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SO‘ZBOSHI

AJOU SCI xalqaro ilmiy jurnalining ushbu soni siz, hurmatli o‘quvchilar, olimlar va tadqiqotchilar e’tiboriga havola etilayotganidan mamnunmiz. Bugungi globallashuv va raqamli transformatsiya jarayonlarida ilm-fan va innovatsiyalar jamiyat taraqqiyotining ajralmas omiliga aylangan. Ayniqsa, ta’lim, texnologiya, axborot tizimlari, muhandislik, tabiiy fanlar va ijtimoiy yo‘nalishlarda olib borilayotgan ilmiy izlanishlar ushbu o‘zgarishlarning muhim poydevoridir.

AJOU SCI jurnali zamonaviy ilmiy tadqiqotlarni keng ommaga yetkazish, turli sohalarda olib borilayotgan ilg‘or ishlanmalarni targ‘ib qilish, yosh va tajribali olimlar o‘rtasida ilmiy muloqot maydonini shakllantirishni o‘z oldiga maqsad qilgan. Jurnal sahifalarida e’lon qilinayotgan maqolalar bugungi kunning dolzarb muammolarini ilmiy asosda yoritadi, ularning yechimiga doir taklif va tavsiyalar beradi.

Mazkur son orqali siz yangi g‘oyalar, izlanishlar va ilmiy qarashlar bilan tanishasiz, ularning amaliy ahamiyatini anglaysiz va o‘z faoliyatingizda qo‘llash imkoniyatiga ega bo‘lasiz, degan umiddamiz.

Barcha mualliflarga ilmiy izlanishlaridagi muvaffaqiyatlar, o‘quvchilarga esa samarali o‘rganish va ilhom tilaymiz.

Hurmat bilan,

Tahrir hay’ati nomidan

Toshkent shahridagi Adju Universiteti rektori

G.A. Muratov

05.00.00 – TECHNICAL SCIENCES

* * *

05.00.00 - TEXNIKA FANLARI

* * *

05.00.00 – ТЕХНИЧЕСКИЕ НАУКИ

“ADVANCED JOURNAL OF UNIVERSITY SCIENCE AND CREATIVE INNOVATIONS”

QOG‘OZNING PAYDO BO‘LISH TARIXI VA ZAMONAVIY ISHLAB CHIQARISH TEXNOLOGIYALARI

Asadova Ruxshona Alisherovna
Toshkent Kimyo Xalqaro Universiteti,
Samarqand filiali.
Boshlang‘ich ta’lim, 3-kurs
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Annotatsiya. *Ushbu maqolada “Qog‘ozning paydo bo‘lish tarixi va zamonaviy ishlab chiqarish texnologiyalari” mavzusi yuzasidan fikr-mulohazalar yuritilgan. Unda qog‘ozning paydo bo‘lish tarixi, uning qadimdan to hozirgi kungacha bo‘lgan rivojlanish bosqichlari, qog‘oz bilan ishlash texnologiyalarining asosiy tamoyillari, qog‘oz turlari va ularning xususiyatlari haqida ma’lumot beriladi. Shuningdek, ta’lim jarayonida qog‘oz bilan ishlashning o‘quvchilarda ijodkorlikni rivojlantirishdagi o‘rni hamda amaliy mashg‘ulotlarda qo‘llash imkoniyatlari haqida so‘z yuritilgan.*
Kalit so‘zlar: *qog‘oz tarixi, qog‘oz tayyorlash, qog‘oz ishlab chiqarish, Tsay Lun texnologiyasi, Samarqand qog‘ozi, islom sivilizatsiyasi va qog‘ozchilik, qog‘oz turlari.*

Abstract. *“This article discusses the issue of “The History of Paper and Modern Production Technologies”. It provides information on the history of paper, its software from ancient times to the present day, the basics of paper processing technologies, types, and properties of paper. the role of paper processing in the educational process in developing creativity in students and its application in practical classes.*
Key words: *history of paper, paper making, paper production, Tsai Lun technology, Samarkand paper, Islamic civilization and paper making, types of paper.*

Аннотация. *«В данной статье рассматривается вопрос «История бумаги и современные технологии ее производства». В ней приведены сведения по истории бумаги, ее программному обеспечению с древнейших времен до наших дней, основам технологий обработки бумаги, видам и свойствам бумаги, роли обработки бумаги в образовательном процессе, развитии творческих способностей у студентов и ее применении на практических занятиях.*
Ключевые слова: *история бумаги, изготовление бумаги, производство бумаги, технология Цай Лунь, Самаркандская бумага, исламская цивилизация и изготовление бумаги, виды бумаги..*

Kirish. Qog‘oz insoniyatning madaniy va ma’naviy rivojlanishida muhim o‘rin tutgan eng qadimiy ixtirolardan biridir. U o‘simlik tolalaridan tayyorlanadigan yupqa material bo‘lib, uning tarkibini yog‘och sellyulozasi, bir yillik o‘simlik tolalari hamda turli qo‘shimcha moddalar tashkil etadi. Qog‘oz massasiga kaolin, talk kabi mineral to‘ldirgichlar, shuningdek, yelimlovchi moddalar, bo‘yoqlar va kimyoviy tolalarning qo‘shilishi natijasida qog‘ozning mustahkamligi, silliqligi va oq rang kabi sifat ko‘rsatkichlari yaxshilanadi.

