NJD-iScience

№123

The Norwegian Journal of Development of the International Science

№123/2023

Norwegian Journal of development of the International Science

ISSN 3453-9875

It was established in November 2016 with support from the Norwegian Academy of Science.

DESCRIPTION

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UOT: 628.543.502

TECHNOLOGY OF THE PURCHASE OF ORGANIC-MINERAL LIQUID AND AMELIORATIVE SUBSTANCES

Kahramanli Y.,
Ibrahimov S.,
Jamalova R.
Azerbaijan State Oil and Industry University
https://doi.org/10.5281/zenodo.10450857

Abstract

Article is dedicated to the technology of obtaining organic-mineral liquid fertilizer and solid chemical meliorants from solid household waste with the presence of nitric acid.Articlebased on the data of nitric acid from solid household waste and the dynamics of decomposition with late participation, extensive information was given about the technology of making liquid fertilizers and chemical meliorants, and the technological scheme and its explanation were broadly explained based on the technological process for both experimental and production conditions. It was concluded that it is possible to buy high-quality liquid fertilizer rich in microelements and chemical ameliorant rich in organic substances based on solid household waste, late and nitric acid. According to the data obtained from the conducted agricultural tests, the purchased liquid fertilizer increases the productivity of plants, the chemical ameliorants in solid state improve the water-physical properties of the soil through the organic substances and gypsum contained in them. This has a positive effect on soil fertility indicators [1].

Keywords: liquid fertilizer, chemical ameliorant, melioration, salinization, granulometric composition, absorbed bases.

Introduction. At present, our republic was in the stage of strong development. The rapid development of oil and non-oil industries has given a strong impetus to the improvement of the standard of living of the population. In such conditions, in order to reduce dependence on foreign countries, ensuring the food security of the country's population is one of the main issues put before us by our state. The solution to this problem can be achieved by improving the land by increasing its meliorative condition and agronomic properties [3,4].

One of the main issues is the supply of fertilizers for agriculture. The composition of the fertilizer prepared by us is rich in organic fertilizers and trace elements, along with N, P, K. Its production in the republic will stimulate the development of agriculture [2,5].

Purpose of work. It is the development of the technological bases of the purchase of organic mineral complex fertilizers on the basis of various wastes and minerals generated in the territory of the Republic and its application to production [7].

Research methodology. The research was conducted on the basis of widely used methodologies in the territory of the republic. The method of preparation of liquid fertilizer and solid chemical ameliorant is explained in detail in the "analysis and discussion" section.

Raw materials and materials used:

The chemical composition of solid domestic waste is given in table 1.

Table 1.

Chemical composition of solid domestic waste, in %

Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	Fe_2O3	TiO_2	MnO	Cl^-	YTI
1.70	1.02	2.56	16.49	0.58	2.56	1.31	27.11	2.63	0.25	0.10	0.82	42.5

Other raw materials used are nirtic acid (GOST 4461-77) and late.

Table 2

Chemical composition of gypsum rocks extracted from different deposits, in %

Substances	Ganja bed		Bed of Khans	Jeyranchol field
	1st field	2nd field		
CaO	26.81	23.72	28.80	25.79
SiO2	15.6	21.39	9.40	17.51
Al2O3	3.01	1.87	4.90	4.45
Fe2O3	2.16	3.12	0.50	2.31
MgO	1.17	1.09	0.21	2.06
N2O	0.88	0.43	–	–
Na2O	0.61	0.39	1.25	–
P2O5	11.34	–	–	–
SO3	35,67	29,24	38.21	34.28
H2O	2.39	1.05	1.51	0.64

Analysis and discussion.

Under experimental conditionssolid household waste and organic mineral liquid fertilizer and solid chemical ameliorant based on 10% nitric acid are purchased according to the following scheme:

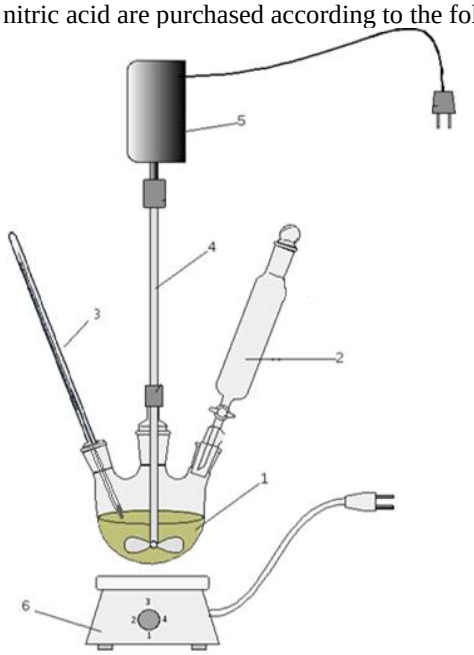


Figure 1. Scheme of the laboratory equipment for the production of organic-mineral liquid fertilizer. 1-three-necked flask; 2-separating sleeve; 3-thermometer; 4-mixer; 5-electric engine; 6-electric heater.

50 grams of sorted and chopped solid household waste is poured into a flask with a volume of 200 ml, and 150 ml of 10% nitric acid is added to it (figure 1). The mixer is turned on and the mass is mixed at a speed of 60 revolutions/minute [6]. After stirring for 20 minutes, 50 g of tar is added to the flask and stirring is continued. Stirring is continued for an additional 40 minutes. After the total mixing period of 1 hour, the mass obtained in the form of horra is neutralized with milk of lime, removed from the flask and filtered. The solid residue is placed in a thermostat with a temperature of 105^0C for drying. Drying is done within 1 hour. The composition of the prepared liquid fertilizer is as follows (%): organic substances -21-26; NO_3 -10.65-11.75; P_2O_5-0.22-0.23; K_2O-0.17-0.19; $CaSO_4$ –2.5-3.5;the rest is water.

After filtration, the solid part that remains in the form of waste can be used as an ameliorant with organic-mineral content in agriculture for the ecological improvement of salinized-salinized soils and for the restoration of their fertility. CaSO4·2H2O, which is used as an additive, and organic mixtures are indispensable components for improving the physico-chemical properties of soils and increasing their fertility.

The composition of the solid part is as follows (%); Organic substances – 74-79; NO_3-0.8-1.5; P,K – 0.03-0.04; $CaSO_4$ – 35-40;the rest is water.

Organic residue enriched with calcium nitrate, which has an acidic environment, can be used as a chemical ameliorant.

In production conditionsliquid fertilizer and solid chemical ameliorant based on solid household waste, late and 10% nitric acid are made according to the following technological scheme:

Sorted and shredded solid household waste is placed in the reactor (1) and 10% nitric acid is added to it (figure 2). The ratio of BMT to acid solution supplied to the reactor should be 1:3. After 10 minutes of starting the stirrer, 1 part by weight is added to the reactor. Stirring 60 cycles/min. continues for 1 hour. The horra-shaped mass neutralized with milk of lime is fed to the auger (5) for dehydration. Here the solid part is separated from the liquid part.

As a result of neutralization, the filtered liquid has a pH of 6.5-7.0, which allows it to be used as a liquid fertilizer in agriculture. The purchased liquid fertilizer is filled in 5 and 10 liter polyethylene containers for use.

The received liquid fertilizer has the following composition (in %): organic substances 21-26; NO_3 -10.65-11.75; P_2O_5-0.22-0.23; K_2O-0.17-0.19; $CaSO_4$-2.5-3.5 the rest is water.

The solid material from the auger is fed to the drying drum (6) for drying. The solid residue, which consists mainly of organic matter, gypsum and a small amount of calcium nitrate, is dried to a moisture content of 15-20%. This substance obtained during the process can be applied to improve salinized and salinized soils as an organic-mineral melioration agent.

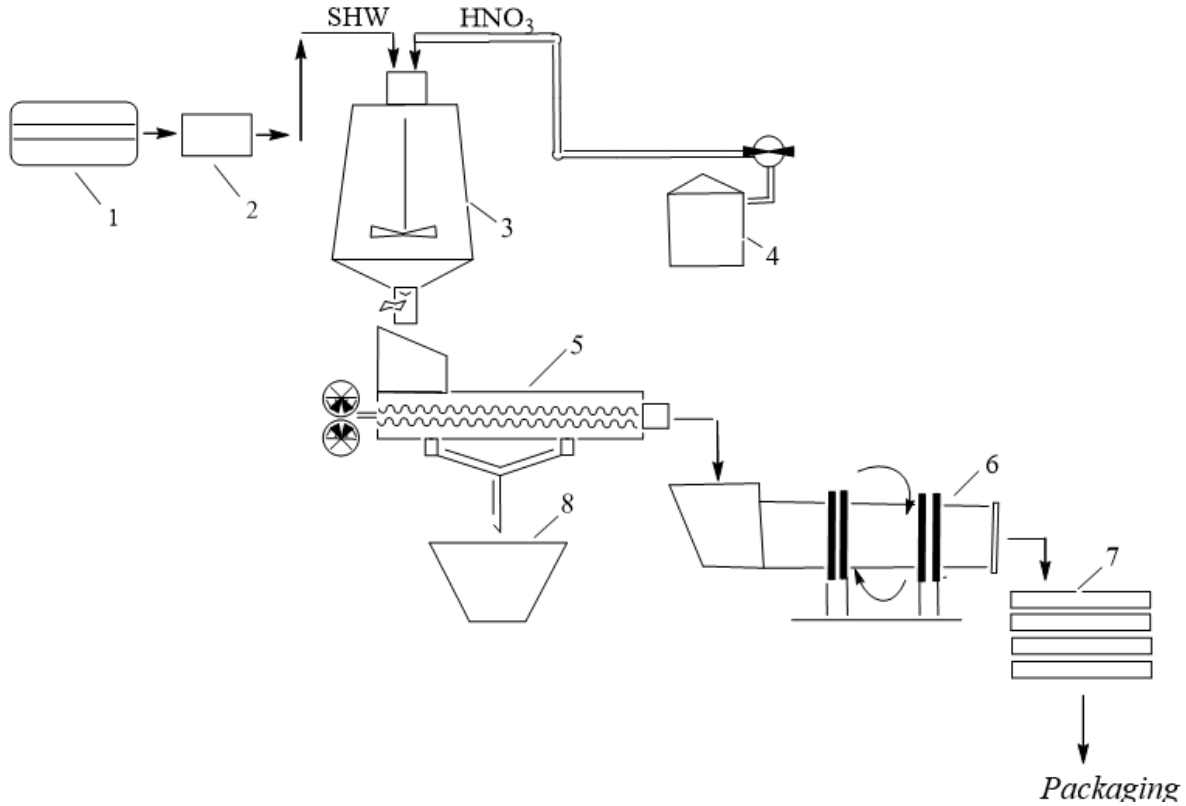


Figure 2. Acquisition of organic-mineral complex fertilizer under production conditions.
1. Sorting shop; 2. Chopper; 3. Reactor; 4. Acid tank;
5. Auger; 6. Drying drum; 7. Sieve; 8. Liquid fertilizer tank.

The received chemical melioration substance has the following composition. Organic substances - 74-79%; NO_3-0.8-1.5; P,K – 0.03-0.04; $CaSO_4$ – 35-40;the rest is water.

Based on the data obtained from the research, the following conclusions can be reached:

CONCLUSION

1. It is possible to buy high-quality organic-mineral complex liquid fertilizers and chemical ameliorants based on solid household waste, manure and nitric acid.

2. Since it contains both NPK, organic substances, and trace elements, the prepared fertilizer has a positive effect on the productivity of agricultural plants and the increase in the fertility of salinized-salinized soils.

3. Due to the fact that it is made on the basis of industrial waste, it is very economically efficient.

References:

1. Mammadov G.Sh., Babayev MP, Jafarov M.I. and b. / Azerbaijan land resources and protection. Works of the Society of Soil Science of Azerbaijan. Volume X, Part I and II, 2005. P.78.

2. Mammadov G.Sh., Hashimov AC, Jafarov XF / Ecomeliorative assessment of salinized and salinized soils. 2005. P. 114.

3. Smith, JF and Wood, DA 1990 Cultivation of Edible Fungi on Plant Residues. In: Coughtan MP, Amaral MT (eds), Advances in Biological Treatment of Lignocellulosic Materials, Elsevier Applied Science, Collago, pp.297-310.

4. Stofella, PJ and Kahn BA 2001. Compost Utilization in Horticultural Cropping Systems. CRC Press LLC. Vol.75, pp.78-91.

5. Ibragimov CK, Kerimova O.U., Rahimova A.G. и др. // Results of the experiment on the washing of soloncet soils with the application of waste products of the chemical industry. Actual problems of ecology and soil sciences in the 21st century, materials of the 8th Republican scientific conference. 2019. P. 113.

6. Ibrahimov SK, Jamalova RH // Technology of preparation of organic-mineral remedial substances based on solid household waste and nitric acid with late addition. Certificate of authorship #13259, 2022, 20 p.

7. Ibragimov CK, Ramazanova Z.R. // Melioration of solonts soils included in crop rotation. Sulfuric acid wastes in the Caspian Lowlands. Ecology and Construction scientific peer-reviewed international journal. 2019. S. 25

BIOLOGICAL SCIENCES

UDK 591.1.(575.1)

DETERMINATION OF THE RELAXANT EFFECT OF SOME HYDROLYZABLE TANNINS ISOLATED FROM THE PLANT SPECIES E. SANESCENS (L.)

Mutalipov A.,
Andijan State University
Karimjonov H.,
Andijan State University
Zaynabiddinov A.,
Andijan Institute of Economics and Construction
Usmanov P.,
Head of the Cell Biophysics Laboratory of the Institute of Biophysics and Biochemistry under UzMU
Omonturdiev S.,
Institute of Bioorganic Chemistry of the Russian Academy of Sciences
Rakhimov R.
Institute of Bioorganic Chemistry of the Russian Academy of Sciences
https://doi.org/10.5281/zenodo.10450873

Abstract

In studies, 2,3-di-O-galloyl-β-D-glucose and 1,2,3,4-tetra-O-galloyl-β-D-glucose The vasorelaxant effect of - hydrolyzable tannins on the contractile activity of the rat aortic blood vessel preparation was studied depending on their structure. In our experiments, it was determined that the vasorelaxant effect of hydrolyzable tannins depends on their structure and applied doses, and it was determined that it is related to the blockade of Ca^{2+} channels of vascular smooth muscle cells and sarcoplasmic reticulum.

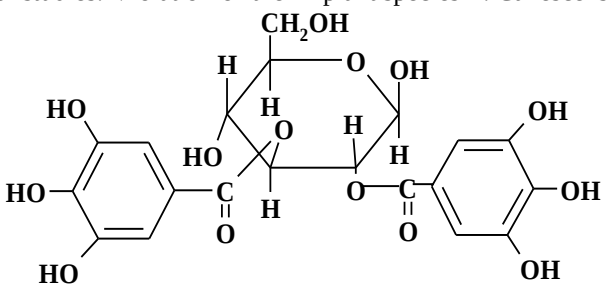
Keywords: Tannin, blood vessel, relaxant effect, aorta, muscle, Ca^{2+}-channel, dose, relaxation.

Abstract. Currently, one of the urgent problems of modern medicine and pharmacology is the creation of highly effective drugs with a targeted effect and no negative side effects. Another fact today is that many diseases, especially cardiovascular diseases, are caused by disruption of the functions of the ion-transport system in cells. Dysfunction of this system causes and/or causes many diseases, including neurodegenerative, cardiovascular and other diseases.

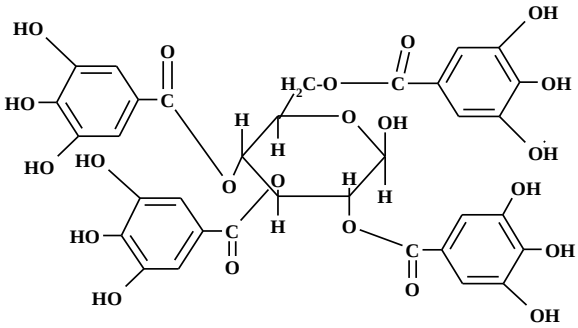
The main function of smooth muscles in blood vessels is to maintain blood vessel tone and arterial blood pressure. Diseases occurring in the cardiovascular system are detected by studying the functioning of smooth muscles [3; pp. 165–168]. In this case, the function of ion channels involved in vasoconstriction/relaxation is studied using control studies. Violation of the function of the channels causes various cardiovascular diseases.

Analysis of the current literature shows that biologically active substances with effective effects on the cardiovascular system have been isolated from plants, including secondary metabolites in plants such as alkaloids, flavonoids, and tannins [4; 11 p.]. These compounds have a wide range of biological activity, and it is reported in the literature that they have antioxidant, antiviral, interferon-inducing, anticancer, and immunosuppressive properties [5; 230 pp.].

Taking into account the above, the purpose of this study is to scientifically substantiate the vasorelaxant effect depending on the chemical structure and dose of certain hydrolyzable tannins (Fig. 1) isolated from the plant species E. Canescens(L.).



1) 2,3-di-O-galloyl- β -D-glucose



2) 1,2,3,4-tetra-O-galloyl- β -D-glucose
Figure 1. Chemical formula of hydrolyzable tannins

Material and methods. Experiments were conducted in the laboratory of experimental innovative research of the Department of Human Physiology and Safety of Life Activities of Andijan State University and were carried out on healthy white, inbred male rats (150-200 gr.) bred in the vivarium under conditions provided with standard food and water.

The preparation of the aortic vascular preparation is carried out using a standard methodincreased [12; p. 110].

After the animals were euthanized by cervical dislocation, the chest was surgically opened, the aorta was isolated, and the connective tissue was cleaned in Krebs-Henseleit saline medium, and annular segments (*l*=2–4 mm; ø=1–2 mm) was cut. Krebs-Henseleit physiological solution with the following chemical composition was continuously circulated in the experimental cell (5 ml): (mM): NaCl – 120.4; KSl – 5; NaHCO3 – 15.5; NaH_2PO_4 – 1.2; $MgCl_2$ – 1.2; $CaCl_2$ – 2.5; $S_6N_{12}O_6$ – 11.5 (pN=7.4). Physiological solution was aerated with carbogen (O2–95% and CO_2–5%), temperature constant (t=+37±0.5°C) was ensured using an ultrathermostat (U–8; Bulgaria). The contractile activity of the aortic vascular preparation was recorded in isometric conditions using a standard method (mechanography) using an Isometric force transducer and amplifier force sensor, a signal amplifier device (Grass Instrument, USA) on an Endim 621.02 samopiset (Czech Republic)was done [13; 195-p; 143; p. 110].Initially, the rat aorta preparation was incubated with a voltage of 1 g (9.8~10 mN) for ~45–60 min until normal electromechanical activity was recorded.

The obtained results and their analysis. 2,3-di-O-galloyl-β-D-glucose in experiments (10–200 μM) and 1,2,3,4-tetra-O-galloyl- β-D-glucose(5–50 μM) of hydrolyzable tannins was found to have a significant vasorelaxant effect on isometric contraction activity (in vitro) of rat aorta blood vessels induced by KCl (50 μM). Including 2,3-di-O-galloyl-β-D-glucosehydrolyzable tannin At a concentration of 30 μM, it was found to reduce the contraction force by 6.17±3.1% compared to the control, and at a maximum concentration of 200 μM, it decreased by 74.8±4.5% (n=4–6). Also 1,2,3,4-tetra-O-galloyl-β-D-glucose hydrolyzable tanninIt was found to reduce the contraction force by 12.5±4.7% compared to the control at a concentration of 10 μM and 85.2±3.2% at a maximum concentration of 50 μM. In this 2,3-di-O-galloyl-β-D-glucose and 1,2,3,4-tetra-O-galloyl-β-D-glucose(IC_{50}) value was found to be – 90 μM and 26.8 μM, respectively (Fig. 2 A and B)

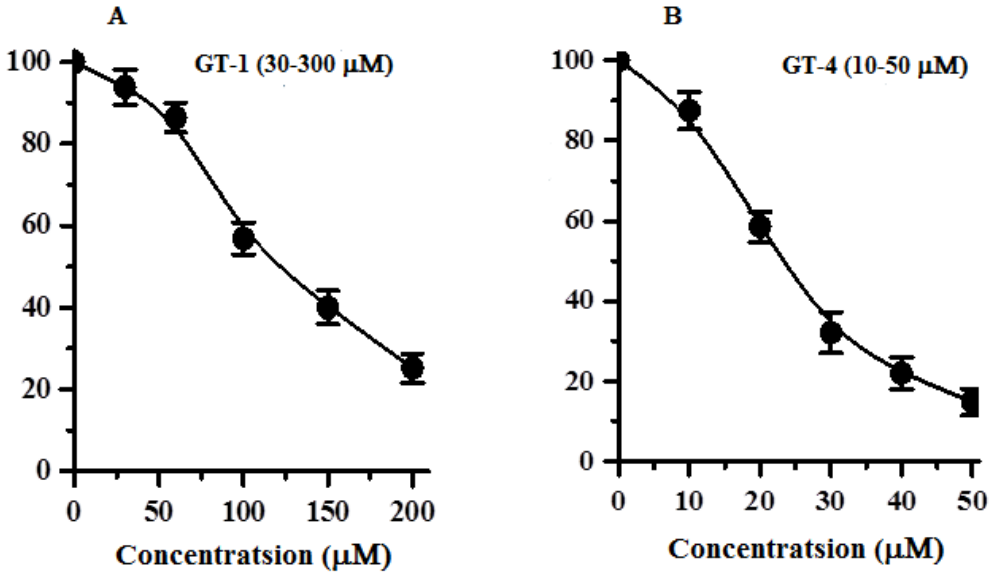


Figure 2.
2,3-di-O-galloyl-β-D-glucose (GT-1) and 1,2,3,4-tetra-O-galloyl-β-D-glucose (GT-4) hydrolyzable tannin of theirconcentration-dependent vasorelaxant effect on contraction induced by KCl (50 mM) in aortic preparation. On the ordinate axis - the contraction force of the aorta is taken as 100%. The abscissa axis shows the concentration of hydrolyzable tannins in μM. In all cases, the reliability index (– p< 0.05; ** p< 0.01; n=4–6).*

During our research, this,2,3-di-O-galloyl-β-D-glucose and 1,2,3,4-tetra-O-galloyl-β-D-glucose of hydrolyzable tannins KCl depends on the potential of the relaxant effect in conditions of contracture induced by To test the involvement of Ca^{2+} channels A specific blocker of the Ca^{2+} $_L$-channel - verapamil (0.01-1 μM) was tested and further analyzed in the experiments.

Verapamil (IC_{50} =0.1 μM)under the conditions of incubation, the contraction strength of the aortic smooth muscle preparation was observed to decrease by 50±3.4% compared to the control, and under these conditionsof the cup (IC_{50}=90 μM)In addition, the strength of the contraction of the aortic smooth muscle drug under the influence of alkaloids- up to 6.4±3.4%, a decrease of 60.6±4.2% compared to the control was observed. alsoverapamil in incubation conditions1,2,3,4-tetra-O-galloyl-β-D-glucose(IC_{50}(=26.8 μM) aortic smooth muscle preparation reduced contraction force by 9.3±3.1% compared to the condition with additional verapamil and 59.8±4.8% compared to the control.(Figure 3).

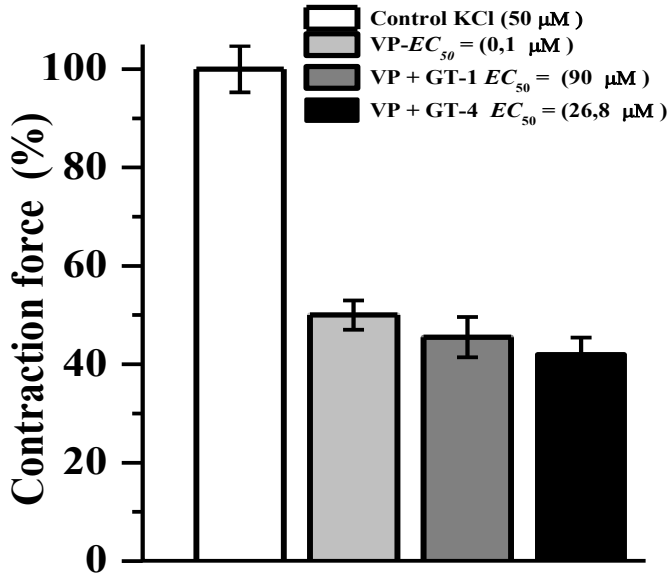


*Figure 3. 2,3-di-O-galloyl-β-D-glucose (GT-1) and 1,2,3,4-tetra-O-galloyl-β-D-glucose (GT-4)Relaxant effect of hydrolyzable tannins depends on the concentration of [Ca2+]o and the state of potential-dependent L-type Ca2+ channels.2,3-di-O-galloyl-β-D-glucose and 1,2,3,4-tetra-O-galloyl-β-D-glucosethe effect of On the ordinate axis, the contraction force evoked by aortic contraction force of 50 mM KCl is taken as 100%. The abscissa axis shows the concentration of CaCl2. 2,3-di-O-galloyl-β-D-glucose and 1,2,3,4-tetra-O-galloyl-β- Relaxant effect of D-glucose (reliability index in all cases *p<0.05; **p<0.01; n=4–6).*

Based on the obtained results, it can be said that 2,3-di-O-galloyl-β-D-glucose and 1,2,3,4-tetra-O-galloyl-β-D-glucosethe relaxant effect of hydrolyzable tannins is based on the blockade of L- Ca^{2+} channels. However, in the presence of verapamil, partial preservation of the relaxant effect of studied hydrolyzable tannins, blockade of L- Ca^{2+} channels, as well as reduction of transport of Ca^{2+} -ions in smooth muscle cells, may be activated by other mechanisms.

In addition to voltage-dependent Ca^{2+} channels, receptor controlled Ca^{2+} channels also play an important role in the control of Ca^{2+} homeostasis in smooth muscle cells [6]. In order to evaluate the effects of hydrolyzable tannins on receptor-controlled Ca^{2+}-channels, aortic muscle contraction induced by α_1-adrenoceptor agonist phenylephrine (FE) is mainly supported by Ca^{2+}-ions entering through receptor-controlled Ca^{2+}-channels [10].

In our experiments, the effect of hydrolyzable tannins on aortic contraction force evoked by FE in the presence of L-type Ca^{2+}-channel blocker-verapamil was studied. Under these conditions, FE-evoked muscle contraction was observed to be 13.7±2.8% lower than control compared to the condition without verapamil. Under these conditions, 2,3-di-O-galloyl-β-D-glucose (100 μM) and 1,2,3,4-tetra-O-galloyl-□-D-glucose (35 μM) hydrolyzable tannins maximally reduced FE-evoked aortic contraction by 74.8±3.4% and 80.4±4.3% compared to control (Fig. 4 A and B).

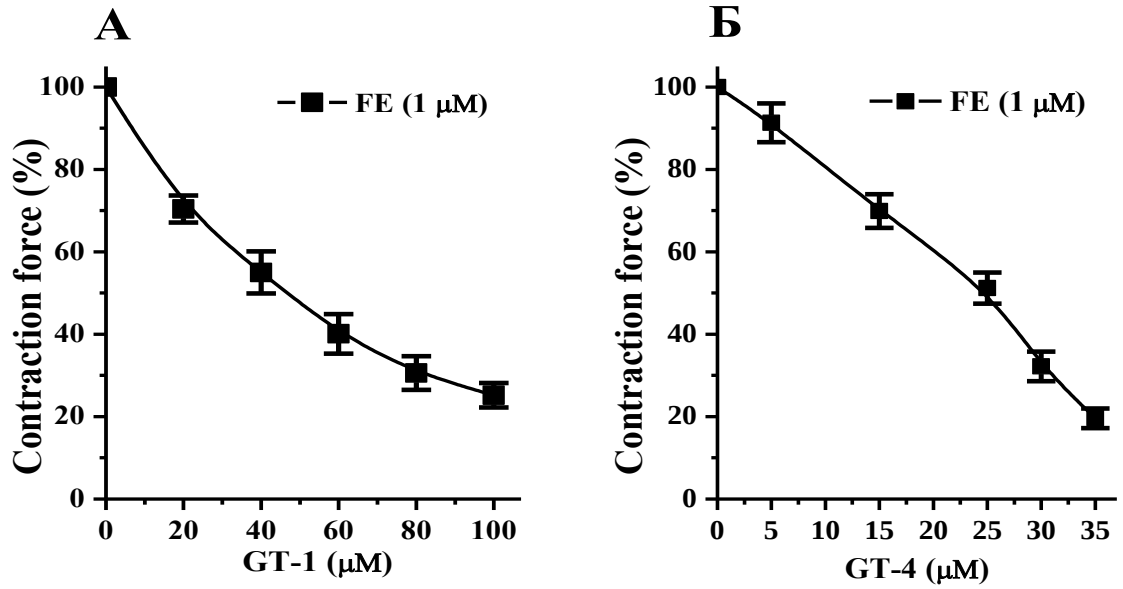


Figure 4.
*2,3-di-O-galloyl-β-D-glucose (A) and 1,2,3,4-tetra-O-galloyl-β-D-glucose(B) Effects of hydrolyzable tannins on phenylephrine-induced rat aortic contraction. 2,3-di-O-galloyl-β-D-glucose and 1,2,3,4-tetra-O-galloyl-β-D-glucose Dose-dependent effect of 1 μM FE-induced rat aortic contraction. On the ordinate axis, aortic contraction force is taken as 100% of aortic contraction force evoked using 1 μM FE. On the abscissa axis is the concentration of hydrolyzable tannins. (in all cases the reliability indicator * – p<0.05; **p<0.01; n=4–6).*

In these experiments, 2,3-di-O-galloyl-β-D-glucose and 1,2,3,4-tetra-O-galloyl-β-D-glucose EC_{50} values were 52.6 μM and 19.4 μM, respectively. The obtained results show that the observed effect of studied hydrolyzable tannins can be predicted to occur with blockade of receptor-controlled Ca^{2+}-channels. The effects of the studied hydrolyzable tannins on receptor-controlled Ca^{2+} channels can be explained by the experiments conducted with α-adrenoceptor blocker-phentolamine (FA) as an additional confirmation. In our experiments, 2,3-di-O-galloyl-β-D-glucose (100 μM) and 1,2,3,4-tetra-O-galloyl-β-D-glucoseRelaxant effect of (35 μM) hydrolyzable tannins in the presence of 10 μM phentolamine was observed to decrease the FE reduction by 55.2±2.3 and 48.4±3.2 compared to the condition without phentolamine (Fig. 5).

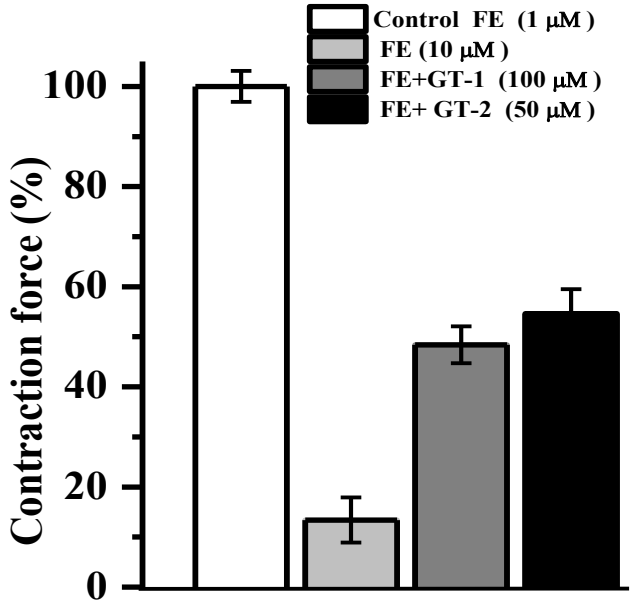


Figure 5.
2,3-di-O-galloyl-β-D-glucoseand1,2,3,4-tetra-O-galloyl-β-D-glucose effect of phentolamine (10 μM) on the relaxant effect of hydrolyzable tannins.On the ordinate axis, aortic contraction force is taken as 100% of aortic contraction force evoked using 1 μM FE. (in all cases the reliability indicator (p<0.05; **p<0.01; n=4–6).*

These results indicate that the relaxant effect of studied hydrolyzable tannins can be related to the blockade of receptor controlled Ca^{2+}-channels.

Conclusions

Hydrolyzable tannins - 2,3-di-O-galloyl-β-D-glucose and 1,2,3,4-tetra-O-galloyl- β-D-glucosehas a relaxant effect and effectively relaxes the contraction of rat aorta pre-challenged with hyperkalemia and phenylephrine.

Based on the analysis of literature data and experimental results, 2,3-di-O-galloyl-β-D-glucose and 1,2,3,4-tetra-O-galloyl-β-D-glucoseThe vasorelaxant effect of hydrolyzable tannins on the isometric contraction activity of the rat aortic blood vessel preparation in vitro may be mainly related to the blockade of the L-type Ca^{2+} channel.

2,3-di-O-galloyl-β-D-glucose and 1,2,3,4-tetra-O-galloyl-β-D-glucoseit can be seen that the basis of hydrolyzable tannins is the same. But the difference between them is that with increasing number of galloyl radicals, 1,2,3,4-tetra-O-galloyl-β-D-glucosecauses a significant increase in the relaxant activity of hydrolyzable tannin.

The scientific/experimental results obtained in this research work can be used as a theoretical basis for the development of antihypertensive pharmacological preparations based on hydrolyzable tannins.

References:

1. Gasser T. Ch. Vascular biomechanics: concepts, models and applications // eBook. - 2022. - P. 353

2. RC Webb, Smooth muscle contraction and relaxation // Adv. Physiol. Educ. -2003. - 27. - S. 201–206

3. Orlov S.N., Koltsova S.V., Anfinogenova Ya.D., Kapilevich L.V., Husakova S.V., Smagliy L.V., Baskakov M.B., Medvedev M.A. sodium-potassium-chlorine-cotransport and regulation of myogenic tone of vessels // Bulletin of Siberian Medicine. – 2014. – T.13. No. 6. - S. 165-173.

4. Gayibov U.G., Tilyabaev K.Z., Tukfatullina I.I., Salakhutdinov B.A. Membranoactive properties of gossypola and ego symmetrical and asymmetrical production // Uzbek biological journal. - 2011. – No. 5. – S. 11-15.

5. Kyle JAM, Duthie GG Flavonoids in foods. In: Flavonoids; chemistry, biochemistry and health implications. - 2006. - N. York, Taylor and Francis Group. - R. 219-263.

6. JD Humphrey, ER Dufresne, MA Schwartz, Mechanotransduction and extracellular matrix homeostasis // Nat. Rev. Mol. Cell Bio. – 2014. - No. 15. – R. 802–812.

7. JE Wagenseil, RP Mecham, Vascular extracellular matrix and arterial mechanics // Physiol. Rev. - 2009. - No. 89. - R. 957–989

8. Y. Castier, RP Brandes, G. Leseche, A. Tedgui, S. Lehoux, p47phox-dependent NADPH oxidase regulates flow-induced vascular remodeling // Circ. Res. - 2005. - #97. - R. 533–540.

9. RJ Guzman, K. Abe, CK Zarins, Flow-induced arterial enlargement is inhibited by suppression of nitric oxide synthase activity in vivo // Surgery. - 1997. - #122. - R. 273–279.

10. T. Matsumoto, K. Hayashi, Stress and strain distribution in hypertensive and normotensive rat aorta considering residual strain // J. Biomech. - 1996. - #118. - R. 62–73.

11. H. Wolinsky, Effects of hypertension and its reversal on the thoracic aorta of male and female rats // Circ. Res. - 1971. - #28. - R. 622–637.

12. RL Gleason, E. Wilson, JD Humphrey, Biaxial biomechanical adaptations of mouse carotid arteries cultured at altered axial extension // J. Biomech. - 2007. - #40. - R. 766–776.

13. ZS Jackson, AI Gotlieb, BL Langille, Wall tissue remodeling regulates longitudinal tension in arteries // Circ. Res. - 2002. - #90. - R. 918–925.

14. G. Martufi, M. Lindquist Liljeqvist, N. Sakalihasan, G. Panuccio, R. Hultgren, J. Roy, TC Gasser, Local diameter, wall stress and thrombus thickness influence the local growth of abdominal aortic aneurysms // J. Endovas. Ther. – 2016. - #23. - R. 957–966

15. A. Nchimi, J.-P. Cheramy-Bien, TC Gasser, G. Namur, P. Gomez, A. Albert, L. Seidel, JO Defraigne, N. Labropoulos, N. Sakalihasan, Multifactorial relationship between 18Ffluoro-deoxy-glucose positron emission tomography signaling and biomechanical properties in unruptured aortic aneurysms // Circ. Cardiovasc. Imaging. - 2014. - #7. - R. 82–91.

ECONOMIC SCIENCES

THE REGULATORY CHALLENGES OF ARTIFICIAL INTELLIGENCE

Jolia G.
Georgian Technical University, Tbilisi,
Professor at Department of Engineering Economics,
Doctor of Economic Science
https://doi.org/10.5281/zenodo.10450879

Abstract

This article discusses the existence, origin, and distinguishing characteristics of the artificial intelligence and one of its aspects - emotional intelligence. It delves into the nuanced aspects of "strong" and "weak" emotional intelligence, exploring indicators such as the potential of artificial intelligence, robotics laws, and resolutions from the European Parliament related to the regulation of the artificial intelligence.

Keywords: artificial intelligence, digital technology, robot, experiential, singularity.

What sets humans apart from other living creatures is the intelligence. Generally, intelligence encompasses an individual's cognitive abilities and covers logical reasoning, abstract thinking, problem-solving skills, absorbing new information and knowledge, and adaptability to challenges and uncertainties.

Intelligence is quantifiable, as evident from its evaluation through the Intelligence Quotient (IQ) coefficient, leading to variations among individuals. From the various facets of intelligence, one stands out - emotional intelligence (EI). EI, also known as emotional quotient (EQ), is an individual's ability to recognize and understand their own emotions, express empathy, engage in effective communication, and manage their emotional responses efficiently.

In contrast to traditional intelligence, EI introduces five components: self-awareness, self-regulation, motivation, empathy, and social skills [1, p. 442].

Today, the new cognitive category Artificial Intelligence (AI) is actively discussed, encompassing the intelligence of machines and such digital technology that, to a greater extent, simulates human behaviour.

Coming up with the concise definition of emotional intelligence is challenging, as its adaptability is more dynamic, and it is increasingly resistant to rigid categorizations prevalent in contemporary descriptions. It encompasses substantial versatility and practicality, akin to its utilization in business environments and public institutions.

The concept of AI has its roots traced back to the ancient era. However, scholarly consideration of artificial intelligence emerged in the XVII century which was based on the theory of mechanical materialism.

In reality, the creation of the artificial intelligence commenced in the XX century. Notably, British mathematician Alan Turing pioneered the development of the theory of computability in the 1950s. He devised a test, known as the Turing Test, to determine the feasibility of machine intelligence, which, compared to other proposed tests, continues to be widely regarded as one of the most effective benchmarks. As per Turing, the generation of artificial intelligence occurs when one can engage in a conversation with a machine without being able to distinguish it from a human interlocutor [2, p. 153].

In this context, Turing explored a significant problem. He posed the question, "Can machines think?" The response to this question is negative, as, to date, no machine program has successfully passed this test [1, p. 453].

It should be noted that for the evaluation of machine intelligence, Turing's test is limited, as human intelligence involves cognitive processes that encompass orientation, problem-solving, and decision-making in novel situations [1, p. 500].

In 1954, Italian mathematician Nils Barricelli introduced the idea of "evolutionary modelling," marking a new focus in intelligence research – artificial intelligence.

In 1956, American researcher John McCarthy introduced the term "Artificial Intelligence" and initiating the era of the “cognitive” machines.

Despite the numerous attempts, the creation of the artificial intelligence faced a delay. In fact, the new era of its development began in the 21st century. A personal computer was able to execute 10 billion commands per second only in 2008. Yet, the realization of human-level artificial intelligence is still distant, as it is only the initial/first phase of the development [1, p. 457].

However, it must also be noted that in recent years, intellectual systems (neural networks) have made significant progress, as active utilization is observed in various spheres (science, economics, politics, etc.). The classification of human intelligence is diverse. One of them is the classification of intelligence into “strong” and “weak” artificial intelligence.

In the case of a strong human intelligence, a machine-robot thinks like a human being, while in the case of weak intelligence, it runs behind that of a human. Currently, the majority is programmed to perform tasks based on logical principles, but in the future, strong artificial intelligence robots will be able to actively analyse various situations and react adequately.

It is noteworthy that, in the next decade, the main issue will be the interaction of humans with technology.

In this process, conflicts may arise due to the rapid development of technology, while human adaptability changes slowly. As a result, as technology advances rapidly in our society, we will increasingly feel and experience its “destructive” power. It is important to note that, if until now machines were discussed in the context of increasing productivity, in the digital society the robot is perceived as a working tool.

The goal of the American innovator Elon Musk is to create a 'Friendly Artificial Intelligence.' In his view, a person and artificial intelligence should work together closely: if a person’s brain can integrate with an AI that in turn is connected to a special network, incorrect actions by humans can be prevented.

Scientists predict that by 2050, there will be two types of intelligent species - genetic (natural) human and technologically constructed humanoid hybrid. According to Gordon Moore's law, processor performance approximately doubles every year and a half.

Now let's imagine that this exponential growth has become exponential *per se*. This phenomenon is called “singularity”, meaning that when a computer is capable of creating an artificial intelligence which is stronger than the human intelligence.

Question: What happens when the computer's intelligence directly competes with that of its creator, and how can the outcomes be controlled?

Prominent scientists (Stephen Hawking and Ray Kurzweil) suggest that if the development of computer intelligence continues at the current pace, singularity will become a reality within the next 20-30 years. This will happen gradually and imperceptibly. Machines will become more complex, replacing us in various tasks, and we will in turn get strongly attached to them.

In order for an AI to replace a human-being, it needs to comprehend the object, communicate with it, exhibit understanding of emotions, and react appropriately to different situations. Robots do already perform mechanical tasks efficiently, but can they truly simulate human emotions (love, affection, excitement, outrage, etc.)? [3, p. 395]

It is less likely, given that the emotions of an individual along with the genetic heritage has evolved throughout human history. The expression of irrational motives needs to be simulated for achieving human-like behaviour. If robots are capable of replacing humans at work, this will increase the work efficiency significantly, while we can invest an additional time in the creative process.

Generally, when a human force is replaced with a mechanical one, it vastly reduces the labour costs (robots do not require salaries or social benefits), however a question still arises as to why do we cherish our free time less?

Perhaps because we have a magnified ambitious anticipation about a creative reflection on what can be achieved or done.

There is a speculation that the increase in automation may lead to mass unemployment and an enforced idleness. However, can a machine replace us in the fields of the traditional professions such as education, law, art, archaeology, etc.?

Who knows what the future holds!

Everything we assess shapes our perception, altering our views, but why doesn't its fundamental nature change?

Advanced digital technologies, specifically the mobile computers, are capable of not only “performing” for us but also influencing our reaction patterns exhibited towards one another. The landscape in a modern society is fundamentally transforming, which in turn affects our beliefs, emotions, knowledge, perspectives, disposition, etc.

On average an adult is engaged with computers, tablets, or smartphones for 5-6 hours daily. And if this trend continues, it is thought provoking to understand the consequences when the speed of the internet communication accelerates?

We may find ourselves in a metalized, automated, extraverted sensing and fast paced environment triggered by digital interventions, lacking peace and compassion that is crucial for human interaction and self-awareness. While we learn filtering and processing the information as our cognition becomes faster and more adaptable, yet, what do we sacrifice?

We sacrifice a reflexive thinking, creativity, ability to exhibit empathy and compassion, perception of the reality, intimate space, as we absorb the information from electronic screens and headphones; and all of it resulting in being less and less indifferent and detached.

Question: How does the foregoing affect the neurophysiological criteria/signals?

The answer is rather simple – our "plastic" brain will respond to stimuli based on what the "others" may offer it. And, through passage of time if such behaviour is religiously adopted, it may lead to a brain (cerebral) atrophy. Due to the lack of brain exercise, the cognitive function i.e. an independent creative thinking can be drastically restrained.

Today, the necessary and essential information is no longer sought in books; instead, we rely on Google's search system, delving into its search results extensively. This practice negatively affects the functioning of the brain, as we entrust the system to find the relevant information, and consequently we stimulate the cognitive laziness.

The idea is not far-fetched that such behaviours may have a more profound impact: we may stop reading books (and such traits can already be observed), the notion of “reality” may lose its intellectual significance.

Bionic eyes and limbs, sensory nerves, cardio-simulators, etc. are already well implemented in today’s practice. Is there a possibility that a human may in fact integrate with an AI/robot?

Starting anew, we create or adapt our physical bodies. We attempt to enhance our cognition. Nevertheless, there may be a risk that we cease to be individuals and become “something else”!

It should not be forgotten that the intellectual capacity of an artificial “mind” tends to double almost annually, while a biological one remains unchanged. The main challenge is not the creation of individual organs with their distinct functions, but rather orchestrating their coordinated functioning.

In the field of medicine, the term “cosmetic neurology” encompasses plastic and cerebral reconstructive surgery. With the “aid” of the nanotechnology we may perceive an artificial matter as a real thing and real may seem unnatural.

Question: What may happen when AI integrates with the physical body? Could we create an immortal robot? A matrix?

Certainly, in the long run the ultimate “integration” with new technologies is inevitable and an expansive evolution is likely to transpire. The realm of possibilities extends to genetics, robotics, nanotechnology, AI, and many more that has yet to be contemplated and created. Will we, through their amalgamation, attain a new hybrid? Will progress, if any, be all-encompassing? And if so, by what means will it be guided? Can we find ourselves redundant?

Thus, the regulation of artificial intelligence stands as one of the most serious challenges in the history of civilization, as its regulation mechanisms are either non-existent or incomplete. Uncontrolled AI, potentially poses a great peril, especially in a scenario when, an AI’s cognitive and intelligence capabilities come close to or surpass those of a human being [4, pp. 76, 83].

What complicates the establishment of norms regulating artificial intelligence is that the technology is rapidly evolving, while corresponding regulatory legislation lags behind the demands of the concurrent trends. The emergence of deepfake videos produced by AI is becoming increasingly rampant. These videos, known as deepfakes, convincingly mimic the reality.

The private and public sectors have a keen interest in investing into AI, because of its dynamic pace of the development. Therefore, the introduction of the “smart infrastructure” (e.g., “smart cities”), “smart transportation” (e.g., auto-pilot/self-driving vehicles), robots in the medical field (e.g., robots performing surgeries) and the possibility of mass development of production without human involvement, requires creation of the regulatory norms.

It is also noteworthy that the autonomous functioning of artificial intelligence in various fields (e.g., healthcare, defence, etc.) poses challenges for its effective control. In such scenarios, a robot becomes an autonomous subject, rather than an object/instrument used for performing a specific task. It may become relevant to scrutinise the degree of accountability of the robot or its owner. Additionally, in specific cases it may be crucial to identify the matters of registration (of a robot) and the respective civil liability. According to the American writer, Isaac Asimov's three laws of robotics: 1) A robot may not injure a human being or, through inaction, allow a human being to come to harm; 2) A robot must obey orders given to it by human beings except where such orders would conflict with the First Law; and 3) A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

There is an opinion that the artificial intelligence should 1) be an object of copyright; 2) be afforded a special type of ownership; 3) have form of a legal person (legal entity); and 4) be regulated as a new legal category.

In addition, in the first scenario, an AI can be subject to the legal norms of the intellectual property rights, e.g., its “creator” could be susceptible to financial sanctions. However, such practice is questionable since national legal regimes do not explicitly recognise the artificial intelligence as an object of IP rights.

It is interesting to scrutinise AI’s IP rights over musical compositions, literary fiction, artwork produced by the artificial intelligence.

In relation to the second scenario (where artificial intelligence is afforded a special type of ownership) e.g., if we consider it as a self-driving autonomous vehicle, who shall be the person to whom the robot's harmful behaviour is actually attributable, who shall be liable for any committed crime or damage/harm sustained by any person triggered by such vehicle/robot: shall it be the owner of the vehicle? The manufacturer? Or the creator or the respective AI?

These questions do not have straightforward answers.

Notwithstanding the consequences and risks of AI’s unpredictable actions could be severe, it is important to acknowledge that over or strict regulation of artificial intelligence may lead to hindering the innovation and its development.

As per the third scenario, given its artificial “characteristic” an AI should have a form and status of a legal entity. In general, in all legal jurisdictions a civil liability may be attracted by legal persons in specific circumstances. However, such an analogy with an AI may be problematic, since in the case of the legal entities, the liability is triggered due to the actions of the individuals representing or acting on behalf of the former. And the AI does not conform to any of the foregoing.

The only reasonable solution in this case is to assign AI to the fourth scenario, i.e. define it as a new legal category and implement the respective new rules for regulating it.

Under "Civil Law Rules on Robotics" a Resolution adopted by the European Parliament in 2017, autonomous robots were proposed to be granted a specific legal status of an "electronic persons," and corresponding rights and liabilities shall be bestowed upon their manufacturers and owners [5].

The same Resolution establishes the "Robotics Code of Conduct," guided by the ethical principles: benefit, safety, autonomy, and fairness.

During the 2020 Economic Forum held in Davos, an initiative emerged to create the "World Constitution on Ethics in the Sphere of Artificial Intelligence" as a fundamental legal basis.

Various countries have issued documents on the regulation of robotics, such as the "Global Map for the Regulation of Human Intelligence" adopted by the United Kingdom; the “National Strategy in the field of the Artificial Intelligence” implemented by France; the "National Strategy of Artificial Intelligence" by Japan and the “Concept of the Development of the New Generation of the Artificial Intelligence " by China, etc.

