənməsi, təkmilləşdirilməsi məqsədilə strateji yol xəritələri müəyyənləşdirilmiş və onların reallaşdırılmasına başlanılmışdır. Bütün bunlar təqdirəlayiq amillər kimi qiymətləndirilməlidir və hesab edirik ki, yaxın perspektivdə nəzərdə tutulan strateji tədbirlərin kifayət qədər səmərəsi olacaq, milli iqtisadiyyatın inkişaf modelinin əsas mexanizmlərinin yenilənməsi sürətlənəcək və bütövlükdə milli iqtisadiyyatın diversifikasiyaşdırılması problemlərinin həllinə münbit şərait yaranacaqdır.

Diaqram 1.

### 2023 - cü ilin yanvar-aprel aylarında istehsal olunmuş ümumi daxili məhsulun strukturu



**Mənbə:** müxtəlif ədəbiyyat mənbələri əsasında müəllif tərəfindən ümumiləşdirilmişdir.

ÜDM-in və milli gəlirin davamlı artımı əslində iqtisadiyyatın bütövlükdə əhatə olunduğu iqtisadi mexanizmlərin və praktiki alətlərin adekvatlığı ilə birbaşa bağlıdır. Bu halda iqtisadi yanaşmalar və iqtisadi mexanizmlərin tətbiqi kifayət qədər məqsədli və effektiv olmalı və tətbiq olunan mexanizmlər dövlətin iqtisadi sistemi, milli iqtisadiyyatın inkişafının strateji hədəfləri ilə uyğunlaşdırılmalıdır. Milli iqtisadiyyatın uğurlu və səmərəli inkişafının təmin edilməsi, ÜDM və milli gəlirin artımına imkan verən fəaliyyət istiqamətlərinin genişləndirilməsi milli iqtisadi sistemin komponentlərindən qarşılıqlı və səmərəli fəaliyyət mexanizmlərinin təşkilini vacib edir. Milli iqtisadiyyat sahələrinin əlavə dəyər yaratmaq və milli gəlirin artım mənbələrinin genişləndirilməsinə imkan verən fəaliyyət istiqamətlərinin mövcud mexanizmlərinin tənzimlənməsi və təkmilləşdirilməsi milli iqtisadi sistemin dayanıqlılığına müsbət təsir göstərir və milli istehsalın həcmnin artırılmasına məhsuldar əlavə mənbələr formalaşdırır. Bazar iqtisadiyyatı şəraitində və gərginləşən global təsirlərin fonunda ÜDM-in və milli gəlirin artırılması və bunlarla bağlı fəaliyyət sahələrinin strukturunun genişləndirilməsi müasir dövrün həlledici məsələləri kimi xarakterizə olunur. Bu məsələlərin mühümlüyü milli iqtisadiyyatın inkişafının dinamikliyinin dayanıqlı təminatı ilə bilavasitə bağlıdır [8].

Hazırda ölkənin sosial-iqtisadi həyatında, xüsusilə regionlarda, o cümlədən kənd yerlərində iqtisadi inkişafın sürətləndirilməsi, əhəlinin layiqli məşğulluğu və sosial rifah halının daha da yüksəldilməsi və ekoloji təhlükəsizliyin gücləndirilməsi istiqamətlərində işlərin yeni keyfiyyət mərhələsinə keçməsi inkişaf gündəliyində ön plana çıxmışdır.

Bu məsələlərin uğurlu həlli ölkənin regionlarında mövcud olan potensialdan daha səmərəli istifadə etməklə bölgələrdə, o cümlədən kənd yerlərində sosial-iqtisadi inkişafın sürətləndirilməsi və bu inkişafın davamlılığının möhkəmləndirilməsini zəruri edir. Bu isə öz növbəsində ölkənin regionlarının sosial-iqtisadi inkişafı ilə əlaqədar siyasət tədbirlərinin, o cümlədən kompleks proqramlar hazırlanıb icra olunmasının davam etdirilməsini nəzərdə tutur.

Dövlət Proqramı çərçivəsində ölkədə regionların inkişafı ilə əlaqədar tənzimlənmə sisteminin, o cümlədən qanunvericilik bazasının, institusional və iqtisadi mexanizmlərin daha da təkmilləşdirilməsi, investisiya və innovasiya fəallığının artırılması, mütərəqqi texniki avadanlıqlar və texnologiyaların tətbiqi əsasında yerli iqtisadi potensialın gücləndirilməsi və təsərrüfat dövryyəsinə tam cəlb olunması, buna uyğun olaraq, iqtisadiyyatın şaxələndirilməsinin genişləndirilməsi və səmərəliliyinin yüksəldilməsi hesabına rəqabətqabiliyyətliliyinin artırılması, sahibkarlığın inkişafı, məhsul və xidmət istehsalı, satışı və istehsal vasitələri bazarında rəqabət mühitinin daha da sağlamlaşdırılması, maliyyə resurslarına və bazara çıxış imkanlarının asanlaşdırılması, istehsal, sosial və bazar infrastrukturunun modernləşdirilməsi, sosial xidmətlərin çeşidinin artırılması, keyfiyyətinin yaxşılaşdırılması və aztəminatlı insanlar üçün əlçatanlığının təmin edilməsi, həssas əhali qruplarının sosial müdafiəsinin gücləndirilməsi, təbii ehtiyatlardan daha da səmərəli istifadə olunması və ekoloji təhlükəsizliyin qorunması üzərində

nəzarətin möhkəmləndirilməsi və bu kimi digər istiqamətlərdə kompleks işlərin görülməsi nəzərdə tutulur [2].

Ölkə iqtisadiyyatının mütləq inkişafı onun investisiya potensialına əsaslanır ki, bu da innovativ texnologiyaların tətbiqi ilə əsas fondların yenilənməsi üçün obyektiv imkanların mövcudluğunu müəyyən edir. İqtisadi sistemdə investisiya potensialının formalaşması üçün maliyyə mənbələri aşağıdakılardır:

- 1) korporativ sektorun bölüşdürülməmiş mənfəəti;
- 2) icmal büdcənin investisiyaları;
- 3) kredit sisteminin resursları;
- 4) fond bazarının resursları;
- 5) ev təsərrüfatlarının əmanətləri.

İnvestisiyaların bu mənbələr hesabına həyata keçirilməsi investisiya və fiskal multiplikatorlarını aktivləşdirir. İqtisadi inkişafın sürətləndirilməsi üçün şirkətlərin mənfəətinin, ev təsərrüfatlarının və büdcə sisteminin gəlirlərinin artması maliyyə mənbələrinin artımına gətirib çıxarır. Üstəlik, onların indiki artımı sonrakı dövrdə daha böyük investisiya potensialı deməkdir. İqtisadi sistemin inkişafı üçün maliyyə mənbələrinin formalaşması aşağıdakı bərabərliklə təmsil oluna bilər:

$$F_n = P_n + S_n + I_n + K_n + R_n,$$

burada  $F_n$  – iqtisadi sistemin maliyyə mənbələrinin ümumi həcmnin artımı;

$P_n$  – şirkətlərin bölüşdürülməmiş mənfəətinin artımı;

$S_n$  – ev təsərrüfatlarının əmanətlərinin artımı;

$I_n$  – icmal büdcə və ehtiyat fondlarından investisiyaların artımı;

$K_n$  – kredit sisteminin resurslarının artımı;

$R_n$  – fond bazarının resurslarının artımı;

$n$  - dövr.

Bərabərliyin iqtisadi mahiyyəti aşağıdakı kimidir: iqtisadi sistemin maliyyə mənbələrinin ümumi həcmi bölüşdürülməmiş mənfəətin, ev təsərrüfatlarının əmanətlərinin, ehtiyat fondlarından investisiyaların, kredit sisteminin və fond bazarının resurslarının artması ilə müəyyən edilir. Mənbələrin bir qrupunun artması digərində azalma ilə müşayiət olunarsa, iqtisadi artımın stimullaşdırılması üçün pul resurslarının ümumi məbləği baxımından netto-effekt sıfıra meyli olacaqdır [7].

Kapital axınının mənfə dinamikası investisiya resurslarının həddindən artıq ixracı və ya qeyri-kafi idxalı ilə əlaqələndirilir. Kapitalın ixracı milli iqtisadiyyatın investisiya potensialının azalmasına səbəb olur. Milli iqtisadiyyatdan kapital axınının amillərinə aşağı mənfəət norması, daxili bazarın qeyri-kafi tutumu, orta və uzunmüddətli inkişaf perspektivlərinin olmaması, ÜDM-in aşağı artım templəri, əlverişsiz investisiya fonu, səmərəsiz makroiqtisadi siyasət, sosial və siyasi qeyri-sabitlik daxildir. Milli iqtisadiyyatdan kapital axınının müqayisəsi göstərir ki, onlar əsasən vergiləri aşağı olan ölkələrdən, maliyyə mərkəzlərindən və ofşor zonalardan keçir. Belə sxemlərdən istifadə bütün səviyyəli büdcələrə və dövlət büdcədən kənar fondlarına ödənişlərin azalmasına gətirib çıxarır. Milli iqtisadiyyatın investisiya potensialının artırılmasını təmin edən mühüm maliyyə mənbəyi həm birbaşa, həm də portfel investisiyaları şəklində xarici kapital axınıdır.

Milli ehtiyatlardan kifayət qədər səmərəli istifadə edilməməsinin səbəbi, onların milli iqtisadiyyatdan çıxarılaraq xaricə yüksək likvidli aktivlər şəklində yerləşdirilməsidir. Bu problemi təhlil edərkən bir sıra hallar nəzərə alınmalıdır. Birincisi, beynəlxalq ehtiyatlardan istifadəyə təsir edən qeyri-iqtisadi amillər. Bunlara toplanmış vəsaitlərdən istifadə imkanları ilə bağlı qeyri-müəyyənlik yaradan beynəlxalq sanksiyalar aid edilməlidir. İkincisi, korporativ borcun xarici valyutada səviyyəsi. Bu borcun formal olaraq özəl olmasına baxmayaraq, neft-qaz sektorunda olan böyük şirkətlərin aksiyalarının çox hissəsi dövlətə məxsusdur.

### Nəticə

Xarici təcrübə ümumilikdə göstərir ki, dövlət həm büdcə vəsaitlərindən, həm də digər mənbələrdən istifadə etməklə iqtisadiyyatda prioritet sahələrin məqsədyönlü maliyyələşdirilməsində fəal rol oynayır, maliyyələşdirmənin istiqamətlərinə, məqsədlərinə və üsullarına ciddi nəzarət edir. Prinsiplər və meyarlar kommersiya meyarlarından fərqlənir: məqsədlər əməliyyatların gəlirliliyi baxımından deyil, əsasən iqtisadi inkişaf sahəsində, o cümlədən verilmiş sənaye proporsiyalarının formalaşdırılması və regional inkişaf səviyyələrinin bərabərləşdirilməsi ilə müəyyən edilir.

Azərbaycan iqtisadiyyatının strukturunun dəyişdirilməsinə yönəlmiş investisiya fəaliyyəti təkcə qısa və orta müddətli deyil, həm də uzunmüddətli perspektivdə proqnozlaşdırılmalı və planlaşdırılmalıdır, əks halda investisiyalar istənilən effekti verməyə bilər.

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## Mathematical sciences

### UTILISING A DIFFERENTIAL EQUATION TO STUDY THE LEGENDRE POLYNOMIAL

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#### Abstract

In the article, orthogonal Legendre polynomials will be determined by means of differential equations. It is known that a system consisting of orthogonal and orthogonal functions, Fourier series are defined according to this system and necessary and sufficient conditions for these series are determined.

It is well-known that separation of variables in 2nd order partial differential equations (PDEs) for physical problems with spherical symmetry usually leads to Cauchy's differential equation for the radial coordinate and Legendre's differential equation for the polar angle  $\theta$ . For eigenvalues of the form  $n(n+1)$ ,  $n \geq 0$  being an integer, Legendre's equation admits certain polynomials  $P_n(\cos \theta)$  as solutions, which form a complete set of continuous orthogonal functions for all  $\theta \in [0, \pi]$ . This allows us to take the polynomials  $P_n(x)$ , where  $x = \cos \theta$ , as a basis for the Fourier-Legendre series expansion of any function  $f(x)$  continuous by parts over  $x \in [-1, 1]$ . These lecture notes correspond to the end of my course on Mathematical Methods for Physics, when I did derive the differential equations and solutions for physical problems with spherical symmetry. It is known that a system consisting of orthogonal and orthogonal functions, Fourier series are defined according to this system and necessary and sufficient conditions for these series are determined.

**Keywords:** Weight function, Legendre polynomial, Leibniz rule, Rodrigues formula, Kronecker delta.

**MSC:** 05E35, 33C45, 33D45

#### 1. Definitions and preliminary tools

Interestingly, Legendre polynomials form a set of orthogonal continuous functions over  $[-1, 1]$ . We give below a formal proof of this property.

**Lemma 1** (Orthogonality of Legendre polynomials). Legendre polynomials  $P_n(x)$ , of distinct degrees are orthogonal over  $[-1, 1]$ , with weighting function  $w(x) = 1$

In fact, Legendre polynomials can be renormalized in order to form a complete set of orthonormal polynomials  $\widehat{P}_n(x)$  on the interval  $[-1, 1]$ , i.e. an orthonormal basis.

**Lemma 2** (Orthonormality of Legendre polynomials). The renormalized Legendre polynomials  $\widehat{P}_n(x) := \sqrt{n + \frac{1}{2}} P_n(x)$ , are orthonormal on the interval  $[-1, 1]$ .

**Theorem 1** (Orthonormality relation for  $P_n(x)$ ). For any non-negative integers  $m$  and  $n$

$$\langle P_m(x), P_n(x) \rangle = \int_{-1}^{+1} P_m(x) P_n(x) dx = \frac{2}{2n+1} \delta_{mn},$$

where  $\delta_{mn}$  is the Kronecker's delta (1 if  $m = n$ , 0 otherwise).

Legendre polynomials also have the following useful representation in terms of the  $n$ -th derivative of  $(x^2 - 1)^n$ , first derived by Rodrigues in 1816 [8].

#### 2. Utilising a differential equation to study the legendre polynomial

**Lemma 3** (Rodrigues' formula for  $P_n(x)$ ). For all non-negative integers  $n$ , the following representation for Legendre polynomials holds:

$$P_n(x) = \frac{1}{n! 2^n} [(x^2 - 1)^n]^{(n)}$$

Let's examine this polynomial using the Legendre polynomial and the differential equation. First, let's show that this polynomial with variable coefficients satisfies a first-order linear differential equation. It is more widely used, especially in the study of various physical and technical subjects.

Having shown that the weight function  $h(x) = 1$  satisfies the differential equation of the Legendre polynomial on the segment  $[-1; 1]$ , the general Pearson equation is known.

$$\frac{h'(x)}{h(x)} = \frac{P_0 + P_2(x)}{q_0 + q_1x + q_2x^2} = \frac{A(x)}{B(x)}$$

In a special case,

$$h(x) = 1 \Rightarrow h'(x) = 0$$

So,

$$\frac{P_0 + P_2(x)}{q_0 + q_1x + q_2x^2} = \frac{A(x)}{B(x)} = 0 \quad A(x) = 0 \quad B(x) \neq 0 \quad (1)$$

Here, the relation of the points of the segment  $[-1; 1]$  of the orthogonal Legendre polynomial is obtained as follows:

$$B(-1) = B(1) \quad (2)$$

It has been proved that the Legendre polynomial is orthogonal, the norm is determined, and it has been investigated that it is orthonormal.

**Theorem 2:** If conditions (1) (2) are satisfied, then the orthogonal  $P_n(x)$  satisfies the solutions of the differential equation for the Legendre polynomial.

$$B(x)y'' + B'(x)y' - n(n+1)q_2 = 0 \quad (3)$$

**Proof:** Let's look at the integral below

$$\dot{I} = \int_{-1}^1 [B(x)P_n'(x)]' x^k dx = 0 \quad (4)$$

If we use the integration by parts formulas,

$$\dot{I} = x^k B(x) P_n'(x) \Big|_{-1}^1 - k \int_{-1}^1 x^{k-1} B(x) P_n'(x) dx$$

According to condition (2), the expression outside the integral is equal to 0. If we apply integration by parts again, then

$$\begin{aligned} \dot{I} &= -k x^{k-1} B(x) P_n(x) \Big|_{-1}^1 + k \int_{-1}^1 P_n'(x) [x^{k-1} B(x)]' dx \\ &= k \int_{-1}^1 P_n(x) [(k-1)x^{k-2} B(x) + x^{k-1} B'(x)] dx \end{aligned}$$

(1) according to condition  $A(x) = 0$ . If we use the previous equation,

$$\dot{I} = k \int_{-1}^1 P_n(x) [(k-1)x^{k-2} B(x) + x^{k-1} B'(x)] dx = 0$$

Here, the quadratic bracket is a polynomial of degree  $k$ , so the equality of the common polynomials  $P_n(x)$  is satisfied.

$$\int_{-1}^1 P_n(x) [(k-1)x^{k-2} B(x) + x^{k-1} B'(x)] dx = 0 \quad k = 0, 1, 2, \dots$$

It is clear that the integral of (4) is equal to 0. If we differentiate successively and take into account that  $A(x) = 0$ , then

$$\dot{I} = \int_{-1}^1 [B'(x)P_n'(x) + B(x)P_n''(x)] x^k dx = 0$$

Quadratic brackets are polynomials of degree  $n$ . Let's express this with the polynomial  $Q_n(x)$

It is clear that,  $\int_{-1}^1 Q_n(x) x^k dx = 0 \quad k = 0, 1, 2, 3, \dots F_m(x)$  Let's take an arbitrary polynomial.

It is known that, given the polynomial  $Q_n(x)$  with a weight function  $h(x) = 1$ , there exists an arbitrary polynomial  $F_m(x)$  ( $m < n$ ) in  $[-1; 1]$  such that

$$\int_{-1}^1 Q_n(x) F_m(x) dx = 0$$

conditionally satisfied.

As a result, the following equality is obtained:

$$B(x)P_n''(x) + B'(x)P_n'(x) = n(n+1)q_1P_n(x) \quad (5)$$

Here  $q_2$  (1) is written in (1). This is the proof.

In the special case, if we take  $B(x) = x^2 - 1$  and write  $q_2 = -1$ , then

$$(x^2 - 1)P_n''(x) + 2xP_n'(x) - n(n+1)P_n(x) = 0 \quad (6)$$

This gives us the Legendre polynomial satisfying the appropriate equality condition for the differential equation (6). Let us prove the differential equation satisfying the Legendre polynomial using a new method. Suppose,

$$u = (x^2 - 1)^n \quad (7)$$

function is given.