Qog‘ozning yaratilishi milodiy II asrga borib taqaladi. Tarixiy manbalarga ko‘ra, bu ixtiro xitoy amaldori Tsay Lun nomi bilan bog‘liq. U o‘simlik tolalaridan olingan suvli massani maxsus to‘rli qolipdan o‘tkazib, qog‘oz tayyorlash texnologiyasini yaratgan. Ushbu usul uzoq vaqt davomida sir saqlangan bo‘lib, VI asrda Yaponiyaga, VI–VIII asrlarda esa Osiyoning boshqa hududlariga tarqalgan.

Asosiy qism.

Markaziy Osiyo, ayniqsa, Samarqand qog‘oz ishlab chiqarish tarixida alohida o‘rin egallaydi. VII asr boshlaridan XIX asrning birinchi yarmigacha Samarqandda ishlab chiqarilgan qog‘oz mustahkamligi va sifati bilan mashhur bo‘lgan hamda Turkiston va qo‘shni mamlakatlarga eksport qilingan. Samarqand ustalari tut daraxti po‘stlog‘i va o‘simlik tolalaridan foydalanib, o‘ziga xos qadimiy texnologiyani yaratganlar.

Islom sivilizatsiyasi qog‘ozning keng tarqalishi va ilm-fan rivojida katta rol o‘ynadi. 794-yilda Xorun ar-Rashid davrida vazir Yahyo ibn Xolid Barmaqiy tomonidan Bag‘dodda musulmon olamidagi ilk yirik qog‘oz fabrikasi tashkil etildi. Bag‘dod Samarqand maktabi tajribasi asosida yirik markazga aylangan. Qog‘ozning arzonligi va qulayligi ilm-fan, kitobat, tarjima maktablari, kutubxonalar va ma’rifatning jadal rivojlanishiga xizmat qildi.

Manbalarga ko‘ra, qog‘ozdan foydalanish Makkada 797-yilda, Misrda 800-yilda, Andalusda 950-yilda, Konstantinopolda 1100-yilda, Sitsiliyada 1102-yilda, Italiyada 1154-yilda, Germaniyada 1128-yilda va Angliyada 1309-yilda boshlangan. Musulmonlar qog‘oz tayyorlash sirlarini avval Sitsiliya va Ispaniyaga, so‘ngra butun Yevropaga yoyganlar. Natijada qog‘oz o‘rta asr Yevropasidagi ilmiy uyg‘onish va madaniy taraqqiyotning asosiy omillaridan biriga aylangan.

XV–XVI asrlarda bosmaxonaning ixtiro qilinishi qog‘ozga bo‘lgan talabni keskin oshirdi. XVII–XVIII asrlarda Gollandiyada roll apparatining yaratilishi, Fransiyada esa N. L. Rober tomonidan uzluksiz ishlovchi qog‘oz quyish mashinasining ishlab chiqilishi qog‘ozchilikni yangi bosqichga olib chiqdi. Keyinchalik bu mashinalar presslash, quritish, kalandr va rulonga o‘rash bo‘limlari bilan takomillashtirilib, ishlab chiqarish to‘liq sanoatlashtirildi.

XIX asrga kelib qog‘oz mashinalari zamonaviy ko‘rinishda shakllandi. Latta o‘rniga yog‘och sellyulozasi qo‘llanila boshlandi, sintetik polimerlar va kimyoviy tolalar bilan boyitish texnologiyalari rivojlantirildi. Bu yondashuv qog‘oz ishlab chiqarish hajmini keskin oshirdi va bugungi qog‘oz sanoati uchun asos yaratdi.

Hozirgi kunda qog‘oz ilm-fan, ta’lim, sanoat, madaniyat, texnika va kundalik hayotning ajralmas qismi bo‘lib, uning tarixi insoniyat taraqqiyoti bilan chambarchas bog‘liq ravishda rivojlanib bormoqda.

Shuningdek so‘zimiz davomida qog‘oz turlari haqida ham to‘xtalib o‘tsak.Bugungi kunda dunyoda 600 dan ortiq turdagi qog‘ozlar mavjud bo‘lib, ular tarkibi, qalinligi, mustahkamligi va ishlatilishiga qarab bir-biridan farq qiladi.Eng ko‘p ishlatiladigan asosiy turlar quyidagilar:

Eng ko‘p qo‘llaniladigan qog‘oz turlari:

Matbuot qog‘ozi – gazeta, jurnal va kartografiya uchun.

Yozuv qog‘ozi – yozish, konvert, pochta va daftarlar uchun.

Chizmachilik–rasmchilik qog‘ozi – rasm va chizma ishlari uchun.