In Georgia, a few research has been conducted at the Business and Technology University (BTU). However, the adoption of a national strategy for AI could position the country as a leading player in the field of the digital services in the South Caucasus region.

In 2023, a new era in the AI space began with the introduction of ChatGPT, developed by Open AI. It's creator (ex-Google VP) Jeffrey Hinton, a prominent figure in deep learning methodology, played a significant role in the creation of the artificial intelligence.

The company Humane introduced a novel product, AI Pin, which is described as "less-intrusive, screenless, and sensitive." It is a compact mechanism, attached on the peace of clothing and reacts to voice, gestures, hand movements, features laser visualization, translation, text-to-speech, organises messages, emails, and multitasking, etc. [6].

Currently, almost every major IT company is actively engaged in creating and developing artificial intelligence. Chinese technological giants like Tencent, Alibaba, Baidu and many others are notably active in this field.

On December 9, 2023, Members of the European Parliament, representatives of national governments, and experts from the European Commission agreed to pioneer on introducing legislative framework on "Artificial Intelligence." Europe thus became the first continent to establish comprehensive rules for the use of AI. However, this does not preclude start-ups and subsequent research from making significant contributions to the field.

The reached agreement regulates face recognition by means of AI, the use of the same by the judicial and law enforcement entities and the scrutiny of the AI systems like ChatGPT [7].

This agreement ensures the establishment of a unique legal framework in the development of the AI technologies produced and sold in the EU and ensures the safety and protection of the fundamental human rights and public values.

Conclusions:

1. It is imperative to determine the status of artificial intelligence and ensure that its functioning adheres to the specific principles.
2. The consequences may pose challenges, as increased funding and resource allocation in the advancement of AI as opposed to the development of the human cognition.
3. The global community must be cautious about the widespread deployment of AI systems, ensuring collaboration rather than its competition with humans.

References:

1. Gabisonia, Z. Internet Law and Artificial Intelligence. Tbilisi. "World of Lawyers". 2022. 583 p. (in Georgian).
2. Harari, Y. N. HOMO DEUS: A Brief History of Tomorrow. Georgian translation copyright. Tbilisi, 2021. By Sulakauri Publishing. 532 p. ISBN 978-9941-30-851-2 (in Georgian).
3. Jolia, G. Creative Development: Education, Knowledge, Action. Monography. Tbilisi, Georgia. European Teaching University. 2016. 445 p. ISBN 978-9941-20-657-3 (in Georgian).
http://dspace.nplg.gov.ge/bitstream/1234/328572/1/KreatiuliGanvitarebaGanatlebaCodnaQmedeba.pdf
4. Jolia, G. Digital Economy: State Development Policy, Regulation, Sectoral Directions. Monography. Tbilisi, Georgia. "Technical University". 2021. 150 p. ISBN 978-9941-28-806-7 (in Georgian).
5. Civil Law Rules on Robotics, European Parliament Resolution of 16 February 2017. https://www.europarl.europa.eu/doceo/document/TA-8-2017-0051_EN.html#title1
6. Video: https://youtu.be/5fQHAZWOUuY?si=QLC-muvhRtnrUJEIy
7. https://www.artificial-intelligence-act.com

DEPOSITS: ON THE EXAMPLE OF THE COMMERCIAL BANKS OF THE REPUBLIC OF ARMENIA

Parsyan S.,
PhD in Economics, ASUE
https://orcid.org/0000-0003-0561-3052
Gabrielyan H.,
PhD in Economics, ASUE
Tumasyan Z.,
PhD in Economics, ASUE
Aslanyan S.,
PhD in Economics, ASUE
Khalatyan H.
PhD student, ASUE

ДЕПОЗИТЫ: НА ПРИМЕРЕ КОММЕРЧЕСКИХ БАНКОВ РЕСПУБЛИКИ АРМЕНИЯ

Парсян С.
кандидат экономических наук, доцент
Государственный экономический университет Армении
Габриелян Г.
кандидат экономических наук, доцент
Государственный экономический университет Армении
Тумасян З.
кандидат экономических наук, доцент
Государственный экономический университет Армении
Асланян С.
кандидат экономических наук
Государственный экономический университет Армении
Халатян А.
Аспирант,
Государственный экономический университет Армении
https://doi.org/10.5281/zenodo.10450898

Abstract

The article presents in detail the theoretical economic content, types and features of the deposit, as well as the advantages of having a deposit. Based on the data published by the Statistical Committee of the Republic of Armenia, the dynamics of demand and term deposits and the calculation of analytical indicators were compiled for the years 2013-2022. The calculation of analytical indicators of the dynamics of current accounts and deposits of RA commercial banks' customers is also presented. An appropriate analysis and conclusion has been made.

Аннотация

В статье подробно представлены теоретическое экономическое содержание, виды и особенности депозита, а также преимущества наличия депозита. На основе данных, опубликованных Статистическим комитетом Республики Армения, была составлена динамика до востребования и срочных депозитов и расчет аналитических показателей за 2013-2022 годы. Также представлен расчет аналитических показателей динамики текущих счетов и депозитов клиентов коммерческих банков РА. Сделан соответствующий анализ и выводы.

Keywords: deposit, investment, bank, analysis.
Ключевые слова: депозит, инвестиции, банк, анализ.

Депозит является одним из способов получения прибыли от размещения финансовых активов в банке. Это могут быть деньги в национальной и иностранной валюте, ценные бумаги, драгоценные металлы. Важно отличать депозит от инвестиции, какой термин правильный и что следует знать владельцам банковских вкладов?

При внесении клиентом вклада банк, принимая его (от вкладчика), обязуется вернуть сумму вклада в конце срока, определенного депозитным договором, а также уплатить проценты в размере и порядке. предусмотренных депозитным договором. Это означает, что клиент доверяет свои сбережения банку на определенный период времени, а банк возвращает ваши сбережения в конце срока, выплачивая взамен процентный доход. Вкладчиком может быть как физическое, так и юридическое лицо. Сегодня банки конкурируют за финансовые ресурсы, то есть за доверие вкладчиков и за привлечение

вкладов, и предлагают самые разнообразные условия для удовлетворения требований клиента.

Депозиты и инвестиции – банковские услуги, доступные физическим и юридическим лицам, а также индивидуальным предпринимателям. Разница заключается в типах выделяемых активов. Вложениями считаются только деньги, ценные бумаги, драгоценные металлы в физическом выражении и на обезличенных металлических счетах, деньги принимаются во вклад. Понимая определение выделяемых ценностей, инвестиции можно назвать вкладом, поскольку размещение денег не противоречит понятию «депозит». Но депозит нельзя назвать инвестицией, потому что было бы неправильно описывать понятие депозита только как деньги. [9]

В случае физических лиц понятия вклада и инвестирования тождественны, и в большинстве случаев речь идет о размещении денег клиента в банке на определенных условиях. Для компаний чаще используется термин «депозит».

Деление типов связано с условиями размещения средств, видами активов, передаваемых банку, и возможностями доступа к ценностям. [1]

Самый большой доход приносит такой депозит, где нет возможности досрочно снять деньги. При подписании договора банк не только принимает ваши средства на хранение, но и использует их для выдачи кредитов и торговли на фондовых и валютных биржах. Это то, что позволяет вам выплачивать проценты по депозиту. это часть прибыли, которую принесло размещение вашего фонда. Банку важно понимать, какой суммой средств он может располагать в определенный период времени, поэтому предоставить гарантии, чтобы деньги по вкладу не были изъяты из банка раньше срока действия договора, следовательно, и проценты по вкладу выше.

В некоторых банках действует правило пополнения вклада: при увеличении суммы вклада в 10 раз процентная ставка по нему автоматически снижается. Точные условия указаны в договоре, но, как правило, такой вклад относится к категории накопительного счета с минимальной ставкой. Тем самым банк мотивирует заключить новый договор на большую сумму, что принесет потенциальному клиенту более высокий доход. чем больше сумма, тем выше процент по вкладу. Но здесь есть еще один нюанс. остановка депозита до истечения срока его действия означает перерасчет процентов по минимальной процентной ставке, и в этом случае вы потеряете все начисления за последний расчетный период.

Существует 2 вида вкладов: до востребования и срочные.

Договор вклада до востребования заключается с условием возврата вклада при первом его требованию. Это означает, что вы отдаете свои сбережения банку не на заранее оговоренный срок, а с условием, что вы сможете забрать свои деньги в любой момент. При этом в таком случае банк обязуется полностью вернуть вложенную вами сумму, а также полученные проценты по вкладу.

В случае срочного вклада заключается договор вклада с условием возврата вклада через определенный период времени. Это деньги, которые вкладчик вкладывает в банк, а банк обязуется вернуть вложенные деньги и выплатить по ним проценты в соответствии с условиями, предусмотренными договором. В широком смысле - это средства юридических и физических лиц, находящиеся в банке на временном хранении, а в узком - это средства, размещенные в банке в виде депозитов и на которые банк выплачивает начисленный процентный доход (проценты).

В этом случае вкладчик и банк «договариваются» о определенном сроке, в течение которого они предоставляют сбережения банку (предполагается, что клиент не намерен требовать возврата денег в течение этого срока). Истечение срока действия и депозитного договора. В этом случае банк также обязуется вернуть вложенную вами сумму в полном объеме, но не исключено, что проценты по вкладу будут выплачены частично или не выплачены вообще, либо начислены по более низкой процентной ставке.

Исходя из этой особенности срочного вклада, обычно процентная ставка, установленная по срочному вкладу, выше, чем по вкладу до востребования. вкладчики требуют более высокой нормы прибыли, чтобы сдержать свое «обещание» относительно срока, а банки готовы платить больше за эти средства, зная, что они смогут удерживать их в течение некоторого времени. Одним из важнейших условий выбора вклада является процентная ставка. Банки устанавливают два типа процентных ставок по одному и тому же депозиту: годовую номинальную процентную ставку по депозиту и годовую процентную ставку по депозиту.

Срочные вклады могут быть заключены как на краткосрочные (до одного года), так и на долгосрочные. Зачастую банки предлагают вклады с условиями, адаптированными к специальным целям – «семейные», «детские», «образовательные» вклады и т. д., процентные ставки, сроки и другие условия которых адаптированы к конкретным целям вкладчиков.

Преимущество депозита являются:

- ❖ Средства, вложенные в депозиты, приносят регулярный доход.
- ❖ Полученный процентный доход можно прибавить к основной сумме и получить все больший процентный доход (в банковской практике это явление называется «капитализация процентов»).
- ❖ При необходимости внесенные средства можно снять в любой момент, независимо от того, является ли вклад до востребования или на определенный срок.
- ❖ Наличие депозитного счета благоприятно скажется на оценке кредитоспособности данного банка.
- ❖ Залогом под кредит может стать депозит, вложенные сбережения могут стать залогом под кредит, что существенно ускорит процесс получения кредита.

❖ Но самое главное, что доверию коммерческим банкам в нашей стране помогают два обстоятельства: первое – деятельность банков контролируется Центральным банком Армении. И второе обстоятельство заключается в том, что согласно закону РА "О гарантировании возмещения банковских вкладов физических лиц" действует Фонд компенсации вкладов. [2]

Таблица 1:

Динамика вкладов до востребования и срочные вклады в Республике Армения 2013-2022 гг., млрд драмов [3, стр 482]

2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Динамика вкладов до востребования в РА в 2013-2022 гг., млрд драмов									
198,7	182,7	209,9	264,5	343,3	417,8	494,1	587,6	730,3	1002,9
Динамика срочных депозитов в РА 2013-2022 гг., млрд драмов									
258,2	279,1	295,2	406,0	580,0	651,4	878,9	915,9	1064,7	1081,8

*Таблица составлена авторами по данным Статистического комитета РА.
** 1USD=405 драм RA (AMD).

Для анализа данных таблицы 1 рассчитаем аналитические показатели ряда динамики и отразим результаты в таблице 2.

Таблица 2:

Расчет аналитических показателей динамики спроса и срочных депозитов в Республике Армения

Год	Показатель, млрд драм	Абсолютный прирост млрд. др.		Темп роста %		Тепм прироста%		Абсол. содерж. 1% прироста млрд драм
		Баз.	Цеп.	Баз.	Цеп.	Баз.	Цеп.	
Динамика вкладов до востребования в РА в 2013-2022 гг., млрд драмов								
2013	198,7	0,0	-	100,0	-	0,0	-	-
2014	182,7	-16,0	-16,0	91,9	91,9	-8,1	-8,1	1,987
2015	209,9	11,2	27,2	105,6	114,9	5,6	14,9	1,827
2016	264,5	65,8	54,6	133,1	126,0	33,1	26,0	2,099
2017	343,3	144,6	78,8	172,8	129,8	72,8	29,8	2,645
2018	417,8	219,1	74,5	210,3	121,7	110,3	21,7	3,433
2019	494,1	295,4	76,3	248,7	118,3	148,7	18,3	4,178
2020	587,6	388,9	93,5	295,7	118,9	195,7	18,9	4,941
2021	730,3	531,6	142,7	367,5	124,3	267,5	24,3	5,876
2022	1002,9	804,2	272,6	504,7	137,3	404,7	37,3	7,303
Динамика срочных депозитов в РА 2013-2022 гг., млрд драмов								
2013	258,2	0,00	-	100,0	-	0,00	-	-
2014	279,1	20,9	20,9	108,1	108,1	8,1	8,1	2,582
2015	295,2	37,0	16,1	114,3	105,8	14,3	5,8	2,791
2016	406,0	147,8	110,8	157,2	137,5	57,2	37,5	2,952
2017	580,0	321,8	174,0	224,6	142,9	124,6	42,9	4,060
2018	651,4	393,2	71,4	252,3	112,3	152,3	12,3	5,800
2019	878,9	620,7	227,5	340,4	134,9	240,4	34,9	6,514
2020	915,9	657,7	37,0	354,7	104,2	254,7	4,2	8,789
2021	1064,7	806,5	148,8	412,4	116,2	312,4	16,2	9,159
2022	1081,8	823,6	17,1	419,0	101,6	319,0	1,6	10,647

*Таблица составлена на основе расчетов авторов по данным Статистического комитета РА.
** 1USD=405 драм RA (AMD).

Из расчета аналитических показателей рядов динамики становится ясно, что объем депозитов до востребования в Республике Армения за последнее десятилетие увеличился почти вдвое, с 198,7 млрд драмов до 1002,9 млрд драмов. В исследуемом периоде показатель зарегистрировал снижение только в 2014 году на сумму 16 млрд драмов или 8,1%. Наибольший рост зафиксирован в 2022 году. По сравнению с 2021 годом объем вкладов до востребования в банках РА увеличился на 272,6 млрд драмов или примерно на 37,3%. По срочным вкладам картина практически такая же. И здесь рост за последнее десятилетие весьма значителен. В 2022 году по сравнению с 2013 годом объем срочных вкладов в банках Армении увеличился на 319%, с 258,2 млрд драмов до 1081,8 млрд драмов. В отличие от депозитов до востребования, объем срочных депозитов не снижался ни в одном году исследуемого периода. Как ни странно, но объем срочных вкладов в банках РА в 2022 году зафиксировал самый низкий рост по сравнению с предыдущим годом: 17,1 млрд драмов или 1,6%.

В настоящее время в Республике Армения действуют восемнадцать коммерческих банков. Ниже мы представляем диаграмму, включающую объем текущих счетов и депозитов клиентов последней в 2022 году. Все данные взяты из годовой финансовой отчетности коммерческих банков.

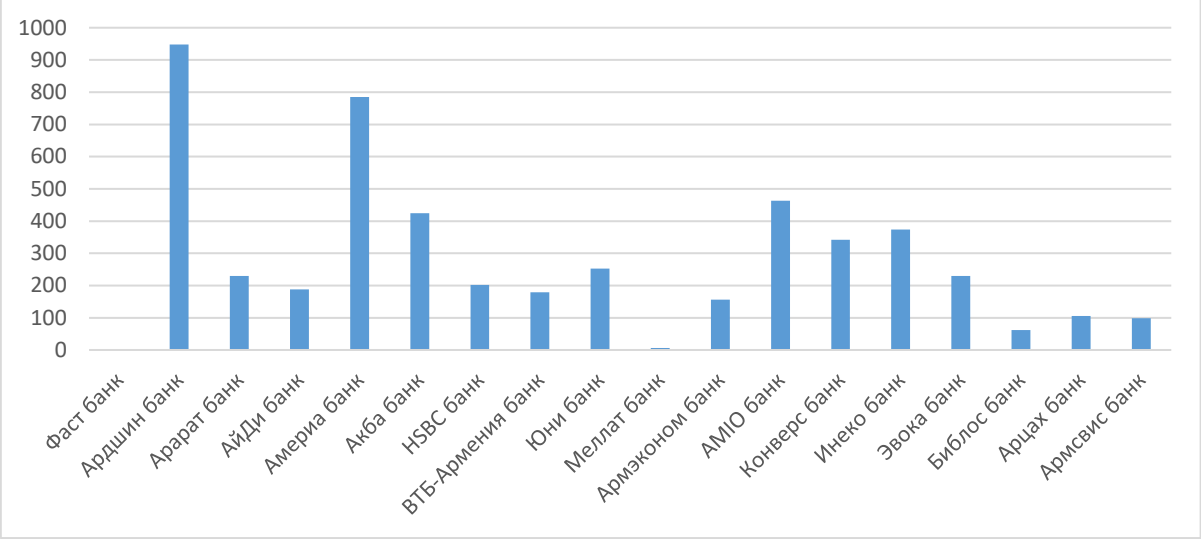


Рисунок 1. Объем текущих счетов и депозитов клиентов коммерческих банков РА в 2022 году, млрд драмов (1USD=405 драм RA (AMD))

Чтобы получить более полное представление о секторе, давайте также изучим объем текущих счетов и депозитов клиентов Америа Банка, Инеко Банка и Акба Банка за период 2018-2022 гг. Ниже мы представляем таблицу с соответствующими показателями.

Таблица 3:

Динамика текущих счетов и депозитов клиентов коммерческих банков Республики Армения в 2018-2022 гг., млрд драмов

2018	**2019**	**2020**	**2021**	**2022**
Динамика текущих счетов и депозитов клиентов Америа Банка, млрд драмов [4]				
399,09	593,22	598,96	600,61	784,64
Динамика текущих счетов и депозитов клиентов Инеко Банка, млрд драмов [5]				
164,38	165,85	220,48	253,22	373,38
Динамика текущих счетов и депозитов клиентов Акба Банка, млрд драмов [6]				
34,49	51,00	42,14	40,19	116,89
Динамика текущих счетов и депозитов клиентов ИД Банка, млрд драмов [7]				
56,3	58,8	66,8	92,3	188,3
Динамика текущих счетов и вкладов клиентов Ардшина, млрд драмов [8]				
367,2	397,0	339,8	418,6	948,1

*Таблица составлена авторами по данным годовой финансовой отчетности указанных банков.
** 1USD=405 драм RA (AMD).

В этом случае воспользуемся аналитическими показателями ряда динамики для проведения экономического анализа. Отразим результаты в таблице 4.

Таблица 4:

Расчет аналитических показателей динамики текущих счетов и депозитов клиентов коммерческих банков РА

Год	**Показатель, млрд драм**	**Абсолютный прирост млрд. др.**		**Темп роста %**		**Темп прироста%**		**Абсол. содерж. 1% прироста млрд драм**
		Баз.	**Цеп.**	**Баз.**	**Цеп.**	**Баз.**	**Цеп.**	
Динамика текущих счетов и депозитов клиентов Америа Банка, млрд драмов								
2018	399,09	0,00	-	100,00	-	0,00	-	-
2019	593,22	194,14	194,14	148,65	148,65	48,65	48,65	3,99
2020	598,96	199,87	5,74	150,08	100,97	50,08	0,97	5,93
2021	600,61	201,53	1,65	150,50	100,28	50,50	0,28	5,99
2022	784,64	385,55	184,02	196,61	130,64	96,61	30,64	6,01
Динамика текущих счетов и депозитов клиентов Инеко банка, млрд драмов								
2018	164,38	0,00	-	100,00	-	0,00	-	-
2019	165,85	1,47	1,47	100,89	100,89	0,89	0,89	1,64
2020	220,48	56,10	54,63	134,13	132,94	34,13	32,94	1,66
2021	253,22	88,84	32,74	154,05	114,85	54,05	14,85	2,20
2022	373,38	209,01	120,17	**227,15**	147,46	127,15	47,46	2,53

Динамика текущих счетов и депозитов клиентов Акба Банка, млрд драмов								
2018	210,78	0,00	-	100,00	-	0,00	-	-
2019	254,67	43,89	43,89	120,82	120,82	20,82	20,82	2,11
2020	296,94	86,16	42,27	140,88	116,60	40,88	16,60	2,55
2021	337,49	126,71	40,55	160,11	113,66	60,11	13,66	2,97
2022	424,17	213,39	86,68	201,24	125,68	101,24	25,68	3,37
Динамика текущих счетов и депозитов клиентов ИД Банка, млрд драмов								
2018	56,3	0,0	-	100,0	-	0,0	-	-
2019	58,8	2,5	2,5	104,4	104,4	4,4	4,4	0,563
2020	66,8	10,5	8,0	118,7	113,6	18,7	13,6	0,588
2021	92,3	36,0	25,5	163,9	138,2	63,9	38,2	0,668
2022	188,3	132,0	96,0	334,5	204,0	234,5	104,0	0,923
Динамика текущих счетов и депозитов клиентов Ардшин Банка, млрд драмов								
2018	367,2	0,0	-	100,0	-	0,0	-	-
2019	397,0	29,8	29,8	108,1	108,1	8,1	8,1	3,672
2020	339,8	-27,4	-57,2	92,5	85,6	-7,5	-14,4	3,970
2021	418,6	51,4	78,8	114,0	123,2	14,0	23,2	3,398
2022	948,1	580,9	529,5	258,2	226,5	158,2	126,5	4,186

*Таблица составлена на основе расчетов авторов по данным годовой финансовой отчетности соответствующих банков.

** 1USD=405 драм RA (AMD).

2018-2022 гг. За последние пять лет объем текущих счетов и депозитов клиентов Америа Банка увеличился на 385,5 миллиарда драмов, или на 96 процентов, с 399,09 миллиарда драмов до 784,64 миллиарда драмов. В прошлом, 2022 году, по сравнению с предыдущим годом, исследуемый показатель в Америа Банке увеличился на 30,64% или около 184,02 млрд драмов.

Аналогичный показатель Инекобанка, согласно опубликованным годовым финансовым отчетам, за последние пять лет увеличился на 127,15% или 209,01 млрд драмов. В 2022 году по сравнению с предыдущим годом текущие счета и депозиты клиентов в банке увеличились на 120,17 млрд драмов или на 47,46%. Указанный показатель зафиксировал самый низкий рост в 2019 году – всего 0,89%.

Экономический показатель текущих счетов и депозитов клиентов Акбабанка имеет ту же картину, что и соответствующий показатель двух предыдущих банков. В 2018-2022 годах этот показатель увеличился на 101,24% или 213,39 млрд драмов. Наибольший рост индекса был зафиксирован в 2022 году. По сравнению с предыдущим годом текущие счета и вклады клиентов в Акбабанке увеличились на 86,68 млрд драмов или примерно на 25,68%.

Объем текущих счетов и вкладов клиентов в ID Bank за последние пять лет увеличился на 132 млрд драмов или 234,5%. В 2022 году по сравнению с 2021 годом исследуемый показатель в банке зафиксировал рекордный рост, увеличившись по сравнению с предыдущим годом на 104,0% или 96 млрд драмов.

Объем текущих счетов и депозитов клиентов в Ардшин Банке в 2022 году также увеличился по сравнению с базовым 2018 годом. Рост составил 580,9 млрд драмов или 158,2%. Анализируемый показатель в банке снизился только в 2020 году. По сравнению с предыдущим годом объем текущих счетов и депозитов клиентов увеличился на 57,2 млрд драмов или примерно на 14,4%.

Подводя итог, следует отметить, что банковская система Республики Армения признана одной из лучших среди стран постсоветского пространства и региона, отличающаяся стабильностью и надежностью. Разумеется, именно этим обусловлен динамичный рост текущих счетов и депозитов клиентов в последние годы. Примечательно, что даже в условиях пандемии и рисков безопасности 2020 года банковская система Армении сохраняет свою инвестиционную привлекательность.

Список литературы:

1. https://www.raiffeisen.ru/wiki/chto-takoe-bankovskij-depozit/
2. www.abcfinance.am
3. Ежегодники Республики Армения СК 2023, стр. 482
4. Годовые финансовые отчеты Америа Банка: https://ameriabank.am/reports
5. Годовые финансовые отчеты Инеко Банка: https://www.inecobank.am/hy/reports
6. Годовые финансовые отчеты Акба Банка: https://www.acba.am/hy/reports
7. Годовая финансовая отчетность ИД Банка: https://idbank.am/information/reports/contentfooter/financial-statements-and-audit-reports
8. Годовые финансовые отчеты Ардшин Банка: https://www.ardshinbank.am/reports/annual-reports
9. Suren Parsyan, Henik Manukyan. Analysis of credit portfolio of ra banks through ecl reserve for 2020. European University of Armenia: Collection of scientific articles, 12(2), Yerevan, 77-99pages: https://bit.ly/4aB2NbB

JURISPRUDENCE

PROSPECTS OF THE DIGITIZED INSURANCE MARKET IN KAZAKHSTAN

Ruslanova A.,
Qyrgi A.,
Kanatova A.,
Educational program «Jurisprudence»., 4th year students
Atyrau University named after H. Dosmukhamedov, Atyrau, Kazakhstan
Mukhanova A.
Head of the scientific article
https://orcid.org/0000-0002-3973-7339

ҚАЗАҚСТАНДАҒЫ ЦИФРЛАНДЫРЫЛҒАН САҚТАНДЫРУ НАРЫҒЫНЫҢ ПЕРСПИКТИВАЛАРЫ

Русланова А.Р.
Қырғи А.Н.
Қанатова А.Н.
«Құқықтану» білім беру бағдарламасы., 4 – курс білім алушылары
Х.Досмұхамедов атындағы Атырау университеті, Атырау, Қазақстан
Муханова А.Т.
Ғылыми мақала жетекшісі
https://orcid.org/0000-0002-3973-7339
https://doi.org/10.5281/zenodo.10450925

Abstract

The rapid growth of computer technology will undoubtedly radically change the traditional methods and style of work of insurers in the near future, as well as the system of relationships between all participants in the insurance market. The structure, purpose, mode of operation, functions of the online representation of insurance companies are studied; the stages of the implementation of a mass insurance product are consistently revealed; the specifics of the work of online insurance sales are determined. Digital technologies contribute to the improvement of transformational processes in the insurance market.

Today, Kazakhstan's e-insurance market is at the stage of formation and development. New technologies are penetrating deeper into the insurance industry and creating the basis for making radical changes to the programs offered by insurers. In addition, new digital technologies allow the Agency for Regulation and Development of the Financial market of the Republic of Kazakhstan to instantly receive important information on insurance and other financial organizations, promptly assess their condition and take timely measures. Thus, the risks of unfair behavior in the insurance market will be reduced in the future.

Түйіндеме

Компьютерлік технологиялардың қарқынды өсуі жақын арада сақтандырушылардың дәстүрлі әдістері мен жұмыс стилін, сақтандыру нарығының барлық қатысушыларының өзара қарым-қатынас жүйесін түбегейлі өзгертері сөзсіз. Сақтандыру компанияларының интернет-өкілдігінің құрылымы, мақсаты, жұмыс тәртібі, функциялары зерттеледі; жаппай сақтандыру өнімін сату кезеңдері дәйекті түрде ашылады; сақтандыру онлайн-сатылымдарының жұмыс ерекшеліктері анықталады. Цифрлық технологиялар сақтандыру нарығындағы трансформациялық процестерді арттыруға ықпал етеді.

Бүгінгі таңда қазақстандық электрондық сақтандыру нарығы қалыптасу және даму сатысында. Жаңа технологиялар сақтандыру саласына тереңірек еніп, сақтандырушылар ұсынатын бағдарламаларға түбегейлі өзгерістер келтіруге негіз жасайды. Бұдан басқа, жаңа цифрлық технологиялар ҚР Қаржы нарығын реттеу және дамыту агенттігіне сақтандыру және басқа қаржы ұйымдары бойынша маңызды ақпаратты лезде алуға, олардың жай-күйін жедел бағалауға және уақтылы шаралар қабылдауға мүмкіндік береді. Осылайша, сақтандыру нарығында жосықсыз әрекет ету тәуекелдері одан әрі төмендетілетін болады.

Keywords: digitalization, economics, insurance, e-government, inflation, insurance company, Electronic policy, unified insurance database

Кілт сөздер: цифрландыру, экономика, сақтандыру , электрондық үкімет, инфляция, сақтандыру компаниясы, электрондық полис, бірыңғай сақтандыру деректер базасы

КІРІСПЕ

Қазіргі заманда бәсекеге қабілеттіліктің басты факторының бірі – барынша цифрландыру. Цифрландыру – адамның әрекеті арқылы жасалатын жұмысты сандық форматқа ауыстыра отырып, уақытты үнемдеу, яғни қағаз толтыру, қажетті анықтама мен сервистік төлемдерді кез келген жерде интернеттің игілігін пайдалана отырып өз қажетіңізге жарату. Жаһандану кезеңінде цифрлық экономикаға қатысты мәселелер өзектілігін жоғалтқан емес. Экономиканы цифрландырудың негізгі мақсаты - экономикалық жүйелердің техникалық-технологиялық дамуының жаңа деңгейіне көшу және әлеуметтік-экономикалық дамудың жаңа деңгейін қамтамасыз ету үшін коммуникациялар мен технологиялардың цифрлық құралдарын белсенді қолдану негізінде өндірістік қатынастарды дамыту болып табылады. Цифрландыру экономиканың барлық салаларын қамтып, оның ішінде сақтандыру саласын тыс қалдырмады. Бүгінгі таңда сақтанушыларға онлайн сақтандыру шартын жасасу ұсынылады,ал сақтандырушылар өз қызметінде мобильді қосымшаларды, веб-сайттарды, жеке кабинеттерді және т.б. қолдана отырып, цифрлық технологияларды пайдалану негізінде сақтандыру өнімдерін сатуға мүмкіндік алды. Цифрландыруға байланысты қоғамдағы жылдам өзгерістер сақтандыру ұйымдарынан сақтандыру қызметтерін интернет арқылы сатып алатын клиенттердің үлесін кеңейту үшін де, клиенттерге қызмет көрсету шығындарын азайту үшін де жаңа техникалық шешімдерді енгізуді талап етеді.

Соңғы жылдары Қазақстан да цифрландыру саласынан тыс қалып жатқан жоқ. Мысалы, БҰҰ-ның жаһандық электрондық үкіметті дамыту индексінде Қазақстан 28-ші орында[1]. Ал, көршілес Ресей 42-ші, Беларусь 46-шы, Украина 58-ші, Өзбекстан 69-шы орынға табан тіреген. Жалпы еліміз қазіргі уақытта сақтандыру саласын цифрландыруда айтарлықтай жетістікке қол жеткізуде. Дәстүрлі қызметтердің онлайн форматқа ауысуы азаматтардың өмірін жеңілдете түсті.

Зерттеудің мақсаты: Қазақстанның сақтандыру полистерін электрондық сатудың тиімді дамуына кедергі келтіретін негізгі факторларды анықтау және интернет желісі арқылы полистерді сататын сақтандыру компанияларының тиімділігін арттыру бойынша практикалық ұсыныстар әзірлеу болып табылады. Цифрлық технологиялар жағдайында сақтандыру нарығын дамытудың өзекті мәселелерін қарастырып, сандық сақтандыруды талдау негізінде сақтанушыларды қорғау сапасын арттыру және цифрлық экономика жағдайында сақтандыру бизнесін дамыту мақсатында сақтандыру индустриясына цифрлық технологияларды одан әрі енгізудің маңыздылығын айқындау. Сақтандыру нарығының дамуына әсер ететін факторларды анықтап , COVID-19 пандемиясының сақтандыру саласының дамуына әсерін көрсету болып табылады.

Зерттеу материалдары мен әдістері. Зерттеудің әдістемелік аппараты жүйелік , құрылымдық, функционалдық, факторлық және салыстырмалы талдау әдістерін қамтиды. Зерттеу барысында электрондық ресурстар, сақтандыруды цифрландырудың жолдары туралы мәліметтер, статистикалық ақпараттар пайдаланылып, қорытынды жасалды.

Зерттеу нәтижелері және оларды талқылау.

Мақала басын "Халық" сақтандыру компаниясының басқарма төрағасының міндетін атқарушы Қайсар Әбдірдің сөзімен бастасақ:

"Сақтандырудың басқа қаржы институттарынан айырмашылығы – жаңа технологияларды баяу енгізетін және дәлелденген шешімдерді қолдануға көбірек көңіл бөлетін жеткілікті консервативті бизнес екенін мойындауымыз керек".[2]

Дегенмен, цифрлық дамытудың негізгі драйвері - пандемия сақтандыруға өсу әлеуетін беретін сандық және платформалық технологияларды, соның ішінде: цифрлық сатуды қамтамасыз ету, процестерді оңтайландыру, тұтынушылармен жұмыс істеу үшін деректерді пайдалануды және аналитиканы кеңейтуді дамыту қажеттілігін көрсетті. Әуелі, Қазақстандағы сақтандыру нарығын цифрландыруға жоғарыда айтылған пандемияның тигізген әсерінен бөлек, жалпы сақтандыру нарығын сандық форматқа ауыстыру қалай жүзеге асырылғандығына тоқталсақ.

Freedom Life өмірді сақтандыру компаниясының мамандарының дамыған елдердегі онлайн-сақтандырудың қалыптасу барысын және өмірді сақтандыру саласындағы ең сұранысқа ие бағдарламалардың қандай екені жөніндегі келтірген ақпараттарын тілге тиек етсек.

Әр елде сақтандыру нарығының дамуы әртүрлі жолдармен жүреді. Бірақ сақтандыру нарығының интернетке ауысу тенденциясын анықтаған негізгі жалпы факторлар бар. 2008-2013 жылдардағы әлемдік экономикалық дағдарыс жаһандық инфляциямен, көптеген ірі компаниялардың банкроттығымен және жаппай жұмыссыздықпен ерекшеленеді. Өзгеріссіз қалған компанияларға әдеттегі офлайн сервисті жаңғырту, тұтынушылар үшін жаңа, неғұрлым ыңғайлы өнімдер жасау талап етілді. Дәл осы уақытта АҚШ, Ұлыбритания, Германия ірі сақтандыру компаниялары ерікті жеке сақтандыру мен өмірді сақтандыруды дамытуға баса назар аудара отырып, онлайн - сақтандырудың жаңа өнімдерін белсенді түрде әзірлеп, енгізе бастады.

Бүкіл әлем бойынша цифрландырудың енуі 2017-2019 жж сәйкес келеді. Дәл осы уақытта

[1] Индекс развития электронного правительства https://publicadministration.un.org/egovkb/en-us/Data/Country-Information/id/87-Kazakhstan

[2] Почему страховой рынок РК не становится кардинально цифровым https://halyksk.kz/ru/about/news/news_more/pochemu-strahovoj-rynok-rk-ne-stanovitsya-kardinalno-cifrovym

Еуропа елдерінің көпшілігі, соның ішінде Жапония, Қытай, Ресей, Қазақстан және басқа да дамыған мемлекеттер онлайн-сақтандыру бағдарламаларын , мысалы: көлік құралдары иелерінің азаматтық-құқықтық жауапкершілігін міндетті автосақтандырудың электрондық полистерін рәсімдеу, шетелге шығатын туристерді медициналық сақтандыру және жазатайым оқиғалардан сақтандыру т.с.с.

Ал, Қазақстандағы көптеген салалардың қарқынды дамып, цифрлық жүйеге көшуіне бірден-бір себеп дамыған елдердегідей 2020-2021 жылдардағы COVID-19 пандемиясы болды. Қатаң карантин мен жаппай оқшауланудың арқасында адамдарға жаңа шешімдер қажет болып, соның арқасында олар өз денсаулығы мен өмірін үйден шықпай-ақ сақтандыру мүмкіндігіне қол жеткізді. Мысалы, "Freedom Life" [3]өмірді сақтандыру компаниясында сол кезеңдегі ең өзекті онлайн-бағдарлама «Corona protect» коронавирусынан сақтандыру болды. Іске қосылғаннан кейінгі алғашқы апталарда екі мыңнан астам жеке және заңды тұлғалар дәл осы сақтандыру түрін сатып алды.

Кейін кейбір елдер карантинді біраз уақытқа жеңілдетіп, шекараны ашқан кезде шетелге шығатын туристерді онлайн сақтандыру түрі қол жетімді болды. Бұл ретте осы сақтандыру түрі бойынша тәуекелдер тізіміне тағы бір тармақ – COVID-19 ауруына шалдыққандардың ауруханадағы емін жабу қосылды.

Сонымен қатар, коронавирустық сақтандырудан басқа денсаулықты сақтандырудың өзге де технологиялық өнімдері жасалды. Мәселен, 2021 жылы Қазақстанда алғаш рет "Денсаулыққа Жазылу" пайда болды. Бұл Freedom health бағдарламасы бойынша ыңғайлы және қолжетімді цифрлық форматта қауіпті аурулардан (қатерлі ісік, инфаркт, инсульт және т.б) онлайн сақтандыру болып табылады. Өнімнің жұмыс принципі музыкалық платформалар, киносервистер және басқа да ақылы қосымшалардағы (Netflix, Itunes, Яндекс) әдеттегі онлайн жазылымдарға ұқсас, оны тұтынушы жыл бойы ай сайын аз мөлшерде төлейді. "Денсаулыққа жазылу" бес минут ішінде жүзеге асырылады және сақтандыру жағдайы туындаған уақытта жылына 150 000 долларға , ал өмір бойына 1 000 000 долларға дейінгі емдеу сомасын жабуды қамтиды.

Қазіргі уақытта заманауи цифрлық технологиялар сақтандыруға көбірек енуде. Есімізге салсақ, 2022 жылдың шілде айында Қазақстан президенті Қасым-Жомарт Тоқаев сақтандыру нарығын реттеуге қатысты өзгерістер пакетіне қол қойған болатын. Бұл өзгерістердің негізгі идеясы-одан әрі цифрландыруға мүмкіндік жасау үшін мемлекеттік реттеуді жеңілдету болып табылады. Осыған орай сақтандыруда цифрлық технологияларды қолдану қаншалықты перспективалы және оңтайлы болатынын бірнеше бағытты көрсете отырып белгілесек. Мысалы, бес жыл бұрын сақтандыру қызметтерін Оңтүстік Кореяның ең ірі KakaoTalk[4] месседжері іске қосты. Ол мессенджердің белсенді аудиториясы 50 миллионнан асатын болғандықтан клиенттерді өте тез тартты. Какао сақтандыру қызметін белгілі бір өнімдерден бастады-мысалы, такси сапарларынан сақтандыру немесе онлайн сатып алуды қайтару т.с.с. Бірақ бүгінде компания дәстүрлі сақтандыру секторларын да кеңейтуде. Сонымен қатар, жақын арада автокөлікті сақтандыруда тағы бір маңызды технологиялық өзгеріс - ЖКО кезінде залалды бағалауды автоматтандыру іске қосылады. Яғни, жасанды интеллект алдағы жөндеудің құнын фотофиксация арқылы бағалай алады. Бұл қашықтан және автоматты түрде жүзеге асырылады. Демек, жүргізуші сақтандыру төлемін ЖКО-дан бірнеше сағат өткен соң ала алады.

Жалпы, Қазақстанда отандық сақтандыру нарығын цифрландыру реттеуші Бірыңғай сақтандыру деректер базасын мемлекеттік деректер базасымен біріктіру арқылы 2019 жылы басталды. Бүгінгі күні «Бірыңғай сақтандыру дерекқоры» – сақтандыру нарығын цифрландыру процесінің негізгі операторы болып табылады. База : 1) міндетті сақтандыру шарттарын жасасуды ұйымдастыру; 2) мемлекеттік дерекқорлармен өзара іс-қимыл жасау; 3) талдау мен есептеулер жүргізу үшін қажетті статистиканы жинақтау; 4) тұлғаларды қашықтан идентификациялау; 5) сақтандыру шартының жасалғанын және қолданыстағы электрондық полистің болу-болмауын тексеру функцияларын жүзеге асырады.

2019 жылы цифрландыру басталғаннан бері Қазақстандағы алғашқы цифрлық сақтандыру өнімдерінің бірі көлік иелерінің азаматтық-құқықтық жауапкершілігін міндетті автосақтандыру полисі болды. Ұлттық банктің мәліметінше, соңғы үш жылда (2019 ж, 2020 ж, 2021 ж) міндетті автосақтандыру бойынша сақтандыру сыйлықақыларының көлемі 42% - ға өсті, қазір ол (2021ж) 61,8 млрд теңгені құрайды. Сақтандыру сыйлықақылары көрсеткіштерінің өсуі негізінен онлайн форматта сақтандырудың дамуына байланысты болды.

2022 жылдың қараша айында еліміздегі цифрлық автосақтандыру саласында серпіліс болып, сақтандыру жағдайында жылдам онлайн-төлемдердің жаңа сервисі– dtp.kz іске қосылды. Осыған сәйкес апатқа ұшыраған автокөлік иелері құжаттармен ұзақ әуре-сарсаңсыз және сақтандырушының кеңсесіне бармай-ақ сақтандыру жағдайы туралы өтінішті өз бетінше онлайн тапсырып, өтемақы алу мүмкіндігіне қол жеткізді. Негізінде dtp.kz -қазақстандықтар үшін сақтандыру төлемдерін алудың барынша жылдам әрі ыңғайлы процесін қамтамасыз ету мақсатында құрылған коммерциялық емес жоба болып табылады.

Онлайн-сақтандыруды дамытудың келесі кезеңі міндетті сақтандыру сыныптары бойынша сақтандыру төлемдерін онлайн реттеуді енгізу

[3] Өмірді сақтандыру компаниясы

[4] смартфондарға арналған ақысыз мобильді жедел хабар алмасу қосымшасы

болмақ. Бұл сақтандыру төлемін алудың транспарентті рәсімін едәуір жеңілдетуге және жасауға мүмкіндік береді. Азаматтар төлем алуға өтініш бере алады, құжаттар пакетін қалыптастырып, жібере алады, сақтандыру төлемін сақтандырушының кеңсесіне бармай-ақ қашықтықтан ала алады. Осылайша, жақын арада міндетті сақтандыру шартын жасасудан бастап сақтандыру төлемін алуға дейінгі сақтандыру қызметтерінің толық циклін цифрландыру қамтамасыз етілетін болады. Бұл, әсіресе, полис ұстаушының аймағына және орналасқан жеріне қарамастан, қызметтерді қашықтықтан алу кезінде байқалады.

Қазақстандағы сақтандыруды цифрлық дамыту барысында 2019 жылы Freedom Insurance сақтандыру компаниясының сақтандыру сервисінің цифрлық моделін бірінші болып ұсынғандығын атап өткеніміз жөн. Компания сақтандыру агенттерінің филиалдары мен қызметтерінен бас тартты. Бастапқыда арнайы терминалдар арқылы және сақтандырушының сайтында рәсімдеуге болатын міндетті және ерікті автосақтандырудың электрондық полистерін енгізуге баса назар аударылды. Осылайша, Мемлекеттік кредиттік бюроның мәліметі бойынша, 2019 жылы елдегі барлық электрондық полистердің 55,5% рәсімделіп Freedom Insurance сақтандыру компаниясы онлайн-сақтандырудың көшбасшысы болды.

Қазіргі уақытта ҚР халқына сақтандыру қызметтерін 25 сақтандыру ұйымы көрсетеді. Оның 16-сы жалпы сақтандыру компаниялары және 9-ы өмірді сақтандыру компаниялары. 2023 жылғы көрсеткіштер бойынша сақтандыру компанияларының активтері 2,4 трлн теңгені құрайды[5]. Ағымдағы жылдың алғашқы 9 айында сақтандыру нарығында төлемдер 164 млрд теңгені құрады. Соңғы 4 жылда сақтандыру шарттарының саны 2 есеге өсті: 5,8 млн шарттан 9,3 млн. дейін, оның 86% - заңды тұлғаларға тиесілі. Шарттардың 49% - ы міндетті автосақтандыру шарттарын құрайды. Соңғы 3 жыл ішінде сақтандыру секторының белсенді дамуына нарықты белсенді цифрландыру ықпал етті. Қаржы секторын дамыту тұжырымдамасы шеңберінде сақтандыру нарығында цифрландыруды дамытудың 3 бағыты бар: Insurtech, RegTech және SupTech.

Біріншісі-Insurtech. Бұл екі тараптың да уақытша және қаржылық ресурстарын ұтымды пайдалануға мүмкіндік беретін сақтандыру қызметтерін көрсету кезінде сақтандыру компанияларының өз клиенттерімен тиімді өзара іс-қимылына ықпал ететін цифрлық технологиялар.

Екінші бағыт – RegTech. Бұл технологиялар сақтандыру нарығына қатысушылар қызметінің тиімділігін арттыруға арналған. Сақтандыру шарттары бойынша толық деректер базасын құру есептілікті қысқарту есебінен сақтандыру компанияларына жүктемені азайтуға мүмкіндік береді. Мемлекеттік деректер базасын интеграциялау әрбір клиент бойынша тәуекелдерді неғұрлым толық және шынайы бағалауды жүргізуге мүмкіндік береді.

Үшіншісі- suptech: сақтандыру компанияларының реттеуші талаптардың орындалуын қадағалауды автоматтандыру. Бұл қадағалау органына сақтандырушылар қызметіндегі жағымсыз факторларға жедел ден қоюға мүмкіндік береді.

Freedom Finance Insurance деректері бойынша Қазақстанда онлайн электрондық полистерді ер адамдардың сатып алу ықтималдығы жоғары. ОГПО онлайн-полистерін сатып алған барлық тұтынушылардың 89% - ер адамдар [6]құрайды. Ал, әйел адамдар көбінесе терминалдарға немесе сақтандырудың басқа тәсілдеріне қарағанда компанияның сайтында сақтандыруды сатып алуды жөн көреді.

Алынған мәліметтерге сүйене отырып, Қазақстан Республикасының сақтандыру нарығы белсенді дамып, кеңейіп келеді деп айтуға болады. Соңғы жылдары онлайн сақтандыру халық арасында өзекті мәселеге айналып, адамдар көптеген мүмкіндіктерге қол жеткізе алды .

ҚОРЫТЫНДЫ

Қорытындылай келе, сақтандыруда цифрландыруды одан әрі енгізу сақтандыру компанияларының бәсекеге қабілеттілігінің өсуін қамтамасыз ететін болады. Ақпараттық технологияларды қорғау бойынша қолданыстағы сақтандыру өнімдерін жетілдіру және кибер сақтандыру бағдарламаларын енгізу ақпараттық , сонымен қатар қаржылық қауіпсіздікке байланысты тәуекелдерді азайтуға мүмкіндік береді. Ақпараттық технологиялардың көмегімен сақтандыруды одан әрі жетілдіру үшін:

- сақтандырушылар мен мемлекеттік билік және басқару органдарының ақпараттық ресурстары арасындағы өзара іс-қимылды жүзеге асыру;
- сақтандыру ұйымдарының ұйымдастырушылық және бизнес-процестерін автоматтандыру;
- "цифрлық" сатып алушының қажеттіліктеріне бейімделген жаңа өнімдерді әзірлеу;
- сақтандыру қызметін көрсетудің барлық кезеңдерінде клиенттердің деректерін тексеру үшін жаңа технологияларды кеңінен қолдану;
- сақтандыру ұйымдарының сайттарында және мобильді қосымшаларында сақтандыру өнімдерін сатуды ұлғайту маңызды болып табылады.

Пайдаланылған әдебиеттер тізімі:

1. Как проходит цифровизация страхования (https://kz.kursiv.media/2023-04-04/kak-prohodit-czifrovizacziya-strahovaniya/)
2. Как изменился сектор общего страхования с начала цифровизации (https://kz.kursiv.media/2023-05-31/kzgr-digital/)

[5] https://ortcom.kz/ru/novosti/1695980482

[6] https://ffins.kz/news/158-tsifrovizatsiya-strakhovogo-rynka-kto-v-kazakhstane-pokupaet-polisy-onlayn

3. Какие изменения ожидаются на страховом рынке Казахстана (https://vecher.kz/kakie-izmeneniia-ozhidaiutsia-na-strakhovom-rynke-kazakhstana-1701931896)

4. С начала года выплаты на страховом рынке РК составили 164 млрд тенге (https://ortcom.kz/ru/novosti/1695980482)

5. Цифровизация страхового рынка: кто в Казахстане покупает полисы онлайн (https://ffins.kz/news/158-tsifrovizatsiya-strakhovogo-rynka-kto-v-kazakhstane-pokupaet-polisy-onlayn)

6. Страховой рынок казахстана: анализ и оценка эффективности (https://cyberleninka.ru/article/n/strahovoy-rynok-kazahstana-analiz-i-otsenka-effektivnosti)

7. Трансформация страхового рынка в условиях цифровизации (https://cyberleninka.ru/article/n/transformatsiya-strahovogo-rynka-v-usloviyah-tsifrovizatsii)

MATHEMATICAL SCIENCES

PROVING PHYSICAL REALITY AND EXPLAINING THE PHYSICAL ESSENCE OF IMAGINARY NUMBERS

Antonov A.
PhD, HonDSc, HonDL, ResProf., H.ProfSci
Independent researcher, Kiev, Ukraine
https://doi.org/10.5281/zenodo.10451085

Abstract

In the article it is shown that the version of the special theory of relativity (STR), stated in all textbooks of physics, is wrong as the relativistic formulas received in it are wrong, they are incorrectly with use of wrong principle of non-exceeding of speed of light are explained and from them wrong conclusions about physical unreality of imaginary numbers and also about existence in the nature of our only visible universe are made. This generally recognized version of STR is refuted experimentally proved as a result of research of transient processes in linear electric circuits by the general scientific principle of physical reality of imaginary numbers discovered 500 years ago.