Let us differentiate this function successively

$$u' = n(x^2 - 1)^{n-1} \cdot 2x = \frac{2x_n(x^2 - 1)^n}{x^2 - 1}$$

$$u' = \frac{2x_n u}{x^2 - 1}$$

or

$$(x^2 - 1)u' = 2xnu$$

$$(x^2 - 1)u'' + 2xu' = 2nu + 2xnu'$$

$$(x^2 - 1)u'' + 2x(1 - n)u' - 2nu = 0$$

$(n+1)$ -If we differentiate until then, according to Legendre's formula,

$$[(x^2 - 1)^n]^{(n)} = [(x+1)^n(x-1)^n]^{(n)}$$

$$= \sum_{k=0}^n C_n^k [(x+1)^n]^{(n-k)} [(x-1)^n]^{(k)}$$

$$= \sum_{k=0}^n C_n^k n(n-1) \dots (n+k)(1+x)^k * n(n-1)(n-2) \dots (n-k+1)(x-1)^{n-k}$$

Then,

$$(x^2 - 1)u^{(n+2)} + 2(n+1)xu^{(n+1)} - n(n+1)u^{(n)}$$

$$= 2nxu^{(n+1)} + (n+1)2nu^{(n)} \quad \text{və ya} \quad (x^2 - 1)u^{(n+2)} + 2xu^{(n+1)} - n(n+1)u^{(n)}$$

$$= 0 \quad (8)$$

For a known function of the Legendre polynomial, it is obtained as follows.

$$P_n(x) = \frac{1}{n! \cdot 2^n} [(x^2 - 1)^n]^{(n)} = \frac{1}{n! \cdot 2^n} u^{(n)}$$

It is clear that

$$P_n'(x) = \frac{1}{n! \cdot 2^n} u^{(n+1)}$$

$$P_n''(x) = \frac{1}{n! \cdot 2^n} u^{(n+2)}$$

Then, according to formula (2),

$$(x^2 - 1)P_n''(x) + 2xP_n'(x) - n(n+1)P_n(x) = 0 \quad (9)$$

Thus, the solution of the differential equation for the Legendre polynomial is obtained.

That is,

$$(x^2 - 1)y'' + 2xy' - n(n+1)y = 0 \quad (10)$$

This is the same as equation (6).

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**MATHEMATICAL MODELS AND PROBLEMS OF EFFICIENT ORGANIZATION OF SIMILARLY  
DISTRIBUTED COMPUTING SYSTEMS WITH A LIMITED NUMBER OF COPIES OF THE SOFTWARE  
RESOURCE**

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**Abstract**

Taking into account the limited number of copies of the structured software resource and the obtained mathematical relationships for calculating the execution time of a set of identically distributed competing processes, a comparative analysis of the asynchronous and two synchronous modes with unlimited parallelism by the number of processors of a multiprocessor system was carried out, a sufficient condition for the efficiency of an identically distributed system was proven, as well as a necessary and sufficient condition for the existence of an efficient system of identically distributed competing processes depending on the amount of additional system costs.

**Keywords:** distributed computing system, process, software resource, structuring, limited parallelism, unlimited parallelism, asynchronous mode, synchronous mode, heterogeneous system, homogeneous system, equally distributed system.

**1. Introduction**

Rapid development of information, communication and network technologies has led to intensive use of geographically distributed computing resources and creation on their basis of dynamically scalable high-performance distributed computing systems (DCS), one of the main advantages of which is the possibility of parallel processing of processes [1-6]. In designing and creating DCS, the problems of constructing and studying mathematical models of organizing the interaction of parallel processes competing for a software resource (SR) are of particular relevance. These problems are of both direct and inverse nature. When setting direct problems, the conditions are the values of the parameters of the distributed computing system, and the solution is the minimum total time for implementing the specified volumes of calculations. Setting inverse problems is reduced to finding criteria for the efficiency and optimality of organizing the execution of a set of distributed processes. The case when there is one copy of the SR in the shared memory of the DCS was studied from various points of view in [7-12]. The study of problems related to the optimal organization of distributed parallel computing is of particular relevance in the case when a limited number of copies of the software resource can be simultaneously placed in the shared memory of the DCS.

**2. A mathematical model of distributed computing with a limited number of copies of a software resource**

The constructive elements for constructing mathematical models implementing distributed computing methods are the concepts of a process and a software resource. As in [7], a process will be considered as the execution of a sequence of sets of blocks  $I_s = (1, 2, \dots, s)$ . Processes that influence each other's behavior by exchanging information are called cooperative or interacting processes. A program or part of it that is repeatedly executed in a multiprocessor system will be called a software resource, and the set of corresponding processes will be called competing.

The mathematical model of a distributed processing system of competing cooperative processes under a limited number of copies of a software resource includes:  $p \geq 2$ , processors of a multiprocessor system that have access to shared memory;  $n \geq 2$ , distributed competing processes;  $s \geq 2$ , blocks of a software resource structured into blocks; matrix  $T = [t_{ij}]$ ,  $i = \overline{1, n}$ ,  $j = \overline{1, s}$ , execution times of the

software resource blocks by distributed cooperating competing processes;  $2 \leq c \leq p$ , the number of copies of the software resource structured into blocks that can be simultaneously located in the RAM available for all processors;  $\theta > 0$  – a parameter characterizing the time of additional system costs associated with parallel processing of blocks of a structured software resource by a set of interacting competing processes during distributed processing.

We will also assume that the number of processes is a multiple of the number of copies of the structured software resource, i. e.  $n = mc$ , where  $m = n/c \geq 2$ , and that the interaction of processes, processors and software resource blocks is subject to the following conditions: 1) no processor can process more than one block at a time; 2) processes are executed in parallel-conveyor mode in groups, i.e. simultaneous (parallel) execution  $c$  of copies of each block in combination with pipelining of a group  $c$  of copies of the  $Q_j$ -th block by processes and processors, where  $j = \overline{1, s}$ ; 3) processing of each block of the software resource is carried out without interruptions; 4) in the case when the number of software resource blocks  $s \leq \left\lfloor \frac{p}{c} \right\rfloor$ , where  $[x]$  is the integer part of the number, for each  $i$ -th process, where  $i = c(l-1) + q$ ,  $l = \overline{1, m}$ ,  $q = \overline{1, c}$ , the distribution of software resource blocks among processors is carried out according to the rule: the block with number  $j$  is distributed to the processor with number  $c(j-1) + q$ .

The asynchronous mode of interaction between processes, processors and blocks of a structured software resource implies that the beginning of execution of a copy of the next block  $Q_j$ ,  $j = \overline{1, s}$ , is determined by the presence  $c$  of processors and the readiness of the block copy for execution.

Fig. 1 is a linear Gantt chart illustrating the asynchronous mode of execution  $n = 4$  of distributed competing processes using  $c = 2$  copies of a software resource structured into  $s = 3$  blocks in a multiprocessor system with  $p = 7$  processors and a given matrix of block execution times taking into account additional system costs  $T^\theta = [t_{ij}^\theta]_{4 \times 3} = [t_{ij} + \theta]_{4 \times 3}$ .

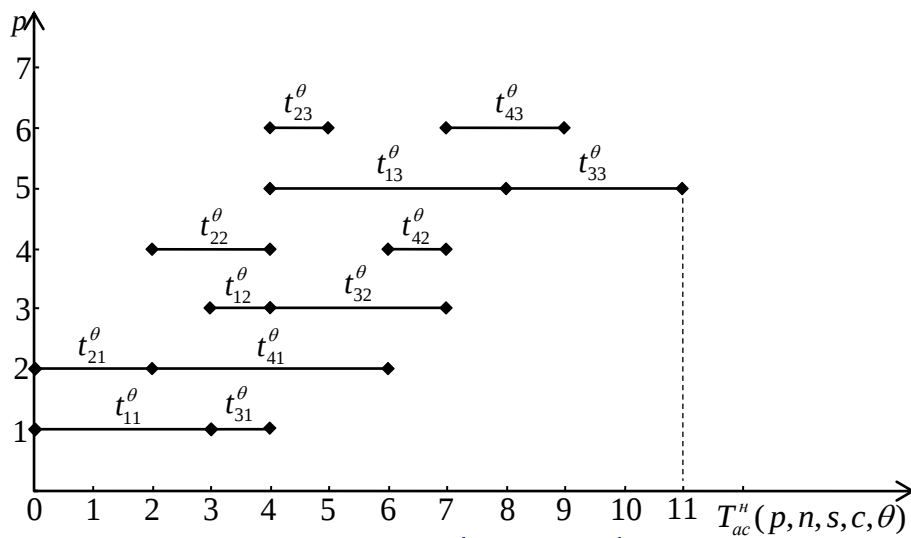


Fig. 1 Asynchronous mode

The first synchronous mode ensures a linear order of execution of blocks of a software resource within each of the processes without delays, i.e. in the case when  $2 \leq s \leq \left\lfloor \frac{p}{c} \right\rfloor$ , the moment of completion of the execution of the  $Q_j$ -th block,  $j = \overline{1, s-1}$ , by the process with number  $i = (l-1)c + q$ ,  $l = \overline{1, m}$ ,  $q = \overline{1, c}$ , on the  $((j-1)c + q)$ -th processor, coincides with the moment of the start of execution of the next  $Q_{j+1}$ -th block on the processor with number  $(jc + q)$  (Fig. 2).

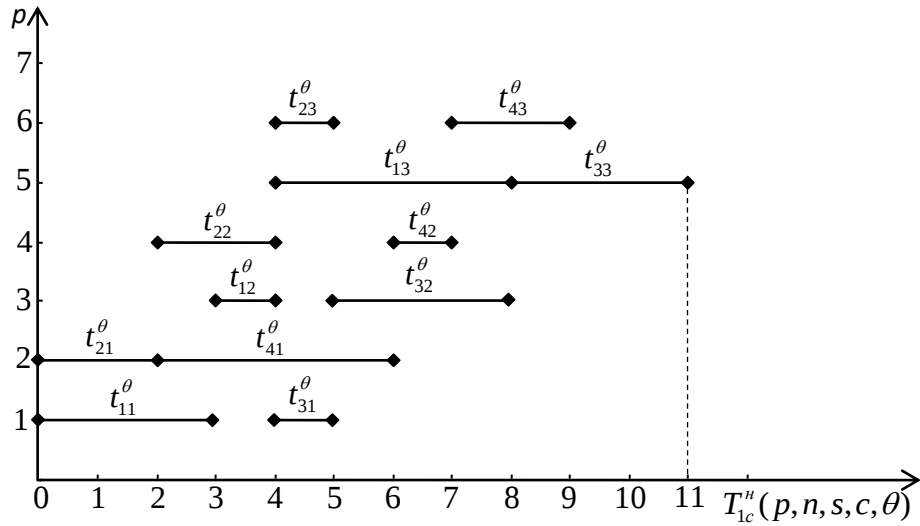


Fig. 2 First synchronous interaction mode processes, processors and blocks

In the second synchronous mode, in the case when  $2 \leq s \leq \left\lceil \frac{p}{c} \right\rceil$ , the moment of completion of execution by the  $i$ -th process, where  $i = (l-1)c + q$ ,  $l = \overline{1, m-1}$ ,  $q = \overline{1, c}$ , of the  $j$ -th block,  $j = \overline{1, s}$ , on the  $((j-1)c + q)$ -th processor coincides with the moment of the start of execution of the  $j$ -th block by process number  $(i+c)$  on the same processor, i.e. continuous execution of each block by all processes is ensured (Fig. 3).

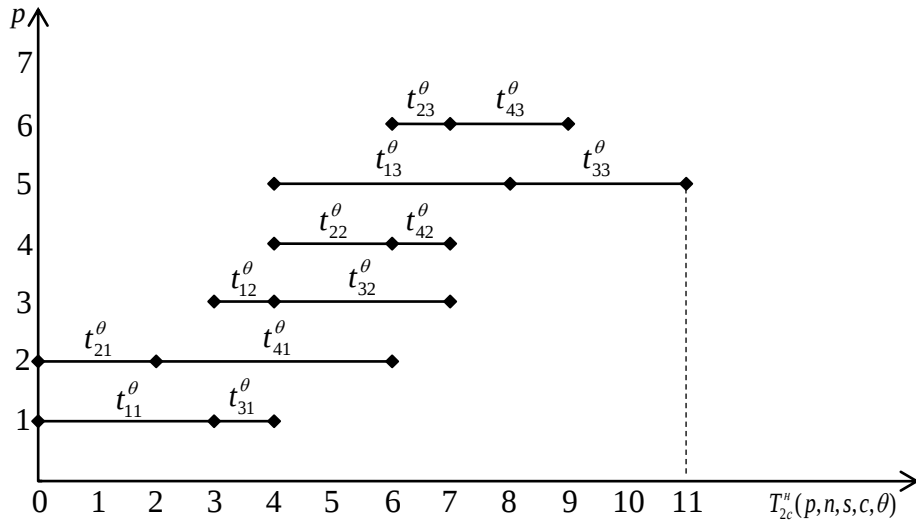


Fig. 3 Second synchronous interaction mode processes, processors and blocks

Next, as in the case of one copy of a software resource [7], we introduce the following definitions.

**Definition 1.** A system  $n$  of distributed competing processes is called heterogeneous if the execution times of software resource blocks  $Q_1, Q_2, \dots, Q_s$  depend on the volumes of processed data and/or their structure, i. e. different for different processes.

**Definition 2.** We will call a system of distributed competing processes homogeneous if the execution times of the  $Q_j$ -th block by each of the  $i$  processes are equal, i. e.  $t_{ij}^{\theta} = t_j^{\theta}$ ,  $i = \overline{1, n}$ ,  $j = \overline{1, s}$ .

**Definition 3.** We will call a system of distributed competing processes identically distributed if the execution times of all blocks of a software resource by each of the processes coincide and are equal  $t_i^{\theta}$ , i. e.  $t_{i1}^{\theta} = t_{i2}^{\theta} = \dots = t_{is}^{\theta} = t_i^{\theta}$ , the chain of equalities is valid for all  $i = \overline{1, n}$ .

### 3. Analysis of the operating modes of identically distributed systems of competing processes

The works [13–15] studied in detail the basic asynchronous and two synchronous modes of interaction of distributed processes in conditions of competition for a limited number of copies of a software resource. Within the framework of the outlined modes, various mathematical relationships have been obtained to calculate the total execution time of a set of heterogeneous, homogeneous and identically distributed processes, taking into account the presence  $2 \leq c \leq p$  of copies of the SR. The problems of comparative analysis of the obtained relationships are of certain theoretical and practical interest. Let us carry out such an analysis for a class of identically distributed systems, taking into account the parameter  $\theta > 0$  characterizing the time of additional system costs associated with the organization of a pipeline mode for the use of blocks of a structured software resource by many competing processes during distributed processing.

Let's consider an identically distributed system of competing processes; this is when the execution times of all blocks of a structured software resource by each of the processes coincide, i.e., the chain of equalities  $t_{i1}^\theta = t_{i2}^\theta = \dots = t_{is}^\theta = t_i^\theta$  is valid for all  $i = \overline{1, n}$  (Def. 3).

To carry out a comparative analysis, we divide the set  $n$  of processes into  $c$  subsets of processes in each. Each  $q$ -th subset,  $q = \overline{1, c}$ , will include processes with numbers  $i = c(l-1) + q$ ,  $l = \overline{1, m}$ , whose

blocks will be executed on  $(c(j-1) + q)$ -th processors,  $j = \overline{1, s}$ . Let  $T_q^\theta = \sum_{i=1}^m t_{c(i-1)+q}^\theta$  us denote the total execution time of the  $q$ -th subset of processes, and  $t_{\max}^{q+} = \max_{1 \leq i \leq m} t_{c(i-1)+q}^\theta$  denote the maximum execution time of a block from this subset,  $q = \overline{1, c}$ .

**Definition 4.** The characteristic set of an identically distributed system will be called a set of parameters of the form  $(t_q^\theta, t_{c+q}^\theta, t_{2c+q}^\theta, \dots, t_{c(m-1)+q}^\theta, T_q^\theta, q = \overline{1, c})$ .

Let  $\beta = \left\{ (t_q^\theta, t_{c+q}^\theta, \dots, t_{c(m-1)+q}^\theta, T_q^\theta) \mid T_q^\theta = \sum_{i=1}^m t_{c(i-1)+q}^\theta, q = \overline{1, c} \right\}$  – the set of all admissible

characteristic sets of a system of identically distributed processes. Let us select from the set a subset of characteristic sets of the form:

$$S(\beta) = \left\{ (t_q^\theta, t_{c+q}^\theta, t_{2c+q}^\theta, \dots, t_{c(m-1)+q}^\theta, T_q^\theta) \in \beta, \text{ where } \begin{aligned} & t_q^\theta \leq t_{c+q}^\theta \leq t_{2c+q}^\theta \leq \dots \leq t_{c(k-1)+q}^\theta \geq t_{ck+q}^\theta \geq \dots \geq t_{c(m-1)+q}^\theta, \\ & k = \overline{1, m}, q = \overline{1, c} \end{aligned} \right\}.$$

For a selected subset of characteristic sets  $S(\beta)$ , the following theorem holds.

**Theorem 1.** In the case of a sufficient number of processors, the minimum total execution times of a set of identically distributed competing processes in a multiprocessor system with parameters  $p \geq 2$ ,  $n \geq 2$ ,  $s \geq 2$ ,  $2 \leq c \leq p$ ,  $\theta > 0$  in asynchronous and two synchronous modes coincide (Fig. 4), i.e.

$$T_{as}^{ed}(p, n, s, c, \theta) = T_{1s}^{ed}(p, n, s, c, \theta) = T_{2s}^{ed}(p, n, s, c, \theta).$$

*Proof.* For any characteristic set of an identically distributed system, in the case of unlimited parallelism for the asynchronous mode and a second synchronous mode ensuring the continuous execution of each block by all processes, the minimum total execution time of  $n$  identically distributed processes competing for  $c$  the use of copies of  $s$  a block-structured software resource in a multiprocessor system with  $p$  processors with taking into account the parameter  $\theta > 0$ , including for any characteristic set  $\mu \in S(\beta)$ , is calculated using the formula [14, 15]:

$$T_{as}^{ed}(p, n, s, c, \theta) = T_{2s}^{ed}(p, n, s, c, \theta) = \max_{1 \leq q \leq c} (T_q^\theta + (s-1)t_{\max}^{q+}).$$

If the interaction of processes, processors and blocks of structured SR is carried out in the first synchronous mode, in which the execution of software resource blocks within each of the processes is ensured without delays, then for any characteristic set of  $\beta$  when  $2 \leq s \leq \left\lceil \frac{p}{c} \right\rceil$  an equality of the form is satisfied:

$$T_{1s}^{ed}(p, n, s, c, \theta) = \max_{1 \leq q \leq c} \left( T_q^\theta + (s-1) \left[ t_{c(m-1)+q}^\theta + \sum_{i=2}^m \max(t_{c(i-2)+q}^\theta - t_{c(i-1)+q}^\theta, 0) \right] \right).$$

Let's show that  $t_{c(m-1)+q}^\theta + \sum_{i=2}^m \max(t_{c(i-2)+q}^\theta - t_{c(i-1)+q}^\theta, 0) = t_{\max}^{q+}$ . Because  $t_{\max}^{q+} = \max_{1 \leq i \leq m} t_{c(i-1)+q}^\theta$ ,

$q = \overline{1, c}$ , then for all numbers  $1 \leq i \leq k \leq m$  we have  $\sum_{i=2}^k \max(t_{c(i-2)+q}^\theta - t_{c(i-1)+q}^\theta, 0) = 0$ , and for

$1 \leq k \leq i \leq m$  there is equality  $\sum_{i=k+1}^m \max(t_{c(i-2)+q}^\theta - t_{c(i-1)+q}^\theta, 0) = t_{c(k-1)+q}^\theta - t_{c(m-1)+q}^\theta$ . Hence,

$$t_{c(m-1)+q}^\theta + \sum_{i=2}^m \max(t_{c(i-2)+q}^\theta - t_{c(i-1)+q}^\theta, 0) = t_{c(k-1)+q}^\theta = t_{\max}^{q+}.$$

The theorem has been proven.