Elektroizolyatsion qog‘oz – kabel, telefon va kondensatorlar uchun.
Papiros qog‘ozi – sigareta va papiros ishlab chiqarishda.
Shimuvchi qog‘oz – filtr va gigiyena vositalarida.
Apparat qog‘ozi – telegraf lenta, perfokarta kabi texnik vositalar uchun.
Yorug‘lik sezgir qog‘oz – fotografiyada.
Ko‘chirish qog‘ozi – kopirovka qilish uchun.
O‘rov qog‘ozi – oziq-ovqat va sanoat mahsulotlarini o‘rash uchun.
Sanoat–texnika qog‘ozi – jilvir, , diffuzor va texnik jarayonlar uchun.

Xulosa.

Xulosa qilib aytganda, qog‘oz insoniyat tarixida eng muhim o‘rin tutgan ixtirolardan biri bo‘lib, uning yaratilishi, rivojlanishi va dunyo bo‘ylab tarqalishi ilm-fan, madaniyat va ma’rifat taraqqiyotiga ulkan ta’sir ko‘rsatgan. Qadimgi Xitoyda boshlangan qog‘oz tayyorlash an’analari Sharq mamlakatlari, xususan Samarqand maktabi tajribasi orqali takomillashib, Islom olamida keng qo‘llanilgan va ilmiy merosning boyishiga xizmat qilgan. Keyinchalik qog‘ozning Yevropaga kirib borishi madaniy uyg‘onish va bosmaxona rivojida hal qiluvchi omil bo‘ldi.

Sanoat inqilobi davridagi texnologik yangiliklar, mexanizatsiya, uzluksiz mashinalarning yaratilishi hamda sellyuloza va kimyoviy tolalardan foydalanish qog‘ozchilikni zamonaviy sanoat darajasiga olib chiqdi. Bugungi kunda qog‘oz turli sohalarda – ta’lim, ilm-fan, texnika, kommunikatsiya va madaniyatda – ajralmas material bo‘lib xizmat qilmoqda.

Shunday qilib, qog‘ozning tarixiy evolyutsiyasi va texnologik rivoji insoniyat taraqqiyoti bilan chambarchas bog‘liq bo‘lib, uning ahamiyati bugungi raqamli davrda ham o‘z qadrini yo‘qotmayapti.

FOYDALANILGAN ADABIYOTLAR

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2. http://zarnews.uz
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"ADVANCED JOURNAL OF UNIVERSITY SCIENCE AND CREATIVE INNOVATIONS"

ANALYSIS OF IMPACT FORCE ON RAW MATERIAL IN TWO-CYLINDER GIN

Azizov Shuhrat Mamatovich
Namangan State Technical University, Dsc
e-mail: azizovshuhrat@gmail.com
https://doi.org/10.5281/zenodo.17906809

Abstract. *This article examines the impact force of a two-cylinder saw on a raw material shaft. This paper theoretically examines the relationship between impact force changes and the position of the first and second cylinders relative to the horizontal axis and the radius of the working chamber. Decreasing the radius of the working chamber reduces the mechanical impact, thereby reducing the load on the raw material shaft, improving fiber quality, and reducing grain damage. The factors influencing this reduction are also examined.*

Key words: *Twin-cylinder gin, saw, raw material roller, impact force, position relative to the horizontal axis, working chamber, radius change, loading, fiber quality, seeds.*

Introduction.

The Art Soft factory has a short fiber content of approximately 5.6% and 229 neps per gram of fiber. Lot-2 (Namangan-3) and Lot-3 (Pop) This is also confirmed by the fact that the cotton fibers in the factories had a short fiber content of 8.7% and 10.3%, and a neps number of 269 and 280 units, respectively. [1] In order to reduce the defects in the fiber content, we need to consider the collision of the saw teeth of the saw cylinder with the raw material roll during the ginning process. After allowing for values close to the above assumptions, we can determine the reactive impact force acting on the supports A and B, accelerating the rotation of the raw material roll, assuming the impact to be absolutely inelastic; AO=OB=h; the moving coordinate axis XYZ is connected to the cylinder. Figure 2 shows the effect of external instantaneous forces. Impact force acting on the surface of the raw material roll[2]. Saw cylinder rotation speed 720 rpm, rotation frequency v=12 revolutions / sec frequency when rotation period T=0.08 seconds, angle speed

$$\omega = \frac{2\pi}{T} = \frac{2 \cdot 3.14}{0{,}08} = 78{,}5\,\frac{rad}{sekund} \approx 12\,\frac{m}{sekund}$$

$$1\,\frac{rad}{sekund} = 0{,}15\,\frac{metr}{sekund}$$

$$S = m \cdot \omega_2 (1)$$

$$S = m \cdot \omega_2 = 269.11 \cdot 12 = 3\,229{,}32\ \text{N/metr}$$

This value remains unchanged because our research is to study the effect of force by changing the diameter of the raw material shaft.