It is explained that imaginary numbers in astrophysics correspond to the world of invisible parallel universes in other dimensions. Its cognition is the task of future science. However, the neighbouring universes can be seen on the starry sky in portals now. The corrected relativistic formulas are obtained and the corrected version of STR corresponding to them is created.

Keywords: imaginary numbers, special theory of relativity, invisible universes, hidden Multiverse, invisible Hyperverse

1. Introduction

Imaginary numbers were discovered 500 years ago by Scipione Del Ferro, Niccolo Fontana Tartaglia, Gerolamo Cardano, Lodovico Ferrari and Raphael Bombelli [1]. And perhaps even earlier than them such a scientific discovery was made by Paolo Valmes [2], who was burned alive at the stake for this by the verdict of the Spanish inquisitor Thomas de Torquemada. Even Sir Isaac Newton[7] was forced to take into account the opinion of the Inquisition about imaginary numbers, who therefore preferred not to use them in his works.

However, their physical significance remains unknown in science to this day. Indeed, everyone knows what 7 seconds, 12 meters, or 19 grams are, but no one knows what 7*i* seconds, 12*i* meters and 19*i* grams, where $i = \sqrt{-1}$, are. We all know that 7, 12 and 19 are simply numbers having no physical significance outside of their context. However, this knowledge was not enough to understand the STR.

2. The Problem of Understanding Imaginary Numbers

Works of famous mathematicians Abraham de Moivre, Leonhard Euler, Jean le Rond d'Alembert, Caspar Wessel, Pierre-Simon de Laplace, Jean-Robert Argand, Johann Carl Friedrich Gauss, Augustin Louis Cauchy, Karl Theodor Wilhelm Weierstrass, William Rowan Hamilton, Pierre Alphonse Laurent, Georg Friedrich Bernhard Riemann, Oliver Heaviside, Jan Mikusiński and others contributed to creation of a perfect theory of functions of a complex variable. However, the theory neither proves physical reality of imaginary numbers nor explains their physical significance[8].

Imaginary numbers are now widely used in all exact sciences, including radio engineering, electrical engineering, optics, mechanics, acoustics, etc. But in them also the physical reality of imaginary numbers is not proved and their physical meaning is not explained[9].

But in the generally accepted version of the special theory of relativity (STR) [3]-[5], which is rightly considered one of the most outstanding theories created in the 20th century and is therefore currently studied in all physics textbooks, it is even denied, since its creators were unable to explain the relativistic formulas obtained therein.

$$m = \frac{m_0}{\sqrt{1-(v/c)^2}} \quad (1)$$

$$\Delta t = \Delta t_0 \sqrt{1-(v/c)^2} \quad (2)$$

$$l = l_0 \sqrt{1-(v/c)^2} \quad (3)$$

[7] In the atmosphere of the omnipotence of the Inquisition and intolerance of dissent that existed at that time, Newton's friend William Whiston was stripped of his professorship in 1710 for some of his careless statements and expelled from Cambridge University.

[8] Naturally, about physical reality and physical essence of imaginary numbers, as well as real numbers, we can speak only in relation to named numbers, equipped with indications on the used units of measurement of corresponding parameters of physical objects and processes.

[9] More precisely, in radio engineering and electrical engineering it is actually revealed in the process of their practical use, but nothing is written about this in textbooks, so as not to refute physics.

where m_0 is the rest mass of a moving physical body;

m is the relativistic mass of a moving physical body;

Δt_0 is the rest time of a moving physical body;

Δt is the relativistic time of a moving physical body;

l_o is the rest length of a moving physical body;

l is the relativistic length of a moving physical body;

v is the velocity of a moving physical body;

c is the speed of light;

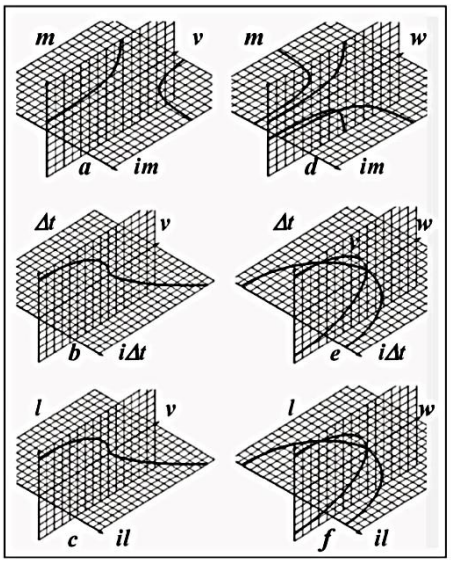


Fig. 1. Graphs of functions $m(v)$, $\Delta t(v)$ *and* $l(v)$ *corresponding to the existing and the corrected versions of the STR in the subluminal* $v < c$ *and superluminal* $v > c$ *ranges*

They could not explain physical significance of these formulas for the superluminal velocity range, where, according to these formulas, mass, time, and distance were measured in imaginary numbers (see Fig. 1a, b, c). However, since a theory that could not be explained even by its creators would be useless to anyone, in the STR had to introduce a postulate[10], known as the principle of light speed non-exceedance, the meaning of which is clear from its name.

In relation, for example, to the Lorentz-Einstein formula (1), it was explained as follows. The postulate asserted that since the situation at $v > c$ never occurred anywhere in the early 20th century, it did not need any explanation. Thus, imaginary numbers were unnecessary. i.e. non-existent. Moreover, they were even called imaginary

However, since the existing version of the STR was based solely on a postulate, that is, an unproven assumption, there was no complete certainty that it was correct. Actually, it turned out to be incorrect, since in 2008-2010 (i.e., even before publication of results of the unsuccessful OPERA experiment[11] conducted at the Large Hadron Collider in 2011), it was experimentally proven [6]-[10] that imaginary numbers are physically real.

3. Proof of Physical Reality of Imaginary Numbers

Thus, in the 21st century, a Hamlet's question has arisen in physics – is the generally accepted version of the STR correct or not correct? Consequently, does it require correction or not? To address this, it was necessary to answer another question – whether imaginary numbers discovered 500 years ago are physically real or not. And the response to this question required experimental confirmation, even though this issue falls within the realm of mathematics. However, Oliver Heaviside asserted on a similar issue, *"Mathematics is an experimental science."*

Let us further examine electromagnetic transient processes in linear electrical circuits[12] [10]-[15], which allow us to answer this question conclusively using simple experiments[13]. These experiments can be carried out by any engineer in less than a day in any radio engineering laboratory. Such processes in linear electrical LCR circuits are described by linear differential equations (or systems of such equations)

[10] Since it has never been proven theoretically or confirmed experimentally by anyone.

[11] Which was no longer needed

[12] Unlike the extremely complex and expensive MINOS, ORERA and ICARUS physics experiments, which were no longer needed

[13] In contrast to the extremely expensive physics experiments MINOS, OPEPA and ICARUS, which were no longer needed

$$a_n \frac{d^n y}{dt^n} + a_{n-1} \frac{d^{n-1} y}{dt^{n-1}} + ... + a_0 y = b_m \frac{d^m x}{dt^m} + b_{m-1} \frac{d^{m-1} x}{dt^{m-1}} + ... + b_0 x \quad (4)$$

where $x(t)$ is the input action (or the input signal);

$y(t)$ is the response (or the output signal);

$a_n, a_{n-1}, ...a_0, b_m, b_{m-1}, ...b_0$ are the constant coefficients;

$n, n-1, ...0, m, m-1, ...0$ is the order of derivatives.

A solution to the equation (5) is known to equal the sum of two components

$$y(t) = y(t)_{forc} + y(t)_{free} \quad (5)$$

where $y(t)_{free}$ is the free component of response, corresponding to the transient process;

$y(t)_{forc}$ is the forced component of response.

They are found in different ways. We are only interested in the free component of response.

Finding a specific type of a free component of response begins with writing and solving the so-called characteristic algebraic equation (usually of the second order) corresponding to the original differential equation (4)

$$a_n p^n + a_{n-1} p^{n-1} + ... + a_0 = 0 \quad (6)$$

where $a_n, a_{n-1}, ...a_0$ are the constant coefficients same as in the equation (4);

$n, n-1, n-2, ...1, 0$ are the degree indices, the magnitude of which is equal to the order of the corresponding derivatives in differential equation (4);

p is the variable, which is often called a complex frequency, when it takes values in the form of complex numbers.

Currently, two algorithms for solving algebraic equations (4) are used in mathematics. According to the first algorithm, solutions are found in the form of real numbers known to everyone. The second algorithm finds solutions to complex numbers that no one understands.

Then, one might assume that no one needs complex numbers because of their incomprehensibility. But, actually, the use of complex numbers greatly simplifies mathematical reasoning and many engineering calculations. Thus, when solving algebraic equations of power n according to the first algorithm, we would receive either n roots or $n-1$ roots or $n-2$ roots ... or even no roots, depending on the value of coefficients. $a_n, a_{n-1}, ...a_0$ And when using the second algorithm to solve the same algebraic equations of power n, we would always receive n roots. Therefore, for some combinations of coefficients $a_n, a_{n-1}, ...a_0$, the algebraic equation (6) might not have any solution within the first algorithm, and would always have n solutions within the second algorithm.

This definitely contradicts common sense and requires an answer to the question – which of the algorithms mentioned above provides the only correct solution in a particular situation? After all, two mutually exclusive statements cannot be simultaneously true. In the formal logics, the Latin aphorism *'Tertium non datur'*, i.e. there is no gap between them that corresponds to this situation.

However, the question is uneasy, otherwise, the answer thereto would have been received long ago. Since humans have a visual thinking, graphical solutions to algebraic equations would be the most helpful in explaining the situation.

For this purpose, we shall convert, for example, the algebraic quadratic equation $a_2 p^2 + a_1 p + a_0 = 0$ as follows

$$\begin{cases} y = a_2 p^2 + a_1 p + a_0 \\ y = 0 \end{cases} \quad (7)$$

Then its solution (see Fig. 2) would correspond to the intersection of the parabola $y = a_2 p^2 + a_1 p + a_0$ and the line $y = 0$, i.e. the abscissa axis p.

As can be seen depending on the parabola position relative to the axis p, which is determined by values of coefficients a_2, a_1, a_0, the parabola $y = a_2 p^2 + a_1 p + a_0$ can cut the axis p either at two or one or none of the points.

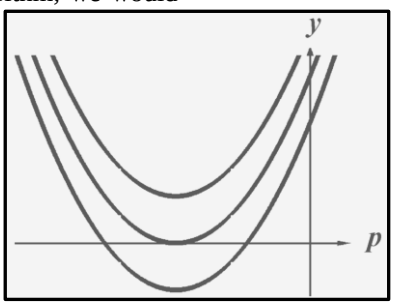


Fig. 2. *Graphical solution to the quadratic equation in the set of real numbers, explaining that the equation can have either or two or one or no solutions*

The result obtained is consistent with the corresponding analytical solution to the quadratic equation. Actually, if a discriminant of the equation $a_2 p^2 + a_1 p + a_0 = 0$ is positive, the equation has two different real roots $p_1 = -\sigma_1$ and $p_2 = -\sigma_2$. If a discriminant is equal to zero, i.e. $a_1^2 - 4a_2 a_0 = 0$, the equation has one real root $p = -\sigma_0$. And if a discriminant is negative, i.e. $a_1^2 - 4a_2 a_0 < 0$, the equation does not have any real root.

The result is so simple and obvious that it would seem to even serve as a proof of existence of the only right solution according to the first algorithm using real numbers. But this is not the case, since a no less clear graphical solution to the quadratic equation can also be obtained within the second algorithm. It looks to be impossible at first sight, since the graph of function , where and are the complex quantities, should be four-dimensional. Humans can neither imagine nor depict four-dimensional graphs. Really, try to imagine and draw, for example, a four-dimensional cube (also referred to as a tesseract or octachoron). But mathematicians can do this.

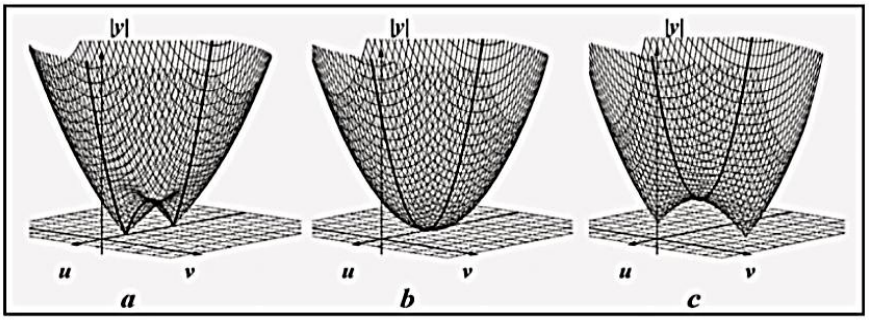


Fig. 3. *Graphical solution to the quadratic equation in the set of complex numbers, explaining that the equation can have two solutions or one double solution*

However, the problem becomes quite solvable if a four-dimensional graph of the function of complex variable $y = f(x)$ is replaced by a three-dimensional graph of function $|y| = |f(x)| = |f(\sigma + i\omega)|$. Thus, within the second solution algorithm, the quadratic equation can be converted into a system of equations, corresponding to the Fig. 3.

$$\begin{cases} |y| = \left|a_2(\sigma + i\omega)^2 + a_1(\sigma + i\omega) + a_0\right| \\ |y| = 0 \end{cases} \quad (8)$$

Herewith, Fig. 3a would correspond to the case when a solution to the quadratic equation for $a_1^2 - 4a_2 a_0 > 0$ has two real roots of different values $p_1 = -\sigma_1$ and $p_2 = -\sigma_2$. In this case, the surface $|y| = |f(x)|$ would contact the plane of the complex variable $x = \sigma + i\omega$ at two different points $p_1 = -\sigma_1$ and $p_2 = -\sigma_2$ on the axis of real numbers σ.

Fig. 3b would correspond to the case when a solution to the quadratic equation for $a_1^2 - 4a_2 a_0 = 0$ has one double[14] real root $p_{1,2} = -\sigma_0$. In this case, the surface $|y| = |f(x)|$ would contact the plane of the complex variable $x = \sigma + i\omega$ at one point $p_{1,2} = -\sigma_0$ on the axis of real numbers σ.

Fig. 3c would correspond to the case when a solution to the quadratic equation for $a_1^2 - 4a_2 a_0 < 0$ has two complex conjugate roots $p_{1,2} = -\sigma \pm i\omega$. In this case, the surface $|y| = |f(x)|$ would contact the plane of the complex variable $x = \sigma + i\omega$ at two points that are not on the axis of real numbers σ.

Algebraic equations of the third and higher degrees can be solved graphically in a similar way. Fig. 4 gives an example of a graphical solution to the algebraic cubic equation $a_3 p^3 + a_2 p^2 + a_1 p + a_0 = 0$, which in the set of real numbers is converted as follows

$$\begin{cases} y = a_3 p^3 + a_2 p^2 + a_1 p + a_0 \\ y = 0 \end{cases} \quad (9)$$

[14] For example, for the equation $(x + \sigma_0)^2 = 0$

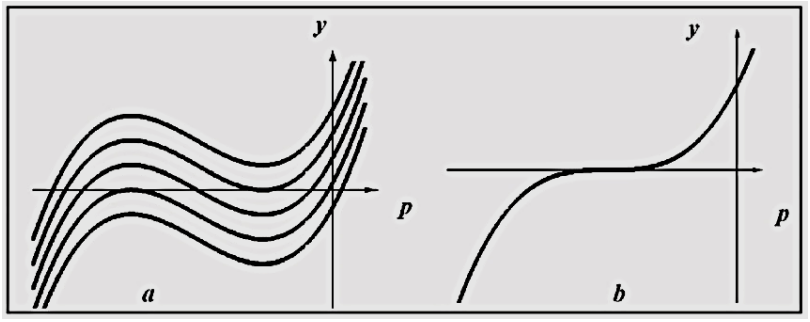


Fig.4. *Graphical solution to the cubic equation in the set of real numbers, explaining that this equation can have either one or two or three solutions*

Apparently, depending on the position of the curve $y = f(x)$ relative to the abscissa axis (i.e. depending on the value of coefficients a_3, a_2, a_1, a_0), the cubic equation can have either one or two or three real solutions within the first algorithm (see Fig. 4a,b). Fig. 5a,b,c,d,e shows graphical solutions to the cubic equation $a_3(\sigma+i\omega)^3 + a_2(\sigma+i\omega)^2 + a_1(\sigma+i\omega) + a_0 = 0$ in the set of complex numbers for the same combinations of coefficients a_3, a_2, a_1, a_0, as in Fig. 4, equivalent to the system of equations

$$\begin{cases} |y| = \left|a_3(\sigma+i\omega)^3 + a_2(\sigma+i\omega)^2 + a_1(\sigma+i\omega) + a_0\right| \\ |y| = 0 \end{cases} \tag{10}$$

As can be seen, a solution to the equation $a_3p^3 + a_2p^2 + a_1p + a_0 = 0$ has always three roots when using the second algorithm. But some roots can be double as in Fig. 4a, 5b, 5d, and even triple[15] as in Fig. 4b and 5f. In the latter case, in Fig. 3b, the graph is somewhat different, looking like a tangentoid (or cotangentoid).

And while the points of intersection of the curve $y = a_3p^3 + a_2p^2 + a_1p + a_0$ and the abscissa axis p correspond to solutions to the equation $a_3p^3 + a_2p^2 + a_1p + a_0 = 0$ in Fig. 4, the points of contact of the surface $|y| = \left|a_3(\sigma+i\omega)^3 + a_2(\sigma+i\omega)^2 + a_1(\sigma+i\omega) + a_0\right|$ of the complex plane $x = \sigma + i\omega$ correspond to solutions to the same equation $a_3p^3 + a_2p^2 + a_1p + a_0 = 0$ in Fig. 5. Moreover, both figures show the same particular cases of the situations mentioned. Consequently, equally convincing graphical solutions can also be proposed to the cubic equations (and equations of higher degrees) in the set of both real (Fig. 4) and complex (Fig. 5) numbers.

Thus, purely mathematical reasoning above do not allow us to make an indisputable conclusion about the truth of one and the falsity of another algorithm for solving algebraic equations; or, in other words, to draw a conclusion about physical reality or unreality of their solution expressed in the form of complex numbers.

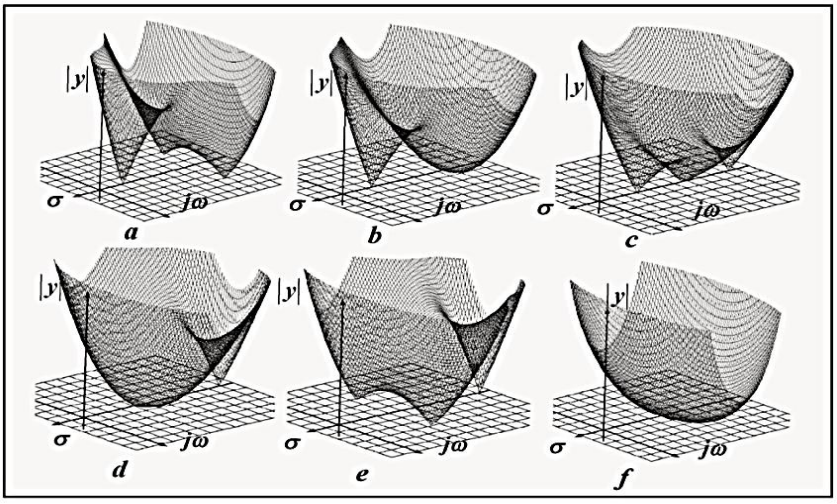


Fig. 5. *Graphical solution to the cubic equation in the set of complex numbers, explaining that in this case it has either three solutions or two solutions, one of which is double, or one triple solution, i.e. having always three solutions*

[15] For example, for the equation $(x+\sigma_0)^3 = 0$

It is clear that then the choice from the mentioned two algorithms for solving algebraic methods could be made differently - in accordance with the general scientific criterion called "Occam's razor" [16]. According to this criterion, the theory that has the simpler explanation[17] must be accepted as true. And in accordance with this criterion, in all likelihood, sooner or later the second recognized algorithm would be true.

But the trouble is that this choice would require explaining physical significance of complex numbers. Physicists do not have an explanation. And, what is worse, instead of admitting this, they state without evidence that imaginary (and, consequently, complex and hyper-complex) numbers have no physical content, referring to the principle of light speed non-exceedance. Authority of the STR actually hinders the study of this important problem. Such a point of view turned out to be even terminologically[18] fixed in science, since one of components of complex numbers is called imaginary, i.e. supposedly non-existent, numbers.

That is why mathematics still uses both algorithms for solving algebraic equations, even despite the fact that

- solutions there to often mutually exclude each other;
- the STR considers one of these solutions (in the form of complex numbers) to be physically non-existent[19].

So what is the answer to the question whether solutions to algebraic equations physically exist in the form of complex numbers? Since, as has just been shown, the use of purely mathematical[20] means cannot answer the question, let us try to figure it out relying solely on common sense.

For this purpose we try to understand what meaning the words 'solution exists' or 'solution does not exist' should have. Where does it exist? On paper? In computer? On a blackboard in a university classroom? We could say so, but "in nature, in the physical world we live in" would apparently be more correct answer.

Therefore, we should talk about existence of a solution as a physical reality. And it would be logical to conclude that answering the question requires physical experiments. What kind of experiments are these? And it turns out that such experiments have been done for a long time by both humans and nature. We meet them everywhere. They are well known to everyone. These are shock oscillations. In any form. In the form of sound of a piano or a tuning fork, in the form of tsunami or 'Indian summer', in the form of children's swing[21] rocking after being pushed by parents, etc.

In this regard, let us recall that only solutions in the form of complex numbers are always used in solving characteristic algebraic equations (6) while studying transient processes (for example, in electrical circuits). The first algorithm for solving algebraic equations using real numbers is never applied in relation to characteristic equations.

Why? The answer to this question is extremely important. Therefore, let us consider in more detail how this question is covered, for example, in the electrical circuit theory. It states that if a characteristic algebraic equation of the second degree has two different real roots $p_1 = -\sigma_1$ and $p_2 = -\sigma_2$, then an aperiodic transient process exists in an electrical circuit and is described by the time function

$$y(t)_{free} = Ae^{-\sigma_1 t} + Be^{-\sigma_2 t} \quad (8)$$

If roots of a characteristic equation of the second degree are real and multiple of $p_{1,2} = -\sigma_0$, then the so-called critical transient process exists in an electrical circuit and is described by the time function

$$y(t)_{free} = (A + Bt)e^{-\sigma_0 t} \quad (9)$$

And, finally, if roots of a characteristic equation of the second power are complex conjugate numbers $p_{1,2} = -\sigma \pm i\omega$, then an oscillatory transient process corresponding to them exists in an electrical circuit, and the quantities p_1 and p_2 are the complex frequencies of free oscillations. This transient process is described by the time function

$$y(t)_{free} = e^{-\sigma t}[A\cos(\omega t) + B\sin(\omega t)] \quad (10)$$

Herewith, integration constants A and B are determined from the initial conditions $y(0)$ and $y'(0)$ in all particular cases.

Solutions to characteristic algebraic equations of higher powers can include aperiodic, critical and oscillatory components. This is covered in detail in textbooks. However, they neither explain nor substantiate why characteristic equations are solved only using the second algorithm, which allows finding their roots in the form of complex numbers And, it turns out, because only in such a case the transient can also exist in the form of shock oscillations (10). The use of the first algorithm would necessitate arguing that shock oscillations should not have existed. However, they do exist.

Thus, the point is that oscillatory transition processes exist in nature. And they can exist only if the

[16] 'Occam's Razor' is a principle formulated in the 14th century by the English monk William of Ockham: "More things should not be used than are necessary".

[17] As, for example, in astronomy the Copernican heliocentric system was recognized as true and the Ptolemaic geocentric system was recognized as false.

[18] Actually, long before the STR was created.

[19] Consequently, mathematicians have not recognized the principle of light speed non-exceedance postulated in the STR as scientifically sound.

[20] But we must not forget that names such as mathematics, physics, radio electronics, etc. were given by people specializing in some narrow research area subject to their limited intellectual capabilities. However, when it comes to Nature, all these names are replaced by the only name of Science.

[21] It is interesting to note that children's swing, on which children are rocking without the help of their parents, refutes another scientific misconception, which, according to information on the Internet, is shared by many authoritative scientists. The misconception suggests that unsupported motion devices, the so-called inertioids, cannot exist, and their existence is therefore denied by modern science, as it contradicts the law of conservation of momentum.

characteristic algebraic equations corresponding to them have solutions in the form of complex numbers. And only for this reason the unsolvable in pure mathematics question about which of the two mutually exclusive algorithms of solving algebraic equations is correct, turned out to be quite solvable with the help of simple physical experiments. And common sense.

It follows from the above that it is necessary to recognise solutions of algebraic equations[22] using complex numbers as the only correct and corresponding to physically real existing processes in the world around us. Therefore, complex frequencies $p_{1,2} = -\sigma \pm i\omega$ of free oscillations are physically real, including their imaginary components. And not only complex frequencies, but also any other imaginary and complex numbers. And as this statement is true for transients not only in the theory of linear electric circuits, but also for transients studied by all other sciences, i.e. it is general scientific, so we will call it the principle of physical reality of imaginary numbers.

And this experimentally provable principle of the physical reality of imaginary numbers naturally refutes the postulated principle of non-exceeding the speed of light, asserting from the unreality,

4. Explanation of Physical Essence of Imaginary Numbers

Hence, for relativistic formulas of STR (1)-(3) the results of calculations on them not only in the form of real, but also in the form of imaginary numbers should be explainable. Nevertheless, these formulas still cannot be explained for one more reason - as can be seen (see Fig. 1a,b,c) their graphs in sublight and hyperlight ranges have essentially different form. Moreover, they correspond to physically unstable processes, which cannot exist in Nature. Therefore relativistic formulas (1)-(3) are still incorrect.

And so that the same patterns took place in nature in the subluminal $V < C$ and superluminal $V > C$ speed ranges, and, therefore, formulas describing the corresponding processes could be explained, the graphs $m(v)$, $\Delta t(v)$ and $l(v)$ should be as depicted in Fig. 1d,e,f. For this purpose, the function i^q should be introduced into the corrected relativistic formulas of the STR corresponding to them.

$$m(q) = \frac{m_0 i^q}{\sqrt{1-(v/c - q)^2}} = \frac{m_0 i^q}{\sqrt{1-(w/c)^2}} \quad (14)$$

$$\Delta t(q) = \Delta t_0 i^q \sqrt{1-(v/c - q)^2} = \Delta t_0 i^q \sqrt{1-(w/c)^2} \quad (15)$$

$$l(q) = l_0 i^q \sqrt{1-(v/c - q)^2} = l_0 i^q \sqrt{1-(w/c)^2} \quad (16)$$

where $q(v) = \lfloor v/c \rfloor$ is the "floor" discrete function of the argument v/c;

$w = v - qc$ is the local velocity of each universe.

This is the function convenient for explaining, as for integer values of the argument *0,1,2,3,4,5,…* it takes the required alternating values *+1,+i,-1,-i,+1,+i,…* corresponding to four types of universes alternating in space. Herewith local velocity $w = v - qc$ (Fig. 1d,e,f) of each universe takes finite values only in the range $0 \le w < c$.

But it's not hard to notice that Euler's formula takes the same values +1, +i, -1, -i, +1, +i..., corresponding to the integer values 0, 1, 2, 3, 4, 5,... of the argument q. And the right side of Euler's formula allows determining the values of this function also for non-integer values of the argument q. Therefore, considering this circumstance, we can conclude that the function i^q takes the form

$$i^q = \cos(q\pi/2) + i\sin(q\pi/2) \quad (17)$$ for both integer and non-integer values of the argument q.

The new formula thus obtained has an important advantage - it introduces into the mathematics of complex and hyper complex numbers the mathematical operation of raising imaginary numbers to a non-integer degree, which has been absent in it until now. In astrophysics, it therefore allows us to assert that the integer values of the quantity in formula (14) correspond to mutually invisible parallel universes[23], since they are relative to each other beyond the event horizon, and its non-integer values correspond to portals between such neighbouring universes. And the invisible Multiverse containing these parallel universes has a spiral structure.

In other cases, described by other mathematical formulas containing imaginary numbers, other objects of the invisible world will correspond to them, Determining the specific nature of these objects will require further specialized research. The research will significantly define the content of future science.

5. Conclusion

In the article by simple researches of transients in linear electric circuits, carried out before publication of results of extremely difficult and expensive, but unsuccessful experiment OPERA, the physical reality of imaginary numbers is proved and, consequently, the fundamental principle of non-exceeding the speed of light in the generally recognised version of STR is refuted. And therefore it is asserted that the version of STR stated in all physics textbooks used in the educational process of even the most prestigious universities is incorrect [16]-[72].

The existence of physically real imaginary numbers, discovered 500 years ago, shows that besides our visible world there is also a bigger, but invisible and unknown to us world. And cognition of physical essence of this invisible world will become the main

[22] And not only characteristic ones.

[23] Since, despite their boundlessness, they do not overlap anywhere, but they do dip slightly into each other in many places, forming portals.

problem of science of the future [73]-[96]. Moreover this problem is now in relativistic physics astrophysics, overcoming the resistance of opponents, is already solved. And that's fine. One of the most authoritative philosophers of science of the 20th century Sir Karl Raimund Popper [97] wrote on this occasion that *"...the struggle of opinions in scientific theories is inevitable and is a necessary condition for the development of science"*. I.e., the development of science is possible only as a result of identifying incorrect statements in existing theories and their subsequent refutations [98]-[104].

This article identifies such false statements and ***demonstrates how the incorrect (due to the use of the erroneous postulate of light speed non-exceedance) version of the STR can be corrected.***

References:

1. Weisstein E.W. 2005. The CRC Concise Enciclopedia of Mathematics. 3-rd ed. CRS Press. Roca Raton. FL.
2. Beckmann P. 1976. A History of π. 3-rd edition. St. Martin's Press. NY.
3. Einstein A. 1920. Relativity: The Special and General Theory. H. Holt and Company. NY.
4. Bohm D. 2006. The Special Theory of Relativity. Routledge, Abingdon on Thames.
5. Penrose R. 2010. The Nature of Space and Time. Princeton University Press. Princeton.
6. Antonov A. A. 2008. Physical Reality of Resonance on Complex Frequencies. European Journal of Scientific Research. 21(4). 627-641. http://www.eurojournals.com/ejsr.htm
7. Antonov A. A. 2009. Resonance on Real and Complex Frequencies. European Journal of Scientific Research. 28(2). 193-204. http://www.eurojournals.com/ejsr.htm
8. Antonov A. A. 2010. New Interpretation of Resonance. International Journal of Pure and Applied Sciences and Technology. 1(2). 1-12. http://doi.org/10.17686/sced_rusnauka_ 2010-888
9. Antonov A. A. 2010. Oscillation processes as a tool of physics cognition. American Journal of Scientific and Industrial Research. 1(2). 342-349.
doi:10.5251/ajsir.2010.1.2.342.349
10. Antonov A. A. 2010. Solution of algebraic quadratic equations taking into account transitional processes in oscillation systems. General Mathematics Notes. 1(9). 11-16.
http://doi.org/10.17686/sced_rusnauka_2010-887
11. Antonov A. A. 2013. Physical Reality of Complex Numbers. International Journal of Management, IT and Engineering. 3(4). 219-230. http://doi.org/10.17686/sced_rusnauka_2013-898
12. Antonov A.A. 2015. Principle of physical reality of imaginary and complex numbers in modern cosmology: the nature of dark matter and dark energy. Journal of the Russian physico-chemical society. 87(1). 328-355. (In Russian). http://doi.org/10.17686/sced_rusnauka_2015-1119
13. Antonov A. A. 2016. Physical Reality and Nature of Imaginary, Complex and Hypercomplex Numbers. General Mathematics Notes. 35(2). 40-63.
http://www.geman.in/yahoo_site_admin/assets/docs/4_GMN-10932-V35N2.31895146. pdf
14. Antonov A.A. 2017. The physical reality and essence of imaginary numbers. Norwegian Journal of development of the International Science. 6. 50-63. http://www.njd-iscience.com
15. Antonov A. A. 2018. Physical Reality and Essence of Imaginary Numbers in Astrophysics: Dark Matter, Dark Energy, Dark Space. Natural Science. 10(1). 11-30.
doi:10.4236/ns.2018.101002.
16. Antonov A.A. 2021. The special theory of relativity stated in physics textbooks is incorrect. 77th International Scientific Conference of the Eurasian Scientific Association "Theoretical and practical issues of modern science". Moscow. ESA. 11-15. (Im Russian)
17. Antonov A. A. 2021). Special theory of relativity presented in physics textbooks is wrong. Norwegian Journal of development of the International Science. 68(1). 3-7.
DOI: 10.24412/3453-9875-2021-68-3-7.
18. Antonov A. A. 2021. Version of the special theory of relativity that is studied in all physics textbooks is incorrect. Österreichisches Multiscience Journal. (Insbruck, Austria). 43(1). 17-22.http://osterr-science.com
19. Antonov A. A. 2021. Generally accepted version of the special theory of relativity contained in physics textbooks is incorrect. The scientific heritage. (Budapest, Hungary). 73(2). 39-43. DOI: 19.24412/9215-0365-2021-73-2-39-43
20. Antonov A. A. 2021. Special theory of relativity, which is studied in physics textbooks, is incorrect. German International Journal of Modern Science. 16, 49-53.
DOI: 10.24412/2701-8369-2021-16-49-53
21. Antonov A. A. 2021. Special theory of relativity, which is studied in all physics textbooks, is incorrect. Danish Scientific Journal. 51(1). 31-35. http://www.danish-journal.com
22. Antonov A. A. 2021. Special theory of relativity taught in all physics textbooks is incorrect. Annali d'Italia. 22(1). 39-44. https://www.anditalia.com/
23. Antonov A. A. 2021. In all physics textbooks an erroneous version of special theory of relativity is given. International independent scientific journal. 31. 34-39.
http://www.iis-journal.com
24. Antonov A. A. 2021. Special theory of relativity taught in physics textbooks is wrong. Journal of science. Lyon. 23. 47-52.https://www.joslyon.com/
25. Antonov A. A. 2021. All physics textbooks study incorrect special theory of relativity. Sciences of Europe. (Praha, Czech Republic). 79(1). 30-35. DOI: 10/24412/3162-2364-2021-79-30-35
26. Antonov A. A. 2021. Experimental proofs of infidelity of the version of the special theory of relativity studied in physics textbooks and the truth of its alternative version. 80th International Scientific Conference of the Eurasian Scientific Association "Development of science and education in the conditions of world instability". Moscow. ESA. 8-17. (In Russian)
https://esa-conference.ru/sborniki/?y=2021

27. Antonov A. A. 2021. The incorrectness of the STR version presented in physics textbooks proven experimentally. Norwegian Journal of development of the International Science. 74(1). 3-7. DOI: 10.24412/2453-9875-2021-74-53-62.

28. Antonov A. A. 2021. The fallacy of the STR version studied in physics textbooks proved experimentally. Österreichisches Multiscience Journal (Innsbruck, Austria). 45(1). 17-26.

http://osterr-science.com

29. Antonov A. A. 2021. Experimental evidences for the fallacy of the STR version in the physics textbooks. European Journal of Applied Sciences. Services for Science and Education. UK. 9(6). 349-364. DOI:10.14738/aivp.96.11304.

30. Antonov A. A. 2021. If the STR version in physics textbooks were true, we would never have heard the music of the piano and the bell ringing, there would be no television, no cellular telephony, no radar or GPS navigation, we would not even be aware of the existence of resonance and Ohm's law as interpreted by Steinmetz, and our children could not swing on the swings. The scientific heritage (Budapest, Hungary). 78(2). 41-50.

DOI: 10.24412/9215-0365-2021-78-2-41-50

31. Antonov A. A. 2021. Experimental refutations of the STR version contained in physics textbooks and confirmations of the truth of its alternative version. German International Journal of Modern Science. 22. 52-61. DOI: 10.24412/2701-8369-2021-22-52-61

32. Antonov A. A. 2021. The STR version in physics textbooks must be corrected, because if it were true, there would be no tsunamis or indian summer in nature, we would be never have heard piano music, engineers would be not have been able to create television, cell phones, GPS trackers, and even children would not be able to swing on swings. Danish Scientific Journal. 54(1). 29-38. http://www.danish-journal.com

33. Antonov A. A. 2021. Experimental evidence of the incorrectness of the STR version studied in physics textbooks. Annali d'Italia. 25(1). 32-41. https://www.anditalia.com/

34. Antonov A. A. 2021. Experimental refutations of the generally accepted version of the SRT studied in physics textbooks. International independent scientific journal. 34(1). 23-32. http://www.iis-journal.com

35. Antonov A. A. 2021. Experimental refutations of the SRT version in the physics textbooks. Journal of science. Lyon. 26(1). 29-37. https://www.joslyon.com/

36. Antonov A. A. 2021. Experimental evidences for the fallacy of the STR version in phisics textbooks. Sciences of Europe (Praha, Czech Republic). 82(2). 19-28.

DOI: 10.24412/3162-2364-2021-82-2-19-28

37. Antonov A. A. 2020. How to discover invisible universes. Norwegian Journal of development of the International Science. 42(1). 36-48. (In Russian) http://www.njd-iscience.com

38. Antonov A. A. 2020. How to See Invisible Universes. Journal of Modern Physics. 11(05), 593-607. DOI: 10.4236/jmp.2020.115039

39. Antonov A. A. 2020. Can invisible universes be seen? International independent scientific journal. 21(2). 51-60. http://www.iis-journal.com

40. Antonov A. A. 2020. Universes Being Invisible on Earth outside the Portals Are Visible in Portals. Natural Science. 12(8). 569-587. https://doi.org/10.4236/ns.2020.128044

41. Antonov A. A. 2021. Invisible universes can be seen in anomalous zones. International independent scientific journal. 23(1). 28-44. http://www.iis-journal.com

42. Antonov A. A. 2020. Invisible universes can be seen in anomalous zones. Danish Scientific Journal. 43(1). 9-24. http://www.danish-journal.com

43. Антонов А. А. 2023. Geophysical exploration of portals will provide new knowledge about space. Proceedings of the III International Scientific Conference. Philadelphia. USA. "The modern vector of the development of science". Philadelphia, USA. 85-101.

DOI https://doi.org/10.5281/zenodo.7709801

44. Antonov A.A. 2023. Why geophysical researches of portals are necessary. Norwegian Journal of development of the International Science. 105. 83-96.

https://doi.org/10.5281/zenodo.7779019

45. Antonov A.A. 2023. Geophysical researches of portals will allow to discover invisible universes and to explore them. European Journal of Applied Sciences. Services for Sciences and education. UK. 11(2). 370-391

46. Antonov A.A. 2023. The necessity of geophysical researches of portals. The scientific heritage. (Budapest, Hungary). 110. 77-90.

47. Antonov A.A. 2023. Geophysical researches of portals will allow to prove the existence of invisible universes and to explore them. German International Journal of Modern Science. 53. 64-78

48. Antonov A.A. 2023. The relevance of geophysical researches of portals. Danish Scientific Journal. 70. 75-89.

49. Antonov A.A. 2023. Geophysical researches of portals will allow to prove the existence of hidden Multiverse and to research it. Annali d'Italia. 42. 71-85.

50. Antonov A.A. 2023. Geophysical researches of portals will allow toprove the existence of hidden Multiverse and to research it. International independent scientific jornal. 49. 23-37.

51. Antonov A.A. 2023. Geophysical researches of portals will allow to discover invisible universes. Journal of science. Lyon. 41. 26-38.

52. Antonov A.A. 2023. Geophysical researches of portals will allow to prove the existence of hidden Multiverse and to research it. Sciences of Europe. 114. 76- 90

53. Antonov A. A. 2021. The version of STO stated in physics textbooks is incorrect, as it denies the existence of radio engineering. 82nd International Scientific Conference of the Eurasian Scientific Association "Scientific results in theory and practice". Moscow. ESA. 11-15. https://esa-conference.ru/sborniki/?y=2021

54. Antonov A.A. 2022. The version of STR stated in physics textbooks is refuted by the existence

of radio engineering. Norwegian Journal of development of the International Science. 78(1). 63-67. DOI: 10.24412/3453-9875-2022-78-63-66.

55. Antonov A. A. 2022. The version of STR presented in physics textbooks is incorrect, since it follows from it that radio engineering should not exist. European Journal of Applied Sciences. Services for Science and Education. UK. 10(1). 440-445.

DOI://doi.org/10.14738/aivp.101.2022

56. Antonov A. A. 2022. The existence of radio engineering refutes the physics textbooks' version of STR. The scientific heritage. (Budapest, Hungary). 83(1). 19-22.

DOI: 10.24412/9215-0365-2022-83-1-19-22

57. Antonov A.A. 2022. The fundamental Ohm's law in radio engineering as interpreted by Steinmetz, which proves the physical reality on imaginary capacitive and inductive reactances, refuted the version of the STR presented in physics textbooks even before its creation. German International Journal of Modern Science. 26. 50-53.

DOI: 10.24412/2701-8369-2022-26-50-63

58. Antonov A.A. 2022. The version of STR stated in physics textbooks is refuted by the existence of radio engineering. Danish Scientific Journal. 56. 56-59.

http://www.danish-journal.com

59. Antonov A.A. 2022. The version of STR presented in physics textbooks is incorrect because it denies the possibility of the existence of Ohm's law as interpreted by Steinmetz and, consequently, the existence of radio engineering. Annali d'Italia 28(1), 43-47.

https://www.anditalia.com/

60. Antonov A.A. 2022. If the physics textbook version of STR were true, then Ohm's law should not exist in nature, and therefore all radio engineering would not exist. International independent scientific journal. 36. 16-19. http://www.iis-journal.com

61. Antonov A.A. (2022). If the version of STR in physics textbooks were true, then there would be no radar, no television, no radio navigation, no telecommunication and many other things. Journal of science. Lyon. 28. 76-79. https://www.joslyon.com/

62. Antonov A.A. (2022). The version of STR set out in physics textbooks is incorrect because it states that Ohm's law as interpreted by Steinmetz does not really exist, and therefore radio engineering does not exist either. Sciences of Europe (Praha, Czech Republic). 87(1). 54-57. DOI: 10.24412/3162-2364-2022-1-54-57

63. Antonov A.A. 2022. Why the physics textbooks teach an incorrect version of the special theory of relativity which denies the existence of radio- and electrical engineering. III international scientific conference "Challenges and problems of modern science." London. Great Britain. 78-86. DOI: https: //doi/org/10.528/zenodo.7486814

64. Antonov A. A. 2023. Why is the incorrect version of the special theory of relativity being studied in physics textbooks, refuted the existence of radio and electrical engeneering even before its creation? The scientific heritage. (Budapest, Hungary) 105. 83-89.

DOI: 10.5281/zenodo.7560145

65. Antonov A.A. 2023. Why is incorrect version of the special theory of relativity that denies the possibility of the existence of radio and electrical engineering being studied in textbooks of physics? Norwegian Journal of development of the International Science. 100. 27-33. https://doi.org/10.5281/zenodo.7528512

66. Antonov A.A. 2023. Why is an incorrect version of the special theory of relativity that denies the possibility of the existence radio and electrical engineerng being studied in physics textbooks? German International Journal of Modern Science. 48. 23-29.

DOI: https://doi.org/10.5281/zenodo.7541137

67. Antonov A.A. 2023. Who needs the incorrect version of special relativity taught in physics textbooks despite all its experimental refutations? Annali d'Italia. 39, 64-70.

DOI: 10.5281/zenodo.7568916

68. Antonov A.A. 2023. Why is incorrect version of the special theory of relativity, refuted by the existence of radio and electrical engineering, is still studies in all university physics textbooks? Danish Scientific Journal. 69. 66-72. https://doi.org/10.5281/zenodo.7692053

69. Antonov A.A. 2023. Why is incorrect version of the special relativity still being studied in physics textbooks, which denies Ohm's law for alternating current used worldwide by millions of radio and electrical engineers? International independent scientific journal. 46. 38-44. https://doi.org/10.5281/zenodo.7525751.

70. Antonov A.A. 2023. Why is the generally accepted version of STR, which denies the possibility of the existence of radio engineering and electrical engineering, tsunamis and bell ringing, the physical phenomenon of resonance and Ohm's physical law for alternating current, music created by the piano and even swing swings on the playground, nevertheless is still considered correct and studied in physics textbooks? Sciences of Europe (Praha, Czech Republic). 112. 44-50.

71. Antonov A.A. 2023. Why is the incorrect version of the special theory of relativity still being studied in physics textbooks, despite all its experimental refutations. European Journal of Applied Sciences. Services for Science and Education. UK. 11(2). 61-71.

DOI: https://doi.org/10.14738/aivp.112.14128

72. Antonov A.A. 2023. Why the incorrect version of the special theory of relativity, which denies the possibility of the existence of radio engineering and electrical engineering, has not yet been refuted. Journal of science. Lyon 40. 19-25. https://doi.org/10.5281/zenodo.7704392

73. Antonov A. A. 2021. Antimatter, Anti-Space, Anti-Time. Journal of Modern Physics, 12(05), 646-660. DOI: 10.4236/jmp.2021.125042.

74. Antonov A. A. 2021. Antimatter, anti-space, anti-time. 75th International Conference of the Eurasian Scientific Association "Strategies of Sustainable Development of World Science". Moscow. ESA. 1-4. DOI: 10.5281/zenodo.4926585

75. Antonov A. A. 2021. From the alternative version of the SRT it follows that there is not only antimatter, but also anti-space and anti-time. Norwegian Journal of Development of the International Science.

62(1). 41-51. DOI: 10.24412/3453-9875-2021-62-1-41-51

76. Antonov A. A. 2021. Do antimatter, anti-time and anti-space exist in nature. Annali d'Italia. 20(1). 14-24. https://www.anditalia.com/

77. Antonov A. A. 2021. Antipodes in space. German International Journal of Modern Science. 11(1). 15-25. DOI: 10.24412/2701-8369-2021-11-1-15-25

78. Antonov A. A. 2021. There is not only antimatter, but also anti-space and anti-time. Journal of science. Lyon. 21. 22-30. https://www.joslyon.com/

79. Antonov A. A. 2021. Where are antimatter, anti-space and anti-time? Österreichisches Multiscience Journal. (Insbruck, Austria). 40(1). 34-44. http://osterr-science.com

80. Antonov A. A. 2021. Do antmatter, anti-time and anti-space exist in nature? Danish Scientific Journal. 48(1). 64-74. http://www.danish-journal.com

81. Antonov A. A. 2021. Antipodes in space. International independent scientific journal. 28. 50-61. http://www.iis-journal.com

82. Antonov A. A. 2021. How alternative version of SRT explains the existence of antimatter, anti-space and anti-time? The scientific heritage (Budapest, Hungary). 67(1). 11-21.

DOI: 10.24412/9215-0365-2021-67-1-11-21

83. Antonov A. A. 2011. Realisation of Human Super-Intelligence (Developmental Learning). WSEAS transactions on advances in engineering education. 4(8): 109-119.

http://www.wseas.us/e-library/transactions/education/2011/55-269.pdf

84. Antonov A. A. 2011. Human Super Intelligence. International Journal of Emerging Sciences. 1(2): 164-173.

https://pdfs.semanticscholar.org/c8cb/b9e7202fcc15e89bb62ecf31b4c3af7d8f05.pdf

85. Antonov A. A. 2010. Human-computer superintelligence. American Journal of Scientific and Industrial Research. 1(2): 96-104. doi:10.5251/ajsir.2010.1.2.96.104

86. Antonov A. A. 2011. From Artificial Intelligence to Human Super Intelligence. International Journal of Computer Information Systems. 2(6): 1-6.

https://www.researchgate.net/publication/267992073_From_Artificial_Intelligence_to_Human_Super-Intelligence

87. Antonov A. A. 2011. Realisation of Human Super-Intelligence (Developmental Learning). WSEAS transactions on advances in engineering education. 4(8): 109-119.

http://www.wseas.us/e-library/transactions/education/2011/55-269.pdf

88. Antonov A. A. 2011. Human Super Intelligence. International Journal of Emerging Sciences. 1(2): 164-173. https://pdfs.semanticscholar.org/c8cb/b9e7202fcc15e89bb62ecf31b4c3af7d8f05.pdf

89. Antonov A. A. 2010. Human-computer superintelligence. American Journal of Scientific and Industrial Research. 1(2): 96-104. doi:10.5251/ajsir.2010.1.2.96.104

90. Antonov A. A. 2021. How to turn human civilisation into a supercivilisation. 72 International Scientific Conference of the Eurasian Scientific Association "Modern concepts of scientific research". Moscow. ESA. 3-15. (Im Russian) https://esa-conference.ru/sborniki/?y=2021

91. Antonov A. A. 2021. Human super civilization. Österreichisches Multiscience Journal. (Insbruck, Austria). 38(1). 34-46.http://osterr-science.com

92. Antonov A. A. 2021. Emergence of human super civilization. International independent scientific journal. 25(1). 30-43.http://www.iis-journal.com

93. Antonov A. A. 2021. Formation of human supercivilization. The scientific heritage (Budapest, Hungary). 63(3) 39-51.

94. Antonov A. A. 2021. Human civilization will soon become a super civilization. German International Journal of Modern Science. 6(1). 15-28.