**Theorem 2.** If the admissible characteristic set of an identically distributed system with parameters  $p \geq 2$ ,  $n \geq 2$ ,  $s \geq 2$ ,  $2 \leq c \leq p$ ,  $\theta > 0$ , does not belong to the subset  $S(\beta)$ , then in the case of unlimited parallelism in the number of processors of a multiprocessor system

$$T_{1s}^{ed}(p, n, s, c, \theta) > T_{as}^{ed}(p, n, s, c, \theta) = T_{2s}^{ed}(p, n, s, c, \theta) \text{ (Fig. 5).}$$

*Proof.* Since for the asynchronous and second synchronous modes the minimum total execution times of identically distributed competing processes, taking into account the limited number of copies of the software resource, are equal and are determined by the formula

$$T_{as}^{ed}(p, n, s, c, \theta) = T_{2s}^{ed}(p, n, s, c, \theta) = \max_{1 \leq q \leq c} (T_q^\theta + (s-1)t_{\max}^{q+}),$$

and for the first synchronous mode by the formula

$$T_{1s}^{ed}(p, n, s, c, \theta) = \max_{1 \leq q \leq c} \left( T_q^\theta + (s-1) \left[ t_{c(m-1)+q}^\theta + \sum_{i=2}^m \max(t_{c(i-2)+q}^\theta - t_{c(i-1)+q}^\theta, 0) \right] \right),$$

then the proof of the inequality  $T_{1s}^{ed}(p, n, s, c, \theta) > T_{as}^{ed}(p, n, s, c, \theta)$  will be the proof of the theorem.

*Proof of inequality*

$$t_{c(m-1)+q}^\theta + \sum_{i=2}^m \max(t_{c(i-2)+q}^\theta - t_{c(i-1)+q}^\theta, 0) - t_{\max}^{q+} > 0, \quad q = \overline{1, c}, \quad (1)$$

let's use induction on the number of processes  $m \geq 2$ .

Let  $m = 2$ . In this case, the set of all admissible characteristic sets of a system of identically distributed competing processes  $\beta = (t_q^\theta, t_{c+q}^\theta) \in S(\beta)$ ,  $q = \overline{1, c}$ .

Let inequality (1) be satisfied for  $m = k$ , we will show that it is also valid for  $m = k+1$ . With  $m = k+1$  we get:

$$t_{ck+q}^\theta + \sum_{i=2}^{k+1} \max(t_{c(i-2)+q}^\theta - t_{c(i-1)+q}^\theta, 0) - t_{\max}^{q+} > 0, \text{ where } t_{\max}^{q+} = \max_{1 \leq i \leq k+1} t_{c(i-1)+q}^\theta, \quad q = \overline{1, c}.$$

The last inequality for all  $q = \overline{1, c}$  is equivalent to an inequality of the form:

$$t_{ck+q}^\theta + \sum_{i=2}^k \max(t_{c(i-2)+q}^\theta - t_{c(i-1)+q}^\theta, 0) + \max(t_{c(k-1)+q}^\theta - t_{ck+q}^\theta, 0) - \max_{1 \leq i \leq k+1} t_{c(i-1)+q}^\theta > 0.$$

If  $\max_{1 \leq i \leq k+1} t_{c(i-1)+q}^\theta$  is achieved with  $i = k+1$ , i.e.  $\max_{1 \leq i \leq k+1} t_{c(i-1)+q}^\theta = t_{ck+q}^\theta$ , then

$$\begin{aligned}
t_{ck+q}^\theta + \sum_{i=2}^k \max(t_{c(i-2)+q}^\theta - t_{c(i-1)+q}^\theta, 0) + \max(t_{c(k-1)+q}^\theta - t_{ck+q}^\theta, 0) - t_{ck+q}^\theta = \\
= \sum_{i=2}^k \max(t_{c(i-2)+q}^\theta - t_{c(i-1)+q}^\theta, 0) + \max(t_{c(k-1)+q}^\theta - t_{ck+q}^\theta, 0) > 0.
\end{aligned}$$

Here the first term is greater than zero, because otherwise  $\mu \in S(\beta)$ , which contradicts the conditions of the theorem, and the second term is equal to zero, since  $t_{ck+q}^\theta \geq t_{c(k-1)+q}^\theta$ .

If value  $\max_{1 \leq i \leq k+1} t_{c(i-1)+q}^\theta$  is in the interval  $1 \leq i \leq k$ , then we have:

$$\begin{aligned}
t_{ck+q}^\theta + \sum_{i=2}^k \max(t_{c(i-2)+q}^\theta - t_{c(i-1)+q}^\theta, 0) + \max(t_{c(k-1)+q}^\theta - t_{ck+q}^\theta, 0) - \max_{1 \leq i \leq k+1} t_{c(i-1)+q}^\theta = \\
= t_{c(k-1)+q}^\theta + \sum_{i=2}^k \max(t_{c(i-2)+q}^\theta - t_{c(i-1)+q}^\theta, 0) - \max_{1 \leq i \leq k+1} t_{c(i-1)+q}^\theta + \\
+ t_{ck+q}^\theta - t_{c(k-1)+q}^\theta + \max(t_{c(k-1)+q}^\theta - t_{ck+q}^\theta, 0).
\end{aligned}$$

Here  $t_{c(k-1)+q}^\theta + \sum_{i=2}^k \max(t_{c(i-2)+q}^\theta - t_{c(i-1)+q}^\theta, 0) - \max_{1 \leq i \leq k+1} t_{c(i-1)+q}^\theta > 0$  by inductive hypothesis and due

to the fact that  $\max_{1 \leq i \leq k+1} t_{c(i-1)+q}^\theta = \max_{1 \leq i \leq k} t_{c(i-1)+q}^\theta$ .

We will further show that  $t_{ck+q}^\theta - t_{c(k-1)+q}^\theta + \max(t_{c(k-1)+q}^\theta - t_{ck+q}^\theta, 0) \geq 0$ :

- if  $t_{c(k-1)+q}^\theta = t_{ck+q}^\theta$  equality to zero is obvious;

- if  $t_{c(k-1)+q}^\theta > t_{ck+q}^\theta$  we get that

$$t_{ck+q}^\theta - t_{c(k-1)+q}^\theta + \max(t_{c(k-1)+q}^\theta - t_{ck+q}^\theta, 0) = t_{ck+q}^\theta - t_{c(k-1)+q}^\theta + t_{c(k-1)+q}^\theta - t_{ck+q}^\theta = 0;$$

- if  $t_{c(k-1)+q}^\theta < t_{ck+q}^\theta$ , we have that  $\max(t_{c(k-1)+q}^\theta - t_{ck+q}^\theta, 0) = 0$ , then

$$t_{ck+q}^\theta - t_{c(k-1)+q}^\theta + \max(t_{c(k-1)+q}^\theta - t_{ck+q}^\theta, 0) = t_{ck+q}^\theta - t_{c(k-1)+q}^\theta > 0.$$

The theorem has been proven.

#### 4. Efficiency of identically distributed systems of competing processes under unlimited parallelism

In the case of unlimited parallelism in the number of processors of a distributed computing system, the minimum total execution times of identically distributed processes competing for the use of a limited number of copies of a structured software resource in a multiprocessor system, taking into account the parameter of additional system costs in asynchronous and two synchronous modes, coincide and are calculated using the formula:

$$T^{ed}(p, n, s, c, \theta) = \max_{1 \leq q \leq c} (T_q^\theta + (s-1)t_{\max}^{q+}), \quad (2)$$

where  $T_q^\theta = \sum_{i=1}^{n/c} t_{c(i-1)+q}^\theta$  is the execution time of the  $q$ -th subset of processes,  $t_{\max}^{q+} = \max_{1 \leq i \leq n/c} t_{c(i-1)+q}^\theta$  is

the maximum execution time of a block from this subset taking into account system costs  $\theta$ ,  $q = \overline{1, c}$ .

As in the case of a single copy of a software resource [7], we introduce the following definition.

**Definition 5.** An identically distributed system of competing processes is called stationary if

$$t_1^\theta = t_2^\theta = \dots = t_n^\theta = t^\theta.$$

In the case of a stationary identically distributed system of competing processes, the minimum total execution times are determined by the equality [14-16]:

$$T^{ss}(p, n, s, c, \theta) = \left( \frac{n}{c} + s - 1 \right) t^\theta, \text{ where } t^\theta = t + \theta.$$

**Definition 6.** An identically distributed system of competing processes will be called efficient for fixed  $p \geq 2$ ,  $s \geq 2$ ,  $c \geq 2$ ,  $\theta > 0$ , if the relation is satisfied  $\Delta_{ed} = \max_{1 \leq q \leq c} sT_q - T^{ed}(p, n, s, c, \theta) \geq 0$ , where  $sT_q$  is the execution time of  $s$  blocks of the software resource by all processes of the  $q$ -th subset in sequential mode, and  $T_q = \sum_{i=1}^{n/c} t_{c(i-1)+q}$ .

In the presence of two efficient identically distributed systems of competing processes, we will assume that the first is more efficient than the second if  $\Delta_{op}^1 \geq \Delta_{op}^2$ .

For the introduced subset of identically distributed systems, the following statement is true.

**Theorem 3.** For any efficient identically distributed system of competing processes with  $s \leq \left\lfloor \frac{p}{c} \right\rfloor$  and  $\theta > 0$  there exists a more efficient stationary identically distributed system.

*Proof.* Let us consider any efficient identically distributed system. According to definition 6, the condition of its efficiency, taking into account (2), can be written as the following inequality:

$$\begin{aligned} \Delta_{ed} &= \max_{1 \leq q \leq c} sT_q - T^{ed}(p, n, s, c, \theta) = \max_{1 \leq q \leq c} (sT_q - T_q^\theta - (s-1)t_{\max}^{q+}) = \\ &= (s-1) \max_{1 \leq q \leq c} (T_q - t_{\max}^q) - \left( \frac{n}{c} + s - 1 \right) \theta \geq 0, \text{ где } t_{\max}^q = \max_{1 \leq i \leq n/c} t_{c(i-1)+q}. \end{aligned} \quad (3)$$

For any stationary identically distributed system, the efficiency condition is written as follows:

$$\begin{aligned} \Delta_{ss} &= sT^m - T^{ss}(p, n, s, c, \theta) = sT^m - \left( \frac{n}{c} + s - 1 \right) t^\theta = \\ &= (s-1)(T^m - t) - \left( \frac{n}{c} + s - 1 \right) \theta \geq 0, \text{ где } T^m = \frac{n}{c} t. \end{aligned} \quad (4)$$

To prove the theorem, it is sufficient to prove that inequality  $\Delta_{ed} \leq \Delta_{ss}$  is satisfied. Substituting expressions from (3) and (4) for  $\Delta_{ed}$  and  $\Delta_{ss}$ , we obtain:

$$\max_{1 \leq q \leq c} (T_q - t_{\max}^q) \leq \left( \frac{n}{c} - 1 \right) t.$$

Let us prove the validity of the last inequality. Let us consider a stationary identically distributed system of competing processes, in which  $t = \max_{1 \leq i \leq n} t_i = t_{\max}^q$ . Let  $t_{\max}^q = t_k$  be definite, then the following chain of relations is valid:

$$\max_{1 \leq q \leq c} (T_q - t_{\max}^q) = \max_{1 \leq q \leq c} \left( \sum_{i=1}^{k-1} t_{c(i-1)+q} + \sum_{i=k+1}^{n/c} t_{c(i-1)+q} \right) \leq \left( \frac{n}{c} - 1 \right) t_{\max}^q = \left( \frac{n}{c} - 1 \right) t.$$

The theorem is proven.

The following statement in the case of unlimited parallelism in the number of processors of a distributed computing system, taking into account a limited number of copies of a structured software resource, defines a sufficient condition for the efficiency of an identically distributed system.

**Theorem 4.** A system of identically distributed competing processes with parameters  $p, n, s, c, \theta$ , satisfying the relations

$$3 \leq s \leq \left\lfloor \frac{p}{c} \right\rfloor, \quad s = \frac{n}{c} \neq 3, \quad ns \geq 2[n + c(s-1)], \quad 0 < \theta \leq t_{\min} = \min_{1 \leq i \leq n} t_i,$$

is efficient.

*Proof.* According to formula (3), the efficiency condition is equivalent to the inequality:

$$\max_{1 \leq q \leq c} \frac{T_q - t_{\max}^q}{\theta} \geq \frac{n + c(s-1)}{c(s-1)}. \quad (5)$$

Therefore, to prove the theorem, it is enough to verify the validity of inequality (5). Due to the choice of  $0 < \theta \leq t_{\min}$ , inequality  $t_{\min}/\theta \geq 1$  will be satisfied, then the chain is valid

$$\max_{1 \leq q \leq c} \frac{T_q - t_{\max}^q}{\theta} \geq \left( \frac{n}{c} - 1 \right) \frac{t_{\min}}{\theta} \geq \frac{n}{c} - 1. \quad (6)$$

Further, from  $ns \geq 2[n + c(s-1)]$  follows the validity of the inequality

$$\frac{n}{c} - 1 \geq \frac{n + c(s-1)}{c(s-1)}. \quad (7)$$

Inequality (5) follows from inequalities (6) and (7). Thus, the theorem is proven.

Below, a necessary and sufficient condition for the existence of an efficient system of identically distributed competing processes under unlimited parallelism is formulated and proven, taking into account a limited number of copies of a structured software resource depending on the amount of additional system costs.

**Theorem 5.** For the existence of an efficient identically distributed system of competing processes with given parameters  $\left\lceil \frac{p}{c} \right\rceil \geq 3$ ,  $2 \leq s \leq \left\lceil \frac{p}{c} \right\rceil$ ,  $2 \leq c \leq p$  and  $\theta > 0$ , the following conditions must be met:

$$\theta \leq \begin{cases} \varphi[c(1 + \sqrt{s})], & \text{если } \sqrt{s} \text{ целое,} \\ \max\{\varphi[c(1 + \sqrt{s})], \varphi[c(2 + \sqrt{s})]\}, & \text{если } \sqrt{s} \text{ нецелое,} \end{cases} \quad (8)$$

where  $\varphi(x) = \frac{c(s-1)T^m(x-c)}{x^2 + xc(s-1)}$  and  $[x]$  are the largest integers not exceeding  $x$ .

*Proof.* According to (4), the condition for the efficiency of any stationary identically distributed system of competing processes is determined by the relation

$$\Delta_{ss} = (s-1)(T^m - t) - \left( \frac{n}{c} + s - 1 \right) \theta \geq 0, \text{ где } T^m = \frac{n}{c}t,$$

which is equivalent to the fulfillment of the inequality

$$\theta \leq \frac{c(s-1)T^m(n-c)}{n^2 + nc(s-1)}. \quad (9)$$

Let us introduce function  $\varphi(x) = \frac{c(s-1)T^m(x-c)}{x^2 + xc(s-1)}$  into consideration. Due to the fact that

$$\varphi'(x) = \frac{c(s-1)T^m[-x^2 + 2cx + c^2(s-1)]}{[x^2 + xc(s-1)]^2}, \text{ then function } \varphi \text{ at } x > 0 \text{ reaches its maximum value at}$$

point  $x = c(1 + \sqrt{s})$ . Let us put

$$n_e = \begin{cases} c(1 + \sqrt{s}), & \text{если } \sqrt{s} \text{ — целое,} \\ \max\{c(1 + [\sqrt{s}]), c(2 + [\sqrt{s}])\}, & \text{если } \sqrt{s} \text{ — нецелое.} \end{cases} \quad (10)$$

The necessity of conditions (8) will be proven if it is established that it is impossible for an efficient identically distributed system of competing processes to exist for which an inequality of the form would hold:

$$\theta > \frac{c(s-1)T^m(n-c)}{n^2 + nc(s-1)}. \quad (11)$$

Obviously, there is no such system for  $n = n_e$ , since by virtue of the definition of function  $\varphi$ , for such  $n$  inequality (11) is satisfied and, consequently, such a system cannot be effective.

If we nevertheless assume the existence of such a system with  $n$  processes, then relation  $n \neq n_e$  must be fulfilled.

It was established above that an identically distributed system with  $n_e$  processes is efficient, therefore, inequality  $\theta \leq \frac{c(s-1)T^m(n_e - c)}{n_e^2 + n_e c(s-1)}$  holds for it. While for a hypothetical system with  $n$  processes, by virtue of the assumption, inequality  $\theta > \frac{c(s-1)T^m(n - c)}{n^2 + nc(s-1)}$  must hold. An obvious consequence of the obtained inequalities is inequality  $\theta > \theta$ .

In case  $n < n_e$ , by virtue of (11), the chain of inequalities

$$\frac{c(s-1)T^m(n_e - c)}{n_e^2 + n_e c(s-1)} < \frac{c(s-1)T^m(n - c)}{n^2 + nc(s-1)} < \theta$$

must be satisfied, from which, by virtue of (9), the inefficiency of an identically distributed system with  $n_e$  processes follows.

Finally, if  $n > n_e$ , then  $\frac{c(s-1)T^m(n_e - c)}{n_e^2 + n_e c(s-1)} > \frac{c(s-1)T^m(n - c)}{n^2 + nc(s-1)} \geq \theta$ , which indicates the

efficiency of the hypothetical identically distributed system of competing processes. The resulting contradictions in all possible cases prove the necessity of conditions (8).

The sufficiency of conditions (8) follows directly from the presence of function  $\varphi$  with property (9). Indeed, in this case the required effective identically distributed system is a system with  $n = n_e$  competing processes, where  $n_e$  is determined by formula (10). The theorem is proven.

## 5. Conclusion

The obtained necessary and sufficient conditions for the efficiency of identically distributed systems of competing processes with a limited number of copies of a software resource have numerous areas of application. In particular, they can be used in designing system and application software oriented towards multiprocessor computing systems and complexes, as well as in solving problems of optimal use of computing resources.

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## Medical sciences

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### SPEECH REHABILITATION IN PATIENTS IN THE ACUTE PERIOD OF STROKE

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#### Abstract

**Relevance:** Aphasia is a partial or complete loss of speech due to local damage to the brain, often occurring in strokes. Effective rehabilitation requires an individual approach and the use of complex speech therapy techniques [6, 8, 9].

**Objective:** To determine speech disorders in patients in the acute period of stroke and to analyze the effectiveness of various speech rehabilitation methods for efferent motor and dynamic aphasia.

**Methods:** The study was conducted in the Almaty stroke center from 2020 to 2022. 72 patients (aged 45-78 years) who had suffered ischemic (37 patients) and hemorrhagic (25 patients) stroke were included. The average age of patients was 61.5 years. Severe stroke and concomitant diseases leading to deterioration of the condition were excluded.