SAX, SAY, SBX, SBY – reactive impact force acting on the raw material shaft in bearings A and B.

$$I_z(\omega_{2z} - \omega_{1z}) = \sum_{k=1}^{n} m_z[S(F_k^e)] \qquad (3)$$

The moment of inertia for the case under consideration

$$I_z = \frac{Pr^2}{2g} (4)$$

Based on the task at hand

$$\omega_{1z=} = 0 \qquad (5)$$

We calculate the second inequality:

$$\sum_{k=1}^{n} m_z[S(F_k^e)] = S_{XD} = \frac{S_r}{2} \qquad (6)$$

If we consider equations (4) and (6), then the equation will look like this:

$$\frac{Pr^2}{2g} \omega_{2z} = \frac{S_r}{2} \qquad (7)$$

Mathematical calculations.

For a new design of a gin machine, we can formulate the following formula for the first and second cylinders:

$$S_1 = S_2 = m_1 \cdot \omega_2 = 113{,}3 \cdot 12 = 1\,359{,}6 \text{ N/ meter}$$

m -mass of the saw cylinder;

ω_2, ω_3 –angular velocity of the saw cylinder;

SAX $_1$, SAY $_1$, SBX $_1$, SBY $_1$ and SAX $_2$, SAY $_2$, SBX $_2$, SBY $_2$ – Reactive impact force acting on the raw material shaft in bearings A and B.

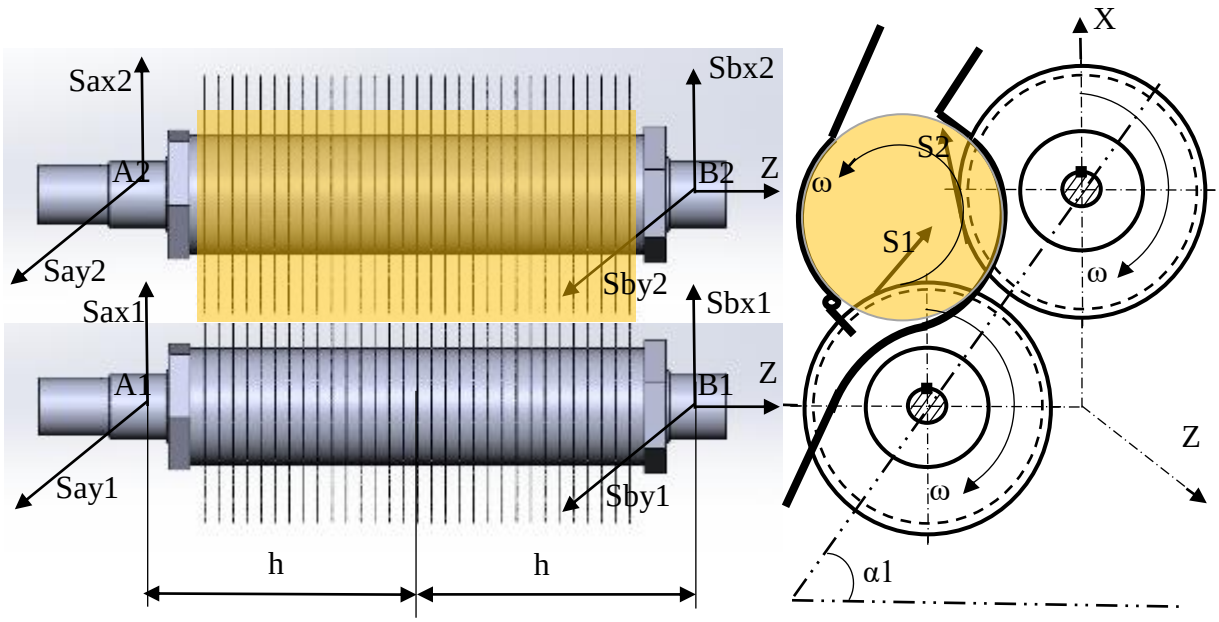


Figure 1. Scheme for determining the impact force of two saw cylinders on a raw material roll.

Based on the above calculations, we can draw up a calculation system for determining the impact force for a new design of a gin machine, shown in Figure 1. In a two-cylinder gin, two saw cylinders with 90 saw discs are located in one working chamber, the total number of saws reaches 180. Using the static loading calculation method, taking into account the location of each

saw cylinder relative to the horizontal axis, we find the reaction force acting on it depending on the change in the radius of the working chamber [2-3].

$$\sum Ma = 0;\ R_B = Px = P \cdot Cos\varphi = P \cdot Cos(90 - \alpha) = P \cdot Sin\alpha; \quad (8)$$

$$\sum Mb = 0; R_A = Px = P \cdot Sin\varphi = P \cdot Sin(90 - \alpha) = P \cdot Cos\alpha; \quad (9)$$