DOI: 10.24412/2701-8369-2021-6-1-15-28

95. Antonov A. A. 2021. How to create a human super civilization. Sciences of Europe. (Praha, Czech Republic). 66(2). 38-50. DOI: 10.24412/3162-2364-2021-66-2-38-50

96. Antonov A. A. 2021. Creation of human super civilization. Danish Scientific Journal. 45(1). 44-57. http://www.danish-journal.com

97. Popper K. R. 2002. Conjectures and Refutations. The Growth of Scienrific Knowledge. Routledge. London.

98. Antonov A. A. 2023. The Corrected Version of the Special Theory of Relativity. Norwegian Journal of development of the International Science. 118. 40-49.

https://doi.org/10.5281/zenodo.10009500

99. Antonov A. A. 2023. The Corrected Version of the Special Theory of Relativity. European Journal of Applied Sciences. Services for Science and Education. UK. 11(5). 68-83.

100. Antonov A. A. 2023. The Corrected Version of the Special Theory of Relativity. The scientific heritage. (Budapest, Hungary). 123. 72-81,

101. Antonov A. A. 2023. Alternative Version of the Special Theory of Relativity. Sciences of Europe. (Praha, Czech Republic). 128. 62-71.

102. Antonov A. A. 2023. Special Theory of Relativity. German International Journal of Modern Science. 67. 64-73. DOI: 10.5281/zenodo.10966458

103. Antonov A. A. 2023. Antonov A. A. (2023). Corrected Version of the Special Theory of Relativity. Danish Scientific Journal. 77. 88-97.

https://doi.org/10.5281/zenodo.10054677

104. Antonov A. A. 2023. Alternative Version of the Special Theory of Relativity. International independent scientific journal. 57. 18-103. https://doi.org/10.5281/zenodo.10353074

PEDAGOGICAL SCIENCES

EDUCATIONAL ANALYTICS AS AN EDUCATIONAL MANAGEMENT TOOL

Aldeshov S.,
PhD
Suleimenova L.,
PhD
Kerimbekov E.,
PhD
Abdimanapova G.,
PhD student
Karabai A.
PhD student
South Kazakhstan Pedagogical University named after Uzbekali Zhanibekov
https://doi.org/10.5281/zenodo.10451100

The work was carried out with the financial support of the grant of the Ministry of education and science of the Republic of Kazakhstan (grant AP19680169 «Integration of machine learning to predict learning strategies in LMS in the formation of professional competencies of students»).

Abstract

Over the past decade, education has seen dramatic changes in the way data is collected and used to support high-stakes decision-making. Using big data as a meaningful objective to inform teaching and learning can enhance academic success. Data-driven research has been conducted to understand the effectiveness of student learning, such as student forecasting from the risk group at an early stage and recommendations of individual interventions to support services. However, few studies in the field of education have adopted Learning Analytics. Over the past decade, education has seen dramatic changes in the way data is collected and used to support high-stakes decision-making. Using big data as a meaningful lens to inform teaching and learning can enhance academic success. Data-based studies have been conducted to understand the effectiveness of student learning, such as predicting at-risk students at an early stage and recommending individual interventions to support services. However, few educational studies have adopted Learning Analytics.

Keywords: learning analytics, predictive modeling, learning formats , higher education, academic performance forecasting

Introduction

In the context of the forced rapid restructuring of the education system, the active introduction of methods of blended learning and learning using distance learning technologies, it is especially important to rely not only on the pedagogical experience and intuition of teachers and course developers, but also on the maximum amount of analytical data that allows you to objectively evaluate the effectiveness of courses, lessons, individual tasks and adjust the created educational materials. The proposed article discusses the use of educational analytics at the level of an educational organization, the use of a data-driven approach in education of the Skyeng online school cases and the use of educational analytics in the work of the "product team" — developers of educational materials.

The modern world and the student challenge the classical educational system. It is extremely difficult for her to move from the standard format of teaching — lessons, classes, studying materials sequentially according to the textbook in the classroom and at home — to gaining the skills necessary for tomorrow, and understanding that the student is the customer of training, the client. He comes to the teacher with certain tasks, and it is already difficult to bring all the students to the same denominator. The speed of market change is so high these days that, when entering a university, one cannot be sure that at the time of graduation the specialty will be in demand. The age of 20-25 ceases to be associated with the completion of education, which saturates the necessary skills for many years to come. As a result, more and more students, parents and employers prefer short-term courses rather than long-term training programs, which provide an applied profession that is relevant at the moment and/or the opportunity to add missing skills to the current one.

Higher education in the usual format of study at a university may lose its attractiveness for today's schoolchildren if it is not able to develop future students in close connection with the goals and objectives of students and employers. It is obvious that changes are inevitable in school education: more and more schools are trying to switch to individual educational trajectories, ensuring the comprehensive development of the student to realize his potential and achieve his goals. And this goal is not just to study the information in accordance with the program and textbooks and pass the Unified National Testing, but to get the necessary skills for life.

Learning is a lifelong activity, starting with education, which can lead to graduation and beyond. A student can leave at any stage to pursue a career of their

choice [1]. Well-developed critical thinking skills are important for solving the multidimensional nature of engineering problems, which are structured on complex thought processes that require evaluation [2]. But each program has pre-defined goals and the OBE determines the way to accomplish them.

Success for each student is the only goal and is measured by the student's ability to meet predetermined outcomes [3].

Pedagogy and andragogy face a challenge: to ensure the flexibility of the educational process and not lose all the knowledge and proven approaches and techniques of past eras, to rethink these approaches and adapt them to modern needs. And often the task is even more radical — to understand how all these techniques work today [4] and whether they work at all. Any research is time-consuming. This is especially true for education: it takes a decade, and sometimes more than one, for methodologists to develop a new approach, validate it and prove its importance, so that society recognizes it and adopts it. But now the speed of change in the world does not allow us to work on the scale of decades. Often a year is a lot. The educational system, which is still developing by inertia, risks increasingly moving away from reality, where there is already a demand for perfect other products and approaches. This was the case in the automotive industry, where electric cars and Elon Musk were not recognized for a long time, and now, according to a number of economists, Tesla is on its way to being more expensive than all the combined giants of the automotive industry. This was the case in retail, and we see Jeff Bezos, the richest man in the world, and his company Amazon storming the lists of the most expensive companies in the world according to Forbes. And even medicine gave up during the pandemic — doctors began to discuss diagnoses remotely more actively, although telemedicine was legitimized in Kazakhstan back in 2020.

Education is an inert sphere, where approaches from the middle of the last century are successfully working, and many public schools and universities were extremely conservative towards the "figure" until March 2020, the beginning of quarantines. And after March, people are also looking in this direction with caution. And even if private schools are conservative, what can we say about public schools, where students come voluntarily and forcibly and which can often be threatened only by demographic pits. We believe that educational analytics and a data driven approach to education can become a tool that will provide completely different principles and approaches in education, provide an evidence base for decision-making and scaling approaches: when the product is not "storing" a child during the school day, but personalized and adaptive learning, receiving and the elaboration of skills, the relevance of which is dictated by their practical application, time, current educational standards, aimed at developing the potential of the student, and often the student's own ideas about the goals of learning.

The transition to online and the rapid development of educational technologies, the emergence of new types of educational formats, such as blended learning (BL), leave behind a trail of data for potential study from a variety of sources in different formats and with different levels of detail [5]. All these systems produce a huge amount of information of high educational value, but it cannot be analyzed manually, despite the fact that the results can be useful to students, teachers and administrative staff [6].

LEARNING ANALYTICS

Learning Analytics has interdisciplinary historical roots in its development, such as social network analysis, education/cognitive modeling, predictive modeling, and data mining technology. In the early 2000s, academic analytics was proposed as a means of applying the principles and tools of the "business intelligentsia" to the academic field [7]. The aim of academic analytics was to improve institutional management, decision-making and resource allocation. Shortly thereafter, Action Analytics shifted academic focus to the action phase, "to create actionable intelligence, service-oriented architectures, information/content and service mashups, proven course/curriculum reinvention models, and changes in faculty practice that improve productivity and reduce costs."[8]

Educational Analytics (LA) can be defined as measuring, collecting, analyzing and presenting data about students, materials, programs, teachers and their context in order to understand and optimize learning and the environment in which it takes place [9]. This definition includes three important elements: data, analysis, and actions.

In parallel with LA, the intellectual analysis of educational data is also developing — Educational Data Mining (EDM), which develops methods for studying data obtained from the educational environment [10] and their use in the interests of education and learning science. Figure 1 shows one of the options for working with educational data.

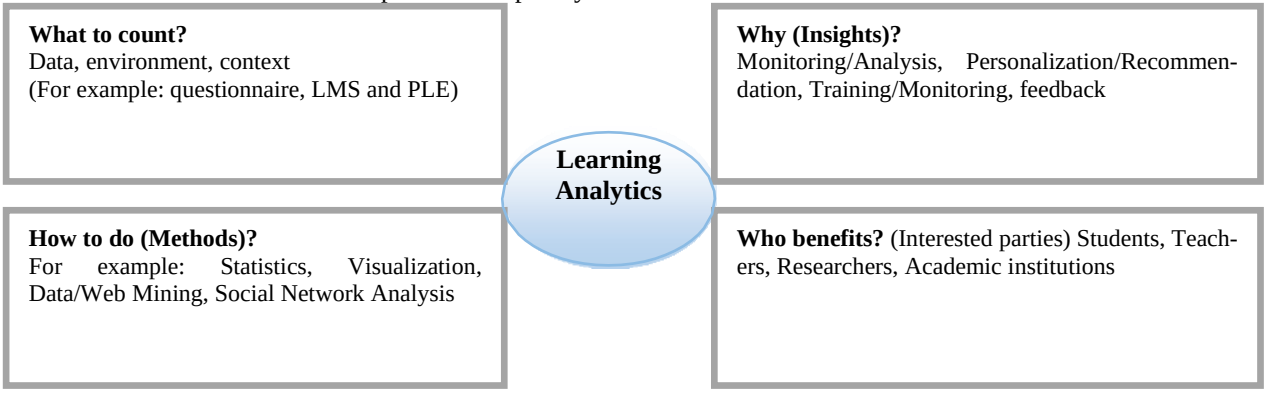


Figure 1. A variant of the outline for working with educational data

Domain Overview In our research, we focus on the following objects of educational analytics data collection.

• **The student**. By collecting data on the learning process of a particular student, we can understand his weaknesses and strengths, topics with which he copes worse. Knowing the goals and characteristics of the student, we will be able to build and change his educational trajectory in the current mode (understanding students' learning process).

• **Content**. By understanding how students and teachers react to the material, we will be able to "reassemble" the content units, providing the student with the necessary materials to bring him to the desired result, personalize the content to suit his interests, level and characteristics. If at the same time we understand that the student has a choice of what, how and where to study, then the content and navigation in it, the format of self-study (self-study) become even more important.

• **Teacher**. By understanding the specifics of a teacher's work, we can better create student—teacher, student—mentor pairs and personalize learning, not only focusing on the teacher's expertise and empathy level, but also using automated recommendations. We can understand the teacher's growth points and provide effective feedback for the development of his competencies [11].

• A quasi—object is an educational environment where a student, teacher, and content interact. This includes the user experience, student's experience and customer experience of the student and teacher. There is a place for offline, online and blended formats; metrics of the educational environment are also important within the framework of educational analytics[12].

When implementing LA to understand the effectiveness of student learning and improve student learning processes, number studies have used predictive analytics to predict learning success and student retention. These predictions can be made in various types of learning environments such as fully online or blended learning [13]. Previous studies have successfully predicted the perforation of the first year of study for students [14]. According to the literature [15], the following data can be used in predicting student learning effectiveness: (i) historical student records and relevant information such as high school grades and parent education, and (ii) student log data from learning management systems and other learning environments [16]. In veterinary education, some studies claim [17] that GRE scores are important for predicting student success in veterinary programs. Other possible significant indicators include previous academic performance [18], psychosocial factors, self-efficacy, personality, and demographic information. Data collected from students' studies [19] can also be used as predictors for student academic performance [20].

Conclusion

Research work on learning analytics is now growing rapidly compared to recent decades. Educational institutions should be attentive to its improvements and future use, cooperation with regular methods in order to achieve real growth in the work of education. This article focused on predictive learning analytics, existing models and algorithms also provided an overview of the type of prediction using a number of input fields and a dataset. The introduction described the differences between analysis and analytics, related areas and problems of learning analytics, and explained the life cycle models of learning analytics, and this article was used mainly for those who focus on the proposed models and want to know the type of predictions that can be made in the field of education.

References:

1. Jandhyala N. Murthy, Gokaraju Rangaraju Institute of Engineering and Technology, India. Satyanarayana Kosaraju, Gokaraju Rangaraju Institute of Engineering and Technology, India. Chapter 5 Teaching and Learning: A Paradigm Shift.62.

2. A Ahern, P Guijarro-Fuentes. Language Acquisition 26 (2), 183-209, 2019.

3. Spady, William G. Outcome-based education (OBE) means clearly focusing and organizing everything in an educational system around what. https://doi.org/10.1016/j.compedu.2019.103595

4. Wong et al. BMC Res Notes (2019) 12:631 https://doi.org/10.1186/s13104-019-4652-y

5. Romero C, Espejo P, Zafra A, Romero J, Ventura S. Web usage mining ... Educational Data Mining Tools: A Survey from 2001 to 2016. February 2.

6. Mark C. Baker. 2015. Case: Its principles and parameters. Cambridge: Cambridge University Press. [Cambridge Studies in Linguistics 146] xviii + 336 pp. ISBN 978-1-07-05522-3. (hardback) ISBN 978-1-107-69009-7.

7. Siemens G. Learning Analytics: Появление dis- cipline. Американский поведенческий ученый. 2013;57(10):1380– 400. https://doi.org/10.1177/0002764213498851

8. Campbell JP, DeBlois PB, Oblinger DG. Академическая аналитика: Новый инструмент для новой эры. EDUCAUSE Re- view. 2007 [цитируется 3 февраля 2020 г.]; 42 (4): 40. Доступный от: https://er.educause.edu/articles/2007/7/ academic-analytics-a-new-tool-for-a-new-era

9. Lang, C, Siemens, G, Wise, A & Gašević, D (eds) 2017, Handbook of Learning Analytics. 1st edn, Society for Learning Analytics Research. https://doi.org/10.18608/hla17. Handbook of Learning Analytics. / Lang, Charles (Editor); Siemens, George (Editor); Wise, Alyssa (Editor) et al. 1st ed. Society for Learning Analytics Research, 2017. 356 p.

10. Bakhshinategh, B., Zaiane, O. R., ElAtia, S., & Ipperciel, D. (2018). Educational data mining applications and tasks: A survey of the last 10 years. Education and Information Technologies, 23(1), 537–553. https://doi.org/10.1007/s10639-017-9616-z.

11. Prieto, L. P., Sharma, K., Dillenbourg, P., & Jesús, M. (2016). Teaching analytics: Towards automatic extraction of orchestration graphs using wearable sensors. Proceedings of the Sixth International Conference on Learning Analytics and Knowledge (LAK '16), 25–29 April 2016, Edinburgh, UK (pp. 148–157). New York: ACM. https://doi.org/10.1145/2883851.2883927

12. Современная аналитика образования № 9 (58) 2021.

13. Siemens G, Dawson S, Lynch G. Повышение качества и производительности сектора высшего образования Политика и стратегия для системного развертывания аналитики обучения. Канберра, Австралия: Society for Learning Analytics Re- поиск Австралийского управления по обучению и обучению. 2013 [цитируется 29 марта 2020 г.].

14. Wright MC, McKay T, Hershock C, Miller K, Tritz J. Лучше, чем ожидалось: Использование аналитики обучения для содействия успешному успеху в науке о воротах. Change: The Magazine of Higher Learning. 2 января 2014 г. [цитируется 29 марта 2020 г.]; 46 (1): 28-34. https://doi.org/10.1080/00091383.2014.867209

15. Conijn R, Snijders C, Kleingeld A, Matzat U. Прогнозирование успеваемости студентов по данным LMS: Сравнение 17 смешанных курсов с использованием moodle LMS. IEEE Transactions on Learning Technologies. 2016 окт. 12; 10 (1): 17-29. https:// doi.org/10.1109/TLT.2016.2616312

16. Allen J, Robbins SB. Прогнозирование основной настойчивости колледжа на основе профессиональных интересов, академической подготовки и успеваемости первого года обучения. Исследования в области высшего образования. 2008, 4 февраля; 49 (1): 62-79. https://doi.org/10.1007/ s11162-007-9064-5

17. Kovačić ZJ. Прогнозирование успеха учащихся путем добычи данных о зачислении. Исследования в области высшего образования. 2012;15.

18. Agudo-Peregrina ÁF, Iglesias-Pradas S, Conde-González MA, Hernández-García Á. Можем ли мы предсказать успех по данным журнала в VLE? Классификация взаимодействий для аналитики обучения и их связь с производительностью в VLE-supported F2F и онлайн-обучении. Компьютеры в Human Be-

хавиор. 2014, 1 февраля; 31 (1): 542-550. https://doi.org/10.1016/j. chb.2013.05.031

19. Rush BR, Sanderson MW, Elmore RG. Предматчевые показатели академической сложности во время ветеринарной школы. Журнал ветеринарного медицинского образования. 2005 дек. 9; 32 (4): 517-522. https://doi.org/10.3138/jvme.32.4.517. Medline:16421838

20. Dawson SP, McWilliam E, Tan JP. Обучение умнее: Как интеллектуальный анализ данных ИКТ может информировать и улучшать практику обучения и обучения. В: Ежегодная конференция Австрало-азиатского общества компьютеров в обучении в третичном образовании. 2008 г. [цитируется 2020 г. 24 февраля]. с. 221 - 230. Доступно по адресу: https://ro.uow.edu.au/medpapers/141

HIGHER EDUCATION QUALITY ASSURANCE OF GEORGIA FROM ITS ASSOCIATION AGREEMENT WITH THE EUROPEAN UNION TO MEMBERSHIP CANDIDATE STATUS

Margvelashvili M.
PhD, Professor, Head of the Sports Management Department,
Georgian State University of Physical Education and Sport
https://doi.org/10.5281/zenodo.10451104

Abstract

On June 14, 2014 Georgia signed the Association Agreement with European Union. According to 361 Article of the Agreement, Georgia was obliged to conduct harmonization of National Legislation to European Union legislative acts referred to in Annex XXXII of the Agreement. The EU documents regarding qualifications and the higher education quality assurance are among them. Georgia has recently taken another step towards the European family. On December 14, 2023, Georgia granted the status of a candidate for EU membership that makes the country more responsible for fulfilling the obligations undertaken within the Association Agreement.

Higher education quality in the European Higher Education Area (EHEA) is regulated according to the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG 2015), a fundamental purpose of which is to contribute to the common understanding of quality assurance for teaching and learning across borders and among all stakeholders. The standards set out agreed and accepted practice for quality assurance in higher education in the European Higher Education Area and should, therefore, be considered and adhered to by those concerned in all types of higher education provision. Its importance and usefulness is recognized and adopted by 48 European countries and proven by time.

However, in Georgia, it seems these regulations are considered insufficient for Higher Education Institutions, and along with programmatic accreditation, institutional authorization also applies. The latter is a remnant of the past, which has not yet renounced. The purpose of the proposed study was a detailed review and comparison of these two national regulations with ESG 2015. Study has revealed that some ESG 2015 standards not presented in Georgian regulations. A number of requirements are duplicated in the National institutional authorization and programmatic accreditation, which leads to putting an excessive burden on already financially weak higher education institutions, both in terms of effort and time loss and in terms of finances, since it requires the preparation of a large volume of documentation and the payment of double fees for authorization and accreditation. In addition, the National Center for Education Quality Enhancement of Georgia is a legal entity under the public law of the Ministry of Education and Science of Georgia that questions its independence. In the conclusion several recommendations are offered to solve these problems.

Keywords: Higher Education, ESG 2015, Institutional Authorization, Programmatic Accreditation

Introduction

On June 14, 2014 Georgia signed the Association Agreement with European Union. According to 361 Article of the Agreement, Georgia was obliged to conduct harmonization of National Legislation to European Union legislative acts referred to in Annex XXXII of the Agreement. The EU documents regarding qualifications and the higher education quality assurance are among them [1. pp. 121, 122]. Georgia has recently taken another step towards the European family. On December 14, 2023, Georgia granted the status of a candidate for EU membership, which now imposes more responsibility in fulfilling the obligations under this agreement.

Higher education quality in the European Higher Education Area (EHEA) is regulated according to the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG 2015) [2].

The EHEA was created by the Bologna Process through harmonizing academic degree standards and quality assurance standards throughout Europe. Georgia joined the mentioned process in 2005 at the Bergen conference [3, p.1].

The ESG was adopted by the Ministers responsible for Higher Education of the European Higher Education Area at the Yerevan Ministerial Conference in May 2015, following the revision of the ESG 2005, which helped shift the paradigm towards student-centered learning and teaching.

A fundamental purpose of the Standards and Guidelines for Quality Assurance in the European Higher Education Area, is to contribute to the common understanding of quality assurance for teaching and learning across borders and among all stakeholders. They have played and will continue to play a significant role in developing national and institutional quality assurance systems across the European Higher Education Area and cross-border cooperation. Engagement with quality assurance processes, allow European higher education systems to demonstrate quality and increase transparency, thus helping to build mutual trust and better recognition of their qualifications, programmes and other provision [2, p.6]. Their importance and usefulness is recognized and adopted by 48 European countries and proven by time.

In the presented analysis, we discussed the first part of ESG - the standards of internal quality assurance, which are of the utmost importance for Higher Education Institutions and according to which they are regulated by the state.

ESG 2015 identifies 10 main criteria for internal quality assurance [2, p.10]:

1. Policy for quality assurance;
2. Design and approval of programmes;
3. Student-centered learning, teaching and assessment;
4. Student admission, progression, recognition and certification;
5. Teaching staff;
6. Learning resources and student support;
7. Information management;
8. Public information;
9. On-going monitoring and periodic review of programmes;
10. Cyclical external quality assurance.

According to these criteria, standards are established and guiding principles defined, covering in detail all areas of higher education programme development and implementation, including quality assurance processes. In addition, the mentioned standards are written in detail with relevant guidelines.

Higher education in Georgia regulated in two ways: by the authorization of higher educational institutions and by accreditation of higher education programmes. Law of Georgia on Higher Education, 2004, is regulating the process of carrying out educational and research activities by higher education institutions and the principles and procedures of administering and financing higher education; it also defines procedures for the establishment, reorganization of the activities and the liquidation of higher education institutions, as well as principles of the authorization and accreditation of higher education institutions [4, Article 1].

Authorization – is a procedures for acquiring the status of a higher education institution, intended to ensure compliance with the standards necessary to implement appropriate activities for issuing a document certifying education recognized by the State (4, Article 2, b^1).

Accreditation – is a procedures for determining the compliance of educational programmes of higher education institutions with accreditation standards, which are intended to introduce a systematic self-evaluation system and facilitate the development of quality assurance mechanisms for the improvement of education quality, on the basis of which state financing is acquired, as well as for the implementation of particular programmes determined by this Law (4, Article 2, h).

Thus, according to current legislation the higher education institutions (HEIs) in Georgia must comply with the internal and external quality assurance mechanisms and undergo both Institutional Authorization and Programmatic Accreditation. In the case of failure to receive authorization, the HEI loses the status of a higher education institution and ceases its activity, and in the case of failure to receive accreditation of the programme - the right to admit students to this program [5].

As stated by National Center for Education Quality Enhancement of Georgia (NCEQE): In the process of implementing external mechanisms of quality assurance in HEIs, the Center takes into account the EU's Agenda of Higher Education Modernization and the recommendations of the Bologna process, including the requirements of the Standards and Guidelines for Quality Assurance in the European Higher Education Area. The external quality assurance mechanisms, procedures and standards implemented in Georgia are in compliance with the Standards and Guidelines for Quality Assurance in the European Higher Education Area [6, p.1). Herewith, NCEQE is the only authorized by the government agency, which carries out authorization of educational institutions and accreditation of educational programs, as well as monitors implementation of authorization and accreditation standards, that is also determined by the above-mentioned Law of Georgia On Education Quality Improvement.

For better understanding of these regulations, we present their content in details.

Institutional Authorization

In 2016, after amendments to the Law of Georgia on Higher Education authorization standards extended. It was explained that - the purpose of the authorization standards of higher educational institutions is to promote the development of education quality in higher educational institutions and ensure a student-centered educational environment. That the authorization standards of HEI also correspond to the purposes of Georgian higher education and the requirements of the European Higher Education Area. The standards envisage a full assessment of the institution, which means evaluation of the resources, regulations, implemented, current and planned activities, achieved results and opportunities for the achievable results (relevant planned activities, mechanisms for their implementation and allocated resources).

These standards cover the following issues:

1. Mission and strategic development of HEI;
2. Organizational structure and management of HEI;
3. Educational programs;
4. HEI staff;
5. Students and their support measures;
6. Research, development and/or other creative activities;
7. Material, information and financial resources.

In addition, each standard detailed with corresponding sub-standards, including a description, assessment criteria and a list of indicators/evidence [7].

Programmatic Accreditation

Amended in 2020, accreditation standards include the following issues:

1. The purpose of the educational programme, the learning outcomes and the relevance of the programme to them;
2. Teaching methodology and organization, adequacy of evaluation of programme utilization;
3. Achievements of students, individual work with them;
4. Provision of teaching resources;
5. Possibilities for the development of teaching quality.

Each standard is also detailed here with relevant sub-standards, including a description, assessment criteria and a list of indicators/evidence [8].

The duration of the granted program accreditation was determined for 6 years, and for institutional authorization - 7 years.

Under the obligations taken by the Association Agreement with the European Union, the National Center for Educational Quality Enhancement started the process of education system analysis in 2014. As a result of this process the revised National Qualifications Framework and Learning Fields Classifier were approved [9].

One of the most tangible and visible results of the changes implemented by higher education institutions in the introducing quality assurance mechanisms is the reduction of the educational programs number. 27 authorized HEIs in 2018, canceled 253 educational programmes before the authorization process began. After implementing the new authorization mechanisms, the number of HEIs operating in Georgia also decreased. 12 HEI's deducted from the national university space.

The changes implemented at the system level were based on the quality assurance standards and guidelines of the European higher education area (ESG 2015). With systemic changes, the quality assurance system of Georgia came into compliance with European requirements. As a result of the changes made, the National Center for Education Quality Enhancement gained the recognition of the World Federation of Medical Education (WFME), joined the European Association for the Quality Assurance of Higher Education (ENQA), and at the same time, registered in the European Register of Independent Agencies for the Development of the Quality of Higher Education (EQAR). In this way, the country mainly fulfilled both the requirements of the European Higher Education Area and the Association Agreement of Georgia with the European Union.

However, despite the overall positive assessment, a detailed discussion and analysis of the issue reveals a number of issues in the existing national regulatory mechanisms, which impact negatively on the activities of higher education institutions and their proximity to the European area of higher education.

In order to highlight the problems, a detailed comparison of ESG 2015 standards and guidelines, in particular, the first part - Standards and guidelines for internal quality assurance, was made with the institutional authorization and programmatic accreditation standards in force in Georgia (see table 1).

It is clear from the presented table that:

1. From the part 1 of ESG 2015, Standards and Guidelines for Internal Quality Assurance, two from the ten standards (1.7 - Information Management and 1.8 - Public Information) are not presented separately in the Georgian authorization or accreditation standards. It seems these standards, or informed decision-making and transparency of activities, were considered less important.

2. The first standard 1.1 of ESG 2015 (Quality Assurance Policy) is present in the accreditation regulations but transferred to the 5th standard under the title Opportunities for the Development of Teaching Quality. The impression remains that the quality of education is at an appropriate level and refers to its further improvement.

3. The requirements of number of standards are divided and dispersed in different sub-standards for authorization and accreditation.

What is the most substantial - several standards are duplicated in national authorization and accreditation standards. In particular, Educational Programmes (3rd authorization standard) and The Purpose of the Educational Programme, Learning Outcomes and Programme Compliance with Them (1st accreditation standard); Students and Their Support Measures (Article 5 of authorization standards) and Achievements of Students, Individual Work with them (Article 3 of accreditation standards), etc.

Authorizing higher education institutions in Georgia made sense at the beginning of the century. Due to the lack of relevant regulations, many universities were opened in the country, most of which could not meet any conditions. At that time, more than 300 HEIs were operating, and in such a situation, their authorization was necessary.

Today situation has changed. There are 56 state and private and 7 Orthodox Divinity higher educational institutions operating in the country [10]. It seems the time has come to revise above regulations. The presence of these two regulations restrains HEIs, both in terms of time loss and the need to prepare a large number of documentation, including follow-up activities in some cases (1-year progress report, monitoring visit in 2 years, 3-year progress report, etc.), as well as in terms of financial costs.

Furthermore, ESG 2015 Standard 3.3 - Independence, requires the accreditation agencies to be independent and act autonomously. They should have both organizational and operational independence from third parties, such as higher education institutions, governments and other stakeholder organizations. This standard violated in Georgia. As stated above, the National Center for the Development of the Quality of Education (NCEQE) is a legal entity under the public law of the Ministry of Education and Science of Georgia, which was established according to the Law of Georgia On Education Quality Improvement and the only agency in the country that authorized by the government of the country to carry out institutional authorization and programmatic accreditation, as well as monitoring the implementation of authorization and accreditation standards. NCEQE is a legal entity under the governance of the Ministry of Education and Science of Georgia. Its director appointed and dismissed by the Minister, with the agreement of the Prime Minister, and its state control carried out by the Ministry according to the rules established by the legislation of Georgia. [11]. Members of the authorization council of higher education institution are appointed and dismissed by the Prime Minister, as recommended by the Ministry of Education and Science of Georgia. Even the members of the Appeals Council are appointed and dismissed by the Prime Minister of Georgia [12].

Concerning financial costs, the cost of programmatic accreditation vary from 8,356.00 GEL to 18,215.00 Georgian Lari (GEL) per programme depending on its level, type and need for business trip plus 200 GEL just for the application review [13], and from

29,948.00 GEL to 57,339.00 GEL for institutional authorization plus 500 GEL for application review. An authorization fee calculation method is complicated and depends on the type of HEI, its condition (existing or new), the number of students, the number of educational programmes, the number of staff, the number of addresses of location, its total space, etc. The workload of the expert panel - the number of person/days determined minimum 20 and maximum 42 [14].

Above fees are high, especially for institutional authorization, considering the cost of education in state universities 2,250.00 GEL per student per year (in private ones it varies and reaches 6,950.00 GEL).

The financial issues of higher education institutions exacerbating by general financial hardship of the population that affects the students' ability to pay tuition fees. In particular, the number of students with suspended status in the country is high. Unfortunately, neither the Ministry of Education and Science of Georgia nor the National Statistics Office provides any data on this issue. However, some independent sources provide data according to which for 13.02.2023, in the database of the Education Management Information System (EMIS) were recorded 178,450 undergraduate students, of which 68,491 students (33.5%) have their status suspended, and 28,590 of them, 11.8%, are due to financial debt [15]. According to another source, the status of 36,156 students suspended in 2022. This information also came from the same EMIS. According to it, student status of 15,013 out of 36,156 students or 42%, suspended due to financial debt [16].

Although the government is trying to solve this problem with some initiatives, combining these two regulations into one institutional accreditation, which will include all the requirements, would undoubtedly facilitate the work of both universities and the accreditation agency. Releasing universities from excessive pressure will leave them more time and funds to help students solve financial problems, strengthen the material-technical base and ensure appropriate quality of education.

Conclusion

Although ESG 2015 is not a mandatory document, and the national education systems have the right to introduce different rules for regulating the quality of higher education. However, it is difficult to understand what benefits provide the simultaneous demand for authorization and accreditation when a number of requirements duplicated, and that puts an excessive burden on already financially weak higher education institutions, both in terms of time and effort loss, and in terms of finances, since it requires the creation of numerous documents and the payment of double fees for authorization and accreditation.

Thus, the correct way out of the current situation, we suppose, is:

1. The National Center for Education Quality Enhancement must be transformed into an independent agency and operate autonomously with complete organizational and operational independence from third parties, such as higher education institutions, government, and other stakeholders. That will make the accreditation process unbiased, reliable, and trustworthy in front of the universities and the public.

2. To combine current institutional authorization and programmatic accreditation in one regulation – Institutional Accreditation. That would free up time for higher education institutions to focus more on teaching quality, new teaching and learning methods, strengthening internationalization, etc. At the same time, the money saved from the fee payment would allow them to increase their spending on student support, new textbooks, equipment, and other significant HEIs expenses.

References:

1. Association Agreement between EU and Georgia, Art. 358, 359, Chapter 16 (https://eur-lex.europa.eu/legal-content/en/TXT/PDF/?uri=CELEX:22014A0830(02).

2. The Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG 2015) (https://www.enqa.eu/wp-content/uploads/2015/11/ESG_2015.pdf).

3. Communiqué of the Conference of European Ministers Responsible for Higher Education, Bergen, 19-20 May 2005 (https://www.ehea.info/media.ehea.info/file/2005_Bergen/52/0/2005_Bergen_Communique_english_580520.pdf).

4. Law of Georgia On Higher Education (https://matsne.gov.ge/ru/document/download/32830/53/en/pdf).

5. Law of Georgia On Education Quality Enhancement, Art. 16, p. 1a, and Art. 24, a, https://matsne.gov.ge/en/document/view/93064?publication=10

6. National Center for Education Quality Enhancement, Quality Assurance in Higher Education (https://eqe.ge/en/page/parent/581/umaghlesi-ganatlebis-khariskhis-uzrunvelqofa).

7. Authorization Standards (https://eqe.ge/en/page/static/449/avtorizatsiis-standartebi)

8. Accreditation Standards (https://eqe.ge/en/page/static/1053/akreditaciis-standartebi-da-procedurebi).

9. Order N69/n of the Minister of Education, Science, Culture and Sport of Georgia of 2019 https://eqe.ge/en/page/parent/787/erovnuli-kvalifikatsiebis-charcho.

10. National Center for Education Quality Enhancement of Georgia https://eqe.ge/en/page/static/89/umaghlesi-saganmanatleblo-datsesebulebebi.

11. Law of Georgia On Education Quality Enhancement, Art. 4, p. 1-4, https://matsne.gov.ge/en/document/view/93064?publication=10

12. Order N 99/n of the Minister of Education and Science of Georgia of October 1, 2010 On Approval of the Charter and Fees for the Authorization of Educational Institutions, Art.75, p.1, and Art.95, p.2. https://eqe.ge/en/page/static/451/protsedurebi

13. Fee for the education programme accreditation - https://eqe.ge/en/faq/10/show.

14. Annex No. 2 to Order of the Minister of Education and Science of Georgia No. 99/N of October 1, 2010, On the approval of Authorization of Educational Institutions provision and Fees - https://eqe.ge/en/faq/35/show.

15. BPN - https://www.bpn.ge/article/106190-sakartveloshi-studentebis-335-s-statusi-shecherebuli-akvs-ramden-procents-sheucherda-pinansuri-davalianebis-gamo/

16. IPN - https://www.interpressnews.ge/ka/article/740763-2022-cels-statusi-36156-students-sheucherda/

Table 1

Comparison of ESG 2015 with National Institutional Authorization and Programmatic Accreditation Requirements of Georgia

	EHEA			GEORGIA	
№	ESG Criteria	ESG Standards	ESG Guidelines	Institutional Authorization Requirements	Programmatic Accreditation Requirements
1.1	**Policy for quality assurance**	Institutions should have a policy for quality assurance that is made public and forms part of their strategic management. Internal stakeholders should develop and implement this policy through appropriate structures and processes, while involving external stakeholders.	Policies and processes are the main pillars of a coherent institutional quality assurance systemthat forms a cycle for continuous improvement and contributes to the accountability of the institution. It supports the development of quality culture in which all internal stakeholders assume responsibility for quality and engage in quality assurance at all levels of the institution. In order to facilitate this, the policy has a formal status and is publicly available.		**5. Teaching Quality Enhancement Opportunities** In order to enhance teaching quality, programme utilizes internal and external quality assurance services and also periodically conducts programme monitoring and programme review. Relevant data is collected, analyzed and utilized for informed decision making and programme development on a regular basis.
1.2	**Design and approval of programmes**	Institutions should have processes for the design and approval of their programmes. The programmes should be designed so that they meet the objectives set for them, including the intended learning outcomes. The qualification resulting from a programme should be clearly specified and communicated, and refer to the correct level of the national qualifications framework for higher education and, consequently, to the Framework for Qualifications of the European Higher Education Area.	Study programmes are at the core of the higher education institutions' teaching mission. They provide students with both academic knowledge and skills including those that are transferable, which may influence their personal development and may be applied in their future careers.	**3. Educational Programmes** HEI has procedures for planning, designing, approving, developing and annulling educational programmes. Programme learning outcomes are clearly defined and are in line with the National Qualifications Framework. A programme ensures achievement of its objectives and intended learning outcomes.	**1. Educational Programme Objectives, Learning Outcomes and their Compliance with the Programme** A programme has clearly established objectives and learning outcomes, which are logically connected to each other. Programme objectives are consistent with the mission, objectives and strategic plan of the institution. Programme learning outcomes are assessedon a regular basis to improve the programme. The content and consistent structure of the programme ensure the achievement of the set goals and expected learning outcomes.
1.3	**Student-centred learning, teaching and assessment**	Institutions should ensure that the programmes are delivered in a way that encourages students to take an active role in creating the learning process, and that the assessment of students reflects this approach.	Student-centred learning and teaching plays an important role in stimulating students' motivation, self-reflection and engagement in the learning process. This means careful consideration of the design and delivery of study programmes and the assessment of outcomes.	**5. Students and their support services** HEI ensures the development of student-centred environment, offers appropriate services, including career support mechanisms; it also ensures maximum awareness of students, implements diverse activities and promotes student involvement in these activities. HEI utilizes student survey results to improve student support services. **(5.2) Student support services**	**3. Student Achievements and Individual Work with Them** The programme ensures the creation of a student-centered environment by providing students with relevant services; promotes maximum student awareness, implements a variety of activities and facilitates student engagement in local and / or international projects; proper quality of scientific guidance and supervision is provided for master's and doctoral students.

1.4	**Student admission, progression, recognition and certification**	Institutions should consistently apply pre-defined and published regulations covering all phases of the student "life cycle", e.g. student admission, progression, recognition and certification.	Providing conditions and support that are necessary for students to make progress in their academic career is in the best interest of the individual students, programmes, institutions and systems. It is vital to have fit-for-purpose admission, recognition and completion procedures, particularly when students are mobile within and across higher education systems.	**5. Students and their support services** - ' - **(5.1) The Rule for obtaining and changing student status, the recognition of education, and student rights**	**2. Methodology and Organization of Teaching, Adequacy of Evaluation of Programme Mastering** Prerequisites for admission to the programme, teaching-learning methods and student assessment consider the specificity of the field of study of the programme, level requirements, student needs and ensure the engagement achievement of the objectives and expected learning outcomes of the programme.
1.5	**Teaching staff**	Institutions should assure themselves of the competence of their teachers. They should apply fair and transparent processes for the recruitment and development of the staff.	The teacher's role is essential in creating a high quality student experience and enabling the acquisition of knowledge, competences and skills. The diversifying student population and stronger focus on learning outcomes require student-centred learning and teaching and the role of the teacher is, therefore, also changing (cf. Standard 1.3).	**4. Staff of the HEI** HEI ensures that the staff employed in the institution (academic, scientific, invited, administrative, support) are highly qualified, so that they are able to effectively manage educational, scientific, research, creative, performing activities and administrative processes and achieve the goals defined by the strategic plan of the institution. On its hand, the institution constantly provides its staff with professional development opportunities and improved work conditions.	**4. Providing Teaching Resources** Human, material, information and financial resources of educational programme/educational programmes grouped in a cluster ensure the sustainable, stable, effective and efficient functioning of the programme and the achievement of the defined objectives. **4.1. Human Resources** **4.3. Professional Development of Academic, Scientific and Invited Staff**
1.6	**Learning resources and student support**	Institutions should have appropriate funding for learning and teaching activities and ensure that adequate and readily accessible learning resources and student support are provided.	For a good higher education experience, institutions provide a range of resources to assist student learning. These vary from physical resources such as libraries, study facilities and IT infrastructure to human support in the form of tutors, counsellors and other advisers. The role of support services is of particular importance in facilitating the mobility of students within and across higher education systems.	**5. Students and their support services** - ' - **7. Material, information and financial resources** Material, information and financial resources of HEI ensure sustainable, stable, effective and efficient functioning of the institution, and the achievement of goals defined through strategic development plan.	**4. Providing Teaching Resources** - ' – **4.4. Material Resources** **4.5. Programme/ Faculty/School Budget and Programme Financial Sustainability**

1.7	**Information management**	Institutions should ensure that they collect, analyse and use relevant information for the effective management of their programmes and other activities	Reliable data is crucial for informed decision-making and for knowing what is working well and what needs attention. Effective processes to collect and analyse information about study programmes and other activities feed into the internal quality assurance system.	**Missing**	**Missing**
1.8	**Public information**	Institutions should publish information about their activities, including programmes, which is clear, accurate, objective, up-to date and readily accessible.	Information on institutions' activities is useful for prospective and current students as well as for graduates, other stakeholders and the public	**Missing**	**Missing**
1.9	**On-going monitoring and periodic review of programmes**	Institutions should monitor and periodically review their programmes to ensure that they achieve the objectives set for them and respond to the needs of students and society. These reviews should lead to continuous improvement of the programme. Any action planned or taken as a result should be communicated to all those concerned	Regular monitoring, review and revision of study programmes aim to ensure that the provision remains appropriate and to create a supportive and effective learning environment for students.		**5. Teaching Quality Enhancement Opportunities** - ' - **5.3. Programme Monitoring and Periodic Review**
1.10	**Cyclical external quality assurance**	Institutions should undergo external quality assurance in line with the ESG on a cyclical basis.	External quality assurance in its various forms can verify the effectiveness of institutions' internal quality assurance, act as a catalyst for improvement and offer the institution new perspectives. It will also provide information to assure the institution and the public of the quality of the institution's activities.		**5. Teaching Quality Enhancement Opportunities** - ' - **5.2. External Quality Evaluation**

BUILDING THE CULTURAL-COMMUNICATIVE COMPETENCE OF FUTURE FOREIGN LANGUAGE TEACHERS THROUGH DIGITAL TECHNOLOGIES

Medet N.
WK. City of Urals ЖОБММ №50
English teacher

ЦИФРЛЫҚ ТЕХНОЛОГИЯЛАР АРҚЫЛЫ БОЛАШАҚ ШЕТ ТІЛІ МҰҒАЛІМДЕРІНІҢ МӘДЕНИЕТАРАЛЫҚ-КОММУНИКАТИВТІК ҚҰЗЫРЕТТІЛІГІН ҚАЛЫПТАСТЫРУ

Медет Н.А.
БҚО. Орал қаласы №50 ЖОББМ
Ағылшын тілі пәні мұғалімі
https://doi.org/10.5281/zenodo.10451369

Abstract

Theoretical foundations of formation of intercultural-communicative competence of future foreign language teachers

Analysis of current research on formation of intercultural and communicative competence of future teachers through digital technologies

Choosing digital technologies as a means of forming intercultural and communicative competence of future foreign language teachers.

Аннотация

Болашақ шет тілі мұғалімдерінің мәдениетаралық-коммуникативтік құзыреттілігін қалыптастырудың теориялық негіздері

Цифрлық технологиялар арқылы, болашақ мұғалімдердің мәдениетаралық - коммуникативтік құзыреттілігін қалыптастыру бойынша қазіргі зерттеулерді талдау

Болашақ шет тілі мұғалімдерінің мәдениетаралық - коммуникативтік құзыреттілігін қалыптастыру құралы ретінде цифрлық технологияларды таңдау.

Keywords: Digital, foreign language, communicative, new technology, intercultural, research, analysis, theory

Негізгі сөздер: Цифрлық, шет тілі, коммуникативтік, жаңа технология, мәдениетаралық, зерттеулер, талдаулар,теория

Құзыреттілік – берілген пән саласында тиімді іс-әрекет үшін қажетті білім мен тәжірибенің болуы. Ресейлік ғалым М.А. Чошанов «құзыреттілік» термині педагогика ғылымында жеткілікті тұрақталмағандығын айтады және көп жағдайларда маманның біліктілігі мен кәсібилігінің жеткілікті деңгейін көрсету үшін интуитивті түрде қолданылады. Оның пікірінше, құзыреттілік білімнің үнемі жаңарып тұруын, жаңа ақпаратты меңгеру және нақты бір жағдайларда оны табысты пайдалануын, яғни жедел әрі ұтқырлы білімді меңгеруді білдіреді. М.А. Чошанов құзыреттілікті жұмысты біле отырып міндеттерді шешудің әлеуетті дайындығы деп түсіндіреді. Ол мазмұндық (білім) және әрекеттік (іскерлік) компоненттерін, мәселенің мәнін білу мен оны шеше білуді қамтиды Коммуникация -бұл белгілі бір әрекеттерден тұратын күрделі процесс. Коммуникация барысында адамдардың бір-біріне өзара ықпалы, қызығушылықтары, сезім алмасулары болады. Қарым-қатынас – адамдар арасындағы қарым-қатынас пен адам қауымдастығындағы прогрестің маңызды құралы. Мәдениетаралық коммуникация әртүрлі мәдениет өкілдері арасындағы қарым-қатынас болғандықтан, ол-күрделі процесс . Бүгінгі таңда мәдениетаралық коммуникацияның өзектілігі көптеген халықаралық компаниялар мен ұжымдарда әртүрлі мәдениеттердің, діндердің, дүниетанымдардың және т.б. өкілдерінің жұмыс істеуіне байланысты артуда. Дәлірек айтсақ, мәдениетаралық коммуникация көпполярлы әлемді құруда маңызды рөл атқарады.

"Мәдениетаралық коммуникация" ұғымы пәнаралық термин болып табылатындығын және лингвистика, мәдениеттану, антропология, психология, әлеуметтану және т.б. сияқты ғылымдар аясында зерттелетінін атап өткен жөн. Әр сала зерттеуде өзіндік көзқарастарын көрсетеді. С. Г. Тер-Минасованың пікірінше, мәдениетаралық коммуникация -бұл "әртүрлі мәдениеттерге жататын адамдар мен топтар арасындағы қарым-қатынас пен қарым-қатынастың әртүрлі формаларының жиынтығы".

Мәдениетаралық коммуникативті құзыреттілік адамның мәдениетаралық өзара қарым-қатынас жасау қабілетінің қалыптасуының көрсеткіші болып табылады. "Мәдениетаралық коммуникативті құзыреттілік" ұғымының мәнін түсіну үшін мәдениетаралық қарым-қатынастың ерекшеліктерін қарастырайық. Жаһандану жағдайында әртүрлі мәдениет өкілдерінің арасындағы қарым-қатынас күнделікті шындыққа

айналды. Бұл мәдениетаралық коммуникация деп аталатын барлық әлемдік мәдениеттердің өзара қарым-қатынастарыңа қызығушылық тудырды.

Заманауи маман мәдениетаралық қарым-қатынасты топтық деңгейде де, жеке деңгейде де жүзеге асыра білуі керек және әрбір коммуникативті әрекетте тілді жақсы білу сияқты тиімді мәдениетаралық қарым-қатынастың құрамдас бөліктері болатынын ескеруі қажет. Сондай-ақ, жеткілікті деңгейде мәдениетаралық қарым-қатынасқа ықпал ететін вербалды емес, паралингвистикалық коммуникация құралдарын пайдалану. Тиімді мәдениетаралық коммуникацияның маңызды құрамдас бөлігі ретінде коммуникативті дағдылар қалыптасады. Осы жағдайда Тищенко В. А "білім беруді ақпараттандыру жағдайында оқу процесінде, содан кейін кәсіби қызметте адамдармен дұрыс қарым-қатынас орнатуға және қолдауға бағытталған ақыл - ой және практикалық іс-әрекеттерді меңгеру және қоғам " деген анықтама береді [7]. Сонымен қатар, маңызды мәселелерді сауатты талқылау, өз көзқарасыңызды дәлелді түрде қорғау, басқалардың пікірін құрметтеу және қарсыластың пікірін жоққа шығару қабілетін мәдениетаралық – коммуникация құзіреттілігінің компоненттеріне қоса аламыз. Мәдениетаралық қарым-қатынас ана тілінің ұлттық-мәдени базасы негізінде, өз тілінен хабардар болған жағдайда ғана жүзеге асады.Бұл - мәдениеттердің өзара араласуы мен өзара әрекеттесуінің қажетті шарты. Көптеген авторлардың пікірінше, мәдениетаралық коммуникация – бұл әртүрлі мәдениеттерге жататын тұлғалардың, топтардың немесе ұйымдардың өзара әрекеттесуі. Бұл жерде мәдени айырмашылықтардың маңыздылығы, оларды тану, түсіну және қарым-қатынас процесінде адекватты түрде есепке алу мүмкіндігі туралы мәселе болып табылады. Кез келген қарым-қатынас процесінің негізгі мақсаты мен мәні серіктесіңіздің түсінуіне деген ұмтылыс болып табылады.Бұл сіздің ақпаратыңызды, біліміңізді және тәжірибеңізді әңгімелесушіге мүмкіндігінше толық және дәл жеткізу қажеттілігін білдіреді. Ал бұл коммуникацияның тиімділігі сөйлесушілер арасындағы өзара түсіністік деңгейіне тура пропорционалды екенін білдіреді. Өзара түсіністікке жету үшін мәдениетаралық құзыреттілік деп аталатын барлық коммуникаторларға ортақ білім, білік және дағдылар қажет.