Anamnestic data from the "Inpatient Medical Record", methods of clinical and neurological examination (NIHSS, Rankin scales, Barthel index), neuropsychological testing (A. R. Luria's method, MMSE, clock drawing test), consultation of all specialists in accordance with the clinical protocol, including a rehabilitation specialist, psychologist, speech therapist to study the set goals and objectives were used. Speech therapy methods were used to identify speech disorders and establish an algorithm for treating aphasia [8, 9].

**Results:** Complete recovery of speech was observed in 32.43% of patients with ischemic stroke and 24.0% with hemorrhagic stroke. Partial improvement was noted in 43.24% and 44.0%, respectively [7, 9].

**Conclusions:** Early rehabilitation increases the effectiveness of speech recovery. Complex methods, including articulation exercises, work with cards, repetition methods and written assignments, improve speech and cognitive functions [8, 9]. Prospects for further research include studying the influence of age and gender on the effectiveness of rehabilitation.

**Key words:** stroke, aphasia, speech rehabilitation, speech therapist, neuropsychological testing, articulatory gymnastics, dynamic aphasia, efferent motor aphasia.

#### Introduction

Aphasia is a speech disorder that occurs as a result of damage to certain areas of the brain. In one third of cases, aphasia develops as a result of a stroke [1]. Speech recovery requires a systemic approach, including medical, speech therapy, and psychological rehabilitation [2, 8, 9].

#### Neuropsychological mechanisms of aphasia

According to the research of A. R. Luria [1], aphasia develops as a result of damage to specific areas of the brain responsible for the production and understanding of speech. Efferent motor aphasia is associated with impaired transitions between articulatory poses, and dynamic aphasia is associated with difficulties in constructing speech utterances. These features must be taken into account when choosing rehabilitation methods [6].

To correct speech pathology, various methods were used depending on the type and form of aphasia. For patients with motor aphasia, articulation exercises were used, and tasks were offered for independent completion with the support of relatives. In dynamic aphasia, the main focus was on the development of logical thinking and decision-making using cards, diagrams, gestures and pictograms [8, 9].

#### **Methods of speech rehabilitation**

##### ***Efferent motor aphasia***

- **Articulatory gymnastics** (exercises for the mobility of the lips, tongue, soft palate).
- **Working with cards** (matching images with captions) [4, 9].
- **Repetition technique** (from simple words to complex phrases).
- **Phonetic exercises** (choral reading, speech rhythmization).
- **Written assignments** (from letters and syllables to sentences).

##### ***Dynamic aphasia***

- **Activation of phrasal speech** (answers to questions, retelling).
- **Working with logical diagrams** (restoring the sequence of events).
- **Stimulating dialogue** (interactive exercises, role-playing games).
- **Use of visual support** (gestures, diagrams, pictograms) [5, 8, 9].

•

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## Pedagogical sciences

### PECULIARITIES OF "METHODICAL HANDBOOK: PURPOSE, STRUCTURE, AND IMPORTANCE"

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#### **Abstract**

A methodical handbook serves as an essential resource for providing structured guidance on the implementation of specific procedures, methods, or tasks. This document outlines the purpose, structure, and importance of such handbooks, focusing on their role in standardizing practices, offering step-by-step instructions, and ensuring consistency across various disciplines. The purpose of a methodical handbook is not only to guide and educate users but also to standardize processes, facilitate problem-solving, and document best practices. Its structure typically includes an introduction, detailed methodologies, theoretical background, step-by-step instructions, practical examples, and evaluation techniques. The importance of these handbooks lies in their ability to serve as comprehensive references, support training, ensure efficiency, and contribute to knowledge dissemination. In essence, a methodical handbook is a vital tool in both educational and professional contexts, fostering systematic approaches and continuous improvement.

**Keywords:** methodology, guidelines, instructional handbook, procedure standardization, educational resource, step-by-step instructions, systematic approach, training tool, consistency

**Introduction.** A methodical handbook is an essential tool designed to provide systematic guidance for educators, researchers, and professionals in various fields. It serves as a structured reference that outlines methodologies, techniques, and best practices to achieve specific objectives. This article explores the purpose, structure, and significance of a methodical handbook in different professional domains.

#### *Purpose of a Methodical Handbook*

The primary aim of a methodical handbook is to standardize procedures and ensure consistency in work processes. It helps professionals follow established guidelines, reducing errors and improving efficiency. Some key purposes include:

- *Providing Clear Instructions:* Step-by-step guidance on specific methods or techniques.
- *Enhancing Learning and Training:* Used as a reference for teachers, students, and employees.
- *Ensuring Consistency:* Helps maintain uniformity in implementation across different organizations.
- *Facilitating Research and Development:* Supports academic and professional research with standardized methodologies.

#### *Structure of a Methodical Handbook*

A well-structured methodical handbook typically consists of the following sections:

1. *Introduction*
  - Overview of the handbook's purpose and target audience.
2. *Theoretical Background*
  - Explanation of fundamental principles, concepts, and methodologies.
3. *Practical Guidelines*
  - Step-by-step procedures for implementation.
4. *Examples and Case Studies*
  - Real-life applications and best practices.
5. *Assessment and Evaluation*
  - Methods for monitoring and improving the applied methodologies.
6. *References and Resources*
  - Additional materials for further reading.

According to the correct remark of Adamko M.A., a foreign language in the conditions of the modern educational environment is moving into the field of profession, combining special disciplines and shifting the boundaries of the educational paradigm in teaching a foreign language as a means of communication, which is a real methodological task [2].

Therefore, it seems logical that students should have a professional and communicative competence of sufficient or high level, to achieve which appropriate methods are used in teaching a foreign language [3].

Currently, the researchers of [4] are talking about an era in the methodology of teaching foreign languages, which is called the post-method era and means that there is a huge variety of methods of teaching foreign languages. The most common, according to the analysis of scientific and pedagogical literature, are:

CLIL:

1. The Natural Approach.
2. The Silent Way.
3. Total Physical Respons.

However, one of the effective methods is the communicative language teaching method within the framework of which various methods and innovative strategies for teaching foreign languages are being developed.

One of such strategies is task-based learning (targeted learning, task-oriented learning, taskbased learning, the method of communicative tasks).

It should be noted that in the scientific literature there is a significant body of works devoted to the study and development of theoretical foundations and methods of teaching a professional foreign language based on a communicative approach in the works of Passov E.I. (Communicative method of teaching foreign language speaking), (Surzhenko O.Y. Communicative methodology against the traditional method of teaching a foreign language), Lebedev O.E. (Competence approach in education) and etc.

However, despite the existence of studies devoted to various aspects of teaching a professional foreign language in school education, it is necessary to state the existence of a number of unresolved issues:

- 1) the methodology of using task-based learning in teaching vocational education to students of specialized classes of secondary school is not justified;
- 2) the features of the professional English language in the specialized classes of the natural science direction have not been identified and substantiated;
- 3) a set of professional foreign language tasks has not been developed for students of specialized classes.

**Research problem:** analysis of existing effective methods in teaching professional language and justification of the choice of the task-based learning method for students of specialized classes in teaching a professional foreign language as the most effective.

*The essence and basic characteristics of foreign language collaborative learning process*

The foreign language communicative competence aimed at making learners understand grammar in traditional terms, and acquire a wide literary vocabulary of a second language. Ultimately, learners were expected to become proficient in writing the language accurately, and also appreciate the literary significance and value of reading text.

This method focused on application of rules of grammar, which are practiced through translation exercises. Learners are asked to write a piece of composition on a topic based on the reading passage. It aimed at teaching learners more about the target language, but not how to use it.

This method favours to teach English by rules not by use. It aims at training the learners to write the language accurately by regular and systematic practice in translating words and sentences from their mother tongue. Students get no opportunities to participate in the discussions of the unit. Translations into mother tongue affect the originality of the words. It does not allow the learners to think directly in target language. Thus, it hinders to create a direct link between thought and expression.

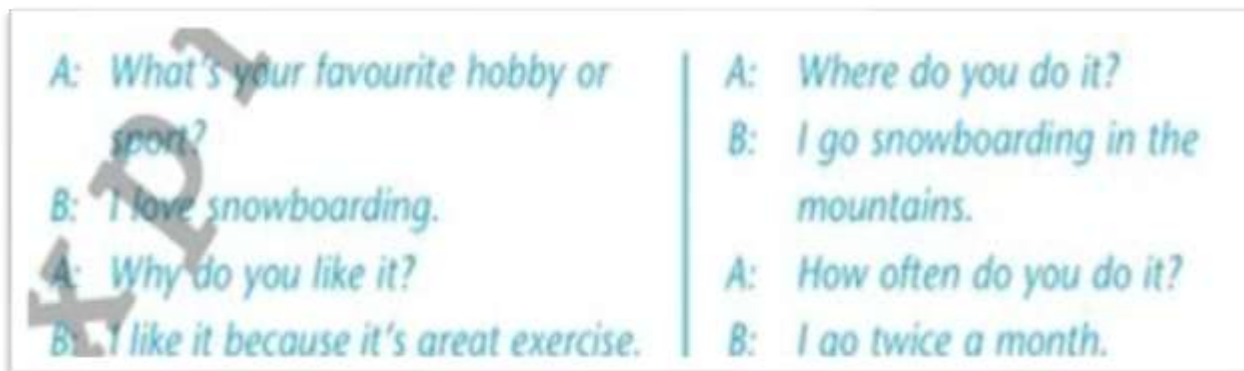
Most of the instructors acknowledge that this method is ineffective by itself as it does not stress on the spoken form of the language and communication skills were neglected. The material this method worked with was literary and as such of little use in transactions. Hence, this method does not enhance the students' communicative ability in the second language.

**Task 4: Complete the sentences with: breathtaking, bright, popular, dive, returns, proud**

1. The sport of falconry is .....in Kazakhstan.
2. I am very .....of my country.
3. There is a .....view from the top of the mountain.
4. The eagle always ..... to the falconer.
5. The sun is so ..... today that I need sunglasses.
6. Birds of prey ..... from high up in the sky.

### Speaking tasks

Ask and answer questions about hobbies and leisure activities. Speaking questions are given in this picture 3:



Picture 3 – Speaking questions are given

### Theme 2: Across cultures

Reading task is shown in this picture 4:

#### Importance of a Methodical Handbook

A well-developed methodical handbook provides numerous benefits:

- **Increases Efficiency:** Reduces time spent on training and learning new methodologies.
- **Improves Quality:** Ensures high standards by following best practices.
- **Enhances Communication:** Acts as a reference guide for collaboration and teamwork.
- **Supports Continuous Improvement:** Encourages feedback and updates to refine methodologies.

#### Conclusion

A methodical handbook is a crucial resource for maintaining consistency, improving efficiency, and ensuring high-quality work in various fields. Whether in education, business, or scientific research, its structured approach helps professionals achieve their goals effectively. Developing a comprehensive handbook requires careful planning, clear guidelines, and continuous updates to stay relevant and useful.

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**THE RISK OF DEVIANT BEHAVIOR IN ADOLESCENTS AND WAYS TO DIMINISH IT****Bazzarbayeva Kyndyzai Mukhametkhankyzy***2<sup>nd</sup> year Master's degree student of Eurasian National University, Nur-sultan, Kazakhstan***Tataeva Roza Kabdygalievna***Professor, Doctor of Medical Sciences, Eurasian National University, Nur-sultan, Kazakhstan***Abstract**

*Adolescence is a critical developmental period marked by significant changes in physical, emotional, and social domains. The risk of deviant behavior in adolescents is influenced by a complex interplay of individual, family, peer, environmental, and societal factors. Family dynamics, including parental supervision and exposure to conflict, can significantly contribute to deviance. Peer influence, particularly in the form of peer pressure and association with deviant peers, is another key factor. Additionally, socioeconomic challenges, community environments, and academic struggles increase vulnerability to risky behaviors. Psychological traits, such as impulsivity or aggression, along with mental health issues like depression or conduct disorders, further elevate the likelihood of deviant actions. Interventions aimed at strengthening family bonds, improving peer relationships, fostering academic success, and addressing mental health are essential to mitigating the risks associated with adolescent deviance. Understanding these multifaceted factors is crucial for the development of targeted prevention and intervention strategies aimed at supporting positive youth development.*

**Keywords:** *adolescent development, deviant behavior, risk factors, family dynamics, peer influence, socioeconomic factors, mental health, substance abuse*

*The risk of deviant behavior in adolescents is influenced by a complex interaction of individual, family, peer, and environmental factors. Understanding these risks can help in preventing or mitigating negative behaviors during this developmental period. Here are some key factors that contribute to the risk of deviant behavior in adolescents.*

**Parental Supervision and Control:** *Lack of parental supervision or inconsistent discipline can contribute to the likelihood of deviant behavior. Adolescents who experience neglect or inconsistent parenting may struggle with boundaries and engage in risky behaviors.*

**Parental Conflict or Abuse:** *Exposure to conflict, abuse, or neglect in the home is a significant risk factor. Adolescents from dysfunctional families may internalize negative behaviors or seek validation and support from peers, which can lead to deviance.*

**Modeling Behavior:** *Adolescents may imitate deviant behavior seen in their parents or guardians. If parents engage in criminal behavior or substance abuse, adolescents may be more likely to follow suit. During adolescence, peers exert a strong influence. The desire for social acceptance and belonging can push adolescents to engage in risky or deviant behaviors, such as drug use, alcohol consumption, or delinquency. Adolescents who associate with deviant peers are at a higher risk of engaging in deviant behavior themselves. Peer groups that encourage rule-breaking or aggressive behaviors can have a strong influence.*

**Socioeconomic and Environmental Factors**

- **Poverty and Unemployment:** *Adolescents from lower socioeconomic backgrounds may face more stressors such as economic hardship, lack of access to quality education, and limited opportunities, which can increase the risk of engaging in deviant behavior.*

- **Community Environment:** *Living in communities with high levels of crime, violence, or drug use can increase an adolescent's exposure to deviant behavior and reduce their perceived alternatives to criminal activity.*

**4. Psychological and Biological Factors**

- **Personality and Temperament:** *Adolescents with impulsive, aggressive, or risk-taking tendencies may be more likely to engage in deviant behavior. Those with externalizing behaviors (e.g., anger, defiance) are at a greater risk.*

- **Mental Health Issues:** *Depression, anxiety, conduct disorders, or attention-deficit hyperactivity disorder (ADHD) may contribute to a higher risk of deviance. In some cases, untreated mental health conditions may lead adolescents to act out in harmful ways.*

- **Substance Abuse:** Adolescents who start using substances at an early age are at a higher risk of engaging in deviant behavior. Substance abuse can impair judgment and increase the likelihood of risky decisions.

#### 5. Academic Failure and School Environment

- **Academic Underachievement:** Adolescents who struggle academically are more likely to disengage from school and may turn to deviant behavior as a form of coping or rebellion.

- **School Environment:** Schools with low academic standards, lack of resources, or poor teacher-student relationships may increase the likelihood of deviant behavior. A lack of positive role models and academic support can leave adolescents feeling disconnected and more prone to delinquency.

#### 6. Cultural and Societal Influences

- **Cultural Norms:** Societal attitudes toward behaviors like drug use, alcohol consumption, or aggression can influence adolescents. In some cultures, deviant behaviors may be normalized or even encouraged.

- **Media Influence:** The portrayal of violence, substance abuse, and other deviant behaviors in movies, TV shows, or social media can glamorize such behaviors, potentially influencing adolescents to imitate them.

#### 7. Cognitive and Developmental Factors

- **Identity Formation:** Adolescence is a time of identity exploration, and some adolescents may engage in deviant behavior as they try to form their identity or rebel against societal norms.

- **Risk Perception:** Adolescents, due to ongoing brain development, may have a less developed capacity for risk assessment. This can lead them to engage in behaviors without fully considering the long-term consequences.

#### Prevention and Intervention

To reduce the risk of deviant behavior, interventions should target multiple areas, including:

**Strengthening family relationships** and improving parenting skills.

**Promoting positive peer relationships** and providing adolescents with healthy, supportive peer groups.

**Improving academic outcomes** and providing access to extracurricular activities to build self-esteem and a sense of belonging.

**Addressing mental health issues** and providing counseling or therapy for those with psychological challenges.

**Community involvement,** including mentorship programs and youth support services, can help reduce environmental risks.

Learning about adolescents is a complex discipline, it has many sections, each of which has its own characteristics, the secrets of our life that seem inaccessible until you join the process of learning them and understand how interesting and attractive this science is. When submitting new material in biology, constant demonstration support is required. Modern students are not interested in simple pictures, they need to be constantly surprised. Research shows that most biology teachers still use traditional and outdated methods in teaching biology. Teachers convey the facts of biology directly to students and encourage rote memorization of actual knowledge for exams that cannot teach students to solve complex biological problems [4].

Deviant behavior refers to actions that violate the social norms, values, or laws of a society or community. What is considered deviant can vary widely depending on culture, time period, and societal rules. Some examples include:

- **Criminal Deviance:** Behavior that violates formal laws, such as theft, assault, or drug abuse.
- **Non-criminal Deviance:** Actions that deviate from social norms but are not necessarily illegal, such as unconventional lifestyles, extreme fashion choices, or certain kinds of political activism.
- **Primary Deviance:** Initial acts of deviance that may not have significant social consequences.
- **Secondary Deviance:** When deviant behavior becomes part of an individual's identity, often due to societal reactions or labeling.

#### 2. CAUSES AND RISK FACTORS

In practical terms, deviant behavior often stems from a mix of personal, social, and environmental factors:

- **Psychological/Emotional Issues:** People dealing with mental health challenges like depression, anxiety, or personality disorders (e.g., antisocial personality disorder) may engage in deviant behavior as a form of coping or due to impaired decision-making.

- **Social and Family Environment:** Growing up in a dysfunctional family or neighborhood where crime or deviance is normalized increases the likelihood of adopting similar behaviors.
- **Peer Influence:** Adolescents are particularly vulnerable to peer pressure, where the desire to fit in or gain social status can lead to rule-breaking.

- **Substance Abuse:** Drugs and alcohol often lead to impaired judgment and can encourage risky or illegal behavior.

- **Socioeconomic Status:** Those facing financial hardship may be more likely to engage in criminal behavior to survive or succeed in a competitive society.

- **Cultural Norms:** In some subcultures or social circles, deviant behavior (e.g., rebellion, lawbreaking) may be encouraged or celebrated.

### 3. COMMON TYPES OF DEVIANT BEHAVIOR

- **Substance Abuse:** Alcohol, drugs, and tobacco use may be socially acceptable in some contexts, but abuse and illegal usage (e.g., illegal drugs, underage drinking) are forms of deviance.

- **Violent Crime:** Acts like robbery, assault, or murder break legal and moral norms and have severe legal consequences.

- **Sexual Deviance:** This includes behaviors like sexual assault, exploitation, or non-normative sexual practices that are not consented to or violate social norms.

- **White-Collar Crime:** Non-violent crime that typically involves financial or corporate wrongdoing, such as embezzlement or fraud.