Using this formula, $R_B = P_1$we find the mass acting on the lower saw cylinder and the upper saw cylinder depending on the change in the radius of the working chamber using the formula for determining the reaction forces. We determine the force acting on the raw material roller relative to the saw $R_A = P_2$cylinder, for this we use the scheme for calculating the impact and inertia forces in the new design of the gin machine. For this, we determine the magnitude of the force acting on the lower and upper saw cylinders using formulas (8) and (9) and, by substituting the obtained values into formula (10), calculate the impact force acting on the saw cylinders from the side of the raw material roller[4 -5]

$$S_{h1} = P_1 \cdot \omega_1 \quad (10)$$

We find the values of the force acting on the saw cylinder located at the bottom of the working chamber : Working camera radius $r = 260mm;$
$r = 230mm; r = 200mm; r = 170mm, r = 140mm$ when raw material wheel mass by formula (11) we will determine

$$P_1 = R_B = P \cdot Sin\alpha (11)$$

By formula (12) we find the impact force $S_{h1} = P_1 \cdot \omega_1$acting on the sawn cylinder located at the bottom (12)

We find the values of the force acting on the saw cylinder located at the top of the working chamber. The working camera radius $r = 260mm;\ r = 230mm;$
$r = 200mm; r = 170mm, r = 140mm$ when it is acting on the saw cylinder located at the top raw material wheel mass

$$P_2 = R_A = P \cdot Cos\alpha (13)$$

(13) formula through and impact on the saw cylinder located at the top provider tattoo strength we will find

$$S_{h2} = P_2 \cdot \omega_3 (14)$$

Found Write the values in Table 1. we will get

Two-cylinder gin impact force Sh 1 Table 1.

Working chamber radius R (mm)	Saw Number n pieces	Length L (mm)	Density ρ 0 (kg/m3)	Impact force Sh2 (n/m)	Raw material roll weight Ra =P2 kg	Impact force Sh1 (n/m)	Raw material roll weight Rb =P1 kg
260	90	1600	340	231.06	57,765	400.16	100.04
230	90	1600	340	180.82	45,205	313.2	78.3
200	90	1600	340	136.72	34.18	236.8	59.2
170	90	1600	340	98.78	24,695	171.08	42.77
140	90	1600	340	67	16.75	116.04	29.01

1 shows the values of the change in the mass of the raw material roll and the impact force in the first and second saws depending on the change in the radius of the working chamber in a

two-cylinder mill. a two-cylinder saw mill are presented. Since the angular velocity w_2 of the raw material roll at the time of impact is unknown, we obtain the rotation of the raw material roll as the sum of the principal moments of action and the instantaneous forces relative to the Z axis of rotation[6].

$$\omega_{2z} = \frac{gS}{P_r} \quad (15)$$

Here

$\omega_2 z$ – the velocity of the raw material roll after the impact force;

g – speed of free fall (g =9.8);

S – impact force;

R is the mass of the raw material roll;

r is the radius of the raw material roll.

To determine the impact force of the reaction forces, we construct a system of equations for the raw material shaft as follows:

$$S_{AX1} + S_{BX1} = -S_{A1}; \quad S_{AZ1} = S_{BZ1} = -S_{Z1};$$
$$S_{AX2} + S_{BX2} = -S_{A2}; \quad S_{AZ2} = S_{BZ2} = -S_{Z2}; \quad (16)$$
$$S_{AX} + S_{BY} = M_{XC}(\omega_{2z} - \omega_{1z}) - S_Y; \quad S_{AY^\alpha} - S_{BY^\beta} = I_{XZ}(\omega_{2z} - \omega_{1z});$$
$$-S_{AX^\alpha} + S_{BX^\beta} = S_{Z^\beta} = S_{Z^\beta} - I_{YZ}(\omega_{2z} - \omega_{1z}).$$