Мәдениетаралық коммуникативті құзыреттілік басқа халықтардың тілі мен мәдениетіне жағымды көзқарасты, олардың және басқа мәдениеттің құндылықтарын, олардың ұқсастықтары мен айырмашылықтарын, сондай-ақ қатысушылардың мәдениет диалогына тиімді қатысу қабілетін қамтамасыз ететін әлеуметтік-мәдени кең ауқымды білімнің міндетті түрде болуын қарастыратындығын ескеру қажет. Мәдениетаралық қарым-қатынас коммуникативтік дағдыларға, сондай-ақ тілдік құзыреттілік дағдыларына ие болуы керек, оның маңызды бөлігі - сөйлеу сауаттылығы.

Мәдениетаралық коммуникативті құзыреттілікті қалыптастыру толерантты қарым-қатынас пен этнорелятивизмді құруға негізделген, этноцентризм мен этностереотиптердің болуын түсіну. Мәдениетаралық қарым-қатынасты құру кезінде мәдениетаралық құзыреттілікке қол жеткізудің табысты стратегиясы интеграция — басқа халықтардың мәдениетін игерумен қатар өзіндік мәдени бірегейлікті сақтау қажеттілігін есте ұстаған жөн.

Әрине, қарым-қатынас актісіне қатысушылар тілді терең білуі керек. Практикалық тәжірибе көрсетіп отырғандай, қазіргі уақытта мәдениетаралық коммуникация құралы ретінде шет тілдерін білуге практикалық сұраныс артты. Бүгінгі таңда шет тілі басқа мәдениетпен танысу құралы ретінде ғана емес, сонымен бірге "студенттер оқытылатын шет тіл елінің мәдениетін біртұтас әлемдік мәдениеттің ажырамас бөлігі ретінде игере алатын маңызды құралдардың бірі" ретінде қабылданады және өзінің мәдени өзін-өзі анықтауы мен жалпы планетарлық ойлауын қалыптастырады. Сондықтан бүгінгі таңда университетте шет тілдерін оқыту ерекше маңызға ие.

Қазіргі уақытта шет тілі мен оның мәдениетін оқытудың қазіргі мақсаты нақты мәдениетаралық қарым-қатынасқа дайындық ретінде тұжырымдалады. Шет тілдерін оқыту проблемаларын мәдениетаралық коммуникацияның тілдік, коммуникативтік және әлеуметтік-мәдени аспектілерін қамтитын кешен ретінде қарастырған жөн. Қазіргі таңда ЖОО-да шет тілдерін оқытудағы басым бағыттар мәдениетаралық коммуникативтік құзыреттілікті қалыптастыратын коммуникативтілік, интерактивтілік, түпнұсқалылық, мәдени контексте тілді үйрену болып табылады.

Маманның шет тілін оқыту жолдарының бірі ретінде мәдениетаралық коммуникация бойынша маман даярлауды қамтуы тиіс мәдени мазмұн, оның негізінде мәдениетаралық коммуникативтік құзыреттілік адамның басқа дүниетаным мен басқа мәдениетті тануға және түсінуге интегративті қабілеті ретінде қалыптасуын қарастырылады. Басқа дүниетанымммен танысу адамның өзіндік болмысын байытуға ықпал етеді. Шет тілін оқыту шеңберінде маман әртүрлі мәдениеттердегі әмбебап категориялар мен ерекше белгілерді ажырата білу қабілетін дамытады.

THE USE OF ARTIFICIAL INTELLIGENCE IN TEACHING ENGLISH AT A UNIVERSITY

Kairova Zh.,
Master of Pedagogical Sciences
lecturer of Foreign language department
S.Seifullin Kazakh Agrotechnical Research University
Kucherbayeva A.
Master of Pedagogical Sciences
lecturer of Foreign language department
S.Seifullin Kazakh Agrotechnical Research University
https://doi.org/10.5281/zenodo.10451376

Abstract

This article considers the problem of using artificial intelligence (AI) technologies for teaching a foreign language at a university. AI services designed for teaching foreign languages, as well as AI tools acting as teaching assistants, are considered. The linguistic and didactic capabilities of chatbots are analyzed. The variants of AI-based tasks for the organization of the educational process are presented. In the course of their research, the authors conclude that the use of AI can facilitate the preparation of a foreign language teacher for classes and checking homework, reducing the time to complete routine tasks. Students can use AI tools to practice different language aspects. However, a complete replacement of the AI teacher is not possible, since AI lacks the ability to navigate in the context of learning, empathize with students, motivate them to personal development and encourage critical thinking. Work in the field of AI application in foreign language teaching, in addition to the creation of new AI tools, should be carried out in relation to the development of systems of appropriate tasks, as well as algorithms for interaction between teachers and students with AI.

Keywords: artificial intelligence, higher education, foreign languages, chat GPT, personolized learning.

Introduction:

The advent of artificial intelligence (AI) has ushered in a new era in various sectors, including education. Particularly in the domain of language education at the university level, AI presents a revolutionary potential. The integration of AI in teaching English is not merely a technological advancement; it is a paradigm shift that redefines traditional pedagogical methodologies. This paper aims to explore the multifaceted implications and applications of AI in the context of English language teaching at universities. It delves into how AI can personalize learning experiences, enhance interactivity, automate assessment processes, and provide valuable insights into student learning patterns. The discussion extends to the role of AI in facilitating access to global resources, supporting non-native instructors, and contributing to linguistic research and development. By examining these aspects, the paper seeks to elucidate the transformative impact of AI on English language education, highlighting its potential to make learning more effective, efficient, and aligned with the dynamic requirements of the contemporary educational landscape.

According to the analytical note of the UNESCO Institute for Information Technologies in Education, AI will play a key role in implementing the idea of personalized learning, namely, adapting the content of learning and the pace of the educational process to the specific needs of each student. [1]

Defining weak forms:

In the context of the use of artificial intelligence (AI) for teaching English at universities, it is necessary to take into account a number of limitations and potential disadvantages that can have a significant impact on the effectiveness and efficiency of the educational process. These factors require careful analysis and consideration when developing and implementing AI technologies in the academic environment.

1. **Limited understanding of context and language nuances:** Artificial intelligence, despite its advanced analytical capabilities, still has difficulty understanding context, idioms, slang and subtle nuances of language, which is a critical aspect in language learning. This can lead to incomplete or distorted perception of language features by students.
2. **Lack of empathy and deep feedback:** The human element in learning plays a key role, especially in providing individualized feedback and support. AI is not able to fully reproduce empathy and a deep understanding of the individual needs of students, which limits its effectiveness in some aspects of pedagogy.
3. **Dependence on data quality:** AI depends on the volume and quality of input data for learning and functioning. Errors in the data or their bias can lead to erroneous conclusions and incorrect training recommendations, which is especially critical in the educational field.
4. **Technical and financial constraints:** The introduction of AI into the educational process requires significant initial and operational investments, which can be problematic for educational institutions with limited resources. This also includes the need to maintain and maintain the appropriate technical infrastructure.
5. **Privacy and Data Security:** The use of AI in education raises questions about the protection and confidentiality of students' personal data. Data leakage or misuse can have serious consequences for privacy and trust in the educational environment.
6. **The risk of unifying the educational process:** There is a danger that standardized AI solutions

will lead to uniformity in learning, limiting opportunities for individualization and adaptation of curricula to the specific needs and interests of students.

Despite the presence of a number of disadvantages, AI should be perceived in the learning system as an innovative technology. However, as with the use of any technical innovations, it should be remembered that the purpose of "smart machines" is to help people, and not to nullify human, pedagogical communication, to destroy such a carefully constructed environment of personal maturation and upbringing, which is created at universities. As noted by a well-known researcher in the field of pedagogy A. Schleicher, innovation in education is not just a matter of introducing new technologies into the learning process, it is about changing approaches to learning so that students acquire the competencies and skills they need to develop in a competitive global economy. [2, p. 23–25]

According to research data from large corporations such as Intellias, Alphary, working on the development and implementation of AI, artificial intelligence algorithms have great potential for the development of e-learning in all spheres of life. International corporations are already using foreign languages to teach their employees. In large universities with modern material and technical facilities, for example, in leading technical universities or in programs focused on training transport engineers, students can also use AI to learn foreign languages at any time and anywhere. After some time, traditional schools, colleges and universities will be able to include language learning using artificial intelligence in their programs in order to diversify and expand the opportunities of students. [3]

The use of artificial intelligence in teaching English at the university level represents a significant breakthrough, opening up new opportunities to improve the efficiency and quality of the educational process. The key positive aspects of using AI in this field are listed below, based on current research and teaching practices.

Personalization of learning. AI allows you to adapt the learning process to the individual needs and level of language proficiency of each student. This is achieved through the analysis of training data and the provision of personalized assignments and recommendations, which contributes to more effective and focused learning.

Real-time feedback. AI can provide instant feedback on various aspects of a language, including pronunciation, grammar, and vocabulary. This allows students to quickly correct their mistakes and improve their language skills.

Expanding educational resources. AI provides access to a wide range of educational materials and resources, which makes learning more diverse and intense. The use of multimedia and interactive tools improves the understanding and memorization of the material.

Effectiveness in teaching pronunciation and speech comprehension. Modern AI technologies, including speech recognition and synthesis, contribute to the development of pronunciation and listening skills, allowing students to practice in conditions as close to real as possible.

An example of using AI is the development of a virtual assistant that helps students hone their pronunciation skills. Such systems use advanced speech recognition and analysis algorithms to provide feedback and pronunciation correction in real time. Students can interactively participate in exercises such as reading texts, dialogues and simulating real conversational situations, while receiving an instant assessment of their pronunciation, stress and intonation. This allows them to quickly improve their skills and increase their level of language competence.

There are also AI tools that were not created for teaching a foreign language, but can be used for this purpose. Such tools include the GPT chat. Since one of the important features of GPT chat is its ability for context-sensitive understanding and text generation, the platform takes into account previous messages and responds taking into account the context, creating natural and appropriate communication situations. This feature of GPT chat allows teachers and students to interact with a "virtual interlocutor": to conduct dialogues, discuss various topics, ask and answer questions.

With GPT chat, students can gain additional practice and support outside the classroom, improve their reading, writing and speaking skills, expand their vocabulary, and improve their communication style. In the audience, the key organizer of the educational process, as P.V. Sysoev P.V. and E.M. Filatov rightly point out, should still be a teacher, acting as an "assistant and expert in the field of a foreign language, helping and creating conditions for learning, education and development".[4]

E.V. Ivakhnenko and V.S. Nikolsky, who investigated the use of GPT chat in education, are convinced that neural networks will become an integral part of education at all levels, just as computer computing functions once firmly entered our lives. The authors note that text generation, analysis and evaluation systems successfully work as catalysts for search solutions, "integrators and optimizers" of mental operations, and help in solving complex cognitive and innovative tasks. GPT chat facilitates faster entry into a new field of knowledge – a dialogue with him allows you to identify relevant issues and formulate hypotheses. [5]

Transitioning to a discussion on AI technologies in foreign language learning, it's pertinent to examine specific programs tailored for this purpose, such as Duolingo and Babbel.

Duolingo, with its AI tool BirdBrain, offers personalized learning paths in over 30 languages by analyzing user profiles and predicting learning trajectories. It identifies challenging tasks for learners and tailors future lessons based on past mistakes. The "Explain My Answer" feature allows interaction with the Duo bot, which provides feedback and examples for better comprehension. Duolingo's Roleplay feature enables learners to gain points through real-life scenario practice with virtual characters.

Conversely, Babbel, as an interactive online course, utilizes AI for speech recognition and pronunciation correction, comparing student's spoken words against native language samples from its database.

Example of a task for students of the Faculty of Foreign Languages using ChatGPT:

Topic: Interactive communication with artificial intelligence in a foreign language

Objective: To practice a foreign language through dialogue with artificial intelligence (ChatGPT) to improve communication skills, expand vocabulary and improve grammatical skills.

Task: Preparation of questions: Students should prepare a list of 10 questions in a foreign language related to culture, history, literature or current events of the country of the language being studied.

Conducting a dialogue with ChatGPT: Using prepared questions, students conduct a dialogue with ChatGPT. They should ask questions, analyze the answers, and continue the dialogue by asking clarifying or additional questions.

Analysis and reflection: After the dialogue, students analyze the information received and their feelings from communicating with AI. They should note what new words or expressions they have learned and evaluate their ability to keep up a conversation.

Assignment Report: Students prepare a short report in which they describe their experiences, mention new words and expressions that they have learned, and share their thoughts on the possibilities of using AI in learning a foreign language.

Expected results: Development of communication skills in a foreign language, expansion of vocabulary, understanding of cultural and historical aspects of the country of the language being studied, and increased confidence in the use of a foreign language in dialogue.

The prospect of AI in universities

The scientific literature pays considerable attention to the prospects of using artificial intelligence in teaching English in university courses. It is expected that the future of AI in this field will be characterized by increased personalization of learning, in which machine learning algorithms will be able to adapt educational material to the individual needs and preferences of students. This approach can provide a significant increase in learning efficiency, allowing students with different language skills and educational backgrounds to achieve better results. In addition, the development of AI promotes innovations in teaching methods, including the use of virtual and augmented reality to create immersive language environments, which can significantly improve students' language understanding and cultural knowledge.

On the other hand, the future of AI in language learning also involves overcoming a number of ethical and technical challenges. In particular, data privacy and security issues are becoming increasingly relevant, as the use of AI requires processing large amounts of personal information of students. It is also necessary to take into account the potential increase in social inequality, since access to advanced technologies may be limited in some regions and institutions. Therefore, the development and implementation of AI in educational programs requires an integrated approach that includes not only technological innovations, but also consideration of ethical, social and cultural aspects, which is the subject of active research in the modern educational field.

Conclusion

Thus, AI is already used in the practice of teaching foreign languages in universities, so it is impossible to ignore its presence. Therefore, it is necessary to start a scientific discussion about its future role in teaching and learning in higher education institutions and what choice universities will make regarding AI. In fact, now is the time for universities to rethink their functions and teaching systems, as well as their future relationships with AI technologies and their owners. In addition, higher education institutions should be aware of the full range of opportunities and challenges that are being actualized by AI. These new opportunities will facilitate lifelong learning within a strengthened model that can preserve the integrity of the core values and goals of higher education. It is very important to conduct further research to identify new roles of teachers in the educational process, as well as new ways of teaching students of higher education institutions with a new set of graduate competencies, with an emphasis on imagination, creativity and innovation, which can hardly ever be reproduced by machines.

It is obvious that fundamental research is needed to develop effective methods of interaction and cooperation between humans and AI. Despite its rapid development, the idea that we can rely only on technology to improve the quality of education is a dangerous path. In our opinion, it is necessary to fully support the right of a person - a teacher and a student - to freely criticize emerging educational issues, make non-standard decisions, human communication and pedagogical support in the process of personal formation and maturation. At the same time, it is necessary to promote the initiative and creativity of each member of the academic community, which will benefit not only individuals, but also all persons involved in the educational process.

References:

1. Duggan S. Artificial intelligence in education: changing the pace of learning. Analytical note by UNESCO IITE. Moscow: UNESCO Institute for Information Technologies in Education, 2020. 44 p

2. Schleicher A. Schools for 21st-Century Learners: Strong Leaders, Confident Teachers, Innovative Approaches. OECD Publishing, 2015. 80 p. http://dx.doi.org/10.1787/9789264231191-en**.**

3. Savchenko I.V., Bessarabova O.N., Shefieva E.Sh. Features of engineering personnel training for the railway industry in English-speaking countries [Electronic resource] // The online journal "Science Studies". 2015. Vol. 7, No. 3 (28). URL: https://naukovedenie.ru/PDF/181PVN315.pdf (date of application: 10/20/2020).

4. Sysoev P.V., Filatov E.M. Chatbots in foreign language teaching: advantages and controversial issues // Bulletin of the Tambov University. Series: Humanities. 2023. No. 1. pp. 66-72.

5. Ivakhnenko E.N., Nikolsky V.S. ChatGPT in higher education and science: a threat or a valuable resource? // Higher education in Russia. 2023. No. 4. pp. 9-22.

PHILOSOPHICAL SCIENCES

ADVANTAGES OF DIGITAL TECHNOLOGIES IN THE LIBERATED TERRITORIES OF AZERBAIJAN IN THE ERA OF ARTIFICIAL INTELLIGENCE (PHILOSOPHICAL ANALYSIS)

Agakishieva T.
PhD in Philosophy, Associate Professor
Institute of Philosophy and Sociology of ANAS

ПРЕИМУЩЕСТВА ЦИФРОВЫХ ТЕХНОЛОГИЙ НА ОСВОБОЖДЕННЫХ ТЕРРИТОРИЯХ АЗЕРБАЙДЖАНА В ЭПОХУ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА (ФИЛОСОФСКИЙ АНАЛИЗ)

Агакишиева Т.С.
Доцент, Доктор философии по философии
Институт Философии и Социологии НАНА
https://doi.org/10.5281/zenodo.10451381

«Будущее уже наступило – просто оно
неравномерно распределена
Уильям Гибсон.

Abstract

The author attempts to meaningfully consider the features of the representatives of the “digital generation”. The innovative educational environment is described as well as the prospects for developing digital technologies are characterized. At the same time, high attention in this research paper was paid to the importance of the digital generation’s role in the reconstruction of Karabakh.

Аннотация

Автор предпринимает попытку содержательно рассмотреть особенности представителей «цифрового поколения. Описывается инновационная образовательная среда, охарактеризована перспектива развития цифровых технологий. В то же время большое внимание в данной исследовательской работе было уделено важности роли цифрового поколения в восстановлении Карабаха.

Keywords: Azerbaijan, digital generation, digital immigrants, digitalization, digital technologies, information technologies.

Ключевые слова: Азербайджан, цифровое поколение, цифровые иммигранты, цифровизация, цифровые технологии, информационные технологии.

Актуальность обращения к данной теме объясняется тем, что за последние 250 лет произошло четыре промышленных революций. Все началось с появления парового двигателя и железных дорог. В конце 19 века распространилось электричество и стал больше использоваться конвейер. Во второй половине 20 века важнейшими факторами жизни и профессиональной деятельности человека стали компьютер, разнообразные средства мобильной связи, Интернет и социальные сети. А сегодня, мы живем в эпоху четвертой промышленной революции, где с **большой скоростью происходят радикальные изменения в мире технологий.** Цифровые технологии активно меняют нашу жизнь и способности. По сути идет создание дополненной реальности с возможностью взаимодействия с физическим миром. Цифровые технологии(**ЦТ**) играют одну из важнейших ролей в жизни общества, так как в эпоху развития цифровой среды, рождается новое поколение, феномен которого во всем мире изучается философами, футурологами, социологами и др. Эквивалентными понятиями нового поколения могут быть цифровое поколение(англ.*dicital generation*), Гугл-поколение (англ. *Google-genaration*), сетевое поколение (англ. *network generation*), поколение цифровых аборигенов (англ. *generation gicital native*), поколение Z (англ.*genaration Z*), поколение Y(англ.*genaration Y*), умные толпы(англ. *smart crowds*), омега(англ. *omega*) и т.д. Все эти словосочетания используются сегодня для обозначения молодежи, прошедших социализацию в условиях широкого распространения цифровых технологий в сфере повседневной жизни и профессиональной деятельности. Нормой сегодняшней эпохи считается то, что в информационном обществе практически вся жизнь цифровизирована, в том числе в таких сферах жизни, как наука, образование, искусство, экономика и пр. В наши дни радикально изменился окружающий мир под воздействием широко распространенных «цифровых технологий», которые стали необходимыми и важными средствами общения, без которых невозможно функционирование общества, так как передовые технологии – наилучшая альтернатива из всех открывающихся сегодня перед человечеством. Сегодня остается все меньше людей, которые незнакомы с веб-услугами, сервисами, смартфонами, электронной почтой, информационными ресурсами и т.д. Информатизация и цифровизация жизни спо-

собствуют формированию образовательных платформ, открывающих легкий доступ к многочисленным интернет-ресурсам.

В работах многих зарубежных исследователей многообразно рассматривалось понятие «цифровое поколение». Термин "цифровое поколение" впервые ввел в обиход Марк Пренски для обозначения представителей поколения, появившихся на свет в период с 1984 по 2000г. «Американский писатель Марк Пренски в 2001 г. опубликовал статью «Digital Natives, Digital Immigrants»» в которой выделил два вида пользователей: цифровых иммигрантов и цифровое поколение.

“Цифровое поколение – это те, кто вырос в мире компьютеров, мобильных телефонов, видеокамер и видеоигр. Они ежедневно ищут что-то в Интернете, отправляют электронные письма и SMS. Они получают информацию быстро, лучше работают с графикой, чем с текстом, а гипертекст для них привычнее, чем обычный текст. Они стремятся к решению множества задач одновременно, нуждаются в частых поощрениях, предпочитают «увлекательные игры» серьезной работе, лучше справляются с совместными проектами, чем с индивидуальными заданиями

Цифровые иммигранты – это старшее поколение, те, кто чувствует себя в цифровом мире неуютно и порой даже неуверенно. Они не могут выполнить простейшее для *digital natives* действие, например прочитать электронное письмо с экрана компьютера или внести исправления в электронный документ. Они предпочитают учиться медленно, поэтапно, индивидуально и серьезно, для достижения результатов предпочитают осваивать специальные знания”[5.стр.14]. Что же необходимо сделать цифровым иммигрантам? По мнению американского философа Э. Тоффлера, «безграмотными в XXI веке будут не те, кто не умеет читать и писать, а те, кто не умеет учиться, разучиваться и переучиваться». «Поэтому, если преподаватели цифровых иммигрантов действительно хотят дойти до уровня цифровых носителей, то есть всех своих учеников, им придется измениться. Им давно пора перестать ворчать, и, как гласит девиз Nike поколения Цифровых носителей: «Просто сделай это!» В долгосрочной перспективе они добьются успеха – и их успех придет гораздо быстрее, если их поддержат руководители»[7.web]. Автор исследования считает, что овладеть знаниями, научиться их применять в жизни, стать образованным человеком в той или иной форме - задача каждого из нас. Конечно, **ЦИ**(цифровые иммигранты) должны стараться приобретать новые навыки, чтобы интегрироваться в новую жизненную цифровую реальность. Но, идея о том, что ЦИ не все знают о цифровом мире, не обладают необходимым для обучения онлайн уровнем компьютерной грамотности также неверна. Во-первых, многие из них на самом деле весьма продвинуты. Во-вторых, большинство из которых быстро овладевает необходимыми навыками при наличии подробных инструкций. Это одна сторона медали, но есть и некоторые необдуманные нюансы. Всем известно, что ЦТ помогают нам экспериментировать и открывать новые горизонты совершенствования во всех отраслях. Однако, некоторые старшие поколения ставят барьер детям, молодым поколениям в обладании навыков цифровизации. Детям запрещают пользоваться компьютерами гаджетами и заставляют жить нормальной детской жизнью и играть в нормальные игры, а технику можно использовать только в некоторых случаях. Проблема в том, что родитель навязывает собственное представление ребенку т.е. подрастающему поколению, родившемуся уже в новом поколении и нуждающемуся в других навыках самовыживания. Подрастающее поколение — это и есть люди будущего, не умеющий общаться и соперничать с ровесниками используя передовые технологии, рискует столкнуться с неблагоприятными последствиями. Компьютер, телефон, планшет — реалии жизни, и отказаться от них нельзя, иначе повзрослевший ребенок будет сильно отставать от сверстников, его навыки будут значительно ниже, он просто отстанет от времени. Естественно при некоторых случаях здравый баланс нужен, но избегать технологических изменений – не та методика, которая подходит поколению, устремлённому вперед, во всем мире доверху переполненной передовой техникой. Это поколение очень хорошо адаптируется и безусловно их жизнь, и решения полностью зависят от их технологической среды. Они не выросли среди видиокассет, кассетных проигрывателей, лампового черно – белого телевидения, радио и т.д. Поэтому отличаются даже их лексикон и язык. Самостоятельно решают, как составить CV для поступления ВУЗ за границей, стать обладателем грин карты, какой купить телефон, одежду, видеоигру и т.д. Однако оно однозначно говорит о поколенческом усовершенствовании в мире прогрессивных технологий, а также в сфере принятия автономных решений, что важно для будущей личной жизни. Например, во многих развитых странах можно потерпеть “фиаско” в поиске работы по специальности, если не используете возможностей аккаунта на LinkedIn или в социальной сети. В их мире изменения непрерывны, а их ускорение – признак движения к лучшему. “Сегодня у детей нет права выбора остаться на стороне от технологий. Так – как, дети с младенческого возраста погружены в этот цифровой мир”[3.стр.239].Через многие годы, а может через несколько лет технологии станут так миниатюрны, всесильны и интегрированы, что мы перестанем видеть в них совокупность устройств, мыши и клавиатуры, как сейчас. Технологии будут внутри нас, на нас, в нашей одежде, в наших домах, машинах, одним словом везде, в каждом своем проявлении они будут в миллионы раз мощнее, чем мощнейшие из сегодняшних компьютеров. Следует отметить, что представители цифрового поколения(**ЦП**) демонстрируют цифровую грамотность, когда способны не только дать оценку своим технологическим навыкам, но и анализируют по поводу того, как они используют эти навыки для решения различных коммуникативных, исследовательских,

творческих задач. Новые коммуникативные технологии оказывают влияние на процессы социализации, формирования систем социального взаимодействия, на способы восприятия и обработки поступающей информации, затрагивая при этом и интеллектуальную, и эмоциональную сторону личности. “В сегодняшнем образовании – и во всем мире – развитие технологий позволяет нам создать новый симбиоз человека и машины, который улучшает практически все, что мы делаем. Нам всем необходимо присоединиться к поиску цифровой мудрости в нашей практике, также как в нашей жизни”[8. web].

“Современный философ М.А. Маниковская рассматривает цифровизацию как «одну из проверок на онтологическую укорененность морали и этики в обществе» и указывает на «увеличение дистанции между очевидностью (цифровая реальность) и адекватным умозрением» [4.с.36]. На основании многочисленных исследований американский социолог Г. О. Рейнгольд утверждает, что “Через десять лет, наблюдений и интервью, основные места средоточия населения Земли будут наводнены микросхемами, способными общаться друг с другом. Люди, оснащенные такими устройствами, составят «умные толпы», и их общение обретет невиданные прежде формы и возможности” [2.с.206]. С этой позиции важно подчеркнуть, что каждая страна находится на своем пути цифрового развития, пытаясь адаптироваться и стремиться соответствовать современным требованиям. Порой кажется, что современный человек чрезмерно зависит от технологий. Насколько важна цифровизация, можно сказать, что все впервые осознали во время пандемии COVID-19, когда внезапно никто больше не мог перемещаться с одного места в другое ускорила использование цифровых платформ первым долгом в сфере образования. Во время пандемии перевод сотрудников на удаленную работу с использованием ИКТ приобрел беспрецедентный масштаб и стимулировал изменение потребительского поведения, а длительность пандемии запустила долгосрочный процесс внедрения новых видов ИКТ-товаров и услуг. ЦТ помогли преодолеть сложности, связанные с пандемией. Интернет позволил людям не просто пережить карантин, но и продолжить вести вполне привычную жизнь — плодотворно работать, жить, общаться и даже ходить на онлайн-концерты, не отдаляясь из социума. “Карантин как одна из форм борьбы с пандемией показал и другую, скажем так, многоканальную связь этики, культуры, права и искусственного интеллекта”[6.стр.7]. Не только в других странах, но и в Азербайджане во время пандемии ЦТ использовались также для контроля распространения коронавируса, для выявления больных, нарушивших изоляционный режим и т.д. Пандемия уже ускорила цифровизацию многих отраслей, создав самое важное, что необходимо для принятия людьми новых технологий. Людям стало очевидно главное: плюсов от внедрения цифровых платформ намного больше, чем минусов. Будущий мир интересен и перспективен, а технологический прогресс – творец огромной массы новых специальностей. Автор статьи своих предположениях и выводах настроена позитивно и оптимистично: соображая опасности, которые потенциально несут в себе передовые технологии, искусственный интеллект, интернет вещей, пересечение цифровой экономики и всего остального аналогового мира, акцентирует плюсы развития. Такие глобальные сдвиги часто открывают богатейшие возможности для общества. Они приводят к трансформации социального устройства. Совершенно очевидно, что возврат к прошлому невозможен. Но удивительно одно, так это упорное нежелание большинства людей признавать происходящие технологические изменения и новые тенденции. Но ведь не сложно осознать, что реальный мир не стоит на месте. Чем больше высокотехнологичных новинок, тем выше наш изобретательский потенциал – и тем скорее появляются еще более продвинутые технологии. “Да, это правда, что люди непрерывно адаптируются к технологическим новшествам. Но правда и то, что в ближайшие два - три десятилетия на человечество обрушится больше изменений, чем за последнюю тысячу лет. Мы познакомимся с машинным интеллектом, как минимум не уступающим человеческому. Мы пересядем на самоуправляемые автомобили и увидим, как первые люди высадятся на Марс. А самое главное, наконец – то будет создана технология, обеспечивающая устойчивое поддержание человеческой жизни в условиях энергетического изобилия и свободы творчества”[1. стр 13]. Важно констатировать, что Азербайджан обладает достаточным потенциалом для того, чтобы стать передовым IT-государством с перспективой постепенного выхода на страны Европы. Азербайджан в этом плане уже сделал существенные шаги на пути к построению цифрового общества: обучение цифровым навыкам в школах, переход к электронному правительству, создание и модернизация необходимой IT-инфраструктуры и т.д. Министр образования Эмин Амруллаев в одном из своих интервью рассказал об основных задачах цифровизации в системе образования. “Большинство классических предметов в современной системе образования утратили свою актуальность, на первый план вышли предметы, требующие цифровых знаний и навыков, а информатика в свою очередь будет включена во вступительные экзамены”[9.web]. В силу того, что цифровые секторы являются самыми быстроразвивающимися, нынешняя национальная стратегия Азербайджана "Стратегии социально-экономического развития Азербайджанской Республики на 2022-2026 годы", утвержденная Президентом Ильхамом Алиевым, более всего фокусируется на цифровых технологиях. С этой позиции Азербайджан создает умные города/деревни на освобожденных от армянской оккупации исконных землях. Следует признать, что перед Азербайджаном, после великой победы в Отечественной войне сегодня стоит важнейшая задача восстановления Карабаха. Президент Ильхам Алиев в одном из своих выступлений отметил, что освобожденные земли должны восстанавливаться с использованием концепции «умный

город и умное село». Освобожденные земли должны быть районами высокотехнологичного развития. Для всего этого в первую очередь нужно подготовить необходимую почву, то есть первичную цифровую инфраструктуру, создать базу, которая позволит развивать освобожденные земли именно в направлении высоких технологий. Удачное географическое расположение страны и природные ресурсы, человеческий потенциал, а также принятые за последние годы Господином Президентом Ильхамом Алиевым государственные программы, указы и распоряжения, создают для этого все возможности. В интервью корреспонденту «Бакинский рабочий», директор ИФС профессор Ильхам Мамедзаде отметил, что «Умная деревня» - это, бесспорно, продукт искусственного интеллекта, означающего цифровую и автоматизированную деятельность, адекватную деятельности человека. Любая страна, где развивается научно-технический прогресс, движется вперед. Научно-технические достижения стали частью нашей жизни, и это стало называться информационным обществом, когда границы между людьми, роботами и технологиями сокращены до минимума. Именно поэтому нам необходимо развивать и анализировать общество с помощью искусственного интеллекта"[6.стр.7].

"Умные города способны предложить людям альтернативную, лучшую и более безопасную реальность, а значит, они нужны – и срочно – не только для более полной физической и интеллектуальной самореализации человека, но и для поддержания жизнеспособности нашей планеты"[1.стр 445]. Концепция умный город/село основана на использовании современных информационных технологий и коммуникаций для всестороннего повышения уровней охраны здоровья, безопасности, образованности и занятости населения, создания дополнительных возможностей для отдыха и устойчивого укрепления благополучия горожан. Одним словом, умный город/село упрощает управление внутренними городскими процессами и делает жизнь жителей комфортнее и безопаснее. Автор работы, аргументируя свою точку зрения по данной проблематике, считает, что для использования концепции умный город, умное село в восстановлении Карабаха, на самом деле первым долгом нужны умные люди, а это молодое цифровое поколение. Так как современная молодежь уже полностью преобразовала свой уклад мыслей под влиянием цифровых трендов. Другими словами, цифровая молодежь, цифровое поколение — это носитель огромного интеллектуального потенциала, они очень хорошо адаптируются, очень быстро думают и совершенно не склонны сопротивляться технологическим изменениям. Конечно, для возвращения вынужденных переселенцев на освобожденные территории, в первую очередь нужно создать коммунальную и дорожную инфраструктуру, рабочие места. Для решения этой задачи региону в первую очередь нужен именно такого склада контингент молодежи, которая обладает вышеуказанными навыками, знаниями, которая поможет его продуктивному восстановлению и которая будет жить, работать в Карабахе и трудиться во его благо. Это поколение сильно отличается от предыдущих, прежде всего информационной насыщенностью, возможностью получить любую информацию и иметь собственную точку зрения. Безусловно, сегодня молодое поколение проявляют интерес к работе в новых сферах, формируемых именно под влиянием новых технологий и задумываются о самореализации в секторах с широкими цифровыми возможностями. Интернет и широкий спектр возможностей цифровой связи, доступных через Интернет, являются одними из основных потребностей сегодняшней «цифровой молодежи», которая привыкла «жить» в сети. Именно эти высокие цифровые технологии сыграют важную роль в развитии Карабаха. Для **ЦП** цифровой образ жизни является естественным, так как положительным характеристикам цифровых поколений относятся: в плане когнитивного развития – постоянное стремление к новизне и самосовершенствованию, креативность, способность к синтезу различных типов мышления, нелинейность, способность к параллельной обработке разных потоков информации (многозадачность), склонность к использованию разных источников информации, высокая скорость переработки информации и принятия решений; особых способностей к творчеству, как например восприятие, усиленные образность мышления, воображение, стремление к фантазии, раскованность, острая память, также выразитель новых и новейших знаний, которые она несет на производство и в другие сферы общественной жизни и т. д. В плане социального развития – стремление к самовыражению, предпочтение «горизонтального» (партнёрского) типа отношений «вертикальному» (иерархическому), открытость к межкультурному общению. Фактические условия и потребности таковы, что освобожденные земли просто необходимо подготовить с точки зрения цифровой индустрии для того, чтобы в будущем строить там аграрную или туристическую зону с применением современных реалий сегодняшнего дня. И это неоспоримо, что в отличие от взрослого поколения цифровая молодежь быстро «схватывает» и осваивает инновационные технологии в различных сферах деятельности (материального и духовного преобразования мира), поведения (приспособления к окружающей среде) и общения (субъектно-субъектных коммуникаций). И поэтому, все эти сферы не могут развиваться без молодежи, а молодежь не будет принимать в этом участия без наличия в регионе современных технологий. С этой позиции, отсутствие в Карабахе молодого населения может сделать его уязвимым и с точки зрения самообороны. "Но если мы не будем применять высокие технологии в развитии региона в условиях интенсивной цифровизации, если не привлечем к этому развитию «цифровую» молодежь, то мы можем столкнуться с задержками в развитии Карабаха. Это означает, что в первую очередь необходимо призадуматься о цифровом развитии региона, о применении в Карабахе передовых цифровых технологий, наличии широкополосного

интернета, чтобы в дальнейшем развивать все остальные сферы экономики уже с применением новейших технологий и цифровизированной экономики" [10.web]. С этой точки зрения, именно представители молодого поколения выполнили главную миссию Отечественной войны, завоевав Великую Победу под руководством победоносного Верховного Главнокомандующего Ильхама Алиева, проявили невиданный героизм, отвагу, любовь к Родине, государству, флагу. Вместе с тем, история учит нас, что любая битва между прошлым и будущим неизбежно завершается победным маршем новых технологий, так - как, передовые технологии всегда меняют жизнь к лучшему. Искусственный интеллект со всеми своими плюсами и минусами, есть будущее человечества. Согласно высказываниям исследователя искусственного интеллекта Даниэля Кревье, исследователи искусственного интеллекта, подобно алхимикам древности, жаждавшим превратить в золото обычный металл, стремятся создать мыслящую машину из бесконечно малых кусочков оксида кремния.

Список литературы:

1. Бретт Кинг - «Эпоха дополненной реальности» (2016)//Бретт Кинг, А.Лайтман, Дж. П. Рангасвами, Э.Ларк [пер.с англ.] // Москва, "Олимп – Бизнес", 2020, 528 стр.

2. Говард Рейнгольд - «Умная толпа: новая социальная революция»// Говард Рейнгольд — Пер. с англ. А. Гарькавого — М.: ФАИР ПРЕСС, 2006, 416с.

3. Qudvin, Kristi - «Rəqəmsal dünyada uşaq böyütmək»// K. Qudvin ; ing. dil. tərc.ed. N. Rəhimova - Bakı : TEAS PRESS Nəşriyyat evi, 2021, 264 s.

4. Маниковская М.А. - «Цифровизация образования: этический аспект» // «Проблемы высшего образования», 2019, №1. с. 35–38.

5. Пошехонова В. А. - «Образовательная гуманитарная технология цифрового поколения» // Журнал «Педагогическое образование в России»? 2018, №5. с. 13 – 20

6. Увидеть общество в его реалиях – /В объективе философского анализа// «Бакинский рабочий» 30. 03.2023, №53 (29438), 1-8 стр.

7. Marc Prensky - «Digital Natives, Digital Immigrants» //By Marc Prensky, From On the Horizon (MCB University Press, Vol. 9 No. 5, October 2001)/ https://www.marcprensky.com/writing/Prensky%20%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part1.pdf

8. Marc Prensky - «What ISN'T Technology Good At?Empathy, for one thing!» // By Marc Prensky Published in Educational Technology Sept-Oct 2012[939 words] /http://marcprensky.com/writing/Prensky-What_Isn't_Technology_Good_At-EDTECH-Sept-Oct-1012.pdf

9. Цифровая экономика: Современные вызовы и реальные возможности - https://edu.gov.az/ru/news-and-updates/18116-1

10. Роль «цифрового поколения» в восстановлении Карабаха- http://interfax.az/view/827667

PSYCHOLOGICAL SCIENCES

SPECIAL ASPECTS OF INCLUSIVE EDUCATION IN AZERBAIJAN

Quliyeva P.
Baku State University, Department of Social and pedagogical psychology,
Phd student;
Baku, Zahid Khalilov street, 1148.

ОСОБЕННОСТИ ИНКЛЮЗИВНОГО ОБРАЗОВАНИЯ В АЗЕРБАЙДЖАНЕ

Гулиева П.В.
Бакинский Государственный Университет, кафедра Социально-педагогической психологии,
Аспирант;
Баку, улица Захида Халилова, 1148
https://doi.org/10.5281/zenodo.10451390

Abstract

According to UNICEF, the number of Azerbaijani children with disabilities enrolled in primary or secondary level education programmes is quite low. Government data indicates that only 14,638 such children are enrolled either in home-based learning programmes (almost 9,355) or in special or residential schools (about 2,725) . For context, of the 72,000 children in Azerbaijan with registered disabilities, UNICEF estimates that approximately 54,000 are of primary and secondary school age. This means that a mere 20% of school-aged children with registered disabilities are actually receiving the education although none of them has an access to inclusive education as required by the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD). To enable all children – including those with disabilities – to access schooling within their own communities and be provided with the appropriate learning opportunities to achieve their full potential, the Government of Azerbaijan adopted the "State Programme on Development of Inclusive Education in Azerbaijan Republic for 2018-2024," which aims to put into practice the principles of both the UNCRPD and the UN Convention on the Rights of the Child (http://www.unicef.org/azerbaijan).

Аннотация

По данным ЮНИСЕФ, количество азербайджанских детей с ограниченными возможностями, обучающихся по программам начального или среднего образования, довольно невелико. Правительственные данные показывают, что только 14 638 таких детей обучаются либо по программам обучения на дому (почти 9 355), либо в специальных школах или школах-интернатах (около 2 725). Для сравнения: по оценкам ЮНИСЕФ, из 72 000 детей с зарегистрированной инвалидностью в Азербайджане около 54 000 относятся к возрасту начальной и средней школы. Это означает, что всего лишь 20% детей школьного возраста с зарегистрированной инвалидностью фактически получают образование, хотя ни один из них не имеет доступа к инклюзивному образованию, как того требует Конвенция ООН о правах инвалидов (UNCRPD - КПИООН). Чтобы дать возможность всем детям, в том числе детям с ограниченными возможностями, получить доступ к школьному образованию в своих общинах и получить соответствующие возможности обучения для полной реализации своего потенциала, правительство Азербайджана приняло «Государственную программу развития инклюзивного образования в Азербайджанской Республике на 2018 год». - 2024», целью которого является реализация на практике принципов UNCRPD и Конвенции ООН о правах ребенка.

Keywords: inclusive education, disabled children, state program of inclusive education.

Ключевые слова: инклюзивное образование, дети-инвалиды, государственная программа инклюзивного образования.

Относительно новая концепция Азербайджанской системы образования, инклюзивное образование (ИО), предполагает, что дети всех способностей учатся параллельно в классе. Предоставление таких возможностей детям с ограниченными возможностями и включение их в качественные образовательные программы окажут долгосрочное положительное влияние на национальный рост. Увеличивая перспективы трудоустройства и уменьшая зависимость образованных взрослых с ограниченными возможностями, улучшая социальные навыки детей и подростков с ограниченными возможностями и уменьшая дискриминацию в отношении людей с ограниченными возможностями, инклюзивное образование может привести к большей социальной сплоченности. Успешная реализация программ инклюзивного образования на национальном уровне потребует: соответствующих изменений в законодательстве и политике, касающихся определения ИО; чтобы все учащиеся могли обеспечить возможности инклюзивного обучения; образовательные учреждения должны быть

физически доступны и оснащены соответствующими технологиями, где это возможно, для облегчения доступа детей к существующей учебной программе; учителя обычных школ должны иметь возможность поддерживать доступное обучение; улучшен сбор данных для регистрации детей с ограниченными возможностями и других соответствующих мер. Еще одним важным компонентом успеха IE будет повышение осведомленности об этой теме среди родителей, учителей и общества в целом для рассмотрения мнений и предположений, которые могут уменьшить или помешать принятию права детей с ограниченными возможностями использовать возможности обучения в общеобразовательных учреждениях.

В ходе моего расследования были выявлены некоторые основные проблемы:

1)Предоставленный на экзамене материал никоим образом не адаптирован к потребностям детей с ограниченными возможностями.

2) Не оказывается помощь в решении экзаменационных заданий и ориентировании на экзаменационных площадках.

3)Здания, в которых проводятся обследования, не приспособлены для проживания людей с ограниченными возможностями. Например: в этих зданиях нет пандусов, лифтов, звуковых сигналов или визуальных указателей для людей с ограниченными возможностями ходьбы, а также с нарушениями слуха или зрения.

Хронология событий

Многие страны прошли период интеграции инклюзивного образования. Интеграция означает процесс перевода детей с особыми потребностями из специальных школ в обычные школы (Томас, 2005). Основная проблема заключается в том, что дети должны вписаться в классную среду и школьную среду и найти опытных сотрудников, которые обучат их процессу обучения в обычных школах.

Отношение азербайджанского общества к этим детям можно оценить как положительное; однако этот позитивизм не уходит слишком далеко от существующих ярлыков и стереотипов (ЮНИСЕФ, 2011). Согласно результатам исследования по данному вопросу, подавляющее большинство родителей и учителей выступают за обучение детей с ограниченными возможностями, а также за их обучение в инклюзивных классах (CIE,2009).

Соответствующий комитет ООН представил 10 апреля 2014 года 57 пунктов заключительных рекомендаций по первому докладу нашей страны в связи с вышеупомянутой Конвенцией. Комитет рекомендовал Азербайджану:

- ускорить создание базы данных,

- организовать сбор, анализ и распространение информации о поле, возрасте, инвалидности, округах,

- подготовить индикаторы по полу и возрасту с целью обоснования изменений, внесенных в законодательство и разработки политики в соответствующей сфере и обеспечения институционального развития, а также иметь возможность проводить мониторинг и отчетность о достигнутом прогрессе в применении различных положений Конвенции, принимая во внимание, что медицинский подход к инвалидности сменился подходом, основанным на правах человека.

Давайте обсудим хронологическое развитие этих программ:

2006- Организация Объединенных Наций разрабатывает Конвенцию о правах инвалидов;

2008 - Правительство Азербайджана ратифицирует КПИ ООН (UNCRPD) вместе со 161 другим государством, подписавшим КПИ;

2018-2024 - Правительство реализует «Государственную программу развития инклюзивного образования в Азербайджанской Республике на 2018-2024 годы»;

2018-2020 - ЮНИСЕФ в партнерстве с Министерством образования Азербайджана и Европейским Союзом реализует «Расширение инклюзивного качественного образования для детей с ограниченными возможностями в Азербайджане».

Эта Государственная программа (Министерства Образование, 2018) поставила перед собой следующие цели:

- Внести соответствующие изменения в законодательство в целях организации инклюзивного образования на всех уровнях образования.
- Принять соответствующие меры по адаптации образовательных учреждений и программ к потребностям детей с ограниченными возможностями.
- Подготовить и обучить педагогические кадры для организации инклюзивного образования;
- Подготовить базу данных людей с ограниченными возможностями;
- Пропагандировать важность вовлечения людей с ограниченными возможностями в образование и их социальную интеграцию;
- Создать соответствующие службы для интеграции людей с ограниченными возможностями в общество;
- Адаптировать городскую и региональную инфраструктуру и транспорт к потребностям людей с ограниченными возможностями.

Результаты показывают несколько ключевых проблем, которые необходимо решить для преодоления проблем в практике инклюзивного образования в Азербайджане:

1) Законодательство;
2) Последовательность и сплоченность;
3) Мониторинг и проверка;
4) Академическая база и обучение;
5) Адаптация контента;
6) Реструктуризация персонала;
7) Общество.

Первым тревожным недостатком в отношении детей-инвалидов является недостаточность законодательной базы. Как отмечается в отчете, в законе есть ряд положений об инклюзивном образовании, но отсутствие закона об инклюзивном образовании показывает, что у государства отсутствует комплексный подход к этому вопросу.

Одной из основных целей Программы развития на 2005-2009 годы было создание единой базы

данных о детях с ограниченными возможностями, но, к сожалению, не была достигнута. Мировая практика предусматривает раннее выявление проблем со здоровьем у детей с ограниченными возможностями и постоянный контакт с ними. Далее каждому ребенку предоставляется школьное образование в соответствии с его проблемой. Это позволяет детям лучше развивать свои навыки и знания.

В Азербайджане очень ограниченная работа ведется по дошкольному образованию детей с ограниченными возможностями, не говоря уже об инклюзивном образовании. Это предотвращает категоризацию детей с ограниченными возможностями государственными структурами на дальнейших этапах. Поскольку инклюзивное образование является новой концепцией для нашей страны, возникают различные недопонимания как со стороны государственных структур, так и со стороны общества. В некоторых случаях родители выступают против того, чтобы их дети учились вместе с детьми, получающими инклюзивное образование.

С другой стороны, родители детей, получающих инклюзивное образование, недовольны тем, что их дети учатся со здоровыми детьми, и отмечают, что их смущает недостаточность их детей. Причина всего этого – отсутствие просветительской работы со стороны государства в этом вопросе. Социальные видеоролики, новости и информация об инклюзивности очень редко появляются на телевидении, радио и в средствах массовой информации.

Поскольку в обществе отсутствует достаточная информация об инклюзивном образовании, процесс развития кадров существенно замедляется. В регионах мало дошкольных и школьных учреждений, достаточных для инклюзивного образования. Есть регионы, в которых их вообще нет. В таких обстоятельствах им приходится заниматься домашним обучением. Поскольку специального контроля за домашним обучением нет, качество его проведения находится под подозрением.

Если обобщить все это, в отчете подробно поясняется, что отношение государства к инклюзивному образованию непрозрачно, общество недостаточно информировано по этой теме, не подготовлено достаточное количество кадров и учебников, не разработаны такие важные аспекты, как законодательство и базы данных. еще сформировался.

Рекомендация:

Для организации инклюзивного образования в соответствии с национальным законодательством и международными стандартами необходимы следующие меры:

1. Должны быть созданы правовая база, определяющая социальную модель инвалидов, законодательство об инклюзивном образовании и подготовлен интенсивный план действий.

2. Создается единая база данных для выявления детей-инвалидов, обучающихся и остающихся без внимания, осуществляется контроль за их здоровьем, реабилитацией, развитием образования, если со временем выяснится, что программа неактуальна для ребенка, то должно быть вмешательство. .

3. На всей территории страны, в том числе в регионах, создаются инклюзивные дошкольные учреждения и школы для детей с ограниченными возможностями, в этих детских садах и школах для детей с ограниченными возможностями создаются специальные условия (построены пандусы, внесены соответствующие изменения в туалеты и спортивные залы). Информация об этих инклюзивных детских садах и школах должна быть открыта для общественности.

4. Для перевозки детей родителей, испытывающих финансовые затруднения, в инклюзивные школы выделяются транспортные средства.

5. Для предотвращения инвалидности у детей должны быть реализованы бесплатные программы раннего вмешательства.

6. Увеличить количество финансируемых государством центров, осуществляющих внеклассную работу для детей с ограниченными возможностями.

7. Для детей с ограниченными возможностями, получающих инклюзивное образование, определяются специальные программы, учебники и методы оценивания.