- **Public Disorder:** Behaviors that disrupt social order or violate public decency, such as public intoxication, vandalism, or loitering.

### 4. CONSEQUENCES OF DEVIANT BEHAVIOR

- **Legal Consequences:** Criminal deviance often results in legal consequences like arrest, fines, probation, or imprisonment.

- **Social Consequences:** Socially, deviant behavior can lead to stigmatization, exclusion, or loss of reputation and relationships. A person may be labeled as "deviant" or "criminal" by society.

- **Psychological Consequences:** Individuals who engage in deviant behavior may experience feelings of guilt, shame, or low self-esteem. They may also struggle with mental health issues or face barriers to recovery.

- **Economic Consequences:** Engaging in criminal or deviant behavior can impact future employment prospects, leading to lower earning potential or lack of job opportunities due to criminal records or reputations.

TABLE 1

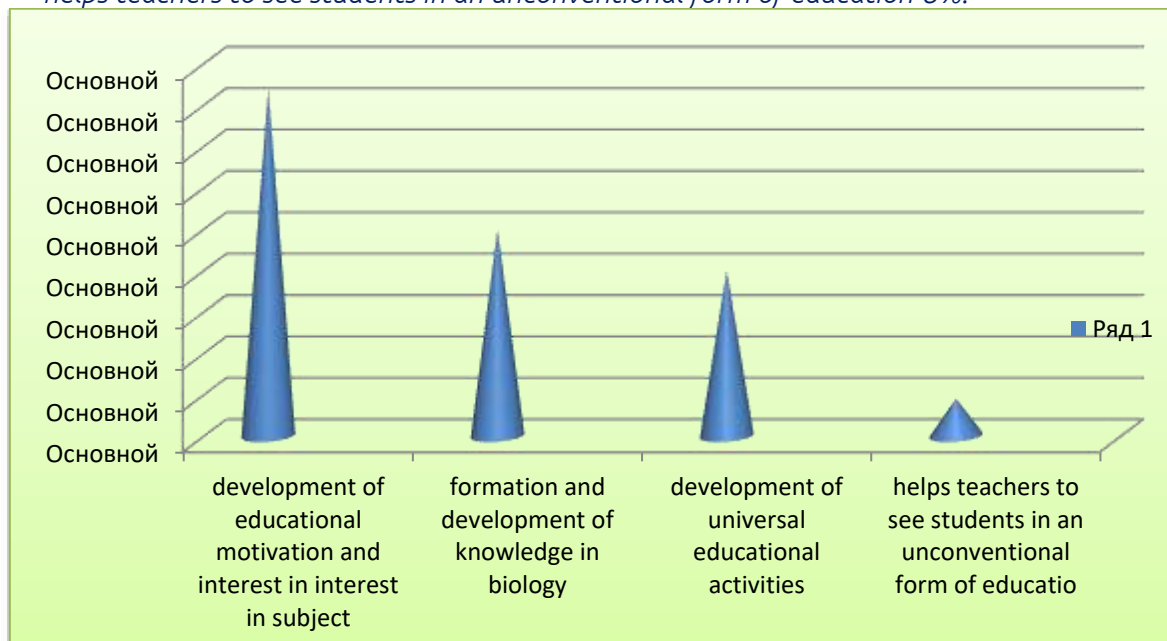
#### THESE PROGRAMS REDUCE RECIDIVISM AND SUPPORT INDIVIDUALS IN MAKING POSITIVE CHANGES.

|   | <b>Names of practical strategies</b>         | <b>Descriptions</b>                                                                                                                                                                                                                                                                                                                       |
|---|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <b>Early Intervention Programs:</b>          | Early identification of at-risk individuals (e.g., youth showing signs of behavioral problems) and offering mentorship, counseling, or community programs can help prevent the development of more severe deviant behavior.                                                                                                               |
| 2 | <b>Support Systems:</b>                      | Strong family and community support systems play a critical role. Positive role models, communication, and healthy relationships help deter individuals from engaging in deviant behavior. For instance, families providing emotional support and guidance can steer children away from harmful influences.                               |
| 3 | <b>Mental Health Services</b>                | Offering psychological support, therapy, or counseling can address underlying mental health issues that may lead to deviant behavior. Substance abuse treatment is also critical in managing behaviors linked to addiction.                                                                                                               |
| 4 | <b>Education and Employment Programs</b>     | Providing access to quality education and job opportunities can reduce the economic motivations behind criminal behavior.                                                                                                                                                                                                                 |
| 5 | <b>Community Policing and Social Control</b> | Building strong, safe communities with positive outlets for youth (e.g., sports programs, after-school activities, or local mentorship) can prevent the spread of deviant behavior. Community-based policing can build trust between law enforcement and citizens, allowing for early intervention and support before behaviors escalate. |

One of the survey questions is aimed at determining the value of multimedia teaching tools in the process of teaching special pedagogy. University teachers showed the values of using ICT tools:

- development of educational motivation and interest in the subject-42%;
- formation and development of knowledge in special pedagogy-25%;

- development of universal educational activities-20%;
- helps teachers to see students in an unconventional form of education-8%.



**Figure 1:** Teachers' answers towards the value of deviant behavior in the process of learning special pedagogy

All these resources allow us to diversify the learning process, make it more visual. In addition, the use of such ICTs helps students to get much more opportunities for independent study of the material, organizing research activities in the form of laboratory work in combination with a computer at home and a real experiment at school, planning and analyzing those experiments that are not feasible in real life in school laboratories, but are possible in virtual reality. In addition, do not forget about the expediency of using ICT for the development of students' personality and their preparation for independent production activities in the conditions of modern information society.

### Conclusion

In conclusion, deviant behavior is a complex and multifaceted phenomenon that is shaped by a variety of individual, social, and environmental factors. It encompasses actions that violate societal norms, values, or laws, and can range from non-criminal behaviors to criminal acts. The risk of engaging in deviant behavior can be influenced by factors such as family dynamics, peer influences, mental health issues, socioeconomic status, and exposure to harmful environments. Understanding deviant behavior involves exploring different theoretical perspectives, including labeling theory, strain theory, and social control theory. These frameworks offer valuable insights into why individuals may engage in deviance, highlighting the role of societal pressures, social bonds, and individual coping mechanisms.

Prevention and intervention efforts to address deviant behavior are crucial for promoting social order and individual well-being. Strategies such as early intervention programs, mental health support, community engagement, and rehabilitation initiatives can help reduce the risk of deviant behavior.

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7. National Institute on Drug Abuse (NIDA). (n.d.). *Substance Use and Its Impact on Behavioral Deviance*, pp. 17-18

## DEVELOPMENT OF THE METHODOLOGY OF INCLUSIVE EDUCATION IN BIOLOGY TEACHING

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### Abstract

The methodology of inclusive education in biology teaching involves adapting teaching practices, content, and assessment methods to meet the diverse needs of all students, including those with disabilities, learning difficulties, and different cultural or linguistic backgrounds. The goal is to create an equitable learning environment where every student can fully participate in learning biology, develop scientific skills, and achieve academic success. This research emphasizes the importance of developing inclusive science curricula that address the diverse needs of students, particularly those with disabilities. It discusses how to create accessible learning environments and promote the participation of all students in science education. The study highlights various strategies, including curriculum design, differentiated instruction, and the integration of assistive technology.

**Keywords:** inclusive education , biology education , differentiated instruction , universal design for learning (UDL) ,culturally responsive teaching ,assistive technology

### 1. Differentiated Instruction

Differentiated instruction involves tailoring teaching methods, resources, and assessments to address the diverse needs of students. In a biology classroom, this could mean:

- **Visual Supports:** Using diagrams, videos, and charts to help students grasp complex biological concepts.
- **Hands-on Activities:** Providing interactive, practical activities like experiments, field trips, or biological model building to support kinesthetic learners.
- **Modified Content:** Simplifying or restructuring lessons for students who struggle with reading or have learning disabilities, while still maintaining the core content.
- **Varied Assessment Methods:** Offering different forms of assessment, such as written tests, oral presentations, group projects, or portfolios, to cater to various strengths and abilities.

### 2. Universal Design for Learning (UDL)

**Universal Design for Learning (UDL)** is an educational framework that promotes flexible learning environments that accommodate all learners. In the context of biology, UDL can be implemented through:

- **Multiple Means of Representation:** Presenting information in various formats (text, audio, video, diagrams) so that all students can access the content in ways that suit their learning preferences.
- **Multiple Means of Expression:** Encouraging students to demonstrate their understanding through different methods (e.g., writing, drawing, speaking, or using technology).
- **Multiple Means of Engagement:** Offering different ways to motivate students and keep them engaged, such as using real-world examples from nature, discussing current scientific advancements, or incorporating students' interests into lessons.

### 3. Collaborative and Cooperative Learning

Cooperative learning encourages students to work together in small, diverse groups. In biology, students can collaborate on activities like:

- **Group Projects:** Working together to research and present topics like ecosystems, human anatomy, or genetics.
- **Peer Teaching:** Allowing students to explain biological concepts to one another, which can be particularly beneficial for students with diverse needs, as it reinforces understanding through peer support.
- **Discussion and Debates:** Engaging in discussions on ethical issues in biology (e.g., genetic engineering or conservation) can help foster critical thinking and inclusion of diverse perspectives.

#### 4. **Scaffolded Instruction**

**Scaffolding** is a teaching strategy where support is gradually removed as students gain independence in learning. In biology, this could involve:

- **Guided Practice:** Providing structured guidance in lab experiments or biological problem-solving before allowing students to work independently.
- **Chunking Information:** Breaking down complex biological concepts (e.g., cell division or ecological relationships) into smaller, manageable parts to make learning more accessible.
- **Providing Clear Instructions:** Giving clear, step-by-step instructions for activities or experiments to help students with different learning needs follow the content easily.

#### 5. **Use of Assistive Technology**

Integrating **assistive technologies** can support students with disabilities or those who need additional help. This could include:

- **Speech-to-Text Tools:** For students with dyslexia or physical impairments that make writing difficult, speech-to-text programs can allow them to demonstrate their knowledge more effectively.
- **Interactive Biology Software:** Using educational software or apps that simulate biological processes (e.g., genetic inheritance or ecological models) can help visual learners understand complex biological concepts.
- **Text-to-Speech Tools:** For students with reading difficulties, software that reads aloud biology texts or instructions can help improve comprehension and engagement.

#### 6. **Culturally Responsive Teaching**

Biology teachers must be sensitive to the cultural backgrounds and lived experiences of their students. Culturally responsive teaching strategies include:

- **Incorporating Diverse Perspectives:** Introducing global examples of biology-related issues (e.g., indigenous knowledge about ecosystems or biodiversity) and celebrating the contributions of scientists from different cultures.
- **Respecting Linguistic Diversity:** Providing language support for students whose first language is not the language of instruction, such as using bilingual resources or visual aids to support understanding.
- **Avoiding Bias:** Ensuring that biology lessons do not inadvertently perpetuate stereotypes or biases and fostering an environment where every student feels valued and included.

#### 7. **Inclusive Assessment and Feedback**

Inclusive education also emphasizes fair and supportive assessment practices. In biology teaching, this can be implemented by:

- **Flexible Assessment Methods:** Allowing students to demonstrate their knowledge in different formats (written tests, oral presentations, models, multimedia projects).
- **Formative Assessments:** Using regular, low-stakes assessments (quizzes, peer assessments, and homework) to gauge understanding and provide ongoing feedback.
- **Differentiated Grading:** Being flexible with deadlines and allowing students to re-submit assignments after receiving feedback or additional support.

#### 8. **Promoting Self-Advocacy and Reflection**

Encouraging students to take responsibility for their learning is key to inclusive education. In biology, this could involve:

- **Goal Setting:** Helping students set personal academic goals in biology and develop strategies to achieve them.
- **Reflection:** Providing opportunities for students to reflect on their learning experiences, including what strategies worked for them and where they might need additional support.
  - The method of integration is a method, using which, the teacher:
    - - creates a problematic situation;
    - - forms a problem task;
    - - solves it by demonstrating the stage of problem solving, the sequence of reasoning, the pattern of reasoning.
  - And the student:
    - - perceives, realizes, comprehends, remembers knowledge about the course of solving a holistic problem;
    - - argues with the teacher.
  - The purpose of the application of integrative presentation is the assimilation by students of knowledge about the main stages of solving the problem, their content and sequence of presentation [3].
  - Stages of the lesson on the theme: "Patterns of heredity and variability in living organisms"

- I. Announcement of the lesson theme and setting the purpose and objectives of the lesson.
- II. Updating students' knowledge on the issues.
- 1) What does biology study? What is the origin of the name of science?
- 2) Define the concept of "integration".
- 3) Who is the founder of biology?
- 4) Define the concept of "biological process".
- 5) Prove by examples the universal character of this property of organisms.
- 6) Define the concept of "variability".
- 7) Prove by concrete examples that this property is universal for all living things.
- 8) Demonstration of PPT presentation illustrating the phenomena of biology and integration
- Integrating biology to secondary school is an exciting way to learn biology and is readily

incorporated into large classes in a lecture hall environment. Integration engages students in solving authentic biological case problems, stimulating discussion among students and reinforcing learning. A learning environment emulates the workplace and develops self-directed learners. This is preferable to a mimetic learning environment in which students only watch, memorize, and repeat what they have been told.

### **(1) Forming Small Groups**

• We may decide to devote all or part of a class session to PBL, but students must form small work groups during that time. We can ask the students to form groups of 3-5 people, or assign the groups ourselves.

### **Conclusion**

The methodology of **inclusive education in biology teaching** is about ensuring that all students, regardless of their abilities, backgrounds, or learning styles, can access and engage with the subject content effectively. By adopting strategies like differentiated instruction, Universal Design for Learning, collaborative learning, and the use of assistive technologies, biology teachers can create an inclusive and supportive environment that promotes understanding, collaboration, and success for every student. The ultimate goal is to help all students not only learn the core concepts of biology but also to foster a deeper appreciation for the subject and its relevance to their lives and the world around them.

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## REASONABLE WAYS TO DEVELOP STUDENTS' RESEARCH AND CRITICAL THINKING SKILLS USING PBL DESIGN METHODOLOGY IN MATHEMATICS

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### Abstract

Project-Based Learning (PBL) offers an effective methodology for developing students' research and critical thinking skills in mathematics. This approach engages students in solving real-world, complex problems that require them to apply mathematical concepts, conduct independent research, and collaborate with peers. By integrating authentic, interdisciplinary problems, PBL encourages students to gather data, analyze information, and explore various mathematical models and solutions. Key strategies for fostering research and critical thinking include iterative problem-solving, the use of technology and data analysis tools, collaborative learning, and guiding students through problem definition and solution framing. Additionally, promoting reflection, self-assessment, and the ability to communicate mathematical results enhances students' deeper understanding and reasoning skills.

**Keywords:** Project-Based Learning (PBL), mathematics education, research skills, critical thinking, problem-solving, interdisciplinary learning, collaborative learning, data analysis, mathematical modeling, reflection, self-assessment, technology in education, student engagement.

### Introduction

Using **Project-Based Learning (PBL)** design methodology in mathematics provides students with opportunities to develop essential research and critical thinking skills in a collaborative, real-world context. In PBL, students engage in solving complex, authentic problems, which requires them to investigate, analyze, and apply mathematical concepts in meaningful ways. Here are some **reasonable ways** to develop research and critical thinking skills in mathematics using the PBL approach:

#### 1. Identify Real-World Problems

The first step in PBL is to identify authentic problems that require mathematical understanding. To help students develop research and critical thinking skills, these problems should be relevant, complex, and interdisciplinary, providing a context where students need to gather information and use mathematical reasoning. Examples include:

- **Designing a sustainable city:** Students can research topics such as population growth, resource allocation, traffic flow, and environmental impact while applying mathematical concepts like geometry, calculus, and statistics.

- **Optimizing a business plan:** Students could work on problems related to budgeting, pricing strategies, and maximizing profit using algebra, functions, and statistics.

#### Research Skills Development:

- Encourage students to use varied sources, including books, online databases, and expert opinions.
- Teach them to evaluate the credibility of sources and extract relevant data.
- Have students collect real-world data that they can analyze mathematically (e.g., conducting surveys, gathering statistics).

#### 2. Encourage Collaborative Learning

PBL naturally involves teamwork, which is crucial for fostering communication and critical thinking. When students collaborate, they can share ideas, challenge each other's thinking, and approach problems from different perspectives.

#### Critical Thinking Skills Development:

- Organize group discussions where students have to defend their solutions, critique others' approaches, and propose alternative methods.

- Provide opportunities for peer feedback and self-reflection to help students evaluate the validity of their findings and reasoning.
- Facilitate debates on mathematical methods or conclusions to encourage deeper thinking about the assumptions and limitations of different approaches.