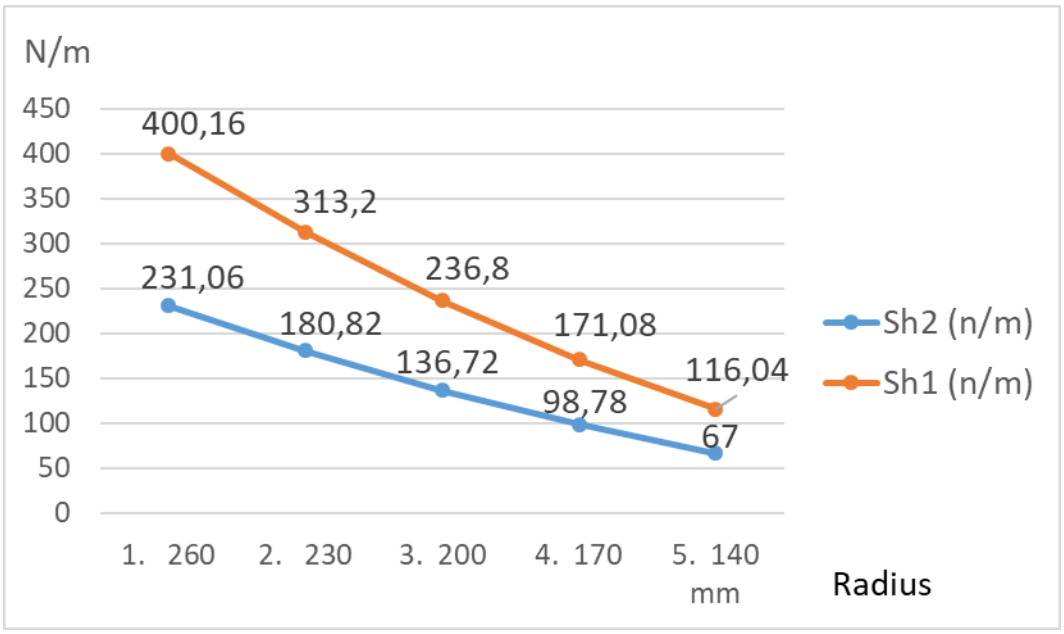


Figure 2. Changes in the impact forces of the raw material roll on the first and second sawing cylinders depending on the change in the radius of the working chamber in a two-cylinder

Based on the previously agreed conditions, S = - Sz, which means,

$$S_X = 0; \quad S_Y = -S; \quad S_Z = 0; \quad (17)$$

The center of gravity of the raw material roll is located at point 0 at the origin of the coordinate system.

$$X_c = 0; \; I_{YZ} = 0. (18)$$

We determine the centrifugal moment of inertia of the raw material roller IXZ.

The Y axis lies in a plane perpendicular to the XZ point and is therefore the principal axis of inertia with respect to the point S. This means that the two centrifugal moments of inertia are zero with respect to the axes, and one of them is the Y axis[7 -8].

$$I_{YZ} = I_{YZ} = 0. \qquad (19)$$

We determine the centrifugal moment of inertia IXZ, which we calculate from the following formula

$$I_{XZ} = \sum_{k=1}^{n} m_k x_k z_k ; \quad (20)$$

We express the coordinates XK and ZK in terms of X1K and Z1K, for this we change the coordinates, and when we rotate the axes by an angle α, we obtain the following values with respect to the k-point:

$$Z_k = Z_{1k} cos\alpha + X_{1k} sin\alpha; \quad (21)$$

$$X_k = -Z_{1k} sin\alpha + X_{1k} cos\alpha;$$

(2 0) into formula (21), we get the following

$$I_{XZ} = \sum_{k=1}^{n} m_k x_k z_k = \sum_{k=1}^{n} m_k (-\mathrm{Z_{1k}sinx} + \mathrm{x_{1k}cos\alpha})(-\mathrm{Z_{1k}cos\alpha} + \mathrm{x_{1k}sin\alpha});$$

(22)

Then formula (22) will take the following form

$$I_{XZ} = (I_{Z1} - I_{X1}) \frac{\sin 2\alpha}{2} + I_{x1z1} cos2x; \qquad (23)$$

Since the Z 1 axis is the axis of symmetry, it is considered the central axis of inertia.

That is why. $I_{Z1X1} = I_{Z1X1} = 0$.formula (19) will look like this:

$$I_{XZ} = (I_{Z1} - I_{X1}) \frac{\sin 2\alpha}{2} ; \qquad (24)$$

It is known from the course of theoretical mechanics that the moment of inertia for a circular cylindrical body is equal to the following value:

$$I_{XZ} = \frac{\mathrm{Mr^2}}{2}; \quad I_x = M\left(\frac{r^2}{4} + \frac{l^2}{3}\right); \qquad (25)$$

formula (24) with formula (25), we get the following form

$$I_{XZ} = -M\left(\frac{r^2}{4} - \frac{l^2}{3}\right)\frac{sin2\alpha}{2}; \qquad (26)$$

So, the moments of inertia we are looking for will look like this:

$$I_{YZ} = I_{YX} = 0, \qquad I_{XZ} = -M\left(\frac{r^2}{4} - \frac{l^2}{3}\right)\frac{sin2\alpha}{2}; \qquad (27)$$

$$\text{Or,} M = \frac{P}{2g}; \quad (28)$$

For two cylinders,

$$M_1 = \frac{P_1}{2g} \quad \text{and} \quad M_2 = \frac{P_2}{2g}; \quad (29)$$

If we take into account the formula changes as follows

$$I_{XZ} = -\frac{P}{2g}\left(\frac{r^2}{4} - \frac{l^2}{3}\right)\frac{sin2\alpha}{2}; \qquad (30)$$

For two cylinders, the formula changes to:

$$I_{XZ1} = -M_1\left(\frac{r^2}{4} - \frac{l^2}{3}\right)\frac{sin2\alpha}{2}; \quad (27)$$

$$I_{XZ2} = -M_2\left(\frac{r^2}{4} - \frac{l^2}{3}\right)\frac{sin2\alpha}{2}; \quad (28)$$

At the beginning of the blow, the raw material shaft is in a stationary state.

ω1=0

Supports A and B are considered bearing supports, therefore

SAZ=SBZ=0

Using the above formulas, we can write

a=v=h and $X_D = \frac{r}{2}$(29)

RESULTS

After solving the system of equations, assuming that sin2α=1, we determine the reaction impact forces and the values of the acceleration of the raw material relative to the points A $_1$ and B $_1$ and A $_2$ and B$_2$ since the saw cylinder and the raw material shaft are parallel to each other.