Список литературы:

1. Situation Assessment: People with disabilities in Azerbaijan (By Ms.Chantelle McCabe, International Consultant to Unicef Azerbaijan, 2011)

2. Access to education of persons with disabilities: real situation, international practice and recommendations (Center for Economic and Social Development (CESD), Baku, 2016)

3. Equal right, equal opportunity – İnclusive Education For Children with Disabilities (Handicap International)

4. Research on Education Services for Children with Disabilities in Azerbaijan (Center for Modern and Education and Support to Education)

5. Children with disabilities – Inclusive Education Project. Second Year Evaluation Report. 2006, Centre for Innovation in Education. Eyyub Hajiyev, MSK)

6. The Law of the Republic of Azerbaijan on Education (special education) of Persons with Disabilities (2001)

7. The Law of the Republic of Azerbaijan on Children's Rights (2012)

8. The decision of the Cabinet of Ministers on Approving of the List of Illnesses Allowing Homeschooling and the Rules on Conduct of Homeschooling (2002)

Internet resources:

http://www.e-qanun.az/framework/1528

http://www.e-qanun.az/framework/1733

SOCIAL SCIENCES

THE USE OF MACHINE LEARNING METHODS FOR THE FORMATION OF PROFESSIONAL COMPETENCIES OF FUTURE COMPUTER SCIENCE TEACHERS

Suleimenova L.,
Candidate of Technical Sciences, Head of the Department of Computer Science, O.Zhanibekov South Kazakhstan Pedagogical University, https://orcid.org/0000-0002-4579-1622
Adylbekova E.,
Candidate of Pedagogical Sciences, Acting Associate Professor, O.Zhanibekov South Kazakhstan Pedagogical University, https://orcid.org/0000-0003-1471-0137
Nakhimova V.
doctoral student, O.Zhanibekov South Kazakhstan Pedagogical University, https://orcid.org/0000-0002-4248-8943
https://doi.org/10.5281/zenodo.10451400

Abstract

The use of machine learning methods makes it possible to more quickly introduce relevant tools and concepts into teaching practice. Machine learning (ML) offers individualized teaching methods that allow teachers to adapt programs for each student, taking into account their specific needs and level of training. The transition to online education and hybrid formats requires new learning strategies. Machine learning can help to adapt programs to these changes, making learning more flexible and efficient. Pedagogical programs based on machine learning methods provide future teachers with relevant skills and knowledge in the educational field.

In general, the application of machine learning methods in education, especially in the training of future computer science teachers, is today an urgent and promising topic that can bring significant innovations to educational practices and training of specialists.

The results of the study clearly demonstrate that the use of machine learning methods in the process of professional training of computer science teachers has a significant positive impact on their competencies and educational practice.

Keywords: Machine learning, formation, competence, teaching methods, innovative methods.

Introduction. Currently, due to rapid technological development and digitalization, education has become an area that needs constant updating, adaptation and innovation.

The training of computer science teachers plays a key role in the formation of highly qualified personnel capable of effectively implementing new technologies and providing high-quality education.

The development of information technology is so fast that modern teaching methods for teachers may become outdated by the time students complete their education. Modern computer science teachers should have the skills to work with innovative technologies and the ability to analyze large amounts of data, as well as the use of machine learning can help in the formation of these professional competencies.

Machine learning methods allow you to create personalized educational trajectories for students. This is important, given the different levels of knowledge, learning styles and interests of students, which contributes to more effective learning of the material.

The use of machine learning algorithms in education helps to analyze learning data, understand successful teaching methods and identify areas where additional help is needed, which ultimately increases the effectiveness of educational programs and saves time and resources [1].

Machine learning technologies enable the development of online courses and platforms that facilitate more flexible access to education. This is especially important in the context of distance learning and in various geographical and social contexts.

In general, the use of machine learning methods to form the professional competencies of future computer science teachers is an important step towards a modern and effective training system in the field of education and information technology.

Materials, methods and discussions. Information technology is becoming an integral part of learning practices, and computer science teachers play an important role in developing the skills needed to successfully adapt to the digital age. Computer science teachers become not only teachers of programming knowledge, but also contribute to the formation of students' skills to work with information, solve problems, analyze data, analyze and interpret information from various sources.

Computer science teachers must constantly improve their knowledge and skills, follow the latest technological trends and adapt their teaching methods to a rapidly changing environment. In addition to programming skills, they also learn how to solve complex problems, analyze data, work in a team and make informed decisions, which is critically important in today's world.

The use of machine learning methods to form the competencies of future computer science teachers fits into this dynamic, providing innovative approaches to training in education, contributing to the creation of

more effective learning strategies and supporting the development of the educational environment as a whole [2].

Computer science teachers play an important role in this process, becoming the foundation for the development of digital literacy and technological skills for future generations.

The lack of effective methods for the formation of professional skills of computer science teachers is a problem affecting not only the quality of teacher training, but also the quality of education in general. Despite the importance and relevance of this field of knowledge, there are several key problems associated with the formation of computer science teachers' competencies: limited educational programs, insufficient practical training, the need for constant updating of knowledge, lack of resources and support, barriers to the introduction of new teaching methods, problems of assessment and evaluation.

Identification of these problems helps to understand the need to develop and implement effective methods for the formation of professional skills of computer science teachers to ensure quality education, adapt the educational environment to modern requirements and prepare students for the digital world [3].

In order to effectively adapt to modern educational requirements and ensure high-quality training of future computer science teachers in the field of pedagogy and information technology, it is necessary to apply innovative approaches in teaching such as the development of technology and education, integration of new technologies into learning, preparation for online learning, creation of an environment for independent learning, ensuring accessibility of education.

The use of innovative approaches in the education and training of future teachers, including computer science teachers, helps to create more flexible, effective and relevant training programs, promotes the development of diverse skills and readiness for a modern educational environment.

Traditional approaches to teaching computer science teachers encompass methods and strategies that have been applied over the years and are largely based on classical educational principles. Although traditional methods remain an important part of the education of computer science teachers, modern pedagogical paradigms raise the question of the need to integrate innovative approaches such as the use of new technologies, adaptive learning and active involvement of students in the learning process.

The integration of these methods into the educational process for future computer science teachers can enrich and diversify approaches to learning, contribute to improving the quality of education and prepare teachers for modern challenges in the field of information technology [4].

These approaches can be used in various combinations to enrich the educational process and develop the professional competencies of future computer science teachers.

As you know, there are a number of methods of teaching and competence formation for future computer science teachers, which are focused on the development of both professional skills and pedagogical skills. These methods are often combined in educational programs for future computer science teachers in order to create a comprehensive learning system that promotes the development of not only technical, but also pedagogical skills.

Evaluating the effectiveness of teaching methods and the formation of competencies for future computer science teachers is an important task. It allows you to determine how effectively students acquire knowledge, develop skills and are ready for future professional activities. However, evaluating the effectiveness of each method has its limitations. For a more complete assessment of the effectiveness of teaching methods for computer science teachers, it is necessary to use an integrated approach that includes both quantitative and qualitative assessment methods, takes into account the opinions of students and teachers, and evaluates the results both in the short and long term.

The use of machine learning methods for educating teachers and developing their competencies is an active area of research. The works of Chen, L., Wang, Q. consider the effectiveness of using machine learning methods for teacher training. Various approaches to integrating ML into teacher training processes are being explored, including personalized educational programs and adaptive technologies for the development of professional skills [5]. Williams, E., Brown, D. discuss the advantages, difficulties and opportunities for integrating ML into teacher training. Their work focuses on the challenges and prospects of teaching teachers new technologies using machine learning methods [6]. Wang, L., Johnson, K. describe practical cases of the use of artificial intelligence and machine learning methods for the training and development of teacher competencies. Examples of learning platforms and technologies that use ML to improve the professional training of teachers are considered [7]. Smith, A. provides an overview of innovative approaches to teacher training using machine learning methods. The tools, platforms and techniques that contribute to effective teacher training in modern conditions are highlighted [8].

These studies reflect various aspects and approaches to the application of machine learning methods in teacher training. They help to understand the effectiveness, advantages and challenges of implementing such methods in the professional education of teachers.

The introduction of machine learning into education opens up many prospects and opportunities for a modern learning system. Machine learning allows you to create personalized educational programs, taking into account the individual needs and level of knowledge of each student; it can analyze learning data, test results and even behavioral patterns of students, which helps to predict their academic performance, needs and possible difficulties; promotes the development of new educational technologies and platforms, allowing you to create more exciting, interactive and innovative teaching methods. Integrating ML into education helps students develop skills in working with data and technologies that are becoming increasingly in

demand in the modern world of work. However, the introduction of ML in education also has its challenges, such as the need for reliable data protection, providing ethics and security training in the use of technology, as well as educating educators to use new tools and technologies.

Machine learning is a subsection of artificial intelligence that studies the development of algorithms and models that allow computers to extract knowledge from data and make decisions based on this data, without explicit programming. An overview of the basics of machine learning and its role in modern education is shown in Figure 1.

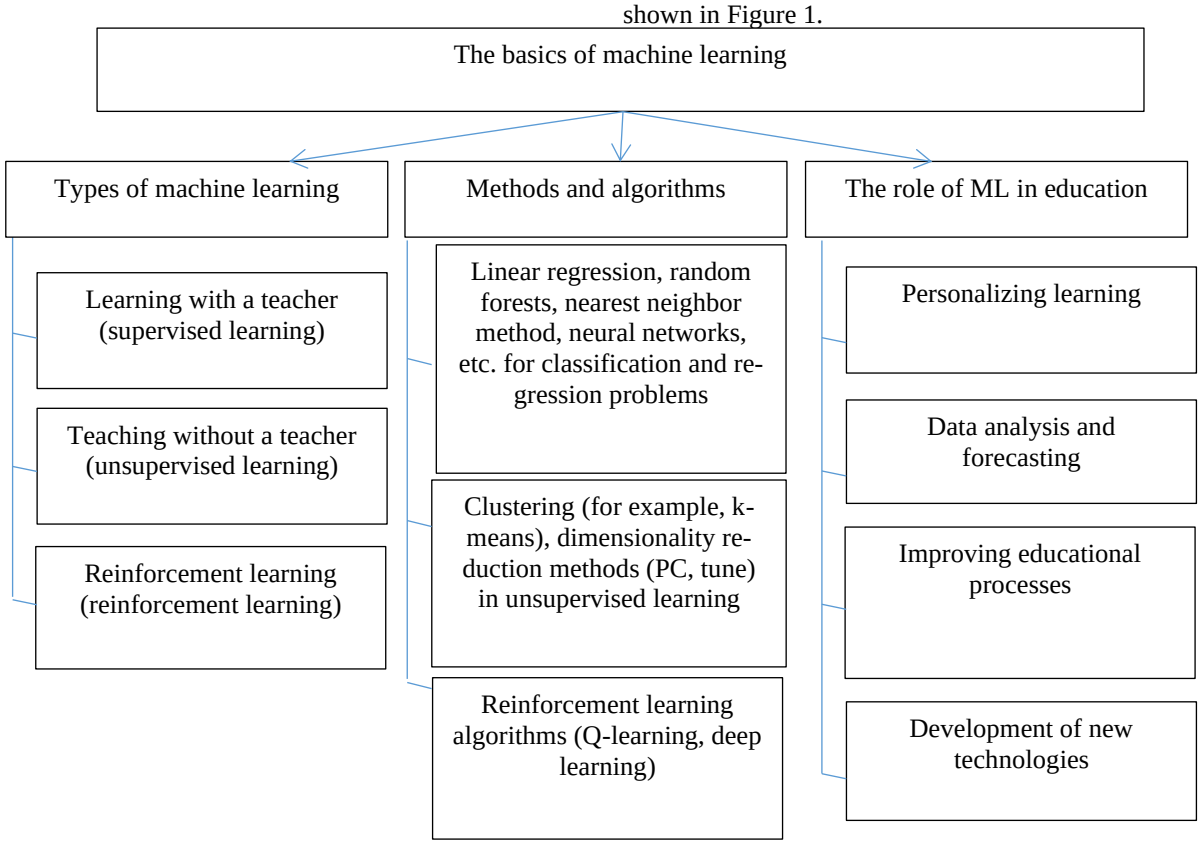


Figure 1. Overview of the basics of machine learning

Machine learning is a powerful tool in modern education, contributing to improving the quality of education, adapting the educational process to the needs of students and developing innovative approaches in education.

The use of machine learning algorithms in pedagogical practice brings innovations to educational processes and can improve the quality of learning [9]. The use of ML in pedagogy has great potential in the following areas: personalized learning, predicting academic performance, adaptive educational platforms, assessment and feedback, analysis of behavior and learning activity, decision support for teachers [10].

Here are some examples of the use of machine learning algorithms in teaching practice, demonstrating a variety of ways to use machine learning algorithms in education, allowing you to personalize learning, improve the adaptability of learning platforms, analyze data to predict student success and optimize evaluation and feedback processes.

For example, the Khan Academy platform uses machine learning algorithms to adapt educational materials to the level and needs of each student. This system provides customized recommendations on materials to study based on test scores and student progress.

Learning Analytics Prediction Engine machine learning algorithms can be used to predict student academic performance. This system helps to identify students who may face learning difficulties and provide recommendations to support them and improve learning outcomes.

ML algorithms are used to develop educational platforms capable of responding to students' actions and providing recommendations on materials based on their preferences and performance. The Duolingo platform system adapts exercises and tasks to each student's level of knowledge, taking into account their progress and mistakes.

The Gradescope application uses machine learning algorithms to automatically evaluate and provide feedback on students' work. This allows you to quickly evaluate work based on specified criteria and provide detailed feedback.

The Coursera platform can be used to analyze student behavioral data. They help identify educational patterns and provide guidance to teachers to improve the quality of courses.

However, it is important to take into account the limitations of the use of ML in pedagogical practice, such as the need to protect data, the correct use of algorithm results to avoid bias and compliance with ethical standards in education. Nevertheless, these technologies offer significant opportunities for the development of education and improvement of learning processes.

The presentation of specific examples of the application of machine learning methods in the process of teaching computer science teachers to develop their professional skills may include the following aspects:

1. An individualized approach to learning. A learning system using machine learning methods can customize educational plans for computer science teachers depending on their level of knowledge, experience and needs. For example, different teachers may be offered customized training programs tailored to their unique needs.

2. Automated knowledge assessment. Development of a system for evaluating the knowledge of computer science teachers based on their answers to test tasks or completed practical tasks. Machine learning techniques can help analyze these responses and provide feedback based on identified errors and successful solutions.

3. Analysis of teaching. The use of text processing algorithms to analyze lesson recordings or presentations by computer science teachers. This will help to identify the features and successful aspects of the teaching style, as well as identify areas for further improvement.

4. Recommendations on teaching methods. Development of a platform using collaborative filtering algorithms to provide computer science teachers with recommendations on the use of techniques, educational materials or tools based on the successful experience of other teachers.

5. Predicting the success of learning. Creation of machine learning models capable of predicting the effectiveness of the implementation of certain educational techniques or tools for computer science teachers. For example, algorithms can predict which teaching strategies will be more successful for specific groups of students.

6. Automation of feedback and evaluation of learning outcomes. For example, creating a tool that applies natural language processing algorithms to analyze and automatically provide feedback to computer science teachers based on their work, lessons, or progress reports is one example of using machine learning methods in the educational process to develop teachers' professional skills.

These examples demonstrate how machine learning techniques can be embedded in educational programs to personalize learning and improve teaching effectiveness.

The analysis of the practical applicability and effectiveness of these machine learning methods for the formation of professional competencies of computer science teachers allows us to assess their real contribution to improving the educational process. Aspects of the analysis of the effectiveness and applicability of these methods are given in Table 1.

Table 1.

Analysis of the practical applicability and effectiveness of these machine learning methods for the formation of professional competencies

Aspects of the method	**Applicability**	**Effectiveness**
Personalizing learning	Machine learning methods can successfully adapt learning to the individual needs of each computer science teacher. However, this requires accurate data on preferences and level of knowledge.	When a personalized approach is set up correctly, it usually leads to more effective learning and increased motivation to learn
Automation of assessment	Automatic assessment of computer science teachers' knowledge through machine learning algorithms can significantly save time when checking papers. However, accurate models are needed for a correct assessment.	The effectiveness of this method depends on the quality and accuracy of algorithms capable of correctly assessing professional competencies.
Analysis of teaching style	Text processing algorithms can highlight key aspects of the teaching style. However, the interpretation of this data may be subjective.	Анализ стиля преподавания может помочь учителям лучше понять свои сильные и слабые стороны в преподавании и внести улучшения.
Selection of recommendations on methods	The use of recommendation algorithms can offer computer science teachers new approaches and materials for their development. However, an accurate recommendation model is required.	If the recommendations are precisely adapted to specific needs, this can lead to an improvement in the educational process and an increase in professional level.
Predicting learning success	Predicting success can help computer science teachers focus efforts on students who need additional support. However, this is only a forecast and does not guarantee a result.	The effectiveness of this method depends on the accuracy of the forecasting models and the teacher's further actions to provide additional assistance.

The critical analysis of the effectiveness and applicability of these methods includes an assessment of the accuracy of the models, interpretation of the results and their practical application in the educational process. Each method has its advantages and limitations that must be considered when using them.

Conclusion. The results of the study clearly indicate the importance of using machine learning methods

in the formation of computer science teachers' competencies. The experiment showed a number of important aspects that have an impact on the professional development of teachers and educational practice: improving professional skills, increasing motivation and interest, adaptability and personalization of learning, evaluating the effectiveness of machine learning methods, feedback from participants in the experiment.

The introduction of machine learning methods into the educational process will significantly increase the level of knowledge and competencies of computer science teachers in the use of new educational technologies. New teaching methods will allow computer science teachers to more effectively adapt teaching materials and methods to the individual needs of students to improve the quality of the educational process. The success of new methods and recommendations for improving the quality of education is feedback. To apply machine learning methods in an educational environment, further research and optimization of learning approaches are necessary.

Thus, the results of this study confirm the prospects of using machine learning methods in the formation of professional competencies of computer science teachers. This opens up new opportunities for improving educational practice and requires further efforts to integrate innovative teaching methods into the educational system.

Information about financing

The work was carried out with the financial support of a grant from the Ministry of Education and Science of the Republic of Kazakhstan (grant AR19680169 "Integration of machine learning for predicting learning strategies in LMS in the formation of professional competencies of students").

References:

1. Miller, P., & Smith, J. (2017). Enhancing Teaching Strategies through Machine Learning Algorithms. Teaching and Teacher Education, 28(1), 112-125.

2. Garcia, R., & Nguyen, T. (2019). Machine Learning Applications in Teacher Training. International Journal of Artificial Intelligence in Education, 15(2), 201-215.

3. Smith, A. (2020). Applying Machine Learning in Education. Educational Technology & Society, 23(1), 112-125.

4. Robinson, S. (2017). The Future of Education: Integrating Machine Learning into Teacher Development Programs. Educational Innovations, 30(2), 89-102.

5. Chen, L., Wang, Q. (2020). Integrating Artificial Intelligence in Teacher Training Programs. International Journal of Educational Technology, 24(2), 301-315.

6. Williams, E., Brown, D. (2021). Future Prospects: Machine Learning Applications in Professional Development for Teachers. Journal of Educational Research, 19(2), 278-291.

7. Wang, L., Johnson, K. (2018). Enhancing Teacher Competencies through Machine Learning: A Case Study in Computer Science Education. Computers & Education, 50(2), 112-125.

8. Smith, A. (2020). Applying Machine Learning in Education. Educational Technology & Society, 23(1), 112-125.

9. Roberts, N., Martin, G. (2020). Machine Learning for Educators: Practical Approaches to Enhance Teaching Practices. Journal of Educational Technology Systems, 33(2), 189-202.

10. Anderson, M., Clark, E. (2017). Machine Learning Applications for Professional Development of Computer Science Teachers. International Journal of STEM Education, 25(4), 278-291.

11. Brown, K., & Clark, E. (2021). Enhancing Teaching Skills through Machine Learning Workshops. Journal of Technology in Education, 18(4), 567-580.

12. Adams, R. (2019). Machine Learning in Education: A Comprehensive Review. Educational Psychology Review, 31(4), 589-605.

13. Gupta, S., & Johnson, M. (2018). Impact of Machine Learning on Pedagogical Practices. Journal of Technology Enhanced Learning, 12(3), 421-435.

14. Kim, S., & Lee, H. (2022). The Role of Machine Learning in Teacher Education: A Review of Current Trends. Educational Technology Research and Development, 70(1), 45-62.

15. Garcia, A., & Patel, R. (2019). Implementing Machine Learning Techniques in Teacher Training Programs. Journal of Educational Computing Research, 37(3), 301-315.

TECHNICAL SCIENCES

A NOVEL APPROACH TO AUTOMATED PCB QUALITY CONTROL: INTEGRATING IMAGE PROCESSING AND LARGE LANGUAGE MODELS

Ilchuk M.,
PhD Student
Lviv Polytechnic National University, Ukraine
Bandery, 12, Lviv, Ukraine, 79013
Stadnyk A.,
PhD Student
Lviv Polytechnic National University, Ukraine
Bandery, 12, Lviv, Ukraine, 79013
Prokhorenko S.
Prof., Doctor of Technical Sciences
Lviv Polytechnic National University, Ukraine
Bandery, 12, Lviv, Ukraine, 79013
https://doi.org/10.5281/zenodo.10451414

Abstract

The integration of automated quality control technologies is nowadays a fundamental requirement for modern PCB production. This automated approach replaces manually based methods that are error-prone with fast, accurate and measurable estimates, helping to reduce the time and costs associated with traditional testing. Human inspection is less efficient, slower and overpriced than automated inspection. In this context, digital image processing, especially for the detection of defects such as faulty components or missing elements, becomes crucial. The production of printed circuit boards requires strict quality control to ensure the reliability and efficiency of electronic devices. Improving the detection and analysis of defects on printed circuit boards is as critical as ever. In addition to this, we propose the concept that combining classical computer vision techniques, such as edge detection and Kenny contour analysis, with large language models opens up innovative possibilities in defect identification.

The main function of the system is to comprehensively detect defects on printed circuit boards using automated visual inspection. It uses a digital camera to capture images of each PCB, which are then processed by a computer. This processing includes converting to greyscale and binary shapes, followed by an XOR operation to extract the necessary information. Contour analysis is then applied for classification. Incorporating language models into defect documentation and description is a significant step in automating quality control, as they can not only describe defects but also suggest corrective measures.

This system is capable of detecting various PCB defects such as missing components, incorrect polarity, open circuits and missing tracks. Its advanced fault detection and classification increase the speed and accuracy of evaluation, reducing human error, which is prevalent in quality testing, and introduces a usable fault and defect notification, detailed description and reporting system. Replacing manual testing methods with this new model significantly increases productivity.

Keywords: Image Processing, Printed Circuit Board, Defect Detection, Edge Detection, Classification system, Large language system.

Introduction

In the fast-growing electronics industry, the implementation of automated test systems is becoming increasingly important to ensure the quality of printed circuit boards (PCBs). This need is driven by the frequent occurrence of defects, mismatches and exposure errors in PCBs. Automated systems equipped with specialised defect detection algorithms significantly improve the quality and accuracy of PCB testing. These systems offer a marked improvement over manual testing, which often suffers from human fatigue, long test periods and increased operating costs.

Modern electronic component manufacturing technologies require efficient PCB design and test processes that meet stringent standards. Test efficiency and minimise human labour. An important step in improving the quality control of PCB production is the effective use of traditional computer vision methods for initial defect detection. Techniques such as Kenny edge detection and contour analysis are well suited to delineate object boundaries and highlight contours in PCB images. This initial stage identifies areas that require further investigation and helps to create a baseline dataset for further analysis. The next stage of defect detection involves the deployment of large-scale language models. These models, developed on the basis of advanced deep learning technologies, are capable of detecting and classifying defects, recognising their sizes, shapes and types. A significant advantage of these models is their ability to integrate textual descriptions of detected defects, enriching the documentation process. Using language models to analyse documentation and describe defects is an important step in automating and improving PCB quality control. Not only can they describe defects, but they also provide insight into potential corrective actions.

The combined use of traditional computer vision techniques and large-scale language models represents

an integrated approach to PCB quality control. This methodology not only improves the accuracy of defect detection, but also reduces the probability of errors, contributing to the creation of a comprehensive system that automates the analysis and description of problems in printed circuit boards. This technological advancement is vital to improving production processes and is a key factor in the evolution of modern quality control methods in electronic manufacturing.

Background. Automated testing in PCB quality control, driven by fault detection systems and specialised algorithms, has significant advantages over manual testing, mitigating issues such as fatigue, long test times and high operating costs. However, there are certain limitations to consider. These include the potential for false positives and negatives, requiring accuracy in interpreting algorithms, and significant upfront investment in technology and infrastructure for implementation. Recognising these constraints is essential to achieving a balanced and effective strategy for controlling PCB quality through automation.

Objective. The central objective of this article is to investigate and verify the integration of state-of-the-art algorithms, such as including the Fault Detection Algorithm, Canny Edge Detection Algorithm, and Contour Analysis, within an automated PCB visual inspection system. The main focus is to demonstrate how the incorporation of large language models (LLMs) extends the inspection system, increasing its effectiveness. This research aims to highlight the highly effective synergies between advanced image processing techniques and LLMs, leading to efficient and accurate detection of a range of PCB defects, including missing components and circuitry issues. The end goal is to significantly increase the accuracy and efficiency of the defect detection process, thereby improving the overall approach to PCB quality control.

PCB quality control technologies. To ensure the production of high-quality final products that seamlessly conform to precise specifications, meticulous attention to detail is imperative. Testing teams within industries ardently strive to identify faults prior to product release, yet these faults often persist, even with the most rigorous manual testing processes. The implementation of automated testing methods emerges as the optimal approach to elevate testing efficiency and analysis [3]. Automated testing, particularly in the context of Printed Circuit Boards (PCBs), is instrumental in identifying common faults such as missing components, tracks, holes, and circuit breaks. Image processing plays a pivotal role in quality control for PCBs, not only facilitating defect identification but also expediting the evaluation of fault detection. This early detection mechanism enables timely corrections, thereby enhancing the efficiency of quality control procedures. Industries that integrate automated testing techniques reap the benefits of reduced testing times for product inspections [4]. Even with effective manual testing, defects in components can sometimes manifest after product delivery to customers, incurring wastage and additional manufacturing costs, or necessitating reevaluation. Recording and monitoring component readings and values via computer systems play a crucial role in maintaining product quality. By employing these methods, companies remain competitive by expediting the transition from concept to product, optimizing production workflows, and minimizing rejects during production [5]. Historically designed systems were primarily adept at detecting faults in bare Printed Circuit Boards, primarily identifying issues like broken tracks. However, these techniques are ill-suited for detecting faults in mounted PCBs, such as short circuits, missing components, and component polarities, which the proposed system effectively addresses. Moreover, these systems tend to be sensitive to variations in lighting conditions [6]. An article “Image Segmentation based on Edge Detection using Boundry Code” [7] classifies PCB defects into two categories: functional defects that impact the performance and quality of the PCB product, and cosmetic defects that affect the PCB's appearance, potentially influencing factors like heat dissipation and high-voltage current. In the proposed system, images are segmented, and defects are classified into distinct groups, such as square segments, hole segments, thick line segments, and thin line segments, each trained from template images. Notably, the system is constrained by its limitation to detect only these predefined defect segments [8]. A model suggested by Takumi Uemura [8] operates solely on grayscale images, potentially limiting its applicability. Future research aims to extend its functionality to color images and other types of images. The proposed approach incorporates the use of boundary code (BC) for edge detection, delineating edges within images as virtual edges within a virtual spatial context, with ongoing efforts directed towards adapting this method for RGB images. In this article I would like to emphasize on some of the methods namely: Fault Detection Algorithm, Canny Edge Detection Algorithm, and Contour Analysis in PCB quality control.

The Fault Detection Algorithm is a crucial component of PCB quality control, serving as an automated system designed to ensure the reliability and performance of electronic devices. This algorithm harnesses the power of advanced machine learning and computer vision techniques to systematically and accurately identify various defects present in printed circuit boards (PCBs). These defects can encompass a wide range of issues, such as soldering imperfections, component misalignments, micro-cracks, and structural damage. The algorithm's primary strength lies in its ability to efficiently and rapidly process large volumes of visual data, significantly reducing the need for labor-intensive manual inspections. By automating defect recognition, it enhances production efficiency and quality, making it an essential tool in the PCB manufacturing process. [9] The article “Enhanced PCB Defect Detection Using Canny Edge Detection” describes Canny Edge Detection Algorithm as a fundamental image processing technique employed in PCB quality control to identify and highlight edges and boundaries within PCB components. It excels at distinguishing edges from image noise, resulting in a precise representation of the PCB's structural features. In the context of quality control, the algorithm plays a crucial role in locating component outlines, verifying their alignment, and ensuring that the PCB layout conforms to design specifications. By enhancing edge detection, the Canny algorithm significantly improves the accuracy and reliability of defect identification in PCBs. [10] Contour Analysis is a fundamental technique in PCB quality control that involves the extraction and examination of geometric fea-

tures within PCB components. It provides valuable insights into component alignment, dimensions, shapes, and orientation, enabling the verification of compliance with design specifications. Contour Analysis is instrumental in detecting manufacturing irregularities and ensuring that each PCB meets quality standards by assessing dimensions, shapes, and component orientations.

Within the framework of defect detection in printed circuit boards (PCBs), there is an exciting prospect of integrating large language models (LLMs). This advanced approach to interacting LLMs with previously discussed algorithms such as Fault Detection Algorithm, Canny Edge Detection Algorithm, and Contour Analysis brings the defect detection system into synergy, contributing to their synergistic enhancement. The use of LLM extends the functionality of the edge detection and contour analysis algorithms, which contributes to more efficient recognition and classification of various defects. The unpredictable ability of LLM to efficiently process large amounts of visual data opens up the prospect of significantly reducing the need for manual inspections, thereby increasing the accuracy of defect detection [11].

Focusing on the interaction of LLM with the Fault Detection Algorithm, there is an increase in the dynamics of the development of the PCB quality control system. The use of machine learning and image analysis inherent in LLM has significant potential to improve the accuracy and efficiency of detecting various defects. This includes detecting not only solder defects and missing components, but also isolated recognition of microcracks and structural damage.

Applied algorithms and methodologies. The proposed system employs several algorithms, including the Fault Detection Algorithm, the Canny Edge Detection Algorithm, and Contour Analysis and modern technologies of Large Language Models.

Fault Detection Algorithm. Input data comprises color images captured using a high-resolution 13-megapixel camera. The objective is the inspection of Printed Circuit Boards (PCBs) for faults, subsequently categorized.

The image processing algorithm proceeds as follows:

First, the two-dimensional RGB image undergoes transformation into grayscale. In the RGB color space, the color pixels—Red (R), Green (G), and Blue (B)—range from 0 to 255. Grayscale conversion entails merging these color channels, yielding a grayscale image. This amalgamation occurs when all three color channels manifest identical pixel values at corresponding coordinates. The grayscale value is computed as follows (1),

$$(R + G + B)/3 \quad (1)$$

Subsequently, the grayscale image undergoes a transformation into a binary image, where pixels are represented as either 0's or 1's, akin to a black and white image. A threshold value is established to interpret the pixel values. When the pixel value exceeds this threshold, it is set to 1 (white), while all other pixels are set to 0 (black). This binary conversion process prepares the image for defect identification. Following the image conversion, a bitwise XOR operation is performed on two binary images. This operation is true if one of the input values is true and false otherwise. The XOR operation is instrumental in the identification of defects. For the purpose of training the images of the PCB, Contour Analysis technique is employed. This technique involves a pixel-by-pixel examination of the entire image and serves the purpose of labeling faults. The results are subsequently generated to determine whether a sample image is deemed faulty or not.

Canny Edge Detection Algorithm. The Canny Edge Detection algorithm, as outlined in references [7] and [5], primarily serves for edge detection, with a focus on fulfilling three key criteria: a low error rate, good localization, and minimal response. The algorithm is applied to grayscale images, and it follows these steps:

The initial step involves removing noise from the image using a Gaussian filter. The Gaussian filter is a non-uniform low-pass filter designed to blur the images, resulting in a smoother image. This algorithm relies on a two-dimensional Gaussian function for image processing, which is mathematically defined as (2):

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} \quad (2)$$

In the equation provided earlier, where x represents the horizontal distance from the origin, y signifies the vertical distance from the origin, and σ denotes the standard deviation of the distribution, it's important to note that this distribution is assumed to have a mean of 0. The next step in the Canny Edge Detection algorithm is to filter the smoothened image using the Sobel kernel. This process involves applying a pair of convolution masks in both the horizontal (x) and vertical (y) directions. The result of this operation yields information about the gradient strength and direction. The direction is typically rounded to one of four angles: 0, 45, 90, or 135 degrees. So Edge Gradient as next(3):

$$(\mathrm{G}) = \sqrt{G_x^2 + G_y^2} \quad (3)$$

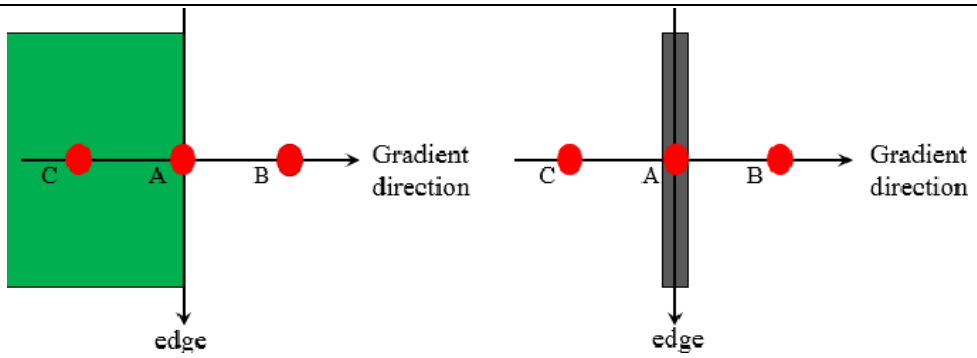
And Angle (Θ) (4):

$$\text{Angle } (\Theta) = \tan^{-1}\left(\frac{G_y}{G_x}\right) \quad (4)$$

Where, Gx is used to find intensity gradient along horizontal direction, Gy is used to find intensity gradient in vertical direction and angle (Θ) is used to calculate Gradient Direction.

The edges should be marked where the gradients of the image has large magnitudes.

After obtaining the gradient magnitude and direction, a comprehensive scan of the image is conducted to eliminate any extraneous pixels that may not constitute actual edges. To achieve this, at each pixel, it is examined to determine if it represents a local maximum within its immediate neighborhood in alignment with the gradient direction. This process helps in identifying and retaining only the essential edges in the image (Picture 1).



Pic.1. Non-maximum suppression

Point A is situated on the edge in the vertical direction, and the gradient direction is perpendicular to the edge. Points B and C are aligned with the gradient directions. Point A is subjected to an evaluation in conjunction with points B and C to ascertain whether it constitutes a local maximum. If it meets this criterion, it progresses to the next stage; otherwise, it is suppressed or reset. In summary, the outcome of the Canny algorithm is the generation of a binary image featuring "thin edges." The Canny algorithm employs two distinct thresholds, namely the upper and lower thresholds, to distinguish authentic edges from non-edges:

1. If the pixel's gradient value exceeds the upper threshold, the pixel is categorized as being on an edge.
2. If the pixel's gradient value falls below the lower threshold, it is rejected and not considered as part of an edge.
3. Pixels with gradient values that fall within the range delimited by the upper and lower thresholds are only considered as part of an edge if they are connected to a pixel with a gradient value exceeding the upper threshold. This ensures that only prominent edges are retained in the final output.

Contour Analysis. Within the PCB fault detection system, Contour Analysis plays a pivotal role in image recognition and fault labeling by analyzing various fault types. Contour Analysis allows describing, comparing, storing, and identifying objects based on their external outlines, or contours. A contour essentially represents the boundary of an object, effectively separating it from the background. It is postulated that the contour contains the essential information regarding the object, while the interior points of the object are excluded from the analysis. This selective focus constrains the algorithm's scope to the contour of the object, streamlining the Contour Analysis process. Contours enable a transition from the two-dimensional space of the image and are adaptable to varying image patterns while remaining invariant to transposition [12].

In contour analysis, the contour is written as a sequence of complex numbers. The starting point of the image is fixed on the contour. The contour is then scanned clockwise, and each displacement vector is denoted by a complex number a+ib. Where a is the displacement along the x axis, and b is the displacement along the y axis. Displacement is noted concerning the previous point. [13]

In the PCB fault detection system, Contour Analysis is specific to applicable area. In the binarized image, contours are selected and individual sections of the image are segmented. This allows for the training of various template images to detect contours and facilitates the process of searching for and comparing sample images with these template images. The objective is to identify the most similar portions of the image, aiding in the precise localization and characterization of faults in the PCB.

Contour Analysis within the PCB fault detection system significantly enhances image processing speed and overall performance. It provides a clear and accurate identification of fault areas, effectively labeling faults by analyzing their types and characteristics. This approach contributes to the system's efficiency and precision in fault detection and localization.

Large Language Models. Visual LLM. The model consists of multiple transformer layers, where each layer performs self-attention and summation operations [14]. This allows the model to interact effectively with different types of information and address language processing tasks.

Another essential part of the algorithms is the training process. The model is trained on a large corpus of text data using deep learning methods. During training, the model determines weights for its parameters, optimizing them to maximize the accuracy of predictions.

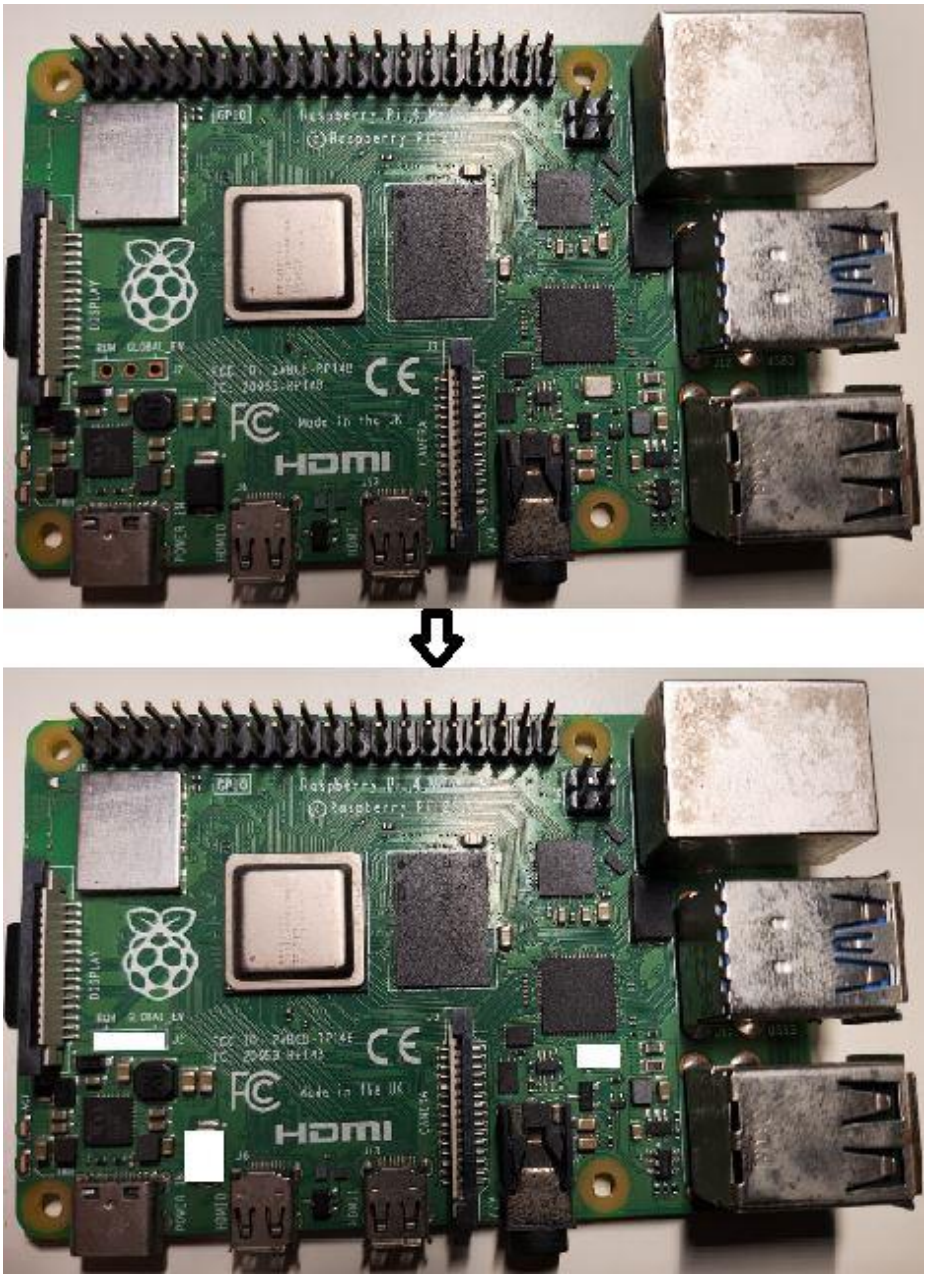
A distinctive feature of large language model algorithms is scalability. They possess a high number of parameters, allowing them to tackle diverse tasks and comprehend a broad context. However, this scalability also results in a significant computational load, making their implementation computationally intensive.

It is important to note that the algorithms of large language models can be dynamically adapted to different tasks. The model can be fine-tuned or pre-trained for a specific type of input data or task, enabling their use in a wide range of applications. A drawback of these algorithms is the large number of parameters, which may lead to efficiency and computational cost challenges. Additionally, the potential emergence of biased or incorrect model outputs due to training deficiencies should be considered. The algorithms of large language models can be effectively integrated into quality control and defect detection tasks for printed circuit boards (PCBs). Leveraging the strengths of these models, such as their ability to comprehend contextual information and patterns, can significantly enhance the precision and efficiency of defect identification in PCB manufacturing.

One application is the analysis of documentation and specifications related to PCB design. Large language models can process and understand textual data, including design requirements, standards, and specifications. By integrating these models, manufacturers

can automate the validation of PCB designs against industry standards and specifications, ensuring compliance and reducing the likelihood of errors in the early stages of production. Large language models can be employed for the interpretation of inspection reports and defect classifications. As part of the quality control process, these models can analyze textual descriptions of defects and corresponding images. This integration allows for a more comprehensive evaluation of defects, as the models can consider both textual and visual information to enhance the accuracy of defect identification.

Image processing experiment and results. A Raspberry Pi 4 microcomputer board was used to demonstrate the process and its results. The Raspberry Pi 4 is a small, affordable computer popular in education, hobby projects and research. It is known for its versatility, low power consumption, and the ability to work with a variety of operating systems. Picture 2 shows the printed circuit board (PCB) during testing, which serves as an input to the fault detection system. We then manually inject a visual defect onto the board, such as a visual spot, to simulate a defect in certain board elements, such as being missing or out of alignment with the physical dimensions.

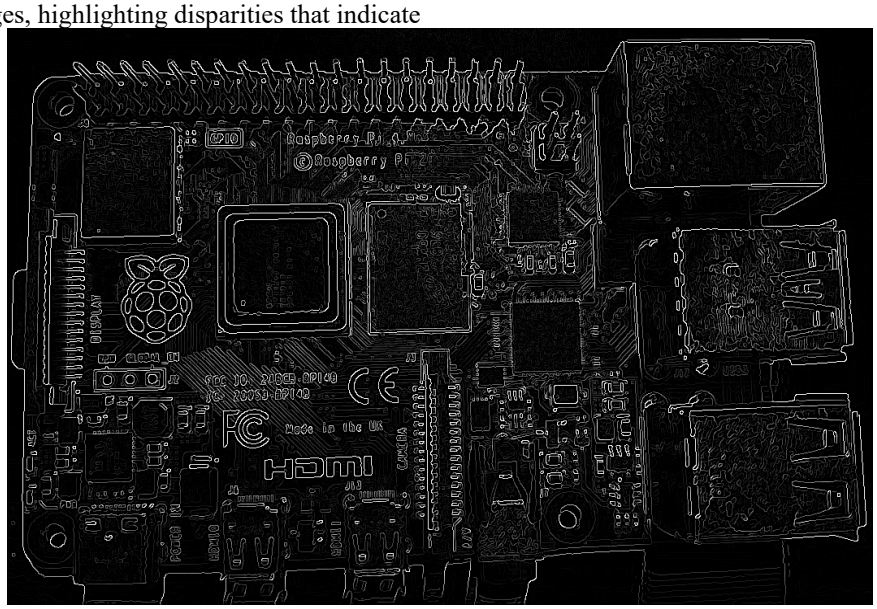


Pic.2. Template Image

In the described method, the template image is used as the initial input signal for the Canny Edge Detection algorithm. This process involves converting the template image to a binary format. This conversion is an important step to improve the visibility and distinguish the edges of the image. Picture 3 shows the result of this procedure: the template image after applying the Canny Edge Detection algorithm. It is important to note that before applying the algorithm, the template image is converted to grayscale, which is a necessary step to facilitate effective edge detection.

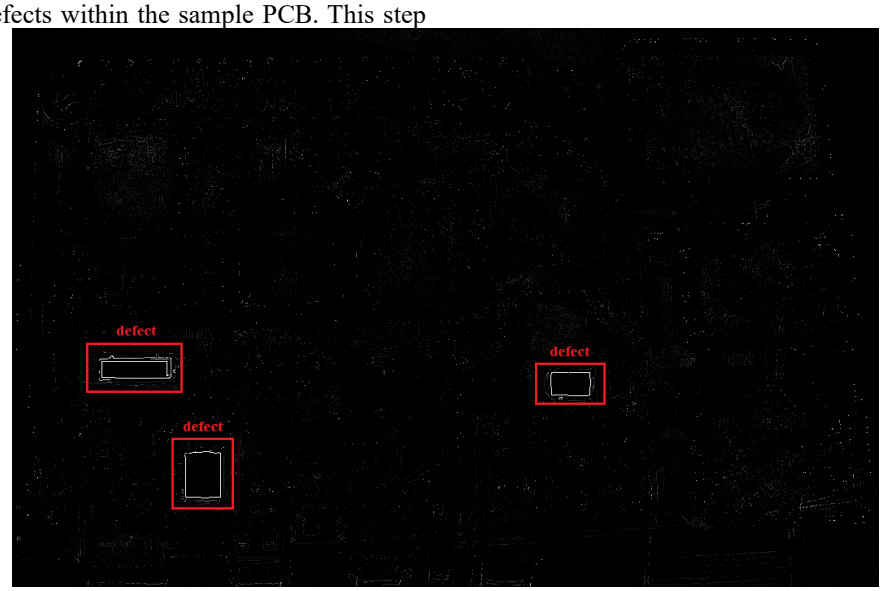
Following this, an exclusive-or (XOR) operation is methodically performed on two specific images: the processed template image and the reference image.

This XOR operation is a pivotal part of the defect identification process within the sample printed circuit board (PCB). It works by comparing the binary values of the two images, highlighting disparities that indicate potential defects. Picture 4 provides a graphical representation of the results derived from this XOR operation.



Pic.3. Results of Canny Algorithm

The visual output from this comparison effectively illustrates the discrepancies between the template and reference images, thereby revealing the existence and locations of defects within the sample PCB. This step is instrumental in diagnosing and analyzing the quality and integrity of the PCB, providing critical insights for further analysis and rectification measures.



Pic.4. XOR Operation

In the next phase of our research, we demonstrate the results of integrating visual large language models. This integration unlocks four key capabilities that are central to our research:

1) Direct use of these models for advanced defect evaluation: This approach allows us to conduct in-depth analysis, identifying both the type of component and the nature of the potential defect.

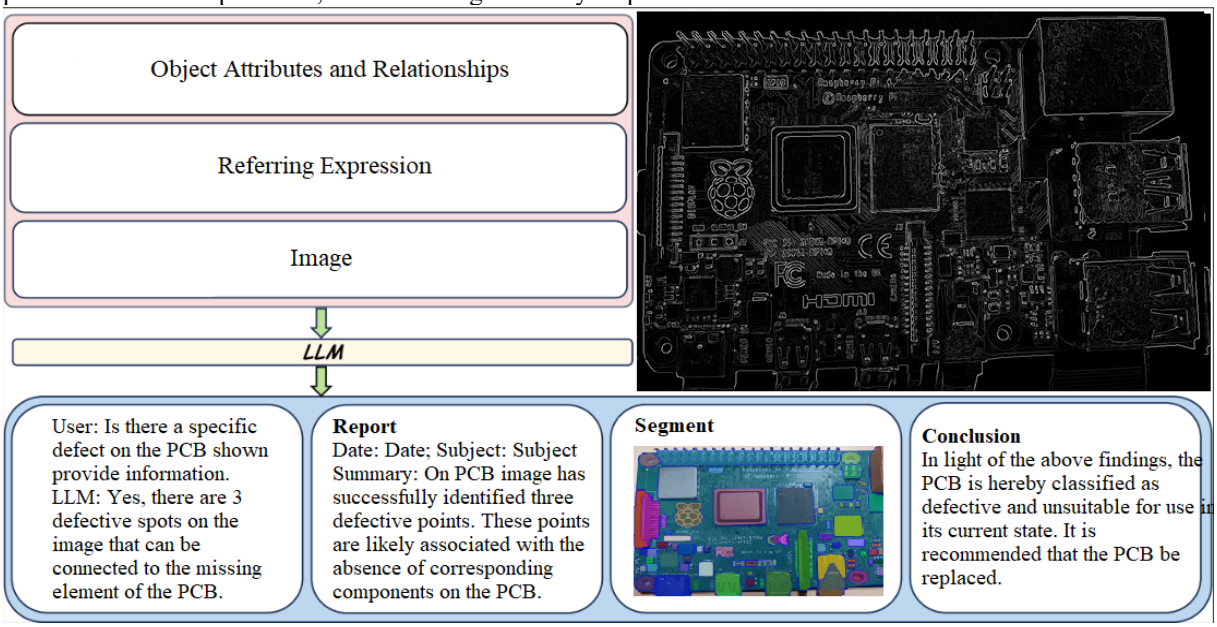
2) The ability to generate and send detailed reports: This feature is particularly useful for communication and documentation. It allows you to automatically generate comprehensive reports to specific stakeholder needs or documentation requirements. This not only simplifies the reporting process, but also ensures that all relevant information about defects and their consequences is communicated accurately and efficiently

3) The ability to segment an image to isolate elements: This feature plays a crucial role in accurately identifying and isolating individual image components. By segmenting the image, the system can focus on specific areas or elements, allowing for a more targeted and detailed investigation.