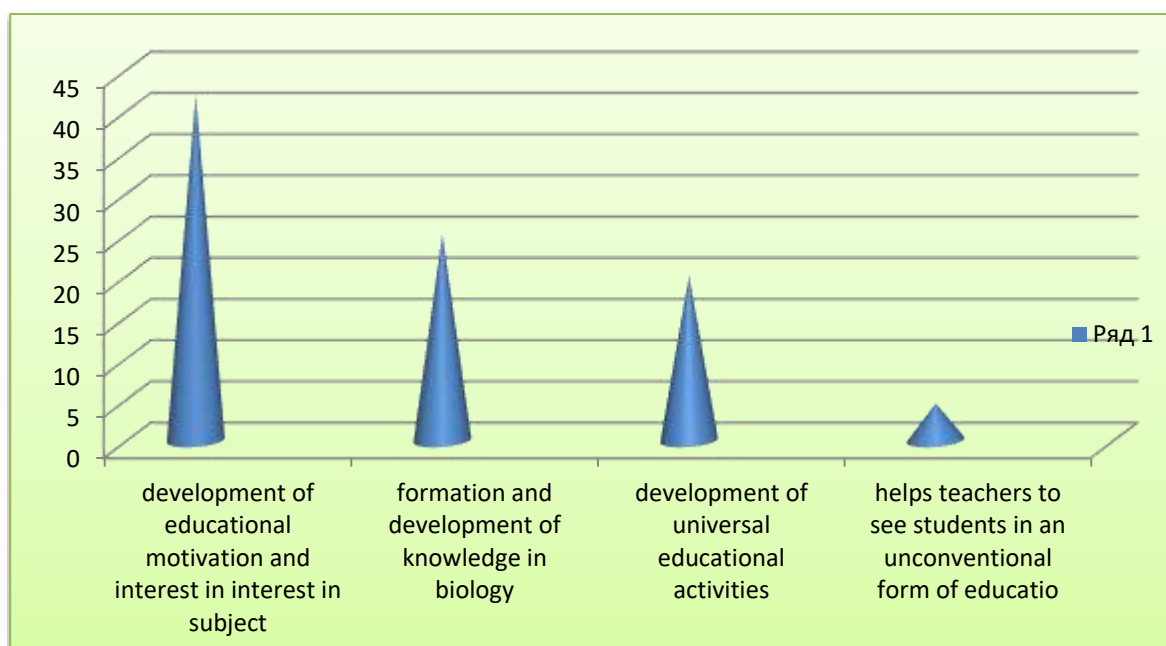
TABLE 1

**THESE PROGRAMS REDUCE RECIDIVISM AND SUPPORT INDIVIDUALS IN MAKING POSITIVE CHANGES.**

|   | <b>Names of practical strategies</b>         | <b>Descriptions</b>                                                                                                                                                                                                                                                                                                                       |
|---|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <b>Early Intervention Programs:</b>          | Early identification of at-risk individuals (e.g., youth showing signs of behavioral problems) and offering mentorship, counseling, or community programs can help prevent the development of more severe deviant behavior.                                                                                                               |
| 2 | <b>Support Systems:</b>                      | Strong family and community support systems play a critical role. Positive role models, communication, and healthy relationships help deter individuals from engaging in deviant behavior. For instance, families providing emotional support and guidance can steer children away from harmful influences.                               |
| 3 | <b>Mental Health Services</b>                | Offering psychological support, therapy, or counseling can address underlying mental health issues that may lead to deviant behavior. Substance abuse treatment is also critical in managing behaviors linked to addiction.                                                                                                               |
| 4 | <b>Education and Employment Programs</b>     | Providing access to quality education and job opportunities can reduce the economic motivations behind criminal behavior                                                                                                                                                                                                                  |
| 5 | <b>Community Policing and Social Control</b> | Building strong, safe communities with positive outlets for youth (e.g., sports programs, after-school activities, or local mentorship) can prevent the spread of deviant behavior. Community-based policing can build trust between law enforcement and citizens, allowing for early intervention and support before behaviors escalate. |

One of the survey questions is aimed at determining the value of multimedia teaching tools in the process of teaching special pedagogy. University teachers showed the values of using ICT tools:

- development of educational motivation and interest in the subject-42%;
- formation and development of knowledge in special pedagogy-25%;
- development of universal educational activities-20%;
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**Figure 1:** Teachers' answers towards the value of deviant behavior in the process of learning special pedagogy

All these resources allow us to diversify the learning process, make it more visual. In addition, the use of such ICTs helps students to get much more opportunities for independent study of the material,

*organizing research activities in the form of laboratory work in combination with a computer at home and a real experiment at school, planning and analyzing those experiments that are not feasible in real life in school laboratories, but are possible in virtual reality. In addition, do not forget about the expediency of using ICT for the development of students' personality and their preparation for independent production activities in the conditions of modern information society.*

### **Conclusion**

*In conclusion, deviant behavior is a complex and multifaceted phenomenon that is shaped by a variety of individual, social, and environmental factors. It encompasses actions that violate societal norms, values, or laws, and can range from non-criminal behaviors to criminal acts. The risk of engaging in deviant behavior can be influenced by factors such as family dynamics, peer influences, mental health issues, socioeconomic status, and exposure to harmful environments. Understanding deviant behavior involves exploring different theoretical perspectives, including labeling theory, strain theory, and social control theory. These frameworks offer valuable insights into why individuals may engage in deviance, highlighting the role of societal pressures, social bonds, and individual coping mechanisms.*

*Prevention and intervention efforts to address deviant behavior are crucial for promoting social order and individual well-being. Strategies such as early intervention programs, mental health support, community engagement, and rehabilitation initiatives can help reduce the risk of deviant behavior.*

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## ENHANCING EFL LEARNERS' MONITORING SKILLS THROUGH COLLABORATIVE WRITING AND PEER FEEDBACK

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### Abstract

Developing strong monitoring skills is essential for English as a Foreign Language (EFL) learners to improve their writing proficiency. However, many learners struggle with self-regulation, error detection, and text organization due to limited exposure and practice. Collaborative writing and peer feedback have been widely recognized as effective strategies to enhance learners' ability to self-monitor their writing. These approaches encourage active engagement, critical thinking, and metacognitive awareness, enabling students to identify and correct linguistic errors while improving coherence and cohesion. This study explores how collaborative writing and peer feedback contribute to enhancing EFL learners' monitoring skills. It examines the theoretical foundations of these strategies, including Vygotsky's Sociocultural Theory and Flavell's Metacognitive Theory, to highlight their role in language development. Additionally, empirical research and case studies are reviewed to demonstrate the effectiveness of these approaches in improving self-regulation, error correction, and overall writing performance.

**Keywords:** peer feedback, monitoring skills, language proficiency, self-editing, critical thinking, metacognition, error identification, reflective learning, language awareness

Despite the numerous benefits, challenges such as reliability of peer feedback, cultural barriers to critique, and time constraints must be addressed. The study suggests that providing structured training and integrating digital tools can enhance the effectiveness of peer collaboration. Ultimately, incorporating collaborative writing and peer feedback into EFL instruction fosters a more interactive and self-directed learning environment, equipping students with essential writing skills for academic and professional success.

### 1. Introduction

Writing in a foreign language is a complex and demanding process that requires learners to integrate multiple skills, including grammar, vocabulary, organization, and coherence. Among these, **monitoring skills**—the ability to review, detect, and correct errors—play a crucial role in improving writing quality. However, many EFL learners face challenges in self-monitoring due to limited language exposure, lack of confidence, and inadequate feedback mechanisms. As a result, their writing often contains persistent errors that hinder effective communication.

To address these challenges, **collaborative writing** and **peer feedback** have emerged as effective strategies that promote active engagement, interaction, and self-regulated learning. Collaborative writing transforms the writing process into a social activity, where learners work together to produce a text, discuss linguistic choices, and negotiate meaning. Similarly, peer feedback allows students to critically evaluate their own and others' work, fostering greater awareness of strengths and weaknesses in writing. These approaches encourage learners to become more reflective and independent in their writing practices, ultimately enhancing their ability to monitor and improve their work.

This research examines the role of collaborative writing and peer feedback in enhancing EFL learners' monitoring skills. It explores the theoretical foundations of these strategies, reviews empirical studies supporting their effectiveness, and discusses challenges and pedagogical implications. By integrating collaborative writing and peer feedback into EFL instruction, educators can create a dynamic and interactive learning environment that promotes long-term writing development.

### 2. Literature Review

#### 2.1 Collaborative Writing in EFL Learning

Collaborative writing involves two or more learners working together to generate and refine written texts. Research suggests that this approach enhances learners' ability to **monitor and self-correct**

their writing by encouraging discussion about grammar, vocabulary, coherence, and text organization (Storch, 2013). Through collaboration, students develop a deeper understanding of language structures and gain exposure to different writing strategies, which strengthens their self-regulation skills.

Additionally, collaborative writing fosters **linguistic scaffolding**, where more proficient learners support less proficient peers in improving grammatical accuracy and lexical choices. Over time, this interaction leads to greater self-awareness and improved writing performance. Furthermore, collaborative writing reduces writing anxiety, as learners feel supported in the process, which encourages risk-taking and creativity (Fernández Dobao, 2012).

## 2.2 Peer Feedback and Its Role in Writing Development

Peer feedback is another essential component of collaborative learning, allowing learners to review and critique each other's work. According to Liu & Carless (2006), peer feedback fosters an interactive learning environment where students engage in error detection, provide constructive criticism, and apply feedback to improve their writing. This process encourages students to develop a sense of responsibility for their own learning, which strengthens their monitoring skills.

Studies have shown that students who participate in peer review activities make more significant **revisions and improvements** in their writing than those who rely solely on teacher feedback (Hyland & Hyland, 2006). Peer feedback also enhances **metalinguistic awareness**, as learners articulate grammatical rules and stylistic choices when providing comments. However, the effectiveness of peer feedback depends on proper training, as unstructured peer reviews may lead to vague or superficial comments.

Two key theories support the role of collaborative writing and peer feedback in developing monitoring skills:

- **Sociocultural Theory (Vygotsky, 1978)**: Emphasizes the role of social interaction in learning. Collaborative writing provides a scaffold for learners to develop monitoring skills through guided participation and feedback.

- **Metacognitive Theory (Flavell, 1979)**: Highlights the importance of self-awareness in learning. Peer feedback and collaboration encourage learners to reflect on their writing process, improving their ability to monitor and revise their work.

## 3. Methodology (Expanded)

### 3.1 Participants

This study involves 50 intermediate EFL learners enrolled in a university-level writing course. The participants come from diverse linguistic backgrounds, with varying levels of exposure to English. They are divided into two groups:

1. **Experimental Group (25 students)** – Engages in collaborative writing and peer feedback activities.

2. **Control Group (25 students)** – Follows a traditional individual writing approach with teacher-centered feedback.

To ensure validity, participants are selected based on similar proficiency levels, determined through a standardized English writing test. The study spans eight weeks, during which both groups complete multiple writing tasks.

To assess the impact of collaborative writing and peer feedback on monitoring skills, multiple data collection methods are employed:

- **Pre-test and Post-test**: All participants complete an individual writing task at the beginning and end of the study. These essays are analyzed for grammatical accuracy, coherence, and overall writing quality.

- **Peer Feedback Analysis**: In the experimental group, peer comments are examined for specificity, usefulness, and impact on subsequent revisions.

- **Questionnaires and Interviews**: Students provide feedback on their experiences with collaborative writing and peer review, offering insights into their perceptions, challenges, and engagement levels.

A mixed-methods approach is used to analyze the data:

- **Quantitative Analysis**: Pre-test and post-test scores are compared using statistical methods to determine improvements in writing quality and monitoring skills.

- **Qualitative Analysis**: Peer feedback comments and student reflections from questionnaires and interviews are examined to identify patterns in metacognitive awareness and writing strategies.

By combining quantitative and qualitative data, this study provides a comprehensive understanding of how collaborative writing and peer feedback influence EFL learners' ability to monitor and improve their writing.

#### 4. Results and Discussion (Expanded)

##### 4.1 Improvement in Monitoring Skills

Findings indicate that students in the collaborative writing and peer feedback group demonstrated significant improvements in their ability to identify and correct errors. The post-test results revealed that these students made fewer grammatical, lexical, and structural mistakes compared to their pre-test performance. Additionally, they exhibited a higher rate of self-correction, indicating enhanced monitoring skills. In contrast, the control group, which relied solely on teacher feedback, showed improvement but at a slower rate.

Furthermore, students in the experimental group developed a habit of cross-checking their work before submission, suggesting increased **self-regulation** in writing. They became more adept at recognizing common grammatical errors and structuring their texts more coherently, aligning with findings from previous studies (Storch, 2013).

##### 4.2 Enhanced Metacognitive Awareness

One of the most significant benefits observed was the development of **metacognitive awareness**—students became more conscious of their writing process and actively engaged in self-monitoring strategies. During interviews, many students reported that collaborative discussions helped them notice patterns in their errors, which they later applied to their independent writing. This shift from teacher-dependent learning to **self-directed improvement** aligns with Flavell's (1979) Metacognitive Theory, which emphasizes the importance of awareness in learning.

Additionally, peer feedback contributed to improved **critical thinking skills**, as students had to analyze their peers' writing and provide constructive criticism. This process reinforced their understanding of writing conventions and enabled them to apply these insights to their own work. Over time, they became more autonomous writers, capable of evaluating their own strengths and weaknesses.

Despite the benefits, some challenges emerged:

- **Reliability of Peer Feedback:** Some students provided generic or overly positive comments, limiting the effectiveness of feedback. Training in **constructive critique strategies** could help address this issue.

- **Cultural Barriers:** In some cultures, students were hesitant to give negative feedback to peers, fearing it might damage relationships. Encouraging a **growth mindset** and framing feedback as a learning tool rather than criticism can help mitigate this challenge.

- **Time Constraints:** Collaborative writing and peer review require more time than individual writing. Integrating technology, such as online peer review platforms, can help streamline the process and make it more efficient.

#### 5. Conclusion and Recommendations

This study highlights the effectiveness of collaborative writing and peer feedback in enhancing EFL learners' monitoring skills. These approaches promote **self-regulation**, **error correction**, and **metacognitive awareness**, ultimately leading to more proficient writing. However, for optimal results, educators should provide training on **effective peer feedback strategies** and incorporate digital tools to streamline collaboration.

Future research should explore the role of **technology-enhanced peer feedback**, including AI-driven writing assistants and online collaborative platforms, in further developing monitoring skills. By integrating these strategies into EFL instruction, teachers can create a **more interactive and learner-centered** writing environment that fosters long-term writing improvement.

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**FORMATION OF STUDENTS' CONCEPTUAL KNOWLEDGE IN THE BLOOD PHYSIOLOGY SECTION****Kasimova Aida Talgatovna***2<sup>nd</sup> year Master's degree student of  
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Eurasian National University named after L. Gumilyev,  
Nur-Sultan, Kazakhstan***Abstract**

*The formation of students' conceptual knowledge in the blood physiology section is critical in building a strong foundation for understanding human biology and medical sciences. Blood physiology is an important topic that explores the composition, function, and regulation of blood within the human body. Teaching this section effectively requires a combination of different strategies to ensure that students develop a deep and comprehensive understanding of key concepts. Techniques such as case-based learning, problem-solving, and formative assessments are highlighted as key methods for reinforcing knowledge and promoting critical thinking. Furthermore, the paper underscores the importance of linking theoretical content to real-world medical scenarios, enhancing student engagement and application of concepts in clinical settings. By fostering a deep, conceptual understanding of blood physiology, educators can better prepare students for advanced studies in biology and health sciences.*

**Keywords:** *Blood physiology, conceptual knowledge, teaching strategies, interactive learning, case-based learning, hemoglobin, blood composition, blood circulation, coagulation cascade, clinical applications*

**Introduction**

*The formation of students' conceptual knowledge in the blood physiology section is critical in building a strong foundation for understanding human biology and medical sciences. Blood physiology is an important topic that explores the composition, function, and regulation of blood within the human body. Teaching this section effectively requires a combination of different strategies to ensure that students develop a deep and comprehensive understanding of key concepts. Below is a breakdown of how to form students' conceptual knowledge in this area:*

**1. Building a Strong Conceptual Foundation**

- **Introduction to Blood Composition:** *Students should first understand the basic components of blood, including red blood cells (RBCs), white blood cells (WBCs), platelets, and plasma. This can be taught through interactive lectures, diagrams, and models to help students visualize blood as a complex fluid.*

- **Functions of Blood:** *Students should then learn the functions of blood, including transportation of gases (oxygen and carbon dioxide), nutrients, waste products, immune response, and regulation of body temperature. Discussions and case studies on blood's role in homeostasis can help solidify this concept.*

**2. Use of Visual Aids and Interactive Learning**

- **Diagrams and Models:** *Visual representations of blood cells, the structure of hemoglobin, and the circulatory system should be used. These help students grasp the microscopic and macroscopic structure and functions of blood.*

- **Microscope Labs:** *Hands-on lab sessions where students observe blood samples under a microscope can enhance their understanding of blood composition and its cellular components.*

- **Simulations and Animations:** *Using 3D simulations or animations of blood circulation, clotting mechanisms, and immune responses can make abstract processes more tangible for students.*

**3. Explaining the Physiology of Blood**

- **Hemoglobin and Oxygen Transport:** *Discuss the physiological process of oxygen transport by hemoglobin in red blood cells, emphasizing the role of partial pressure gradients, the Bohr effect, and*

the oxygen dissociation curve. Use interactive charts or software to demonstrate how oxygen binding and release work in different tissues.

- **Blood Clotting Mechanism:** The coagulation cascade is a vital concept, and students should understand the sequence of events in clot formation. This can be taught through flowcharts, videos, and case studies about bleeding disorders or clotting abnormalities.

- **Regulation of Blood Volume and Composition:** Teach the processes of hemostasis, the role of kidneys in regulating blood volume and pressure, and the endocrine factors that influence blood composition (e.g., erythropoiesis).

The purpose of the application of integrative presentation is the assimilation by students of knowledge about the main stages of solving the problem, their content and sequence of presentation [3].

Stages of the lesson on the theme: "Patterns of heredity and variability in living organisms"

I. Announcement of the lesson theme and setting the purpose and objectives of the lesson.

II. Updating students' knowledge on the issues.

1) What does biology study? What is the origin of the name of science?

2) Define the concept of "integration".

3) Who is the founder of biology?

4) Define the concept of "biological process".

5) Prove by examples the universal character of this property of organisms.

6) Define the concept of "variability".

7) Prove by concrete examples that this property is universal for all living things.

8) Demonstration of PPT presentation illustrating the phenomena of biology and integration

Integrating biology to secondary school is an exciting way to learn biology and is readily incorporated into large classes in a lecture hall environment. Integration engages students in solving authentic biological case problems, stimulating discussion among students and reinforcing learning. A learning environment emulates the workplace and develops self-directed learners. This is preferable to a mimetic learning environment in which students only watch, memorize, and repeat what they have been told.

## RESEARCH METHODS

### (1) Forming Small Groups

We may decide to devote all or part of a class session to PBL, but students must form small work groups during that time. We can ask the students to form groups of 3-5 people, or assign the groups ourselves.

### (2) Presenting the Problem, f.e, osteoporosis

Present the students with a brief problem statement (preferably on a printed work sheet, an example of which is shown below), e.g., "A 28-year-old man appears to have osteoporosis." In some cases a video clip or specimen might be used as a trigger. Emphasize to the students that they are dealing with an authentic case history[4]. Bizarre problems work best. Prior to class you should review the case history and arm yourself with data that can be released incrementally (progressive disclosure) as the case proceeds. Needless to say, the students should not be given the reference, as the objective is to solve a problem, not read a solution.

### (3) Activating the Groups

Ask the groups to brainstorm possible causes of the osteoporosis. Each group will have to discuss, review, or investigate the biology of bone, including the role of osteoblasts, diet, vitamin D, parathyroid hormone, growth hormone, calcitonin, kidney function, etc. This is when much learning occurs, as the students help each other understand the basic biology. PBL students must reflect upon biological mechanisms rather than just memorize facts (as might occur in some traditional lecture-only courses). The instructor circulates among the groups, providing assistance but not solutions. The groups may well explore avenues unanticipated by the instructor. This is highly desirable and should not be discouraged. The instructor should avoid controlling the agenda of the groups[5]. Each group ranks its hypotheses in order of priority and prepares requests for more data. (E.g., for calcium deficiency hypothesis – "What did he usually eat?")

### (4) Provide Feedback

Ask that a rep from each group place their top priority hypothesis or data request on the chalkboard (if already entered by another group, place their second choice, etc.). If this is not practical, ask for oral suggestions from the groups when the small group work is halted and the class is reconvened. Student suggestions may include:

- ✓ Low calcium diet

- ✓ Immobility
- ✓ Low density of vitamin D receptors
- ✓ Calcitonin deficiency
- ✓ Excessive PTH
- ✓ Chronic acidosis buffered by salts mobilized from bone

The small group work can be stopped and the instructor can briefly discuss the ideas with the entire class. It is important to value every contribution, to assist the students in analysis of the biology involved, and to provide further information [he was not immobile, he had a normal diet, etc.]. The students can be prompted for data requests: "If you could ask for just three test results from examination of this man, what would they be?"