$I_{XZ2}$and I_{XZ1}Moments of inertia Table 2.

No.	Worker camera radius r, mm	Home material wheel mass P 1, kg	Home material wheel mass P 2, kg	Inertia moments I_{XZ1} N/cm2	Inertia moments I_{XZ2} N/cm2	Shock from the strength then raw material of the governor speed ω2z	M_1	M_2
1	260	100.04	57,765	21,331.3	12,316	0.452	5.1	2,945
2	230	78.3	45,205	16,769.2	9 682	0.511	3,992	2,305
3	200	59.2	34.18	12,707.7	7 337	0.588	3,014	1.74
4	170	42.77	24,695	9 195.2	5 309	0.691	2,174	1,255
5	140	29.01	16.75	6 282	3,627	0.84	1,472	0.85

We write the values (29) into the formula:(30)

SAX+SBX =0 ; SAY+SBY =0 -S;

$$S_{AY}h - S_{BY}h = -\frac{S}{2r}\left(\frac{r^2}{4} - \frac{l^2}{3}\right)sin2\alpha; \quad (30)$$

$$S_{AX}h - S_{BX}h = 0; \quad (31)$$

$$S_{AX} = S_{BX} = 0; \qquad S_{AY} = S_{BY} = S + S_{130};$$

The formula for the two sylinder gin machine changes as follows:

$S_{AY1} = S_{BY1} = S_1 + S_{h1}$

$S_{AY2} = S_{BY2} = S_2 + S_{h2}$

Here SAY is the impact force along the Y axis on bearing A in the saw cylinder when the raw material roller rotates;

Force distribution SAX 2, SAY 2, SBX 2, SBY 2 at supports A and B Table 3.

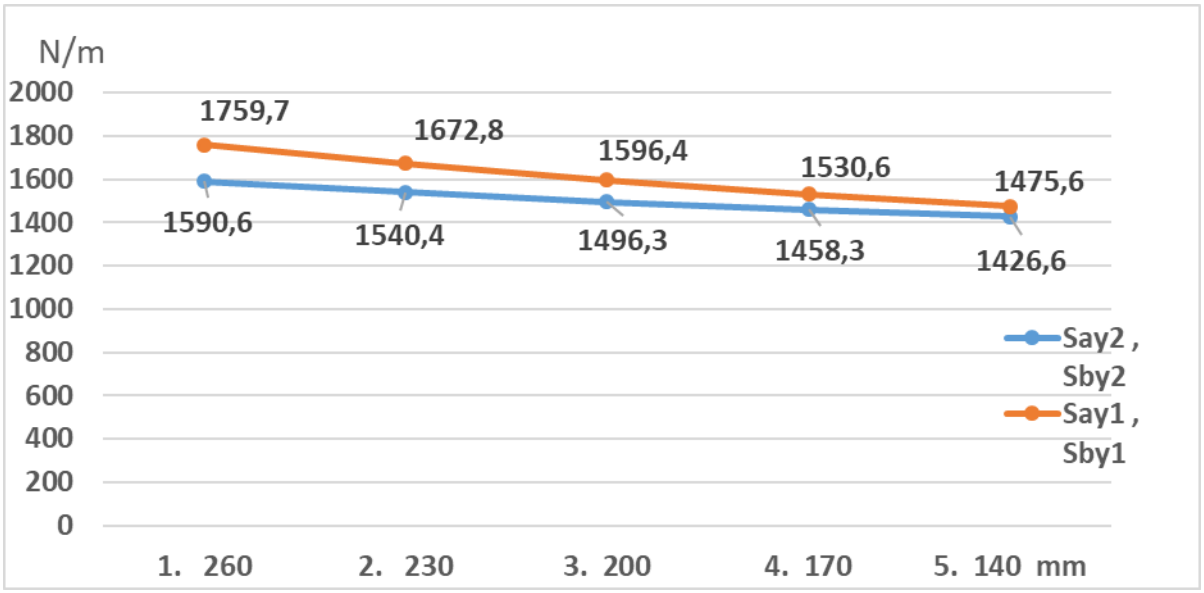
No.	Number of saws N (mm)	Worker camera radius r=mm	Length L (mm)	Saw cylinder S1 = S2 (n/m)	Raw material roller Sh2 (n/m)	S_{AY2} , S_{BY2}
6	90	260	1600	1 359,6	231.06	1590.6
7	90	230	1600	1 359,6	180.82	1540.4
8	90	200	1600	1 359,6	136.72	1496.3
9	90	170	1600	1 359,6	98.78	1458.3
10	90	140	1600	1 359,6	67	1426.6

Table 3 presents the load values for the bearings located on the SAY $_2$ and SBY$_2$ supports, taking into account the change in the impact force of the raw material roller depending on the change in the radius of the working chamber and the impact force of the upper saw cylinder relative to the raw material roller.