4) Making the final decision on the quality of the PCB.

Picture 5 shows the system response based on the operational functionality of these integrated large lan-

guage models. This image illustrates the practical application of these capabilities, demonstrating how they specifically contribute to the analysis and evaluation process in the context of PCB assessment.



Pic.5. Response based on the operational functionality

Conclusion. The implemented system consistently provides accurate test results for printed circuit boards (PCBs). Its effectiveness lies in the ability to qualitatively determine the presence or absence of faults in PCB samples. The results obtained are systematically classified based on the different categories of faults observed in the PCB samples. These categories include defects such as missing components, polarity reversal, open circuits and missing tracks. Comprehensive reports are systematically generated to document the frequency of faults found in PCBs. To further improve the accuracy of the results, the system uses Large language models, which allows for the expansion of the functionality of PCB quality assessment. Further improvements can be made by using 3D images to detect complex defects such as solder joint quality and solder thickness.

References:

1. Sonal Kaushik, Javed Ashraf, “Automated PCB Defect Detection Using Image Subtraction Method”, International Journal of Computer Science and Network (IJCSN)Volume 1, Issue 5, www.ijcsn.org ISSN 2277-5420, October 2012.

2. Theingi Aye, Aung Soe Khaing, “Automatic Defect Detection and Classification on Printed Circuit Board”,

International Journal of Societal Applications of Computer Science Vol 3 Issue 3, https://www.ijert.org/automatic-misalignment-defects-detection-correction-in-pcb-using-surf-speed-up-robust-features-technique ISSN 2319 – 8443, March 2014.

3. Xiaojing Tian,Liang Zhao,Huajun Dong, “Application of image processing in the detection of printed circuit board”, IEEE Workshop on Electronic Computer And Application, DOI: 10.1109/IWECA.2014.6845582, 2014.

4. N. Yogesh Bagrecha, “Quality Control Using Image Processing”, et al Int. Journal of Engineering Research and Applications ISSN : 2248-9622, Vol. 4, Issue 3(Version 1),pp.15-18 , DOI: 10.5120/ijca2016909623, March 2014.

5. Suhasini A ,Sonal D Kalro , Prathiksha B G, Meghashree B S , Phaneendra H D, “PCB Defect Detection Using Image Subtraction Algorithm”, International Journal of Computer Science Trends and Technology (IJCST) –

Volume 3 Issue 3, ISSN: 2347-8578 www.ijcstjournal.org, May-June 2015.

6. “Printed circuit board defect detection using mathematical morphology and MATLAB image processing tools”, Researchgate Article, DOI: 10.1109/ICETC.2010.5530052, January 2010.

7. Takumi Uemura, Gou Koutaki and Keiichi Uchimura, “Image Segmentation based on Edge Detection using Boundry Code”, International journal of innovative computing, information and computing, Volume 7, Number 10, https://www.researchgate.net/publication/287469226, October 2011.

8. S. Bhardwaj, Ajay Mittal. “A Survey on Various Edge Detector Techniques” Proc. IEEE, vol.4, pp. 220-226, DOI:10.1016/j.protcy.2012.05.033, 2012.

9. Y. Zhou, M. Yuan, J. Zhang "Review of vision-based defect detection research and its perspectives for printed circuit board", Journal of Manufacturing Systems Vol. 70, Pp. 557-578, DOI:10.1016/j.jmsy.2023.08.019, (2023).

10. Qin Ling, " Printed Circuit Board Defect Detection Methods Based on Image Processing, Machine Learning and Deep Learning: A Survey", DOI:10.1109/ACCESS.2023.3245093, (2023).

11. S.S.Zakaria, A. Amir "Automated Detection of Printed Circuit Boards (PCB) Defects by Using Machine Learning in Electronic Manufacturing: Current Approaches", DOI:10.1088/1757-899X/767/1/012064, (2020).

12. A.P. James. “Edge Detection for Pattern

Recognition: A Survey, DOI:10.48550/arXiv.1602.04593, 2013.

13. Mrs. Namrata. S. Mandvikar, "Augmented Reality Using Contour Analysis In e-learning", International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, DOI:10.17577/IJERTV3IS041706, 2014.

14. Junnan Li, Dongxu Li, Silvio Savarese, and Steven Hoi. Blip-2: Bootstrapping language-image pre-training

with frozen image encoders and large language models. arXiv preprint arXiv:2301.12597, https://arxiv.org/abs/2301.12597, 2023.

SOME CURVILINEAR COORDINATES IN DYNAMIC ELASTICITY THEORY

Gorgidze D.,
Doctor of Engineering Science, Professor, Georgian Technical University, Tbilisi.
Museridze R.
PhD in Civil Engineering, ,Assistant Professor, Georgian Technical University,
Georgian Technical University,Tbilisi

НЕКОТОРЫЕ КРИВОЛИНЕЙНЫЕ КООРДИНАТЫ В ДИНАМИЧЕСКОЙ ТЕОРИИ УПРУГОСТИ

Горгидзе Д.А.
доктор технических наук, профессор, Грузинский технический университе, Тбилиси
Мусеридзе Р.Р.
академический доктор технических наук, профессор, Грузинский технический университе, Тбилиси
https://doi.org/10.5281/zenodo.10451424

Abstract

In various orthogonal curvilinear coordinate systems, general solutions to the dynamic problem of the theory of elasticity for an isotropic homogeneous body are constructed. Dynamic problems of the theory of elasticity associated with pure shear, pure torsion, plane-strain and axisymmetric stress states are considered. Solutions to some specific dynamic problems are given.

Аннотация

В различных ортогональных криволинейных системах координат строятся общие решения динамической задачи теории упругости для изотропного однородного тела. Раасматриваются динамические задачи теории упругости связанные с чистым сдвигом, чистым кручением, плоскодеформированным и осесимметричным напряженным состоянием. Приводятся решения некоторых конкретных динамических задач.

Keywords: dynamic, curvilinear, coordinate, elasticity.
Ключевые слова: динамический, криволинейные, координата, упругость.

Введение

Некоторые криволинейные координаты. Рассмотрим на плоскости ортогональную криволинейную изотермическую систему координат θ,α,в которой оси *Ox* и *Oy* декартовой системы координат *x, y* являются осями ее симметрии. В изотермических координатах параметры (коэффициенты) Ламе $h_\theta = h_\alpha = h(\theta,\alpha)$. Справедливы следующие равенства

$$\frac{\partial x}{\partial \theta} - \frac{\partial y}{\partial \alpha} = 0, \qquad \frac{\partial x}{\partial \theta} + \frac{\partial y}{\partial \alpha} = 0. \qquad (1.1)$$

Если ввести прямолинейную координату z, ортогональную к плоскости координат *θ, α, z*, то получим систему координат с осью сдвига Oz; параметры Ламе системы $h_\theta = h_\alpha = h(\theta,\alpha), h_z = 1$.

Если же вращать систему координат вокруг одной из осей ее симметрии, то получим вращательно-симметричную систему координат *θ, α, β,* при этом, после соответствующей перестановки координат, окружной координатой принимается координата *α.* Параметры Ламе такой системы $h_\theta = h_\beta = h(\theta,\alpha), \quad h_\alpha = H(\theta,\beta)$ [1].

В системах координат с осью сдвига *θ, α, z* справедливы формулы (1) и следующие равенства.

$$\begin{aligned}
&a)\ \frac{\partial x}{\partial \theta}\frac{\partial y}{\partial \alpha} - \frac{\partial y}{\partial \theta}\frac{\partial x}{\partial \alpha} = \left(\frac{\partial x}{\partial \theta}\right)^2 + \left(\frac{\partial x}{\partial \alpha}\right)^2 = \left(\frac{\partial y}{\partial \theta}\right)^2 + \left(\frac{\partial y}{\partial \alpha}\right)^2 = h^2;\\
&b)\ \frac{\partial}{\partial \theta}\left(\frac{1}{h^2}\frac{\partial x}{\partial \theta}\right) - \frac{\partial}{\partial \alpha}\left(\frac{1}{h^2}\frac{\partial x}{\partial \alpha}\right) = 0;\\
&c)\ \frac{\partial}{\partial \alpha}\left(\frac{1}{h^2}\frac{\partial x}{\partial \theta}\right) + \frac{\partial}{\partial \theta}\left(\frac{1}{h^2}\frac{\partial x}{\partial \alpha}\right) = 0; \qquad (1.2)\\
&d)\ \frac{\partial}{\partial \theta}\left(\frac{1}{h}\frac{\partial h}{\partial \theta}\right) + \frac{\partial}{\partial \alpha}\left(\frac{1}{h}\frac{\partial h}{\partial \alpha}\right) = 0;\\
&e)\ \frac{\partial}{\partial \alpha}\left(\frac{1}{h}\frac{\partial h}{\partial \theta}\right) - \frac{\partial}{\partial \theta}\left(\frac{1}{h}\frac{\partial h}{\partial \alpha}\right) = 0;
\end{aligned}$$

В системе вращательно-симметричных координат *θ, α, β* справедливы следующие равенства.

$$
\begin{aligned}
&a)\ x = H\cos\alpha,\ y = H\sin\alpha;\\
&b)\ \frac{\partial H}{\partial\theta}+\frac{\partial z}{\partial\beta}=0,\quad \frac{\partial H}{\partial\beta}-\frac{\partial z}{\partial\theta}=0;\\
&c)\left(\frac{\partial H}{\partial\theta}\right)^2+\left(\frac{\partial H}{\partial\beta}\right)^2=0;\\
&d)\ \left(\frac{\partial h}{\partial\theta}\right)^2+\left(\frac{\partial h}{\partial\beta}\right)^2=h\left(\frac{\partial^2 h}{\partial\theta^2}+\frac{\partial^2 h}{\partial\beta^2}\right);\\
&e)\ \frac{\partial h}{\partial\theta}\frac{\partial H}{\partial\beta}+\frac{\partial h}{\partial\beta}\frac{\partial H}{\partial\theta}=h\frac{\partial^2 H}{\partial\theta\,\partial\beta};\\
&f)\ \frac{\partial h}{\partial\beta}\frac{\partial H}{\partial\beta}-\frac{\partial h}{\partial\theta}\frac{\partial H}{\partial\theta}=h\frac{\partial^2 z}{\partial\theta\,\partial\beta}.
\end{aligned}
\qquad (1.3)
$$

Полный комплект соотношений типа (1.2) и (1.3) приведен в [2].

К важнейшим системам координат с осью сдвига принадлежат

1. Декартовы координаты *x , y, z.*

$-\infty < x < \infty,\ -\infty < y < \infty,\ -\infty < z < \infty;\quad x = \theta,\ y = \alpha,\ h = 1.$

2. Круговые цилиндрические координаты *r*, α, *z.*

$$0 \le r < \infty,\ \ 0 \le \alpha < 2\pi,\ \ -\infty < z < \infty;\ r = \theta,\ \ r\frac{\partial}{\partial r} = \frac{\partial}{\partial\theta};$$

$$x = r\cos\alpha,\quad y = r\sin\alpha,\quad h = r.$$

3. Цилиндро -эллиптические координаты θ, α, *z.*

$0 \le r < \infty,\ \ -\pi \le \alpha < \pi \quad -\infty < z < \infty;$ *или* $\quad -\infty < \theta < \infty,\ 0 \le \alpha \le \pi \quad -\infty < z < \infty;$

$$x = c\cdot ch\theta\cdot\cos\alpha,\quad y = c\cdot sh\theta\cdot\sin\alpha,\quad h = \frac{c}{\sqrt{2}}\sqrt{ch2\theta-\cos 2\alpha}.$$

4. Цилиндро- параболические координаты θ, α, *z.*

$-\infty < \theta < \infty,\ 0 \le \alpha \le \infty,\quad -\infty < z < \infty;$

$$x = c\,\frac{\theta^2-\alpha^2}{2},\quad y = c\cdot\theta\cdot\alpha,\quad h = c\sqrt{\theta^2+\alpha^2}.$$

5. Цилиндро-биполярные координаты θ, α, *z.*

$-\infty < \theta < \infty,\ -\pi \le \alpha \le \pi \quad -\infty < z < \infty;$

$$x = \frac{c\cdot sh\,\theta}{ch\theta+\cos\alpha},\quad y = \frac{c\cdot\sin\alpha}{ch\theta+\cos\alpha},\quad h = \frac{c}{ch\theta+\cos\alpha}$$

или

$$x = \frac{c\cdot\sin\alpha}{ch\theta-\cos\alpha},\quad y = \frac{c\cdot s\,h\theta}{ch\theta-\cos\alpha},\quad h = \frac{c}{ch\theta-\cos\alpha}.$$

В Цилиндро-эллиптических, цилиндро-параболических и цилиндро-биполярных координатах с –масштабный множитель. Координатная линия α в системах с номерами 2,3 и 5 замыкается. Такие системы координат будем называть сз координатами, где аббревиатура основывается на словах „сдвиг“ и „замикание“.

К важнейшим системам координат с осью вращения принадлежат следующие координаты.

1. Круговые цилиндрические координаты *r*, α, *z.*

$0 \le r < \infty,\ \ 0 \le \alpha < 2\pi,\ \ -\infty < z < \infty;\ r = \theta,\ \ z = -\beta;$

$$x = r\cos\alpha,\quad y = r\sin\alpha,\quad h = 1,\ H = r.$$

1. Сферические координаты *r, α, β.*

$$0 \le r < \infty,\ \ 0 \le \alpha < 2\pi,\ \ 0 \le \beta \le \pi;\ r\frac{\partial}{\partial r} = \frac{\partial}{\partial\theta};$$

$$x = r\cdot\cos\alpha\cdot\sin\beta,\quad y = r\cdot\sin\alpha\cdot\sin\beta,\quad z = r\cdot\cos\beta,\quad h = r,\ H = r\cdot\sin\beta.$$

2. Эллипсоидальные вытянутые координаты *θ, α, β.*

$$0 \le \theta < \infty, \quad 0 \le \alpha < 2\pi, \quad 0 \le \beta \le \pi;$$

$$x = c \cdot sh\theta \cdot \cos\alpha \cdot \sin\beta, \quad y = c \cdot sh\theta \cdot \sin\alpha \cdot \sin\beta, \quad z = c \cdot ch\theta \cdot \cos\beta,$$

$$h = \frac{c}{\sqrt{2}}\sqrt{ch2\theta - cis2\beta}, \; H = c \cdot sh\theta \cdot \sin\beta.$$

4. Эллипсоидальные сплюснутые координаты *θ, α, β*.

$$0 \le \theta < \infty, \quad 0 \le \alpha < 2\pi, \quad 0 \le \beta \le \pi;$$

$$x = c \cdot ch\theta \cdot \cos\alpha \cdot \sin\beta, \quad y = c \cdot ch\theta \cdot \sin\alpha \cdot \sin\beta, \quad z = c \cdot sh\theta \cdot \cos\beta,$$

$$h = \frac{c}{\sqrt{2}}\sqrt{ch2\theta + cos2\beta}, \; H = c \cdot ch\theta \cdot \sin\beta.$$

5. Параболоидальные координаты *θ, α, β*.

$$0 \le \theta < \infty, \quad 0 \le \alpha < 2\pi, \quad 0 \le \beta < \infty;$$

$$x = c \cdot \theta \cdot \beta \cdot \cos\alpha, \quad y = c \cdot \theta \cdot \beta \cdot \sin\alpha, \quad z = c \cdot \frac{\theta^2 - \beta^2}{2},$$

$$h = c\sqrt{\theta^2 + \beta^2}, \; H = c \cdot \theta \cdot \beta.$$

6.Тороидальные координаты *θ, α, β*.

$$0 \le \theta < \infty, \quad 0 \le \alpha < 2\pi, \quad -\pi \le \beta \le \pi;$$

$$x = \frac{c \cdot sh\theta \cdot \cos\alpha}{ch\theta - \cos\beta}, \quad y = \frac{c \cdot sh\theta \cdot \sin\alpha}{ch\theta - \cos\beta}, \quad z = \frac{c \cdot \cos\beta}{ch\theta - \cos\beta},$$

$$h = \frac{c}{ch\theta - \cos\beta}, \; H = \frac{c \cdot sh\theta}{ch\theta - \cos\beta}.$$

7. Бисферические координаты *θ, α, β*.

$$0 \le \theta < \infty, \quad 0 \le \alpha < 2\pi, \quad -\infty \le \beta \le \infty;$$

$$x = \frac{c \cdot \sin\theta \cdot \cos\alpha}{ch\beta - \cos\theta}, \quad y = \frac{c \cdot \sin\theta \cdot \sin\alpha}{ch\beta - \cos\theta}, \quad z = \frac{c \cdot \mathrm{sh}\,\beta}{ch\beta - \cos\theta},$$

$$h = \frac{c}{ch\beta - \cos\theta}, \; H = \frac{c \cdot \sin\theta}{ch\beta - \cos\theta}.$$

В этих системах координат, также как и в предыдущих системах, *c* - масштабный множитель.

Основные уравнения и постановка задач при динамическом, чистом сдвиге упругих тел

Рассмотрим в системах координат с осью сдвига упругое динамическое равновесие изотропного тела с упругими характеристиками μ и λ, ограниченного плоскостями $z = 0, \quad z = z_1$ и кусочно-гладкой цилиндрической поверхностью П, которая состоит из координатных поверхностей $\theta = \theta_i$ и $\alpha = \alpha_i$, где i=1,2. Заметим, что $\mu = \frac{E}{2(1+\nu)}$, $\lambda = \frac{\nu E}{(1-2\nu)(1+\nu)}$ или $\nu = \frac{\lambda}{2(\lambda+\mu)}$, $E = \frac{\mu(\lambda+\mu)}{3\lambda+2\mu}$;

E - модуль упругости, ν - коэффициент Пуассона, λ- модуль сдвига, λ- коэффициент податливости.

Пусть при $z = 0, \quad z = z_1 : \mathrm{u}_\theta = 0, \; \mathrm{u}_\alpha = 0, \quad \sigma_z = 0$, а на поверхности П отличной от нуля является только лишь та составляющая вектора внешнего напряжения или вектора смещения которая направлена вдоль z; составляющая эта не должна зависеть от z. u_θ и u_α -компоненты вектора смещения вдоль касательных к координатным линиям $\theta = \theta_0$ и $\alpha = \alpha_0$, σ_z -нормальная к плоскости z=const напряжение. Что касается вектора массовых сил, то отличной от нуля является лишь его проекция на z; проекция эта не должна зависеть от координаты z.

Изложенное выше соответствует динамическому чистому сдвигу в упругом теле (динамическое антиплоское напряженное состояние)[3].

Будем считать, что

$$\mathrm{u}_\theta = 0, \; \mathrm{u}_\alpha = 0, \quad \mathrm{u}_z = \mathrm{u}_z(\theta, \alpha, t)$$

где u_z - компонент вектора смещения вдоль координаты z , t - время. В этом случае из компонент тензора напряжения

$$T_{н}=\begin{pmatrix}\sigma_{\theta} & \tau_{\theta\alpha} & \tau_{\theta z}\\ \tau_{\alpha\theta} & \sigma_{\alpha} & \tau_{\alpha z}\\ \tau_{z\theta} & \tau_{z\alpha} & \sigma_{z}\end{pmatrix},$$

где σ_{θ}, σ_{α}, σ_{z} и $\tau_{\theta\alpha}=\tau_{\alpha\theta}$, $\tau_{\theta z}=\tau_{z\theta}$, $\tau_{z\alpha}=\tau_{\alpha z}$, соответственно нормальные и касательные напряжения, останутся лишь касательные напряжения

$$\tau_{\theta z}=\frac{\mu}{h}\frac{\partial \mathrm{u}_{z}}{\partial\theta}\ \text{и}\ \ \tau_{z\alpha}=\frac{\mu}{h}\frac{\partial \mathrm{u}_{z}}{\partial\alpha}, \tag{2.1}$$

А из уравнений движения, лишь уравнение

$$\frac{\partial\left(h\tau_{\theta z}\right)}{\partial\theta}+\frac{\partial\left(h\tau_{\theta\alpha}\right)}{\partial\alpha}-h^{2}\rho\frac{\partial^{2}\mathrm{u}_{z}}{\partial t^{2}}=-h^{2}Z\left(\theta,\alpha,t\right), \tag{2.2}$$

где ρ -плотность тела(ρ > 0), а $Z\left(\theta,\alpha,t\right)$ – массовая (объемная) сила [4]. Из (2.1) следует

$$\frac{\partial}{\partial\alpha}\left(\frac{h\tau_{z\theta}}{\mu}\right)-\frac{\partial}{\partial\theta}\left(\frac{h\tau_{z\alpha}}{\mu}\right)=0. \tag{2.3}$$

Из (2.1) и (2.2) следует

$$\begin{aligned} &a)\ \mu div\,\mathrm{grad}\,\mathrm{u}_{z}-\rho\frac{\partial^{2}\mathrm{u}_{z}}{\partial t^{2}}=-Z,\\ &b)\ \frac{\partial^{2}\mathrm{u}_{z}}{\partial\theta^{2}}+\frac{\partial^{2}\mathrm{u}_{z}}{\partial\alpha^{2}}-\frac{h^{2}\rho}{\mu}\frac{\partial^{2}\mathrm{u}_{z}}{\partial t^{2}}=-\frac{h^{2}}{\mu}Z. \end{aligned} \tag{2.4}$$

Естественно, к приведенным уравнениям добавляются граничные и начальные условия.

Введем обозначения $h\tau_{z\theta}=\tau_{\theta}$, $h\tau_{z\alpha}=\tau_{\alpha}$, $\mathrm{u}_{z}=\frac{a\mathrm{w}}{G}$, где $G=\sqrt{\mu}$, $a=const\left(a>0\right)$ тогда (2.2), (2.3), (2.1), (2.4) примут, соответственно, вид:

$$a)\ \frac{\partial\tau_{\theta}}{\partial\theta}+\frac{\partial\tau_{\alpha}}{\partial\alpha}-\frac{ah^{2}\rho}{\theta}\frac{\partial^{2}\mathrm{w}}{\partial t^{2}}=-h^{2}Z, \tag{2.5}$$

$$b)\ \frac{\partial}{\partial\theta}\left(\frac{\tau_{\alpha}}{G^{2}}\right)-\frac{\partial}{\partial\alpha}\left(\frac{\tau_{\theta}}{G^{2}}\right)=0;\tau_{\theta}=aG^{2}\frac{\partial}{\partial\theta},\tau_{\alpha}=aG^{2}\frac{\partial}{\partial\alpha}\left(\frac{\mathrm{w}}{G}\right);$$

$$a)\ div\ grad\ \mathrm{w}-\frac{\rho}{G^{2}}\frac{\partial^{2}\mathrm{w}}{\partial t^{2}}=-\frac{1}{aG}Z,\ \text{или (2.7)}$$

$$b)\ \Delta\mathrm{w}-\frac{\rho}{G^{2}}\frac{\partial^{2}\mathrm{w}}{\partial t^{2}}=-\frac{1}{aG}Z,\ \text{или}$$

$$c)\ \frac{\partial^{2}\mathrm{w}}{\partial\theta^{2}}+\frac{\partial^{2}\mathrm{w}}{\partial\alpha^{2}}-\frac{h\rho}{G}\frac{\partial^{2}\mathrm{w}}{\partial t^{2}}=-\frac{h^{2}}{aG}Z,$$

где $div grad\cdots=\Delta\cdots=\frac{1}{h^{2}}\left(\frac{\partial^{2}}{\partial\theta^{2}}+\frac{\partial^{2}}{\partial\alpha^{2}}\right)$.

Перейдем к постановке задач на множестве Ω×τ, где Ω={θ<θ<θ,α<α<α}, а τ=(0,τ) – конечный или бесконечный (если τ=(0,∞)) промежуток времени.

На множестве Ω×τ следует найти функцию w = w(θ, α, t), удовлетворяющую уравнению (2.7) и условиям:

$$\begin{aligned} &a)\gamma_{i1}\left(\alpha\right)\frac{\partial\mathrm{w}}{\partial\theta}+\gamma_{i2}\left(\alpha\right)\cdot\mathrm{w}=f_{1i}\left(\alpha,t\right) && при\ \ \theta=\theta_{i},\\ &b)\gamma_{i1}\left(\theta\right)\frac{\partial\mathrm{w}}{\partial\alpha}+\tilde{\gamma}_{i2}\left(\theta\right)\cdot\mathrm{w}=f_{2i}\left(\theta,t\right) && при\ \ \alpha=\alpha_{i},\\ &c)\ \mathrm{w}\big|_{t=0}=F_{1}\left(\theta,\alpha\right)\qquad и && \left.\frac{\partial\mathrm{w}}{\partial t}\right|_{t=0}=F_{2}\left(\theta,\alpha\right). \end{aligned} \tag{2.8}$$

В сз координатах когда 0<α<2π или - π <α<π, условия (2.8b) заменяются условиями периодичности. Здесь i=1,2; γ_{ij}, $\tilde{\gamma}_{ij}$, f_{ij}, F_1, F_2 – заданные функции, естественно, $\gamma_{i1}^2+\gamma_{i2}^2\neq 0$, $\tilde{\gamma}_{i1}^2+\tilde{\gamma}_{i2}^2\neq 0$. В угловых точках области (при наличии таких точек) выполняются условия согласования. Выполняются условия согласования и по времени, т.е. при *t* =0. $F_1(\theta,\alpha)$ – решение задачи (2.7), (2.8*a,b*), а $F_2(\theta,\alpha)$ –решение задачи $(2.7)_t$, $(2.8a,b)_t$, где индекс *t* означает дифференцирование *t* по уравнения и условия. Заметим, что условия (2.8*a,b*), обеспечивает при $\theta=\theta_i$ и $\alpha=\alpha_i$, задание смещения, -напряжения либо их сочетания.

При рассмотрении кусочно-однородного многослойного тела, будем предполагать, что упругие однородные слои контактируют по цилиндрическим поверхностям $\theta=const$ или $\alpha=const$. Если, например, контактные поверхности $\theta=\theta_{\bar{s}}$, где $\bar{s}$ номер контактной поверхности, причем $\bar{s}$=2,3,4,….,*l* , а *l* - количество слоев ($\theta=\theta_1$ и $\theta=\theta_{l+1}$ –граничные поверхности), то для каждого слоя

$$\tilde{\gamma}_{i1}(\theta)\frac{\partial \mathrm{w}}{\partial\alpha}+\tilde{\gamma}_{i2}(\theta)\cdot \mathrm{w}=f_{2i}(\theta,t) \qquad при\ \ \alpha=\alpha_i; \tag{2.9}$$

В сз координатах, когда 0 < α < 2π или -π < α < π, условия (2.9) заменяются условиями периодичности.

Здесь s − номер слоя, причем s=1, 2, 3,…,*l*. Предполагается выполнение условий согласования в угловых точках областей $\Omega_s=\{\theta_s<\theta<\theta_{s+1},\ \alpha_1<\alpha<\alpha_2\}$ и условий согласования по времени; на функцию Z_s при $\alpha=\alpha_i$ накладываются те же требования, что и на w_s.

На граничной поверхности $\theta=\theta_1$

$$\gamma_{11}(\alpha)\frac{\partial \mathrm{w}_1}{\partial\theta}+\gamma_{12}(\alpha)\cdot \mathrm{w}_1=f_{11}(\alpha,t); \tag{2.10}$$

На граничной поверхности $\theta=\theta_{l+1}$

$$\gamma_{21}(\alpha)\frac{\partial \mathrm{w}_l}{\partial\theta}+\gamma_{22}(\alpha)\cdot \mathrm{w}_l=f_{12}(\alpha,t); \tag{2.11}$$

На контактных поверхностях $\theta=\theta_{\bar{s}}$

$$\mathrm{w}_{\bar{s}-1}-\mathrm{w}_{\bar{s}}=\eta_{1\bar{s}}(\alpha,t) \text{ и } \tau_{\theta(\bar{s}-1)}-\tau_{\theta\bar{s}}=\eta_{2\bar{s}}(\alpha,t); \tag{2.12}$$

Начальные условия примут вид:

$$\mathrm{w}_s\big|_{t=0}=F_{1s}(\theta,\alpha),\qquad \frac{\partial \mathrm{w}_s}{\partial t}\bigg|_{t=0}=F_{2s}(\theta,\alpha). \tag{2.13}$$

В правых частях равенств стоят заданные функции.

Постановка задачи для указанного многослойного тела формулируется следующим образом.

Следует найти функцию

$$\mathrm{w}=\begin{cases}\mathrm{w}_1 & на\ множестве\ \Omega_1\times\tau_1,\\ \mathrm{w}_2 & на\ множестве\ \Omega_2\times\tau_2,\\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\\ \mathrm{w}_l & на\ множестве\ \Omega_l\times\tau_l,\end{cases} \tag{2.14}$$

такую, что на множестве удовлетворяют уравнению

$$\frac{\partial^2 \mathrm{w}_s}{\partial\theta^2}+\frac{\partial^2 \mathrm{w}_s}{\partial\alpha^2}-\frac{h^2\rho}{G_s^2}\frac{\partial^2 \mathrm{w}_s}{\partial t^2}=-\frac{h^2}{a_s G_s}Z_s \tag{2.15}$$

и условиям (2.9)-(2.13), когда s = 1,2,3,….,l (точнее, 1-ой слой удовлетворяет условиям (2.9), (2.10), (2.12), (2.13), *l* -ый слой- условиям (2.9), (2.11), (2.12), (2.13), а остальные слои- условиям (2.9), (2.12), (2.13)).

Поставленные задачи с формулированы в общем виде и не накладывалось никаких условий на внешние данные, равно как и не было указано, в каком классе функций ищется w. Все это целесообразно делать при постановке конкретных задач.

Заметим, что если рассматривается статическая задача об упругом чистом сдвиге $\left(\frac{\partial^2 \mathrm{w}}{\partial t^2}=0\right)$ и на контуре области задаются напряжения, тогда, как это следует из (2.5), задача становится статически определимой, т.е. решается в напряжениях (определяется из (2.6)) и вообще говоря, справедлива теорема Леви-Мичела, поэтому статическую задачу можно решать как в напряжениях (с введением функций напряжения) так и в смещениях. Целесообразность применения того или другого подхода зависит от граничных условий.

Заключение

Предложенный метод безо всякого изменения может быть использована для решения динамических задач теории упругости связанных с чистым кручением, плоско - деформированным и осесимметричным напряженным состоянием. Предлагаемый метод можно применит и для построения общего решения в системах координат с осью сдвига и в сферических координатах.

Список литературы:

1. Г. Арфкен, Математические методы в физике, Москва, 1970.

2. В. В. Новацкий, Теория упругости, Москва: Судпромгиз, 1958.

3. Ю. Н. Работнов, Механика деформируемого твердого тела; Москва: Наука, 1988.

ABOUT ONE PROBLEM FOR A RECTANGULAR SLAB

Tsitskishvili Z.,
Academically Doctor of Mathematical Sciences,Professor
Museridze R.,
Academic Doctor of Construction Sciences, assistant professor.
Chkheti V.,
PhD student. Georgian Technical University

ОБ ОДНОЙ ЗАДАЧЕ ДЛЯ ПРЯМОУГОЛЬНОЙ ПЛИТЫ

Цицкишвили З.А.
академически доктор матемаьтических наук, профессор
Мусеридзе Р.Р.
академический доктор строительных наук,
асистент-профессор
Чхетия В.Р.
студент
(Грузинский технический университет)
https://doi.org/10.5281/zenodo.10451496

Abstract

Determining the complete picture of the stress-strain state (SSS) of massive elements (bodies whose overall dimensions are of the same order) requires the use of three-dimensional models.

A special case of a massive element—a parallelepiped-shaped plate—is one of the most common objects used in technology.

A large number of works have been devoted to the problem of the equilibrium of a loaded elastic parallelepiped, but it remains relevant to the present day, since a closed solution has not yet been obtained.

Existing analytical solutions for three-dimensional problems of the theory of elasticity do not allow satisfying arbitrary boundary conditions on the faces of a parallelpiped.

In the work under consideration, for one class of boundary value problems using the method of separation of variables and double series, solutions to static boundary value problems of thermoelasticity for a rectangular coordinate parallelepiped are constructed.

Аннотация

Определение полной картины напряжённо–деформированного состояния (НДС) массивных элементов (тел, габаритные размеры которых имеют один порядок) требует использования трёхмерных моделей.

Частный случай массивного элемента —плита в форме параллелепипед — является одной из самых распространённых объектов, применяемых в технике.

Задаче о равновесии нагруженного упругого параллелепипеда посвящено большое количество работ, но она остаётся актуальной по настоящее время, поскольку замкнутого решения до сих пор не получено.

Существующие аналитические решения для трёхмерных задач теории упругости не позволяют удовлетворять произвольным граничным условиям на гранях параллелепипеда.

В рассматриваемой работе для одного класа граничных задач с использованием метода разделения переменных и двоиных рядов, строятся решения статических граничных задач термоупругости [1] для прямугольного координатного параллелепипеда.

Keywords: boundary value problem of thermoelasticity, stress-strain state, isotropic plate, equilibrium equations (without taking into account body forces), Equation of state (physical law or Hooke's law), heat equation, Sturm-Liouville problem, method of separation of variables, double series, convergence.

Ключевые слова: граничная задача термоупругости, напряжённо–деформированное состояние, изотропная плита , уравнения равновесия (без учета обьемных сил), Уравнение состояния (физический закон или закон Гука), уравнение теплопроводности, задачи Штурма-Лиувилля , метода разделения переменных, , двойные ряды, сходимость.

Рассмотрим прямоугольную плиту, которая занимает область

$\Pi = \{x_0 < x < x_1, y_0 < y < y_1, z_0 < z < z_1\}$, где x, y, z – прямоугольные координаты.

При $z = 0$ и $z = z_1$ вместе с температурным возмущением задаются либо напряжения, либо смещения, либо их сочетания. На боковых граничных $(x = x_0, x = x_1, y = y_0, y = y_1)$ задаются однородные граничные условия специального вида.

Если температурное поле не зависит от времени, а массовые силы отсутствуют, тогда упругое равновесие изотропного тела в декартовой прямоугольной системе координат описывается следующими уравнениями [1,2].

1. Уравнения равновесия (без учета объемных сил)

$$\left.\begin{aligned} a)\ &\frac{\partial N_x}{\partial x}+\frac{\partial S_{xy}}{\partial y}+\frac{\partial S_{xz}}{\partial z}=0,\\ b)\ &\frac{\partial N_y}{\partial y}+\frac{\partial S_{yz}}{\partial z}+\frac{\partial S_{yx}}{\partial x}=0,\\ c)\ &\frac{\partial N_z}{\partial z}+\frac{\partial S_{zx}}{\partial x}+\frac{\partial S_{zy}}{\partial y}=0, \end{aligned}\right\} \tag{1}$$

где N_x, N_y, N_z –нормальные напряжения, $S_{xy}=S_{yx}, S_{xz}=S_{zx}, S_{yz}=S_{zy}$ касательные напряжения.

2. Уравнение состояния (физический закон или закон Гука)

$$\left.\begin{aligned} N_x &= (\lambda+2\mu)\varepsilon_{xx}+\lambda\varepsilon_{yy}+\lambda\varepsilon_{zz}-\beta_0 T=(\lambda+2\mu)\frac{\partial \mathrm{u}}{\partial x}+\lambda\frac{\partial \mathrm{v}}{\partial y}+\lambda\frac{\partial \mathrm{w}}{\partial z}-\beta_0 T\\ N_y &= \lambda\varepsilon_{xx}+(\lambda+2\mu)\varepsilon_{yy}+\lambda\varepsilon_{zz}-\beta_0 T=\lambda\frac{\partial \mathrm{u}}{\partial x}+(\lambda+2\mu)\frac{\partial \mathrm{v}}{\partial y}+\lambda\frac{\partial \mathrm{w}}{\partial z}-\beta_0 T;\\ N_z &= \lambda(\varepsilon_{xx}+\varepsilon_{yy})+(\lambda+2\mu)\varepsilon_{zz}-\beta_0 T=\lambda\left(\frac{\partial \mathrm{u}}{\partial x}+\frac{\partial \mathrm{v}}{\partial y}\right)+(\lambda+2\mu)\frac{\partial \mathrm{w}}{\partial z}-\beta_0 T;\\ S_{yz} &= \mu\,\varepsilon_{yz}=\mu\left(\frac{\partial \mathrm{w}}{\partial y}+\frac{\partial \mathrm{v}}{\partial z}\right);\\ S_{xz} &= \mu\,\varepsilon_{xz}=\mu\left(\frac{\partial \mathrm{w}}{\partial x}+\frac{\partial \mathrm{u}}{\partial z}\right);\\ S_{xy} &= \mu\,\varepsilon_{xy}=\mu\left(\frac{\partial \mathrm{v}}{\partial x}+\frac{\partial \mathrm{u}}{\partial y}\right), \end{aligned}\right\} \tag{2}$$

где $\mathrm{u}, \mathrm{v}, \mathrm{w}$ компоненты вектора смещения $\vec{\mathrm{U}}$ вдоль координатных линии x, y, z; $\varepsilon_{xx}, \varepsilon_{yy}, \varepsilon_{zz}, \varepsilon_{zx}=\varepsilon_{xz}, \varepsilon_{zy}=\varepsilon_{yz}, \varepsilon_{xy}=\varepsilon_{yx}$ –деформации; λ и μ упругие характеристики (их выражения через технические характеристики E и ν смотри в [ ]); $T=\tilde{T}-T_0$ - относительная температура, $\tilde{T}$ - абсолютная температура, T_0 -начальная температура; $\beta_0=\frac{E\alpha_T}{1-2\nu}$, α_T -линейный коэффициент теплового расширения.

3. Уравнение теплопроводности [3]

$$\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}+\lambda^2\frac{\partial^2 T}{\partial z^2}=0, \tag{3}$$

λ -коэффициент теплопроводности. Верхный индекс T указывает, что соответствующие должны быть экспериментально определены при постоянном температурном (T) поле, а также при постоянном уровне деформации.

Пусть изотропная плита, ограниченная плоскостями декартовой, прямоугольной систем координат $oxyz$, занимает область $\Pi=\{x_0<x<x_1, y_0<y<y_1, z_0<z<z_1\}$. Граничные условия, которые фигурируют при постановке граничных задач имеют следующий вид:

$$\text{при } x=x_i:\ \left.\begin{aligned} &a)\ \frac{\partial T}{\partial x}=0, \mathrm{u}=0,\ S_{xy}=0,\ S_{xz}=0,\ \text{или}\\ &b)\ T=0, N_x=0,\ \mathrm{v}=0,\ \mathrm{w}=0 \end{aligned}\right\}, \tag{4}$$

$$\text{при } y = y_i: \left.\begin{array}{l} a)\dfrac{\partial T}{\partial y} = 0, \mathrm{v} = 0,\ S_{yx} = 0,\ S_{yz} = 0, \text{ или} \\ b) T = 0, N_y = 0,\ u = 0,\ \mathrm{w} = 0 \end{array}\right\}, \tag{5}$$

$$\text{при } z = z_i: \left.\begin{array}{ll} a)\ \mathrm{w} = f_1(x,y), & \mathrm{u} = f_2(x,y),\ \ \mathrm{v} = f_3(x,y) \quad \text{или} \\ b)\ N_z = F_1(x,y),\ S_{zx} = F_2(x,y), \mathrm{S}_{zy} = F_3(x,y) & \text{или} \\ c)\ \mathrm{w} = f_1(x,y), & S_{zx} = F_2(x,y), \mathrm{S}_{zy} = F_3(x,y) \quad \text{или} \\ \mathrm{d}) N_z = F_1(x,y),\ \mathrm{u} = f_2(x,y), & \mathrm{v} = f_3(x,y) \end{array}\right\}. \tag{6}$$

$$\text{при } z = z_i:\ a) T = t(x,y), \text{ или } b)\frac{\partial T}{\partial z} = \tilde{t}(x,y) \text{ или } c)\frac{\partial T}{\partial z} + \Theta_i T = \tilde{t}(x,y) \tag{7}$$

Здесь $i = 0,1$, причём $z_0 = 0$: Θ_i – заданные постоянные. Функции заданные на гранях плиты таковы, что на ребрах плиты выполняются условия согласования.

Введем обозначения:

$$\frac{\partial \mathrm{u}}{\partial x} + \frac{\partial \mathrm{v}}{\partial y} + \frac{\lambda}{\lambda + 2\mu}\frac{\partial \mathrm{w}}{\partial z} - \frac{\beta}{\lambda + 2\mu}T = \frac{K}{\lambda + 2\mu},\ \frac{\partial \mathrm{v}}{\partial x} - \frac{\partial \mathrm{u}}{\partial y} = \frac{1}{\mu}B, \tag{8}$$

тогда систему (1) можно переписать в следующем виде[4]:

$$\begin{aligned} &a)\frac{\partial K}{\partial x} - \frac{\partial B}{\partial y} + \frac{\partial S_{xz}}{\partial z} = 0, \\ &b)\frac{\partial B}{\partial x} + \frac{\partial K}{\partial y} + \frac{\partial S_{yz}}{\partial z} = 0, \\ &c)\frac{\partial \tau_{xz}}{\partial x} + \frac{\partial \tau_{yz}}{\partial y} + \frac{\partial K}{\partial z} + \frac{4\mu(\lambda+\mu)}{\lambda}\frac{\partial \mathrm{w}}{\partial z} = -\frac{2\mu\beta}{\lambda}\frac{\partial T}{\partial z}, \\ &d)\frac{\partial \tau_{yz}}{\partial x} - \frac{\partial \tau_{xz}}{\partial y} - \frac{\partial B}{\partial z} = 0. \end{aligned} \tag{9}$$

Используя (2) и (7) легко показать, что равенство $(8a)$ является тождеством. Т.к. в дальнейшем при решении граничных задач рассматриваемых в настоящей работе применяем метод разделения переменных, граничные условия представим в следующим образом:

$$\text{при } z = z_i: \left.\begin{array}{ll} a)\ \mathrm{w} = f_{i1}(x,y), & \Gamma_1(\mathrm{u},\mathrm{v}) = \tilde{f}_{i2}(x,y), \Gamma_2(\mathrm{v},\mathrm{u}) = \tilde{f}_{i3}(x,y) \quad \text{или} \\ b)\ N_z = F_{i1}(x,y), & \Gamma_1(S_{zx}, \mathrm{S}_{zy}) = \tilde{F}_{2i}(x,y), \Gamma_2(\mathrm{S}_{zy}, S_{zx}) = \tilde{F}_{3i}(x,y) \quad \text{или} \\ c)\ \mathrm{w} = f_{i1}(x,y), & \Gamma_1(S_{zx}, \mathrm{S}_{zy}) = \tilde{F}_{2i}(x,y), \Gamma_2(\mathrm{S}_{zy}, S_{zx}) = \tilde{F}_{3i}(x,y) \quad \text{или} \\ \mathrm{d}) N_z = F_{i1}(x,y), & \Gamma_1(\mathrm{u},\mathrm{v}) = \tilde{f}_{i2}(x,y), \Gamma_2(\mathrm{v},\mathrm{u}) = \tilde{f}_{i3}(x,y), \end{array}\right\} \tag{10}$$

где $\Gamma_1(\mathrm{g}_1, \mathrm{g}_2) = \dfrac{\partial \mathrm{g}_1}{\partial x} + \dfrac{\partial \mathrm{g}_2}{\partial y}$, $\Gamma_2(\mathrm{g}_2, \mathrm{g}_1) = \dfrac{\partial \mathrm{g}_2}{\partial x} - \dfrac{\partial \mathrm{g}_1}{\partial y}$, при этом $g_1 = S_{zx}$ или $g_1 = \mathrm{u}$, $g_2 = S_{zy}$ или $g_2 = \mathrm{v}$. Примем, что функции $\tilde{F}_{2i}(x,y), \tilde{F}_{3i}(x,y)$ сами, — $F_{i1}(x,y), \tilde{f}_{i2}(x,y)$ и $\tilde{f}_{i3}(x,y)$ функции вместе со своими первыми, — а $f_{i1}(x,y)$ функции в месте со своими первой и второй производными разлагаются в абсолютно и равномерно сходящиеся ряды Фурье по собственным функциям задачи[6]:

$$\Delta_2 \psi_{mn} + p^2 \psi_{mn} = 0; \tag{11}$$

$$\text{при } x = x_i: a)\ \psi_{mn} = 0 \text{ или } \mathrm{b})\frac{\partial \psi_{mn}}{\partial x} = 0, \tag{12}$$

$$\text{при } \mathrm{y} = y_i: a)\ \psi_{mn} = 0 \text{ или } \mathrm{b})\frac{\partial \psi_{mn}}{\partial y} = 0. \tag{13}$$

Далее, в работе [5] показано, что в термически однородной среде функцию T в области $\Pi = \{x_0 < x < x_1, y_0 < y < y_1, z_0 < z < z_1\}$, используя метод Фурье, можно представить следующим виде

$$T = \tilde{A}_0 + \tilde{A}_1 z + \sum_{n=0}^{\infty}\sum_{m=0}^{\infty}\left(A_{Tmn}e^{-\tilde{p}n} + B_{Tmn}e^{-\tilde{p}(z-z_1)}\right)\psi_{mn}(x,y), \tag{14}$$

где $\tilde{A}_0, \tilde{A}_1, \tilde{p} = \lambda^{0,5} p(m,n) \geq 0, A_{Tmn}, B_{Tmn}$ — постоянные; $\psi_{mn}(x,y)$ — нетривиальное решение соответствующей задачи Штурма-Лиувилля (см. (11)-(13)).

Следуя работе [4] для рассматриваемого класса Уравнение состояния (физический закон или закон Гука)для изотропной среды общее решение в классе регулярных функции можно представит в виде

$$\left.\begin{aligned} \mathrm{u} &= \frac{\partial}{\partial x}\left(\varphi_3 + \frac{1}{2\mu}\varphi_2\right) + \frac{1}{\mu}\frac{\partial \varphi_1}{\partial y}, \\ \mathrm{v} &= \frac{\partial}{\partial y}\left(\varphi_3 + \frac{1}{2\mu}\varphi_2\right) - \frac{1}{\mu}\frac{\partial \varphi_1}{\partial x}, \\ \mathrm{w} &= -\frac{\partial}{\partial z}\left(\varphi_3 + \frac{1}{2\mu}\varphi_2\right) + \frac{1}{\mu}\frac{\partial \varphi_2}{\partial z}. \end{aligned}\right\} \tag{15}$$

где функции $\varphi_1, \varphi_2, \varphi_3$ -решения соответствующих уравнений

$$\left.\begin{aligned} a)\ &\frac{\partial^2 \varphi_1}{\partial z^2} + \Delta_2 \varphi_1 = 0, \\ b)\ &\frac{\partial^2 \varphi_3}{\partial z^2} + \Delta_2 \varphi_3 = 0, \\ c)\ &\frac{\partial^2 \varphi_2}{\partial z^2} + \Delta_2 \varphi_2 = \frac{4\mu(\lambda+\mu)}{\lambda+2\mu}\frac{\partial^2 \varphi_3}{\partial z^2} + \frac{2\mu}{\lambda+2\mu}\beta_0 T. \end{aligned}\right\} \tag{16}$$

Приняв во внимание, что $\lambda = \frac{E\nu}{(1+\nu)(1-2\nu)}, \mu = \frac{E}{1+\nu}$, где E - модуль Юнга, а ν-коэффициент Пуассона. Полагая $T = \frac{\partial^2 \tilde{T}}{\partial z^2}$, третье уравнение примет вид

$$\frac{\partial^2 \varphi_2}{\partial z^2} + \Delta_2 \varphi_2 = \frac{E}{1-\nu^2}\frac{\partial^2 \varphi_3}{\partial z^2} + \frac{E(1-\nu)}{1-2\nu}\beta_0 \frac{\partial^2 \tilde{T}}{\partial z^2}. \tag{16'}$$

Общее решение этого уравнения имеет следующий вид: $\varphi_2 = \bar{\Phi}_2 + \tilde{\Phi}_2$, где $\bar{\Phi}_2 = \frac{E}{2(1-\nu^2)} z\frac{\partial \varphi_3}{\partial z} + \frac{E(1-\nu)\beta_0}{2(1-2\nu)} z\frac{\partial \tilde{T}}{\partial z}$ частное решение данного уравнения, а $\tilde{\Phi}_2$ - общее решение уравнения $\frac{\partial^2 \tilde{\Phi}_2}{\partial z^2} + \Delta_2 \tilde{\Phi}_2 = 0$.

Представления решения задач термоупругости используя функции $\varphi_1, \varphi_2, \varphi_3$ и T, позволяет аналитически выписать решения для целого ряда граничных задач.