It is not likely that the students will solve a problem on the first pass, and the feedback from the instructor motivates the next round of small group work. The students could now be told that the man's lumbar spine density is 3.1 standard deviations below the average age-matched healthy female (osteoporosis = 2.5+ SD), his height is 204 cm, his left middle finger is 10 cm, and knee films show open epiphyses[6]. The cycle of small group work and instructor feedback can be continued during the current class session or on future occasions. The key to managing a PBL session is providing continual feedback to maintain student enthusiasm while simultaneously prolonging the resolution of the problem to ensure that adequate learning occurs.

#### **(5) Ask for a Solution**

At this point in our example the groups will likely focus on the hormones required for epiphyseal closure and bone mineralization. They may ask you for serum estrogen levels (high) which will suggest estrogen-resistance. Were estrogen receptors defective? (Yes.) When a reasonable number of groups have solved the problem, you might request a brief written analysis from each group describing the biology involved in the case. Students may be asked to include certain key words in their reports. If you wish to further pursue this case at a later date you could tackle the genetics of the defect [7].

Effective problem-solving requires an orderly approach. Problem-solving skills do not magically appear in students as a result of instructors simply throwing problems at them.

It will be effective if students use the following heuristic: "How to make a DENT in a problem: Define, Explore, Narrow, Test."

#### **Conclusion**

The researchers expect this study can be a source of information for teachers in applying Biological content in schools, thus students can construct their knowledge. The implementation of this model should be done continuously to improve the students' critical thinking skill. Before the class begins, teachers should prepare everything well mainly the selection of real problems appropriate with the materials. Therefore, students can analyze and solve problems accordingly. Teachers also need to manage their time to better implement integrative technologies with Fishbone Diagram. Further researchers can conduct the similar study focusing on other materials, and even other fields of study.

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**THE ROLE OF MEDIA LITERACY FOR ENGLISH LANGUAGE TEACHERS IN DISTANCE LEARNING****Akzhan Abdykhalykova***Candidate of Pedagogy, Associate Professor of the Foreign Languages Theory and Practice  
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EKA University of Applied Sciences  
Riga, Latvia***Abstract**

*This article explores the role of media literacy in the distance learning system for English language teachers, highlighting its significance in developing essential digital competencies. The study analyzes global and regional approaches to integrating media literacy into education, comparing practices from the United States, Europe, Kazakhstan, and Latvia. While developed countries have successfully incorporated media literacy into national curricula, Kazakhstan faces challenges such as limited digital infrastructure and a lack of systematic training programs. Latvia provides an example of how media literacy initiatives can be integrated into teacher training to support digital education. The paper proposes practical solutions, including specialized teacher training, improved access to digital resources, curriculum updates, and international collaboration. Addressing these issues can enhance the quality of distance education and equip teachers and students with critical skills for navigating the modern information landscape. Further exploration of long-term strategies for media literacy development in Kazakhstan remains essential.*

**Keywords:** Media literacy, distance learning, English language teachers, digital education, Kazakhstan, international practices.

**Introduction**

*With the rapid advancement of information technology, education has undergone significant transformations. In recent years, distance learning has become an essential part of the educational landscape, offering new opportunities for both students and teachers. The COVID-19 pandemic further accelerated this shift, forcing educators to rethink their teaching strategies and integrate digital tools into their lessons. In this context, media literacy has emerged as a key skill for modern educators.*

*Media literacy goes beyond simply finding and using information- it involves critically analyzing, evaluating, and applying it effectively. For English language teachers, this skill is particularly valuable, as their work relies heavily on global information sources. Ensuring that students engage with credible, well-researched materials is essential in language learning, where exposure to authentic content plays a crucial role.*

*In a digital learning environment, teachers are not just content providers but also facilitators of critical thinking. They must guide students in navigating vast amounts of online information, distinguishing reliable sources from misinformation, and making informed decisions. At the same time, teachers themselves face challenges, such as varying levels of digital competence, inconsistent experience with media tools, and limited access to necessary technological resources.*

*This article explores the impact of media literacy on the professional development of English language teachers in distance learning. The primary goal is to highlight the significance of media literacy in education and examine how it enhances the quality of online teaching.*

*The article is structured as follows: the first section provides an overview of the theoretical foundations of media literacy, the second section discusses gaps in existing research and areas that require further study, and the final section offers practical recommendations for improving media literacy among educators.*

**Theoretical Framework****Understanding Media Literacy**

*Media literacy is a crucial competency that involves the ability to search for, evaluate, and critically analyze information resources. It encompasses skills related to consuming media, creating content, and accurately interpreting information. Wuyckens, Landry, and Fastrez [13] describe media literacy as a core skill that develops alongside information and digital literacy. They outline three key aspects of media literacy:*

- *Information literacy - the ability to search for and analyze information;*
- *Functional literacy - proficiency in using digital technologies;*
- *Visual-communication literacy - the ability to create and convey messages through media tools.*

*The role of media literacy in education has grown significantly, as the overwhelming flow of information today demands that teachers develop critical evaluation skills. This is particularly important in distance learning, where digital platforms and online resources have become primary sources of information for students. Research by Soifah, Jana, and Pratolo [10] suggests that higher levels of digital literacy contribute to better information selection and overall improvements in the quality of education.*

#### *The Connection Between Digital and Media Literacy*

*Although media literacy and digital literacy are closely related, they have distinct differences. Digital literacy refers to the ability to use technological tools, while media literacy focuses on analyzing and evaluating the information accessed through these tools. Studies by Soifah, Jana, and Pratolo [10] reveal that while teachers often demonstrate strong digital skills, they may lack the critical thinking abilities necessary for evaluating online content. This highlights the need for further development of media literacy among educators.*

*To successfully conduct distance learning, teachers must integrate both digital and media literacy into their teaching practices. Doing so not only enhances students' educational experiences but also strengthens their ability to assess information critically [7]. Furthermore, media literacy empowers educators to use digital technologies more effectively in their teaching and encourages students to take a more active role in independent learning.*

#### *Media Literacy in Distance Learning*

*The widespread adoption of distance learning during the pandemic introduced new challenges for educators. Research by Gaston [2] highlights that media literacy helps teachers select reliable information and guide students in critically engaging with digital tools. In particular, media literacy in distance education helps address several key issues:*

- *Reducing information inequality – ensuring equitable access to quality education through digital resources;*
- *Combating misinformation – teaching students to verify the credibility of information;*
- *Implementing interactive teaching methods – enhancing the effectiveness of distance learning.*

*Geers, Boukes, and Moeller [3] found that incorporating media literacy into distance learning increases student engagement and fosters responsible media consumption habits. This is especially relevant for English language teachers, as working with foreign-language resources requires a strong ability to assess credibility and accuracy.*

*Research underscores the importance of integrating media literacy into teaching methods for distance learning. On a global scale, numerous initiatives have been launched to promote media literacy in education. For example, McNelly and Harvey [6] argue that media literacy equips teachers with the tools to help students evaluate information critically in an online environment. This became particularly vital during the pandemic, when students increasingly encountered unreliable sources while studying online.*

*At the regional level, media literacy development in Kazakhstan remains an area requiring further research. Limited access to digital tools and a lack of experience in applying media literacy principles among teachers are among the key challenges that need to be addressed.*

#### **Challenges and Opportunities in Developing Media Literacy in Distance Learning**

##### *Challenges:*

*The key challenges in developing media literacy in distance learning include:*

- *Insufficient Technical Infrastructure – In some regions, slow internet speeds negatively impact the quality of distance learning [7].*
- *Lack of Professional Skills Among Teachers – The absence of specialized training in media literacy hinders teachers from effectively utilizing digital technologies [2].*
- *Difficulties in Combating Misinformation – Students often struggle to analyze information obtained online.*

##### *Opportunities for Overcoming These Challenges:*

- To address these barriers, the following measures are proposed:
- Developing media literacy courses for teachers;
- Conducting practical training on the effective use of digital resources;
- Providing technical support for schools.

Media literacy is considered a key element in distance learning, enhancing critical thinking and the ability to analyze media messages for both teachers and students. McNelly and Harvey [6] found that integrating media literacy into the educational process enables students to assess the authenticity of information and understand media influence. Additionally, according to Mudra [7], using media literacy tools improves students' language skills, including listening, reading, writing, and speaking. Thus, media literacy is not only about using digital tools but also about developing content creation and critical analysis skills as part of a comprehensive approach.

Recent studies emphasize the importance of strengthening teacher-student interaction when integrating media literacy into education. Research by Soifah et al. [10] indicates that utilizing technological tools for media literacy development allows teachers to modernize their teaching methods. This includes advantages such as working with authentic materials through digital tools, engaging in interactive assignments, and increasing student motivation. Similarly, Syahrul et al. [11] found that teachers' ability to effectively use digital media directly influences the quality of their teaching. However, these studies also highlight significant barriers, such as insufficient teacher training in technological tools and limited internet access.

In their study on rural Indonesia, Armanda and Yosintha [1] explored the role of digital literacy among adolescent students and teachers' perspectives on it. The authors argue that digital literacy plays a crucial role in English language acquisition by increasing student motivation and facilitating learning through technology.

Wuyckens, Landry, and Fastrez [13] explored the interconnectedness of media literacy, information literacy, and digital literacy, noting that these concepts are often confused and lack clear distinctions. Nonetheless, their study underscores the significance of media literacy in education and the necessity of incorporating it into curricula.

In the Kazakhstani context, Yeleussiz [14] examined English language teachers' perceptions of media literacy and the challenges of its implementation. The study found that while teachers recognize the importance of media literacy, they face obstacles such as resource shortages, lack of training, and limited administrative support. These studies contribute significantly to understanding the role of media literacy in education and exploring strategies for its development.

### **Practical Significance**

The results of the literature review presented in the article directly contribute to the development of media literacy among English language teachers in Kazakhstan's distance learning system.

Firstly, developing media literacy enables teachers to modernize the learning process by effectively utilizing digital tools. This, in turn, enhances students' motivation to learn and improves their information-processing skills. For example, the use of interactive platforms makes lessons more engaging and effective, while multimedia resources help increase students' knowledge levels.

Secondly, media literacy equips teachers with strategies to combat misinformation. This helps students develop the ability to use reliable information sources and ensures that learning materials are based on verified facts. For instance, teachers can use "fact-checking" methods to train students in verifying data and assessing their sources. Through digital platforms, students' critical thinking skills improve, leading to better academic performance. This is especially crucial in an era of increasing online information flow.

Thirdly, integrating media literacy helps teachers modernize their teaching methods. In distance learning, fostering media literacy guides teachers and students in effectively organizing the learning process, selecting relevant information, and utilizing credible sources. Teachers can use adapted tasks via online platforms to address the diverse needs of students at different levels. Additionally, digital tools allow teachers to monitor students' progress, provide feedback, and develop personalized learning strategies.

Fourthly, the development of media literacy cultivates students' ability to engage in lifelong learning. Today, students are not only consumers of knowledge but also producers of information. In this regard, media literacy helps prepare students for the demands of the modern labor market. This is particularly relevant in distance learning, as mastering media technologies contributes to the development of students' future professional skills.

*Thus, the development of media literacy serves as a key tool for improving the quality of education in the distance learning system. It helps teachers and students adapt to the demands of the information society, significantly enhancing learning outcomes.*

### **Comparative Analysis**

*Incorporating media literacy into distance education varies across countries, each adopting unique strategies to address specific challenges. This comparative analysis examines approaches in the United States, Finland, Germany, Kazakhstan, and Latvia, highlighting their methodologies and the implications for educational practices.*

#### *United States*

*In the U.S., the surge of misinformation and conspiracy theories has prompted educators to embed media literacy into school curricula. Teachers are proactively addressing disinformation, equipping students with skills to critically evaluate information sources. Despite these efforts, only 39% of students received news literacy training last year, though 94% believe it should be mandatory. Challenges include inconsistent definitions of media literacy and the lack of a standardized curriculum. Initiatives like "MisInfo Day" and resources from nonprofits aim to enhance critical thinking and responsible information consumption among students.*

#### *Finland*

*Finland is renowned for its comprehensive media literacy education, integrated into national curricula since the 1970s. The 2019 National Media Education Policy emphasizes a holistic approach, involving various stakeholders such as schools, libraries, NGOs, and universities. Media education is mandatory across all educational levels, focusing on critical analysis of media content and responsible information sharing. Initiatives like the annual Media Literacy Week further promote these skills among citizens.*

#### *Germany*

*Germany's media literacy efforts gained momentum in the 1970s and 1980s, with a focus on theoretical foundations. Over time, practical applications have been emphasized, particularly in combating misinformation and understanding media's societal impact. Media education is integrated into various subjects, aiming to develop students' critical thinking and analytical skills regarding media consumption.*

#### *Kazakhstan*

*In Kazakhstan, media literacy integration into education is emerging. Challenges include limited digital infrastructure and insufficient access to high-speed internet, especially in rural areas. While national curricula are beginning to recognize the importance of media education, its implementation is inconsistent. Collaborations with international organizations and adoption of global best practices are underway to enhance media literacy, but progress is gradual.*

#### *Latvia*

*Latvia has made significant strides in integrating media literacy into higher education, particularly for English language teachers engaged in distance learning. The shift to digital education has increased the necessity for teachers to critically evaluate online information, adapt digital resources, and ensure secure interactions in virtual classrooms. Latvian universities have implemented specialized professional development programs focusing on media literacy, digital security, and the ethical use of online content. These initiatives aim to enhance teachers' ability to navigate misinformation and improve the overall quality of online education. As a result, Latvia demonstrates a proactive approach to equipping educators with media literacy skills essential for the digital age.*

### **Comparative Insights**

*The United States and Finland have established media literacy frameworks, though their approaches differ. The U.S. focuses on combating misinformation through targeted programs and events, while Finland employs a systemic, policy-driven strategy involving multiple societal sectors. Germany emphasizes theoretical and practical aspects within its educational system, aiming for a balanced development of media competencies. Kazakhstan, facing infrastructural and resource limitations, is in the nascent stages of integrating media literacy, looking to international models for guidance. Latvia stands out for its emphasis on media literacy in higher education, particularly among English language teachers in distance learning settings. Its structured professional development programs address misinformation, digital security, and ethical content use, providing a model for other countries seeking to enhance media literacy among educators.*

*These variations underscore the influence of cultural, political, and infrastructural factors on media literacy education. Countries with established policies and resources demonstrate more cohesive*

*integration, whereas those with emerging frameworks encounter challenges that require tailored solutions. Sharing best practices and fostering international collaborations can support the development of effective media literacy programs worldwide.*

### **Solutions**

*To enhance the media literacy of Kazakhstani English language teachers in the context of distance learning, the following recommendations can be implemented:*

#### *Organizing Specialized Training for Teachers*

*Short-term and long-term courses should be introduced to develop media literacy skills among teachers. These courses should focus on essential competencies such as using digital tools, identifying misinformation, and critically analyzing information. For example, training models used in Germany could be adapted to the Kazakhstani context, as they emphasize practical experience in detecting information manipulation.*

#### *Improving Access to Digital Resources*

*Enhancing internet speed in rural and suburban schools and equipping them with modern digital tools is crucial. This will enable teachers to develop media literacy skills through online platforms. Additionally, improving the availability of Kazakh-language versions of digital platforms and developing new educational content are necessary steps.*

#### *Updating Educational Curricula*

*Media literacy should be integrated into school curricula. The subject should not only focus on analyzing information but also on applying knowledge in practice. Drawing on Finland's experience, media literacy can be incorporated into various subjects to enhance students' overall educational attainment.*

#### *Implementing Fact-Checking Methods*

*Specialized educational materials should be developed to teach teachers and students how to verify information. This will help reduce the spread of misinformation and improve students' media literacy. Simple and user-friendly fact-checking tools should be made available for teachers.*

#### *Encouraging Local and International Collaboration*

*It is essential to establish partnerships with international organizations and local IT companies to advance media literacy. Joint projects can be initiated to develop educational materials and digital tools for teachers. By aligning local needs with international standards, this approach will contribute to improving education quality.*

*By implementing these recommendations, Kazakhstan can enhance the media literacy of English language teachers and improve the effectiveness of the distance learning system. These measures will ultimately contribute to higher educational standards and better adaptation of both teachers and students to the modern information society.*

### **Conclusion**

*This article has comprehensively examined the significance of media literacy for English language teachers in the distance learning system. Research has shown that media literacy enables teachers to develop essential skills such as effectively utilizing digital tools, critically analyzing information, and combating misinformation. Furthermore, the advancement of media literacy increases students' engagement in learning and improves their academic performance.*

*Although media literacy development in Kazakhstan is still in its early stages, there are significant opportunities for growth by incorporating international best practices. Considering regional characteristics, enhancing digital infrastructure, providing professional development for teachers, and updating educational curricula will contribute to improving education quality. Experiences from countries such as Finland, Germany, and the United States demonstrate that media literacy is not only about using technical tools but also about developing the ability to assess and analyze information accurately.*

*Latvia presents another relevant example, particularly in higher education. Its universities actively implement media literacy training for educators, equipping them with the necessary competencies for effective online instruction. The integration of media literacy in teacher training programs highlights its role in ensuring high-quality distance education and fostering digital safety awareness. Kazakhstan can benefit from adopting similar initiatives by incorporating media literacy modules into professional development courses for educators.*

*Thus, fostering media literacy plays a crucial role in enhancing the effectiveness of distance learning and supporting the professional and academic success of both teachers and students. Future research should focus on identifying specific strategies for media literacy development in Kazakhstan*

while drawing insights from Latvia's experience in teacher training and integrating long-term solutions in this field.

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## Physical sciences

### RESEARCH OF ELECTROPHYSICAL PROPERTIES OF PbTe IMPLANTED BY ARGON IONS

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### ИССЛЕДОВАНИЕ ЭЛЕКТРОФИЗИЧЕСКИХ СВОЙСТВ РЬТЕ ИМПЛАНТИРУЕМОЙ ИОНАМИ АРГОНА

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#### **Abstract**

Thin layers of PbTe (film thickness:  $d \approx 0.35 \dots 0.55 \mu\text{m}$ ) were produced at the department of physics of the Azerbaijan Technological University. Muscovite mica was used as a substrate. The films were obtained by discrete evaporation and were block single crystals oriented with the  $\langle 111 \rangle$  axis perpendicular to the plane of the layer. The conclusion that can be drawn on the basis of such a comparison is that there is no  $n(Z)$  dependence after implantation and, therefore, the Hall concentration is the true carrier concentration.

#### **Аннотация**

Тонкие слои PbTe (толщина пленки:  $d \approx 0,35 \dots 0,55 \mu\text{м}$ ) были получены на кафедре физики Азербайджанского технологического университета. В качестве подложки использовалась мусковитовая слюда. Пленки были получены методом дискретного испарения и представляли собой блочные монокристаллы, ориентированные осью  $\langle 111 \rangle$  перпендикулярно плоскости слоя. Вывод, который можно сделать на основе такого сравнения, заключается в том, что после имплантации отсутствует зависимость  $n(Z)$  и, следовательно, концентрация Холла является истинной концентрацией носителей.

**Keywords:** implantation, annealing, films, dose.

**Ключевые слова:** имплантация, отжиг, пленки, доза.

Тонкие слои РвТе (толщины пленки:  $d \approx 0,35 \dots 0,55 \mu\text{м}$ ) были изготовлены на кафедре физики Азербайджанского Технологического Университете. В качестве подложек использовалась слюда мусковит. Пленки получались методом дискретного испарения и представляли собой блочные монокристаллы, ориентированные осью  $\langle 111 \rangle$  перпендикулярно плоскости слоя.

Исследования на растровом электронном микроскопе позволили определить средний размер блоков  $\sim 10^{-1} \mu\text{м}$ . Следует указать, что их свойства изменялись во времени. Отжиг слоев при  $T = 580 \dots 630 \text{K}$  в течение 30 мин. в атмосфере гелия стабилизировал свойства образцов. После отжига пленки подверглась к имплантации ионами аргона ( $\text{Ar}^+$ ).

Энергия имплантируемых ионов  $\text{Ag}^+$  составляла  $E=90\text{кэВ}$ , плотность тока при имплантации  $j=0,5..1\text{ мкА/см}^2$ , интегральная доза облучения изменялась от  $10\text{ мкКл/см}^2$  ( $6,2 \cdot 10^{13}\text{ см}^{-2}$ ) до  $900\text{ мкКл/см}^2$  ( $5,6 \cdot 10^{15}\text{ см}^{-2}$ ). В пересчете на единицу объема пленки  $\text{PbTe}$  концентрация имплантированных атомов  $\langle N_{\text{Ag}} \rangle$  составляла от  $1,3 \cdot 10^{18}\text{ см}^{-3}$  до  $1,5 \cdot 10^{20}\text{ см}^{-3}$ . Основной результат бомбардировки ионами аргона-смена типа проводимости (знака коэффициентов Холла  $R$  и термоэдс  $\alpha$ )/1/с дырочного на электронный (рис. 1).

Один из образцов, который имплантации имел проводимость  $n$ -типа, сохранил знак  $R$  и  $\alpha$ .

Таким образом, преобладающий тип радиационных дефектов РД имеет донорный характер.

При этом, однако, сразу возникает вопрос о дозовой зависимости концентрации электронов после имплантации. Казалось бы, поскольку с ростом дозы увеличивается концентрация РД, должна увеличиваться и концентрация электронов. Из рис. (1) видно, что это не так. Зависимость  $n$  ( $D$ ) практически отсутствует. После имплантации холловская концентрация составляет  $0,7...1,5 \cdot 10^{18}\text{ см}^{-3}$ .

Ионной имплантации при  $D = 100\text{ мкКл/см}^2$  ( $6,2 \cdot 10^{14}\text{ см}^{-2}$ ) было подвергнуто около десятка образцов. До имплантации они обладали различными холловскими концентрациями дырок  $P = (0,15...2,2) \cdot 10^{18}\text{ см}^{-3}$ , а один из образцов имел проводимость  $n$ -типа с  $n = 4 \cdot 10^{17}\text{ см}^{-3}$ . После имплантации разброс значений  $n$  составил всего  $(0,7...1,1) \cdot 10^{18}\text{ см}^{-3}$ , т.е. практические отсутствовал. Таким образом, отсутствует зависимость концентраций носителей после имплантации от исходной концентрации носителей.

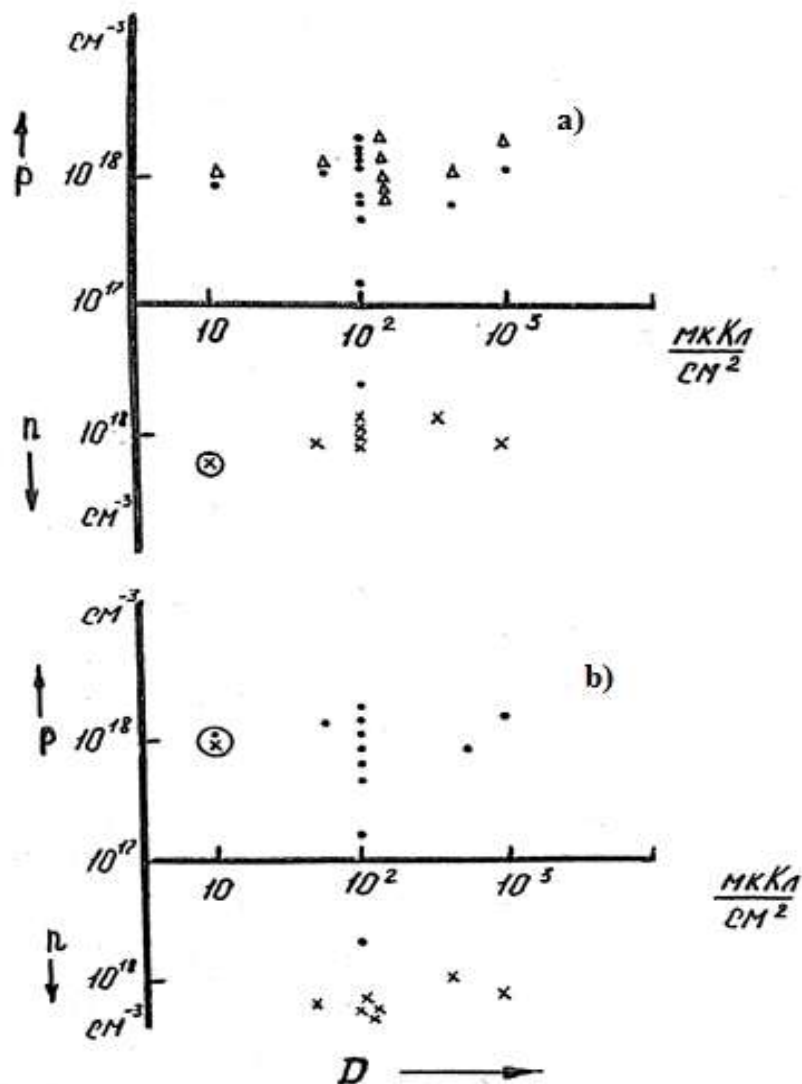


Рисунок 1. Влияние ионной бомбардировки и отжига на холловскую концентрацию носителей.

Температура измерений: а)  $T = 300\text{К}$ ; б)  $T = 77\text{К}$ .

•• до имплантации; х – после имплантации;  $\Delta$  - имплантированные образцы после отжига

При наличии зависимости концентрации носителей (а тем более типа проводимости) от глубины слоя даже оценки средней концентрации из коэффициента Холла могут дать значительные ошибки. Поэтому важно знать, сколь велика неоднородность  $n(z)$ . Ответ на этот вопрос может дать сопоставление значений разных кинетических коэффициентов для ионно-имплантированных образцов и образцов заведомо однородных по толщине. При этом, по-видимому, имеет смысл сравнивать те и другие образцы при одинаковых холловских концентрациях. Анализ, показал, что при наличии слоистой неоднородности для заданного значения  $R$  могут существенно изменяться величины термоэдс и других коэффициентов.

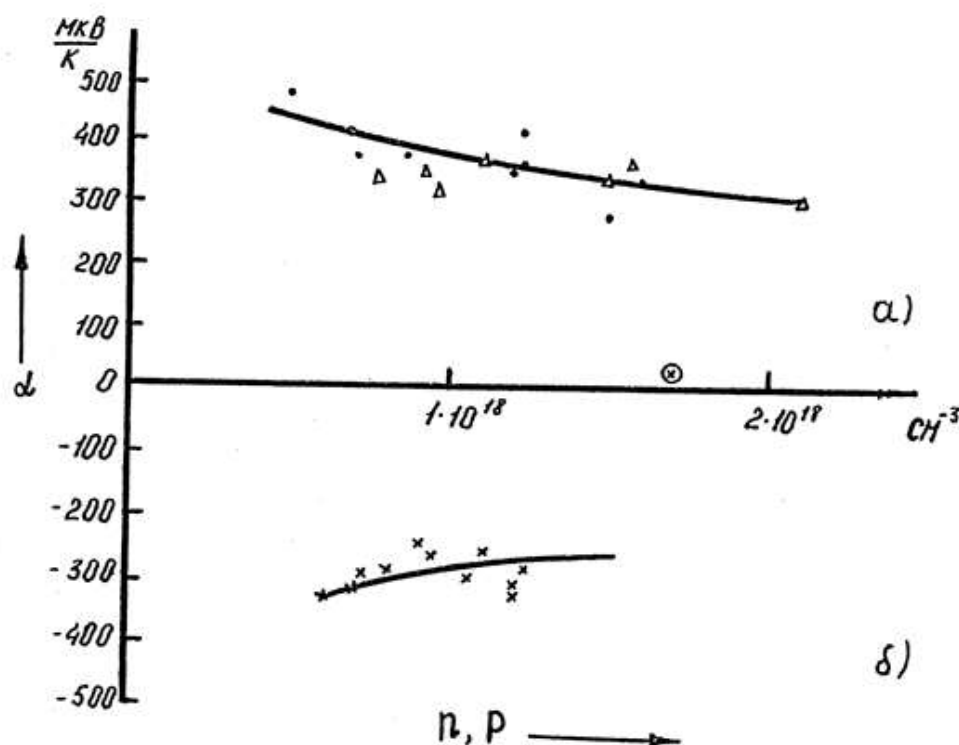


Рисунок 2. Зависимость коэффициента термоэдс от концентрации носителей:

а) усредненные данные по однородным пленкам  $p$  – типа;

б) усредненные данные по однородным пленкам  $n$  – типа;

• - до имплантации;

х – после имплантации;

Δ - имплантированные образцы после отжига.

На рис. 2 представлены зависимости коэффициента термоэдс от холловской концентрации в пленках  $n$ -и  $p$ -РВТе при 300 К. Сплошные кривые получены путем усреднения данных для большого числа образцов (более 50) не подвергавшихся ионной бомбардировке, т.е. таких, которые можно считать достаточно однородными по толщине. Для пленок  $n$ -типа кривая совпадает с кривой для объемных монокристаллов. В случае  $p$ -типа кривая  $\alpha(R)$  проходит приблизительно на 5...10% выше, чем для объемных образцов, что обусловлено рассеянием носителей на межблочных границах в пленках [2]. Точками представлены значения  $\alpha$  для исследованных нами образцов до имплантации. Видно, что они с некоторым, но не очень большим разбросом, ложатся на кривую "а". Крестиками изображены значения  $\alpha$  в имплантированных образцах. Видно, что они также неплохо согласуются с данными для однородного РВТе (кривая "б"), причем разброс точек не больше, чем в образцах до имплантации. Подобное согласие имеется и для эффекта Нернста-Эттингсгаузена ( $Q$ ). Этот эффект чрезвычайно чувствителен к неоднородностям электрофизических свойств, а также к механизму рассеяния. Поэтому как в неимплантированных, так и в имплантированных образцах

значения  $Q$  имеют значительный разброс (до  $\pm 30\%$ ). Однако, в пределах этого разброса практически незаметно влияние ионной бомбардировки.

Вывод, который можно сделать на основе такого сопоставления, состоит в том, что зависимость  $n(Z)$  после имплантации отсутствует и следовательно, холловская концентрация есть истинная концентрация носителей.

Исключение составляет один образец, подвергнутой имплантации при наименьшей дозе ( $10 \text{ мкКл/см}^2$ ). Данные для него помечены на рис. 1 и 2 кружками.

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## Sociological sciences

### DEVELOPMENT OF THE SYSTEM TO PROMOTE EMPLOYMENT OF DISABLED PEOPLE IN KAZAKHSTAN

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#### **Abstract**

*The article considers the peculiarities of employment of disabled people in Kazakhstan, lists the conditions that promote social adaptation and involvement of persons with disabilities in the sphere of labor activity.*

**Keywords:** *disabled, Kazakhstan, state, republic, development, society, employment of disabled persons, workplace.*

#### **Introduction**

*People with disabilities in Kazakhstan are the most vulnerable group of the population from the position of multidimensional understanding of poverty (i.e. from the point of view of human development opportunities). The risk of poverty among persons with disabilities is the highest, firstly, due to the limitation of their life activities due to health impairment, and thus, the limitation of their ability to meet their basic needs. Secondly, people with disabilities in Kazakhstan are more limited than other population groups in access to participation in public and political life, to education services, to satisfaction of social and cultural needs [1].*

*In December 2008, the Republic of Kazakhstan signed the Convention on the Rights of Persons with Disabilities and the Optional Protocol. The Convention is the first human rights agreement adopted specifically for persons with disabilities, which provides universal legal recognition that persons with disabilities are not objects of charity, but holders of rights and agents of change for development. The signing of the Convention is evidence of Kazakhstan's agreement with the fundamental principles on which the modern state policy on persons with disabilities is based, of the country's readiness to comply with international standards, political, economic, social, legal and other vital rights of persons with disabilities [2].*

*Worldwide there are approximately 470 million people with disabilities of working age. It is evident that persons with disabilities suffer from the decent work deficit much more than other people. Having lost self-confidence when confronted with discriminatory barriers and societal misconceptions about their inability to work, many persons with disabilities stop actively seeking work and live on disability benefits where they exist, or scrape by on marginal earnings in the informal economy and rely on the support of family and friends.*

#### **Main body**

*Under all these circumstances, it is not surprising that there is a strong link between disability and poverty. According to UN statistics, 82% of people with disabilities in developing countries live below the poverty line and are among the most vulnerable and marginalized groups, estimated at between 15% and 20% of all poor people in these countries. Significant efforts are needed to include persons with disabilities in employment promotion, poverty reduction and other programs to open up productive employment and decent work opportunities for them [3].*

*The system of employment of persons with disabilities in OECD countries (good practices) is based on the following principles:*

*1. Legislative definition of "reasonable accommodation of the workplace for people with disabilities";*

*2. A fundamental change in the attitude towards employment of people with disabilities from "loss of ability to work" to "ability to work";*

*3. A comprehensive economic incentive mechanism for employers, including many types of subsidies for employing people with disabilities, such as compensation for the cost of workplace adaptation, wages of a person with disabilities, and the cost of vocational training;*

4. Wide access to labor rehabilitation through financing private and public vocational rehabilitation centers;

5. Development of a system of "supported employment" aimed at integrating people with disabilities into the open labor market and including preparation for work, training, job search, employment counseling and ongoing support in the workplace.

Kazakhstan's practice currently differs significantly from global norms. It should be noted that the existing system of employment of persons with disabilities in a market economy has a number of problems and needs to be improved.

For example, Kazakhstan has an insignificant set of economic instruments to stimulate employers to hire persons with disabilities. Kazakhstan applies a 3% quota of jobs for persons with disabilities, and the sanctions for failure to fulfill them are quite high (in accordance with Article 87-1 of the Code of Administrative Offenses, a legal entity that is a small and medium-sized business entity may be fined 70-200 MCI for violation of legislation on the social protection of persons with disabilities, and 200-400 MCI for a legal entity that is a large business entity). However, this quota mechanism does not work. Thus, in 2006-2008, 3493 disabled persons were actually employed under the quota out of 16961 places provided for under the quota. Surveys of employers conducted by public organizations show that entrepreneurs exaggerate the potential problems associated with hiring a disabled person, and often do not even want to think about it.

The competitiveness of the products of specialized enterprises providing jobs for disabled persons of groups I and II is low, which also requires additional state support. Despite the fact that according to the Tax Code of the Republic of Kazakhstan, organizations are exempt from VAT on turnover on the sale of goods, works and services, if they meet certain conditions: disabled people make up at least 51% of the total number of employees, expenses on wages for disabled people make up at least 51% of total expenses on wages.

The practice of employment of persons with disabilities shows that disabled persons are mainly offered low-paying jobs on the open labor market that do not require high qualifications. One of the reasons for this is the lack of opportunities to obtain the necessary vocational education for people with special needs. There is a problem of accessibility of secondary vocational and higher education for persons with disabilities. A number of factors make it problematic for persons with disabilities to enroll and study at vocational schools and universities, since almost all educational institutions in Kazakhstan are not provided with even the minimum conditions necessary for disabled persons to study there.

There are no subsidies for the adaptation of the working environment, subsidies for retraining an employee according to the demand in the labor market, improving the qualifications of a potential employee, partial compensation of wages and social insurance contributions, subsidies to compensate the costs of assistant services (e.g., sign language interpreter) and other measures to support the employment of people with disabilities [2].

In Kazakhstan, the creation of conditions that promote social adaptation and involvement of disabled people in the sphere of labor activity, first of all, ensuring the accessibility of housing, social and transport infrastructure in cities, is of particular importance.

### **Results of the research**

An important issue in this case is the assessment of the effectiveness of the proposed measures. The effect of accessibility is created by increasing the total socio-economic effect in all spheres of the national economy. Social integration of disabled people into society leads to the creation of additional jobs, replenishment of the state budget, increase in the gross domestic product, transition to the conditions of a developed socially protected society. It is economically advantageous to provide disabled people with the opportunity to fully realize their potential. Unfortunately, to date, Kazakhstan has not conducted fundamental scientific research on the economic efficiency of creating and maintaining jobs for the disabled. Partly due to this, society, and, most importantly, the structures that determine social policy with regard to the disabled, have developed a very erroneous notion that the creation or refurbishment of jobs for the disabled requires huge financial resources. The results of studies conducted in the United States, which yielded the following data, may serve as a basis for asserting the erroneous view:

- 69% of persons with disabilities do not need special conditions to perform their job duties;
- in 70% of cases of employment of persons with disabilities, the creation of special conditions costs no more than USD 500, including in 50% - no more than USD 50, in 20% - from USD 51 to USD 500;
- in 17% of cases of employment of persons with disabilities the creation of special conditions costs from 501 to 1000 USD;

– only in 13% of cases these costs exceed USD 1,000.

*It seems that in the conditions of Kazakhstan these costs may be higher, but still they will not be as huge as it seems to many people.*

*It should be noted that vocational rehabilitation of disabled people is one of the most important elements of their comprehensive rehabilitation, the successful implementation of which:*

– makes it possible to improve the standard of living of persons with disabilities, provide for the family, and achieve economic independence;

– facilitates the integration of persons with disabilities into society;

– contributes not in words but in deeds to ensuring equal opportunities for all members of society.

*Vocational rehabilitation itself requires a comprehensive approach and includes the following elements:*

– determining the professional potential of persons with disabilities;

– conducting their professional orientation;

– providing vocational training or retraining for persons with disabilities;

– their professional adaptation and rational employment.

*When employing persons with disabilities, it is necessary to flexibly apply various methods of increasing the interest of enterprise managers in the employment of persons with disabilities and of persons with disabilities themselves.*

*Such techniques and methods may include:*

– ensuring reasonable workplace accommodations for persons with disabilities;

– implementing professional orientation programs and vocational training programs;

– expanding opportunities for employment and career advancement, as well as providing assistance in finding, obtaining, retaining and resuming employment;

– organization of jobs for disabled persons through adaptation of jobs that compensate for the limitations of disabled persons (subsidies for the creation of jobs in regular enterprises, reimbursement of part of the salary of an employed disabled person, subsidizing a job for a disabled person);

– creation of special jobs in regular enterprises (supporting “suppportive” employment);

– creation of social enterprises [4].

### **Conclusion**

*Thus, the implementation of the UN Convention on Persons with Disabilities in Kazakhstan is a long process that is based on the transition to the social concept of disability, which asserts that a person's disability is actually an environmental problem that does not ensure accessibility of social services for all members of society.*

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