Рассмотрим следующую граничную задачу. Пусть на плиту, занимающая область $\Pi = \{x_0 < x < x_1, y_0 < y < y_1, z_0 < z < z_1\}$, воздействует температурное поле T, на его поверхности заданы следующие граничные условия:

$$\begin{aligned} &x = x_0 : T = 0, K = 0, \mathrm{v} = 0, \mathrm{w}=0, \\ \text{При}\quad &x = x_1 : \frac{\partial T}{\partial x} = 0, \mathrm{u} = 0, B = 0, \tau_{xy} = 0; \end{aligned} \tag{17}$$

$$\text{При } \begin{matrix} y = y_0 : \dfrac{\partial T}{\partial y} = 0, \mathrm{v} = 0, B = 0, \tau_{xy} = 0, \\ y = y_1 : T = 0,\ K = 0, \mathrm{w} = 0, \mathrm{u} = 0; \end{matrix} \tag{18}$$

При $z = z_i \left(i = 0,1\right)$:

$$\mathrm{w} = f_{i1}\left(x, y\right), \quad \Gamma_1\left(\mathrm{u}, \mathrm{v}\right) = \tilde{f}_{i2}\left(x, y\right), \Gamma_2\left(\mathrm{v}, \mathrm{u}\right) = \tilde{f}_{i3}\left(x, y\right), T = t(x, y), \tag{19}$$

Тогда для нахождения упругого равновесия плиты, функциям T, φ_2, φ_3 и φ_1 придадим следующий вид:

$$\begin{aligned} T &= \sum_{n=0}^{\infty}\sum_{m=0}^{\infty}\frac{1}{p_T^2}\left(A_{Tmn}e^{-pz} + B_{Tmn}e^{-p\left(z-z_1\right)}\right)\cos\left(\bar{m}x\right)\sin\left(\bar{n}y\right), \\ \varphi_1 &= \sum_{n=0}^{\infty}\sum_{m=0}^{\infty}\left(A_{1mn}e^{-pz} + B_{1mn}e^{-p\left(z-z_1\right)}\right)\sin\left(\bar{m}x\right)\cos\left(\bar{n}y\right), \\ \varphi_3 &= \sum_{n=0}^{\infty}\sum_{m=0}^{\infty}\left(A_{3mn}e^{-p_1 z} + B_{3mn}e^{-p_1\left(z-z_1\right)}\right)\cos\left(\bar{m}x\right)\sin\left(\bar{n}y\right), \\ \varphi_2 &= \sum_{n=0}^{\infty}\sum_{m=0}^{\infty}\left(A_{2mn}e^{-p_1 z} + B_{2mn}e^{-p_1\left(z-z_1\right)}\right)\cos\left(\bar{m}x\right)\sin\left(\bar{n}y\right), \end{aligned} \tag{20}$$

где $\bar{m} = \dfrac{m\pi}{2x_1}$, $m = 0,1,2,3,\cdots$; $\bar{n} = \dfrac{n\pi}{2y_1}$, $n = 0,1,2,3,\cdots$.

Выражения для смещений и напряжений можно записать следующим образом.

$$\left.\begin{aligned} \mathrm{u} &= \frac{1+\nu}{E}\frac{\partial\tilde{\Phi}_2}{\partial x} + \frac{\partial\tilde{\Phi}_3}{\partial x} + \frac{E}{2\left(1-\nu\right)}z\frac{\partial^2\tilde{\Phi}_3}{\partial x\partial z} + \frac{1-\nu^2}{1-2\nu}\beta_0 z\frac{\partial^2\tilde{T}}{\partial x\partial z} + \frac{2\left(1+\nu\right)}{E}\frac{\partial\tilde{\Phi}_1}{\partial y}, \\ \mathrm{v} &= \frac{1+\nu}{E}\frac{\partial\tilde{\Phi}_2}{\partial y} + \frac{\partial\tilde{\Phi}_3}{\partial y} + \frac{E}{2\left(1-\nu\right)}z\frac{\partial^2\tilde{\Phi}_3}{\partial y\partial z} + \frac{1-\nu^2}{1-2\nu}\beta_0 z\frac{\partial^2\tilde{T}}{\partial y\partial z} - \frac{2\left(1+\nu\right)}{E}\frac{\partial\tilde{\Phi}_1}{\partial x}, \\ \mathrm{w} &= -\frac{1-2\nu}{2\left(1-\nu\right)}\frac{\partial\tilde{\Phi}_3}{\partial z} + \frac{1+\nu}{E}\frac{\partial\tilde{\Phi}_2}{\partial z} + \frac{1}{2\left(1-\nu\right)}z\frac{\partial^2\tilde{\Phi}_3}{\partial z^2} + \frac{1-\nu^2}{2\left(1-2\nu\right)}\beta_0\frac{\partial\tilde{T}}{\partial z} + \frac{1-\nu^2}{2\left(1-2\nu\right)}\beta_0 z\frac{\partial^2\tilde{T}}{\partial z^2}. \end{aligned}\right\}$$

$$\left.\begin{aligned} \Gamma_1\left(\mathrm{u}, \mathrm{v}\right) &= \frac{1+\nu}{E}\left(\frac{\partial^2\tilde{\Phi}_2}{\partial x^2} + \frac{\partial^2\tilde{\Phi}_2}{\partial y^2}\right) + \frac{E}{2\left(1+\nu\right)}\frac{\partial}{\partial z}\left(\frac{\partial\tilde{\Phi}_3}{\partial x} + \frac{\partial\tilde{\Phi}_3}{\partial y}\right) + \frac{1-\nu^2}{1-2\nu}\beta_0 z\frac{\partial}{\partial z}\left(\frac{\partial\tilde{T}}{\partial x} + \frac{\partial\tilde{T}}{\partial y}\right), \\ \Gamma_2\left(\mathrm{v}, \mathrm{u}\right) &= \frac{\partial\mathrm{v}}{\partial x} - \frac{\partial\mathrm{u}}{\partial y} = -\frac{2\left(1+\nu\right)}{E}\left(\frac{\partial^2\tilde{\Phi}_1}{\partial x^2} + \frac{\partial^2\bar{\Phi}_1}{\partial y^2}\right). \end{aligned}\right\}$$

Постоянные A_{lmn}, B_{lmn} с учетом (17) –(20) и последних формул, определяются из систем линейных алгебраических уравнений. Так например, для определения постоянных A_{1mn}, B_{1mn} получим следующую систему алгебраических уравнений:

$$\left.\begin{aligned} A_{1mn} + B_{1mn}e^{-pz_1} &= \frac{E}{2p\left(1+\nu\right)}\bar{f}_{omn} \\ A_{1mn}e^{-pz_1} + B_{1mn} &= \frac{E}{2p\left(1+\nu\right)}\bar{f}_{1mn} \end{aligned}\right\}$$

где $\bar{f}_{omn}$ и $\bar{f}_{1mn}$ соответственно, коэффициенты Фурье функции $\tilde{f}_{i3}\left(x, y\right)$ разложенных в ряд Фурье по функциям ψ_{mn}.

Несложно доказать и сходимость соответствующих функциональных рядов в замкнутой области $\bar{\Pi}$, построением сходящегося числового ряда, мажорирующего в $\bar{\Pi}$ эти функциональные ряды. Совершенно аналогично решаются и другие граничные задачи для плиты.

Список литературы:

1. Тимошенко С.М., Гудер Дж. - Теория упругости. Москва, ”Наука”, 1975.
2. Демидов С.П. - Теория упругости.Москва, ”Высшая школа”, 1979.
3. КоваленкотА.О. - Основы теормоупругости. Киев, ”Наукова думка”, 1970.
4. Горгидзе Д.А. Основные уравнения термоэлектроупругости и общие решения в обобщенных цидиндрических координатах//Труды международного симпозиума по проблемам механики сплошных сред.Тбилиси, 1997.
5. Khomasuridze N.G. Thermotlastic stresses of Mulltilaye Cylindrical Bodies.// Jornal of Thermal Stresses. 24 : 919-936,2001.
6. Тихонов А. Н., Самарский А. А. - Уравнения математической физики, М., 1951.

ADVANTAGES OF METAL STRUCTURES COMPARED TO CONCRETE IN CONSTRUCTION

Zuleta Diana Patricia
Alvarado Natalia
Professor, UTE University, Faculty of Architecture and Urbanism, Quito, Ecuador

ПРЕИМУЩЕСТВА МЕТАЛЛИЧЕСКИХ КОНСТРУКЦИЙ ПО СРАВНЕНИЮ С БЕТОННЫМИ В СТРОИТЕЛЬСТВЕ

Сулета Диана Патрисия
Альварадо Наталия
Профессор, Университет UTE, Факультет Архитектуры и Урбанистики, г. Кито, Эквадор
https://doi.org/10.5281/zenodo.10451515

Abstract

This scientific article represents a detailed and comparative analysis of metal and concrete structures, two key options in the field of construction. The assessment focuses on several dimensions, covering key aspects such as structural strength, durability over time, environmental sustainability, and associated costs. Data for the analysis were obtained from a wide range of real structures, from skyscrapers to bridges, providing a solid foundation for the study.

Rigorous methods were applied, including static and dynamic tests, as well as life cycle analysis to obtain accurate and meaningful results. This multidisciplinary approach allowed for a comprehensive understanding of the advantages and challenges associated with each type of construction. The conclusions drawn provide valuable guidance for engineers, architects, and decision-makers in the construction industry.

Аннотация

Настоящая научная статья представляет собой детальный и сравнительный анализ металлических и бетонных конструкций, двух ключевых вариантов в области строительного дела. Оценка фокусируется на нескольких измерениях, охватывая ключевые аспекты, такие как структурная прочность, долговечность в течение времени, экологическая устойчивость и связанные с этим расходы. Данные для анализа были получены из широкого спектра реальных строений, от небоскребов до мостов, обеспечивая прочную основу для исследования.

Применялись строгие методы, включая статические и динамические испытания, а также анализ жизненного цикла для получения точных и значимых результатов. Этот многопрофильный подход позволил получить всестороннее понимание преимуществ и сложностей, связанных с каждым типом конструкции. Сделанные выводы предоставляют ценное руководство для инженеров, архитекторов и принимающих решения в строительной отрасли.

Keywords: Metal structures, concrete, construction, strength, durability.
Ключевые слова: Металлические конструкции, бетон, строительство, прочность, долговечность.

Введение:

С течением времени строительная индустрия сталкивается с постоянным вызовом выбора оптимальных материалов для создания структур, способных выдерживать разнообразные нагрузки при максимальной долговечности. Металлические конструкции, такие как стальные фермы и алюминиевые компоненты, выделяются своей уникальной способностью обеспечивать не только выдающуюся прочность, но и легкость в сравнении с традиционным бетоном [1].

Приведем несколько реальных примеров успешного применения металлических конструкций. Знаменитый мост Голден-Гейт в Сан-Франциско — яркий пример эффективного использования стальных кабелей и балок для поддержки огромных нагрузок при минимальной массе конструкции[2]. Этот мост стал архитектурным символом не только благодаря своей изысканной форме, но и благодаря применению металла, обеспечивающего надежность в условиях зон с высокой сейсмической активностью.

Еще одним важным примером является высотное здание Бурдж Халифа в Дубае. Структурные элементы этого небоскреба включают в себя металлические компоненты, что обеспечивает не только высокую прочность, но и удивительную легкость конструкции при такой внушительной высоте[3]. Этот пример подчеркивает эффективность металлических материалов в создании структур с экстремальными параметрами.

Такие реальные проекты служат обоснованием не только для применения металлических конструкций в различных сценариях строительства, но и для продвижения инновационных подходов в создании структур, отвечающих современным требованиям прочности и легкости[4]. В свете этих факторов, наше исследование направлено на более глубокое понимание преимуществ металла и его

решающей роли в эволюции строительной индустрии.

Материалы и Методы:

Проведение тщательного сравнения металлических и бетонных конструкций требует детального анализа, охватывающего все аспекты, начиная от фундаментальных характеристик до устойчивости в эксплуатационных условиях.

1. **Сбор данных:** Выборка данных была осуществлена на основе реальных строительных проектов, включающих в себя небоскреб с металлической конструкцией и мост с бетонной основой. Полученные данные о материалах, размерах, геометрии и условиях нагрузки были детально изучены и использованы в дальнейшем анализе[5].

2. **Анализ прочности:** Прочность материалов была одним из ключевых аспектов исследования[6]. Для металлических конструкций были использованы следующие формулы:

- **Прочность на растяжение (*Rt*):**

$$Rt=\sigma y \cdot A$$

- **Прочность на изгиб (*Rf*):**

$$Rf=SM$$

Где σy - прочность на растяжение материала, A - площадь поперечного сечения, M - момент приложенной силы, а S - модуль сечения.

Для бетонных конструкций, где прочность на сжатие (Rc) также была важным параметром:

- **Прочность на сжатие (*Rc*):**

$$Rc=fc \cdot A$$

Такой детальный анализ позволил точно определить, какой материал обладает преимуществами в различных аспектах прочности.

3. **Анализ Долговечности:** Одним из основных критериев выбора материала является его способность сохранять прочность и структурную целостность в течение времени. Для оценки долговечности металлических конструкций проводились тесты на устойчивость к коррозии, в то время как для бетонных конструкций проводились тесты на стойкость к износу. Результаты этих тестов предоставили важную информацию о том, как каждый материал поддерживает свою структуру в различных условиях.

4. **Анализ Устойчивости:** Важным компонентом современной инженерии является учет воздействия строительства и эксплуатации на окружающую среду. Анализ жизненного цикла (АЖЦ) был применен для оценки совокупного воздействия обоих типов конструкций на окружающую среду. Углеродный след, внедренная энергия и возможность переработки были включены в этот анализ[7,8].

Этот подход к сбору и анализу данных позволяет получить глубокое понимание преимуществ и ограничений каждого материала в различных сценариях строительства и эксплуатации.

Обсуждение Результатов:

Проанализированные результаты предоставляют уникальный взгляд на преимущества и недостатки металлических и бетонных конструкций, с фокусом на ключевых параметрах.

В контексте прочности, результаты указывают на явное преимущество металлических конструкций в области сопротивления растяжению, что делает их более подходящими для приложений, где важна гибкость и устойчивость к деформациям. С другой стороны, бетонные конструкции проявляют более высокую прочность на сжатие, что делает их идеальным выбором для ситуаций, где необходима устойчивость к тяжелым нагрузкам.

Важно отметить, что данные, представленные в Таблице 1, представляют лишь примерные значения, и реальные характеристики могут варьироваться в зависимости от конкретных условий проектирования и материалов.

Таблица 1

Сравнительная Прочность

Тип Конструкции	Прочность на Растяжение (МПа)	Прочность на Сжатие (МПа)
Металлическая	450	-
Бетонная	-	35

При обсуждении долговечности, результаты подчеркивают, что металлические конструкции более подвержены коррозии в условиях агрессивных окружающих сред, в то время как бетонные конструкции проявляют более высокую стойкость к износу, особенно в условиях высокой влажности или химического воздействия[9].

Вопрос устойчивости также играет важную роль в современной инженерии, особенно с учетом стремления к устойчивым и экологически чистым решениям. Результаты анализа жизненного цикла подчеркивают, что металлические конструкции, несмотря на их возможность переработки, требуют более высокого энергопотребления в процессе производства по сравнению с бетонными конструкциями. Это поднимает вопросы о общей экологической эффективности и устойчивости в течение времени.

Проанализированные данные не только предоставляют инженерам и архитекторам ценную информацию для принятия решений, но и подчеркивают необходимость учета контекста и спецификаций каждого проекта при выборе оптимального строительного материала.

Данный подробный анализ материалов и методов, а также обсуждение результатов, подчеркивают важность комплексного подхода к выбору конструкционных материалов, учитывая не только прочность, но и долговечность, устойчивость к различным условиям эксплуатации и экологическую устойчивость[10].

Анализ результатов предоставил углубленное понимание преимуществ и недостатков металлических и бетонных конструкций. На основе полученных данных составим таблицу, выявляющую ключевые характеристики каждого материала.

Таблица 2

Сравнение Преимуществ и Недостатков

ХАРАКТЕРИСТИКА	МЕТАЛЛИЧЕСКИЕ КОНСТРУКЦИИ	БЕТОННЫЕ КОНСТРУКЦИИ
ПРЕИМУЩЕСТВА		
ПРОЧНОСТЬ НА РАСТЯЖЕНИЕ	Высокая прочность на растяжение, гибкость	Прочность на сжатие, подходит для тяжелых нагрузок
СРОК СЛУЖБЫ	Могут быть долговечны, при правильной защите от коррозии	Отличная стойкость к износу в условиях нормальной влажности и химической активности
ВЕС	Легкие по сравнению с бетоном, что упрощает транспортировку и установку	Тяжелые, что может быть преимуществом для устойчивости к вибрациям и стихийным бедствиям
ПРОИЗВОДСТВО	Требуют меньше энергии для производства, более поддаются переработке	Требуют больше энергии, но могут быть устойчивыми в течение долгого срока эксплуатации
НЕДОСТАТКИ		
КОРРОЗИЙНАЯ СТОЙКОСТЬ	Могут подвергаться коррозии в агрессивных средах	Высокая коррозийная стойкость, но могут подвергаться расколам при воздействии химически активных сред
СТОИМОСТЬ	Возможно более высокие первоначальные затраты на материал	Обычно более доступные по стоимости в производстве и строительстве
АРХИТЕКТУРНАЯ ГИБКОСТЬ	Ограничены в архитектурных формах из-за свойств материала	Могут быть легко адаптированы для различных архитектурных решений
ГДЕ ИСПОЛЬЗОВАТЬ		
СТРОИТЕЛЬСТВО НЕБОСКРЕБОВ	Легкость и прочность могут быть востребованы в высотных зданиях	Бетонные конструкции могут быть предпочтительными для небоскребов из-за их стойкости к тяжелым нагрузкам
МОСТЫ И ИНФРАСТРУКТУРА	Преимущество легкости при строительстве и транспортировке	Бетонные конструкции предоставляют стабильность и устойчивость в инфраструктурных проектах
ПРОМЫШЛЕННЫЕ ЗДАНИЯ	Гибкость и возможность быстрой установки	Бетонные конструкции предоставляют долговечность и устойчивость в промышленных условиях
ЭСТЕТИЧЕСКИЕ РЕШЕНИЯ	Ограниченные архитектурные возможности, но могут быть покрыты различными материалами	Имеют большую архитектурную гибкость и могут быть легко интегрированы в различные дизайны

Эта таблица демонстрирует, что выбор между металлическими и бетонными конструкциями зависит от конкретных потребностей проекта. Металлические конструкции подходят для ситуаций, где важны легкость и гибкость, в то время как бетонные конструкции предоставляют стабильность и устойчивость в условиях высоких нагрузок[3,4].

Важно также отметить, что оба материала имеют свои места в различных контекстах, и иногда комбинирование обоих может предложить оптимальное решение для конкретного проекта. Окончательное решение должно учитывать баланс между требованиями по прочности, долговечности, стоимости и экологической устойчивости.

Заключение:

В результате тщательного анализа металлических и бетонных конструкций можно сделать несколько важных выводов, которые могут оказать влияние на решения в области строительства и инженерии.

1. **Прочность и Применение:** Металлические конструкции обладают высокой прочностью на растяжение и гибкостью, что делает их отличным выбором для приложений, требующих устойчивости к деформациям. Однако, бетонные конструкции проявляют более высокую прочность на сжатие, что делает их предпочтительными в ситуациях с тяжелыми нагрузками.

2. **Долговечность и Устойчивость:** В условиях агрессивных окружающих сред, металлические конструкции могут подвергаться коррозии, в то время как бетонные конструкции проявляют высокую стойкость к износу. Это делает бетонные конструкции предпочтительными в условиях высокой влажности или химического воздействия.

3. **Экологическая Устойчивость:** Анализ жизненного цикла подчеркивает, что металлические конструкции более поддаются переработке, но требуют больше энергии в процессе производства по сравнению с бетонными конструкциями. Это важное обстоятельство, которое следует учитывать при оценке общей экологической эффективности.

4. **Контекст Проекта:** Решение о выборе конструкционного материала должно быть принято

с учетом контекста каждого проекта. Спецификации, условия эксплуатации и окружающая среда играют критическую роль в определении оптимального варианта.

В целом, выбор между металлическими и бетонными конструкциями зависит от конкретных требований проекта и целей, учитывая прочность, долговечность, стойкость к различным условиям эксплуатации и экологическую устойчивость. Инженеры и архитекторы должны принимать решения, исходя из комплексного анализа, который учитывает все аспекты каждого конкретного случая.

Список литература:

1. Иванов, Алексей П. (2020). Преимущества металлических конструкций в современном строительстве. Журнал Строительства, 25(3), 45-56.

2. Сидоров, Петр Н. (2018). Технологии строительства: Металлические и бетонные конструкции. Издательство "СтройМир".

3. Козлов, Владимир С. (2015). Исследование прочности металлических конструкций. Московский Технический Университет, Факультет Инженерии.

4. Федеральный Институт Строительства. (2021). Стандарты и Нормы в Строительстве. http://www.fis.ru/standards.

5. Петров, Андрей В. (Ed.). (2019). Современные Тенденции в Строительстве. Издательство "СтройПресс".

6. Николаев, Дмитрий М. (2017). Инновации в строительстве: металлические конструкции. Международная Конференция по Строительству, Санкт-Петербург, 112-125.

7. ГОСТ 12345-2018. (2018). Строительные материалы: Металлические конструкции.

8. Романов, Сергей И. (2022). Интервью: Тенденции в применении металлических конструкций. Журнал Инженерных Решений, 40(5), 22-30.

9. Смирнов, Егор А. (2016). Система укрепления металлических конструкций. Патент RU 1234567.

10. Гаврилов, Иван С. (2014). Анализ применения металлических конструкций в строительстве. Отчет Федерального Агентства по Строительству.

INFORMATION TECHNOLOGIES IN EDUCATION MANAGEMENT

Ali Sabzaliyev,
Nakhchivan State University lecturer
ORCID iD: https://orcid.org/0009-0007-1755-4500
Annagi Asgarov Musa oglu
Nakhchivan State University lecturer
ORCID iD: https://orcid.org/0009-0004-1767-2863
https://doi.org/10.5281/zenodo.10451565

Abstract

The article describes the features of using information technologies in the management of education. Two main directions are described: the management of a higher education institution as an organization and the management of knowledge delivery. Two main principles of higher education institution management have been identified: hierarchy and cyclicity. The education system is considered a complex organizational-technical system. The formation of the structure of educational materials is described.

Keywords: education, education management, information, information technologies, management information technologies, education information technologies.

The adoption of information technologies in the administration of educational processes is linked to the development of a new management paradigm — the information space. This evolving space is underpinned by the utilization of network technologies, which include comprehensive global and local networks, as well as the establishment of resource centers within these networks, all operated through advanced network management technologies [4]. Presently, information technologies (IT) and information systems (IS) constitute crucial components of educational management frameworks [1]. The deployment of these technologies is nearly universal across educational systems in operation, which rely extensively on telecommunication systems and resource centers as their foundational infrastructure.

The primary objectives of employing information technologies in the management of education are manifold. They aim to bolster the dependability of the educational processes and the environments in which they occur. By leveraging such technologies, educational institutions aim to enhance the robustness and efficiency of their educational delivery, ensuring that students and educators alike can rely on a stable and dynamic educational infrastructure. This, in turn, supports the broad goal of elevating the quality of education and facilitating a more effective learning experience. Information technologies are instrumental in achieving these goals by providing the necessary tools and platforms to manage educational resources and processes more effectively [1].

Information Management Processes and Models in Education

Information management processes and models play a transformative role in the educational sector. The core of education management now increasingly relies on the sophisticated interplay between information methods and technologies. These are not standalone elements but are built upon the foundational principles of information management. These principles are multifaceted, involving the strategic use of information space—a virtual environment where data is stored, accessed, and manipulated. Network technologies are the backbone of this space, providing the infrastructure for connectivity and data exchange. Within these networks, we observe meticulously structured information architectures composed of hierarchical information structures, well-defined information models, and discrete information units. Each of these components serves a specific function, from data organization to process modeling and the execution of informational transactions.

The application of IT in education unfolds in two principal trajectories. Firstly, there is the organizational aspect, where IT is leveraged to streamline the management of an educational institution as a corporate entity. This encompasses the holistic management of human resources, overseeing the careful allocation and tracking of budgets, meticulous planning and scheduling, rigorous registration processes, and the implementation of control mechanisms to ensure that all operations align with the institution's objectives.

Secondly, there is the pedagogical aspect, focusing on the management of educational processes—essentially, the facilitation and delivery of knowledge. This involves deploying IT systems that support curriculum development, enable innovative teaching methodologies, and provide platforms for e-learning and digital resource distribution. The goal is to ensure that knowledge transfer is not only efficient but also effective, engaging, and adaptable to the diverse needs of learners.

Within these overarching domains, information management in education is a multidimensional endeavor. It requires a balance between technology and human-centric approaches. On one hand, it demands a seamless integration of data systems to support decision-making and administrative efficiency. On the other hand, it calls for a sensitivity to the human elements of education—recognizing that behind every data point is a student, educator, or staff member whose needs and experiences are paramount.

The management of personnel, for instance, is not just about maintaining staff records or tracking attendance. It is about understanding the career trajectories of educators, identifying training needs, fostering professional development, and creating an environment where talent is recognized and nurtured. Budget management transcends mere accounting; it involves strategic financial planning to ensure that educational programs are well-funded and that resources are allocated in a manner that maximizes educational outcomes.

Similarly, planning in an educational context is an intricate process. It involves not only setting academic calendars and scheduling classes but also preparing for long-term developments in the educational landscape, anticipating future learning trends, and preparing institutions to adapt and thrive in a changing world.

Registration and control processes, while administrative in nature, have a direct impact on the student experience. Efficient registration systems reduce bureaucratic hurdles for students, while control mechanisms ensure that educational standards are upheld, and that the institution's integrity is maintained.

Finally, the delivery of knowledge is perhaps the most critical aspect of IT-based management in education. Here, information technologies are not mere tools but catalysts for educational innovation. They empower educators to curate and disseminate knowledge in ways that were previously unimaginable, support personalized learning experiences, and open doors to global information resources.

In light of these expansive roles, it's clear that IT-based management in education is not just about adopting technology; it's about reshaping the entire educational ecosystem. It requires a nuanced understanding of how information flows, how it can be optimized, and how it serves the ultimate goal of enriching the educational journey for all stakeholders involved [6].

Management of Educational Institutions

The management of educational institutions is based on the developmental model of the management object. The development of the management object is governed by management operations and patterns that are either interrelated with the organization or occur within it. The concept of information management includes cyclicality and hierarchy.

Cyclicality in management refers to the implementation of management in cycles, while hierarchy pertains to the hierarchical relationship of the main components of management. These components include information technology, information design, information model, and information unit.

Information design is the generalized description of a set of related information models that perform an integrated general function, while the information model performs a differentiated function. Information units are components of models or information processes. In managing an educational institution, information sections mainly perform communication functions [8].

The essence of managing higher education institutions lies in the fact that information models, which simulate management operations, influence the management object or its parts to change the situation of the organization in the direction determined by the development strategy of educational institutions. Essentially, such a management information model is a generalized concept of a business process.

The state of an educational institution as a complex organizational-technical system depends on many factors and numerous operations. This correlates the operations as procedural models of management and the decision-making processes as the implementation of these opportunities. Therefore, the purpose of making control decisions is to determine the rules of operation execution, taking into account its technological features and external factors.

In the management of educational institutions, resources are objects of various compositions, hence their interpretation also varies. These can be information, time, money, materials, equipment, intellectual property, geographical factors, space allocation, operations, knowledge, etc.

Information management can be presented as a series of methods to achieve the organization's goals. Certain rules are used to formalize such management.

The staff of educational institutions is the most important source of providing high-quality education. The level of expertise of the staff ensures the quality of knowledge and skills of future specialists. The quality of staff management in educational institutions reflects the effectiveness of institutional management. It comprises the optimal coordination of the interests of employees and employers, provision of working conditions for employees, and achieving high results in the activities of the educational institution.

The quality of staff management in higher education institutions can be understood as the efficiency of performing staff management functions that ensure the optimal coordination of the interests of employees and employers. It creates comfortable living conditions for employees and achieves a high level of education. This determines the life situation of the collective as one of the characteristics of staff management in an educational institution.

Management of Teaching Processes

In the context of education, information technologies in education must efficiently complete the teaching process of any form of education. The management of education can be accepted as the management of educational technologies. There are three main groups of information management technologies: information support or support for the educational process; teaching, methodological, and organizational support; information-educational interaction. In this type of management, the perception factor, which is related to the cognitive abilities of students and teachers, plays an important role [2].

Information provision includes obtaining information that allows teachers and students to acquire general knowledge about the goals and tasks of education. This block includes: creating electronic versions of schedules and workloads; compiling electronic catalogs of the library funds of higher education institutions; compiling electronic catalogs of existing electronic libraries; describing academic discipline in terms of educational standards; links to similar sites on the

topic; a list of information resources to support the course.

Teaching, methodological, and organizational support contains instructions and materials for using this educational technology. It forms the basis of the system and is not openly available to users. The components of this block are: electronic educational materials and their archived versions; electronic training modules; education plans; instructions for mastering the subject; user help files.

As a part of information support for teaching, the teacher ensures the compilation of assignments and guides the student in learning the necessary material. Mainly, this function consists of establishing a sequence of actions while studying the material, monitoring the learning dynamics, and communicating with the student when necessary. The instructor also facilitates the exchange of information among students and supports the development of interactive student groups around the course. This arises from the tasks of information management and is implemented with information management methods [5, 3]. The primary role of the teacher is not only to be a highly skilled specialist in a certain knowledge area but also to be the information integrator of the teaching process and teaching support. The idea of information teaching systems [8] is the teacher's study and use of electronic information resources. This problem is resolved as part of the student's independent work based on interactive information technologies and electronic materials. In this case, the teacher (as part of the information support) answers students' questions or offers additional information related to the given topic.

In special cases, if problems with understanding the material arise, the student personally approaches the teacher for clarification. However, this occurs rarely, and the teacher provides more detailed answers to the student's individual questions rather than giving information based on a general abstract scheme. Certification is carried out for each teaching block, and an exam is given at the end of the full course. Generalizing various forms of training, we can note that the educational process in preschool education consists of the following blocks (fig.):"

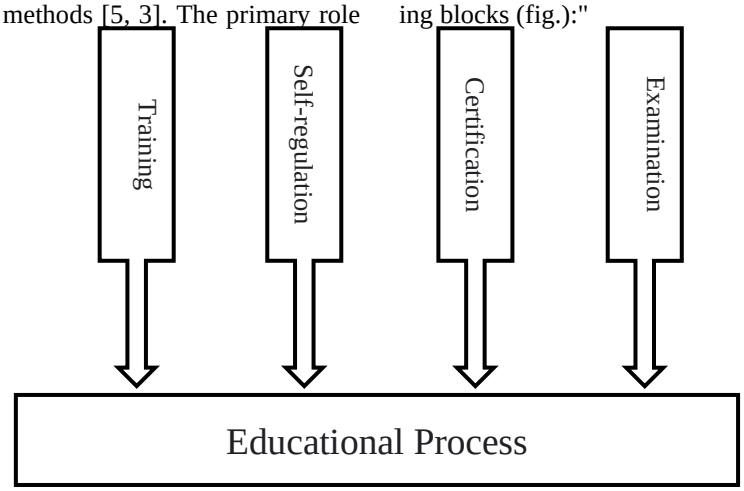


***Figure**. Components of the teaching process organization.*

- Education - The study of structured theoretical material with the possibility to repeat the source on a local computer for in-depth learning or to print it;

- Self-regulation - Independent study of material on individual issues with feedback to electronic sources of theoretical material;

- Certification is an intermediate control implemented as an interactive block of various types of questions, which allows both the students and teachers to assess the breadth and depth of the knowledge they have acquired on a section of the academic subject;

- Examination is the final control stage that takes into account the results of the intermediate certification and current grades for the overall subject course. The examination is organically integrated into the learning process and is not a separate act of learning.

Conclusion

The management of information technologies represents the direction of intensively developing technologies in the education system. Information management in education covers the needs associated with the traditional model of education and provides specific opportunities not implemented in it. Information education technology combines methods and tools that use the latest ICT developments to ensure the continuous assimilation of knowledge and skills for future professional activities. In general, summarizing the existing experience, the following conclusions can be drawn. The development of information technologies for the management of education is based on the use of specialized information resources. The organization and management of modern educational institutions are impossible without the use of information and communication technologies.

References:

1. Andreev A.A., Ozherelyeva T.A. Management of network educational resources // Slavic Forum. 2012. 2 (2). pp.80-83

2. Bolbakov R.G. Development and application of methods and algorithms of cognitive semantics in multimedia educational portal systems. / Ph.D. thesis Specialty 05.13.01. Moscow: MGTU MIREA, 2013

3. Elsukov P.Y. Management using information methods // State Counselor. 2015. №2. pp.29-33

4. Zhuchkov R.N., Pakshin P.V. Stabilizing network management of linear discrete systems under conditions of data packet loss // Management of Large Systems. 2011. Vol. 33. pp.113-126

5. Obolyaeva N.M. Elimination of information asymmetry as a tool to improve the quality of education // Geodesy and Aerophotography. 2012. №6. pp.123-124

6. Ozherelyeva T.A. The application of information technologies for managing educational processes // Management of Education: Theory and Practice. 2013. № 4. pp.133-137

7. Pavlov A.I. Information resources in education // International Journal of Experimental Education. 2014. №5. pp.74-78

8. Rosenberg I.N. Features of information training of specialists // Management of Education: Theory and Practice. 2013. № 3. pp.167-172"

VETERINARY SCIENCES

UDC: 619/616.235

BLOOD INDEX CHANGE OF THE CALVES SICK WITH BRONCHOPNEUMONIA

Ganjayev İ.,
PhD in Veterinary, Head of the Department of Therapy, Obstetrics and Surgery and scientific supervisor
Mammadova A.,
Assistant of the Department of Therapy, Obstetrics and Surgery
Orudzhov E.,
Assistant of the Department of Pharmacy
Mammadzade T.,
Assistant of the Department of Therapy, Obstetrics and Surgery
Huseynov A.
Master student of the Department of Therapy, Obstetrics and Surgery
Azerbaijan State Agricultural University, Az2000, Ganja, Azerbaijan.

UOT: 619/616.235

QEYRİ SPESİFİK BRONXOPNEVMONİYA İLƏ XƏSTƏLƏNMİŞ BUZOVLARDA QANIN BƏZİ GÖSTƏRİCİLƏRİNİN DİNAMİKASI

Gəncəyev İ. F.
Baytarlıq elmləri üzrə fəlsəfə doktoru,
Terapiya, Mamalıq və Cərrahiyyə kafedrasının müdürü, magistrantların elmi rəhbəri
Mammadova A.A.
Terapiya, Mamalıq və Cərrahiyyə kafedrasının assistenti
Orucov E. P.
Əczaçılıq kafedrasının assistenti
Məmmədzadə T. M.
Terapiya, Mamalıq və Cərrahiyyə kafedrasının assistenti
Hüseynov A. S.
Terapiya, Mamalıq və Cərrahiyyə kafedrasının magistrantı
Azərbaycan Dövlət Aqrar Universiteti, Az2000, Gəncə, Azərbaycan
https://doi.org/10.5281/zenodo.10451582

Abstract

Diseases of the respiratory organs are widespread among calves, causing serious economic damage to livestock. Respiratory diseases are observed mainly among calves up to one year of age (85-100%), of which 10-15% get sick some time. The success of treatment depends on timely diagnosis and treatment. The diagnosis of the disease is made by taking into account the results of laboratory tests (bacteriological, virological, serological) and anamnestic data. The main goal of the conducted work was to study the changes in the blood of calves with bronchopneumonia compared to clinically healthy calves. Experiments were conducted on three groups of animals (five clinically healthy calves, five calves with acute bronchopneumonia, and five calves with semi-acute and chronic bronchopneumonia) selected by analogy. The blood index changes of calves sick with bronchial pneumonia with acute and chronic clinical course in comparison with the same indices of clinically healthy ones are described in the article.

Keywords: calves, bronchopneumonia, blood test.
Açar sözlər: buzovlar, bronxopnevmoniya, qanın müayinəsi.

Körpə kənd təsərrüfatı heyvanları arasında tənəffüs orqanlarının xəstəlikləri geniş yayılaraq maldarlığa ciddi iqtisadi ziyan vurur. Respirator xəstəliklər əsasən bir yaşa gədər olan buzovlar arasında müşahidə edilir (85-100%), bunlardan 10-15% bir neçə dəfə xəstələnir.(Мищенко В.А (2006),Глотов А.Г(2002), Костыркин Ю.А(2005) Палунина В.В(2013).

Mualicənin müvəffəqiyyəti vaxtında qoyulan diaqnoz və aparılan müalicədən asılıdır. Xəstəliyin diaqnozu epizootoloji vəziyyətin, kliniki əlamətlərinin, patoloji anatomik dəyişirliklərin analizi laborator muayinələrin (bakterioloji, virusoloji, seroloji) nəticələrinin və anamnestik məlumatların nəzərə alınması yolu ilə qoyulur. Tənəffüs orqanları xəstəliklərinin diaqnostikasında xəstə heyvanların qanının hemotoloji və immunobioloji muayinələri xüsüsi əhəmiyyət kəsb edir. Aparılan işlərin əsas məqsədi bronxopnevmoniya ilə xəstələnmiş buzovların

kliniki sağlam buzovlarla müqayisədə qanında gedən dəyişirliklərin öyrənilməsi olmuşdur.

Təcrübələr analoq prinsipi ilə seçilmiş üç qrup (beş baş kliniki sağlam buzovlar, beş baş kəskin bronxopnevmoniya ilə xəstələnmiş buzovlar və beş baş yarımkəskin və xroniki bronxopnevmoniya ilə xəstələnmiş buzovlar) heyvanlar üzərində aparılmışdır. Pnevmoniyanın diaqnoz və etioloqiyası epizootooji və kliniki muayinələr əsasında təyin edilmişdir, qanda morfoloji və biokimyəvi muayinələr aparılmışdır.

Qanda morfloji müayinə zamanı aşağıdakı göstəricilər Qoryayevin hesablayıcı kamerasında saymaqla eritrositlərin və leykositlərin miqdarı, hemoqlobinsianid usulla hemoqlobinin miqdarı, qan serumunda refraktometrik usulla ümümi zülalın miqdarı təyin edilmişdir. Qeyri spesifik rezistentliyinin faktorlarını qiymətləndirmək məqsədi ilə Smirnova O.V, və Kuzmina T.A usulu ilə leykositar profili, qan serumunun bakterisid aktivliyi, Qosteva V.S üsulu ilə isə neytrofillərin faqositar aktivliyi təyin edilmişdir. Zülal fraksiyaları nefelometrik üsulla təyin edilmişdir. Alınan nəticələr xüsüsi kompyuterlər üçün olan " Статистика"MS EXEl paketi vasitəsi ilə biometrik üsulla işlənirdi Merkuryeva E.K., 1970il. Təcrübə hevanların orqanizmində maddələr mübadiləsinin vəziyyətini qiymətləndirmək məqsədi ilə qanda ümümi zülalın miqdarı refraktometr usulu ilə, ümümi kalsiumun miqdarı fluorekson indikatorla trilonometrik usulla, ümümi fosforun miqdarı vanadat-molibden reaktivi ilə, qələvi ehtiyatının miqdarı ikiləşmiş kolbalar vasitəsilə diffuzion usulla, şəkərin miqdarı orto-toluidin üsulla, keton cisimlərinin miqdarı isə yodometrik , üsulla təyin edilmişdir.

Kəskin bronxopnevmoniya ilə xəstələnmiş buzovların kliniki müayinəsi zamanı temperaturun 39,9 – 41^0C qədər artması, burun boşluğunun və konyunktivanın selikli qişalarının hiperemiyası, burun boşuğundan isə serozlu selikli axıntıların olması müşahidə olunurdu. Xəstəliyin başlanğıcında öskürək quru və seyrək, sonralar isə nəmişli olurdu. Tənəffüs tezləşmiş və ağırlaşmış olurdu. Auskultasiya zamanı sərt vezikulyar tənəffüs və nəmişi xırıltılar müəyyən olunurdu. Ürək tonları ağır eşidilən, ürək vurğuları zəifləmiş nəbz isə tezləşmiş olurdu.

Buzovlarda bronxopnevmoniya xəstəliyinin yarımkəskin və xroniki gedişində iştahanın zəifləməsi, boyun inkişafdan qalması və arıqlama müşahidə olunurdu. Bədən temperaturu norma çərçivəsində və ya ondan biraz (39,5 – 39^0C) artıq olur. Səhər tezdən yemləmə zamanı xəstələrdə nəmişli öskürək, auskultasiya zamanı isə bronxial tənəffüs və xışıltılar müəyyən edirdik

Bronxopnevmoniya ilə xəstə buzovların burun axıntısında Staphylococcus aureus, hemolitik streptokokk və bəzən E. coli, Proteus sp., Ps. Aeruginosa və b. müəyyən edilmişdir. Qanın muayinəsində sağlam buzovların qanında eritrositlərin miqdarı 6,82±0,12 1012/ml, hemoqlobinin miqdarı isə 112,8±1,37 q/l olmuşdur. Cədv №1. Bronxopnevmoniya ilə xəstə buzovların qanında morfoloji dəyişirliklər eritrositlərin və hemoqlobinin müəyyən azalması ilə (kəskin gedişi zamanı 11,9% və xroniki gedişi zamanı isə 25,6% erirtositlərin , uyğun olaraq 14,2% və 20,35 hemoqlobin) bürüzə verirdi. Eritrosit və hemoqlobinin azalması yəqin ki qana eritrositləri parçalayan və eritropoezi pozan ekzotoksinlərin daxil olması ilə əlaqədardır, bu isə öz növbəsində qırmızı qan iliyinin depressiyası, və ürək-damar sisteminin çatışmazlığının inkişafı nəticəsində güclənən hipoksiya ilə baş verir.

Cədvəl № 1

Buzovlarda bronxopnevmoniya zamanı qanda göstəricilərin dinamikası

Göstəricilər	Kəskin gedişli	Yarımkəskin, xroniki	Sağlam buzovlar
Eritrositlər 10^{12}/ml	6,0 ± 0,53	5,07 ± 0,95	6,82 ± 0,12
Hemoqlobin q/l	96,7 ± 3,58	89,8 ±3,58	112,8 ± 2,37
Leykositlər 10^9/ml	9,17 ± 0,27	8,9 ±0,26	7,03 ± 0,91
Leykositar profil %	9,17 ± 0,27	19±0,26	7,03± 0,91
Bazofillər	0,1	0,1	0,1
Eozinofillər	6,5 ± 0,48	4,71 ± 0,45	2,53 ± 0,37
Çubuxnüvəli	15,1± 0,45	3,9 ± 0,33	10,40 ± 0,51
Seqmentnüvəli	25,5±1,11	32,1±0,63	27,8±0,72
Limfositlər	55,2±0,93	56,5±0,99	50,1±0,72
Monositlər	8,1±0,37	4,1±0,38	3,9±0,33
EÇS, mm/s	2,15±1,95	1,19±0,71	0,71±0,05
Ümümi zülal q/l	64,5±1,53	63,70±1,98	65,20±1,49
O cümlədən albuminlər, %	33,82±1,33	35,82±0,39	40,26±1,19
Alfa- qlobulinlər	12,99±1,59	13,71±1,37	14,92±0,47
Beta-qlobulinlər	14,62±1,19	12,83±0,31	16,35±1,57
Qamma-qlobulinlər	38,38±2,03	35,64±0,47	28,53±1,58
Qan serum. Bakt.akt	77,50±1,79	73,13±2,97	84,75±1,35
Opson faqositar reaksiyası			
Leyk. Faqosit.akt	82,3±2,37	75,1±1,55	88,2 ± 1,31
Faqosit rəqəm	5,93±0,39	5,42±0,22	4,91± 0,05
Qələvi ehtiyyatı H%CO_2	47,6±1,4	48,4±1,65	51,8 ± 2,0
Ümümi kalsium mq%	9,86±0,14	9,64±0,10	12,24 ± 0,12
Qeyri üzvü fosfor mq %	6,12±0,11	6,64±0,12	4,86 ± 0,14
Qlukoza mq%	42,13±0,40	44,54±0,24	54,12 ± 0,22

Xroniki bronxopnevmoniya zamanı eritrositlərdə patoloji prosesin ağır keçməsindən xəbər verən anizositoz müşahidə olunurdü . Kliniki sağlam buzovlarla müqayisədə (0,71+0,05mm/s), kəskin (2,15+1,95 mm/s), və xroniki gedişli (1,19 +0,71 mm/s) xəstələrdə EÇS tezləşməsi müəyyən edilmişdi. Xəstə buzovların qanında kliniki sağlam buzovlarla müqayisədə leykositlərin miqdarı (7,03 +0,91 109 ml) artmaqa meyilli olurdu, kəskin gedişli xəstələrdə (9,17+0,27 109 ml) 30,4%, xroniki gedişli xəstələrdə isə (8,19+0,26 109 ml) 16,5% artıq olurdu.

Bronxopnevmoniya xəstəliyinin kəskin və xroniki gedişində mötədil leykositozda eozinofillərin faizcə miqdarı uyğun olaraq 2,6 və 1,88 dəfə artmağa meyilli olurdu, bu isə hesab edirik ki mikrob aqentlərinin sensibilizasiya təsiri nəticəsində baş verən bir prosesdir. Eyni vaxtda monosit və limfositlərin artmasını müşahidə edirdik. Bronxopnevmoniyanın kəskin gedişində çubuxnüvəli neytrofillərin miqdarı (15,1+0,45) kliniki sağlam buzovlarla müqayisədə (10,40+0,51) artır, seqmentnüvəli neytrofillərin miqdarı isə uyğun olaraq(25,5+1,11 və 27,8+0,72%) azalır. Xəstəliyin xroniki gedişində çubuxnüvəli neytrofillərin(3,9+0,33%) azalmasını seqmentnüvəli neytrofillərin isə(32,1+0,63) artmasını müşahidə edirdik. Bronxopnevmoniya ilə xəstələnmiş buzovların qan serumunda ümümi zülalın miqdarı demək olar ki dəyişməmişdir beləki kliniki sağlam heyvanlarda bu göstərici 65,20+1,49 q/l bərabər olmuşdur, xəstəliyin kəskin gedişi zamanı 64,5+1,53 q/l olmuşdur, xroniki gedişində isə 63,70+1,98q/l olmuşdur. Eyni vaxtda zülalların fraksiyalarının tərkibində müəyyən dəyişirliklər müəyyən edilmişdir. Sağlam heyvanlarla müqayisədə(40,26+1,19), kəskin (33,82 +1,33) və xroniki bronxopnevmoniyada (35, 82+0,39) albuminlərin miqdarı azalır.Qamma – qlobulinlərin miqdarı (38,82+2,03) kəskin bronxopnevmoniya ilə xəstələnmiş heyvanlarda 34,5%, xroniki xəstələnmiş heyvanlarda isə 24,9%artmişdir. Buzovlarda qan serumunun bakterisid aktivliyi xəstəliyin kəskin gedişində (77,50+1,79)-9,3%, xroniki gedişində isə(73,13+2,97) -13,7% azalmişdir. Sağlam heyvanlarda bu göstərici84,75+1,35% olmuşdur. Bu göstəricinin aşağı düşməsi heyvanlarda orqanizmin təbii rezistentliyinin zəifləməsindən xəbər verir.Sağlam heyvanlarla müqayisədə kəskin formada xəstələnmiş buzovlarda neytrofillərin faqositar aktivliyi 6,7% , xroniki gedişli buzovlarda isə 14,9% azalmişdir, bu isə heyvanların virus-bakterial respirator infeksiyalara qarşı uyğunlaşma reaksiyalarının zəifləməsi ilə əlaqədar ola bilər Bronxopnevmoniya xəstəliyində zülal fraksiyalarının nisbəti ümümi zülalin miqdarından asili olmayaraq dəyişə bilər, bu isə həkim üçün çox vacib informativ bir göstəricidir. Xəstəlik zamanı qan serumunda albuminlərin miqdarının azalması – hipoalbuminemiya və toxumalarda üzvü zülalların artması və aralıq mübadiləsinin pozulması nəticəsində – metabolik asidoz, və qan serumunda ümümi kalsiumun azalması-hipokalsiemiya müşahidə olunur.

Nəticə

Beləliklə bronxopnevmoniya ilə xəstələnmiş buzovlarda – eritrositlərin və hemoqlobinin azalması, EÇS tezləşməsi, mötədil leykositoz, qamma-qlobulinlərin artması,qan serumunda sağlam heyvanlarla müqayisədə bakterisid aktivliyin və neytrofillərin faqositar aktivliyin azalması,hipokalsiemiya, hipoqlikemiya və metabolik asidoz müəyyən edilir

References:

1. Распространение вирусных респираторных болезней крупного рогатого скота / А.Г. Глотов, О.Г. Петрова, Т.И. Глотова [и др.] // Ветеринария. - 2002. - №3. - С.17—21.

2. Эффективность инактивированной вакцины при факторных респираторных болезнях телят / Ю.А. Костыркин, В.А Мищенко, В.В. Думова [и др.] // Ветеринарная патология. - 2005. - №3(14). - С.72-75.

3. Мищенко В.А., Павлов Д.К., Думова В.В. с соавт. Анализ заболеваемости молодняка крупного рогатого скота респираторными инфекциями // Міжнар. конгресс з вет. мед. присвяч. 85-річчю з дня заснув. Націон. наук центру «Ыститут експ. !клин. мед.» Міжвид. Фом. Наук збірник. - Харків, 2006. - №1. - С. 3-6. diaqnoz və etioloqiyası

№123/2023

Norwegian Journal of development of the International Science

ISSN 3453-9875

It was established in November 2016 with support from the Norwegian Academy of Science.

DESCRIPTION

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