SAX $_1$, SAY $_1$, SBX $_1$, SBY $_1$ Distribution of forces on the axes is shown in Table 4.

No.	Number of saws N (mm)	Working chamber radius r =mm	Length L (mm)	Saw cylinder S1 = S2 (n/m)	Raw material roller Sh1 (n/m)	S_{AY1} , S_{BY1}
6	90	260	1600	1 359,6	400.16	1759.7
7	90	230	1600	1 359,6	313.2	1672.8
8	90	200	1600	1 359,6	236.8	1596.4
9	90	170	1600	1 359,6	171.08	1530.6
10	90	140	1600	1 359,6	116.04	1475.6

Table 4 presents the load values for the bearings located on the SAY1 and SBY1 supports, taking into account the change in the impact force of the raw material roller depending on the change in the radius of the working chamber and the impact force of the lower saw cylinder relative to the raw material roller.



4 – The values of the forces acting on the supports A $_1$, B $_1$ and A $_2$, B $_2$ in a two-cylinder sawmill with the first and second saw cylinders.

Next, using the formula, we calculate the reactive impact forces for the working chamber radius from 140 to 260 mm and plot the variation of the impact impulses for different values of the working chamber radius. (Fig. 4)

Conclusion.

The results of the calculations show that the impact force acting on the raw material roll of the DP-130 saw gin remains constant at the working chamber radius r=260, r=230, r=200, r=170 and r=140 at the value of S=3229.32 N/meter. Dividing this value by 130 saws, it was found that one saw affects the raw material roll with a force of 24.84 Newtons. The impact force exerted by the saw cylinders of a two-cylinder gin machine on the raw material roll remains constant at the value of S=1359.6 N/meter at the working chamber radii r=260, r=230, r=200, r=170 and r=140. Dividing this value by 90 saws, it is found that one saw exerts a force of 15.1 Newton on the raw material roll. Although two of the 90 saw cylinders are placed in one working chamber in our gin machine, since they are the same size, the force exerted by one saw on the raw material roll by 15.1 Newton does not change.

Thus, it can be seen that with the increase in the radius of the working chamber, the impact force increases, which leads to an increase in mechanical impact. When comparing the maximum impact force of the saw cylinder of the DP-130 sawing machine with the maximum impact force of the saw cylinder of the double-cylinder sawing machine, the difference is S=3229.32-1359.6=1 869.72 N/meter. This figure shows that the double-cylinder sawing machine has decreased by 58%. As the radius of the working chamber decreases, the mechanical impact also decreases, that is, the loading of the raw material shaft decreases, the fiber quality improves, and the damage to the grain decreases. When we take the optimal value of r=200mm, the forces SAX, SAY, SBX, SBY =3625.8 Newton act on the supports of the shaft A and B of the DP-130 sawing machine.

When we take the optimal value of r=170mm for the supports A1 and B1 of the two-cylinder gin machine, SAX $_1$, SAY $_1$, SBX $_1$, SBY $_1$ =1530.6 Newtons, 57% less force is required compared to the old gin, so the damage to the grain and fiber is reduced by 57%.

When we take the optimal value for the supports A2 and B2 of the two-cylinder gin machine, SAX $_2$, SAY $_2$, SBX $_2$, SBY $_2$ =1458.3 Newtons, the force required is 59% less than the old gin, and the damage to the grain and fiber is reduced by 59% due to the less force required.

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ANALYSIS OF VARIATION PATTERNS IN LINEAR DENSITY OF FALSE-TWISTED YARN DURING TENSILE ELONGATION UNTIL BREAKAGE

Ergashev Zoirbek Nurmatjon o'g'li[1],
Mamadjanov Shukurjon Rustamovich[2],
Sayidmurodov Mirzoxid Mirzaraximovich[3]
[1]Researcher, Namangan State Technical University
Uzbekistan, Namangan city,
[2]Namangan State Technical University,
Independent Researcher,
[3]Candidate of Technical Sciences, Associate Professor,
Namangan State Technical University
Uzbekistan, Namangan city
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Abstract. *The article theoretically studies the factors affecting the quality indicators of the pneumatically spun yarn during the process of false twisting, the values of the linear density of the yarn. The effect of increasing the degree of yarn breakage and reducing the weight of the fibers involved in the spinning process on the relative stiffness of the yarn is studied. Also, the deformation moduli of the yarn when the maximum value is reached are analyzed using a graph-analytical method.*

Key words: *Yarn, false twist, yarn quality parameters, yarn linear density, deformation modulus, deformation value.*

Аннотация. *В статье теоретически исследованы факторы, влияющие на показатели качества пневмопряденой пряжи при ложной крутке, значения линейной плотности пряжи. Исследовано влияние повышения обрывности пряжи и снижения массы волокон, участвующих в прядении, на относительную жёсткость пряжи. Также графоаналитическим методом проанализированы модули деформации пряжи при достижении максимального значения.*

Ключевые слова: *пряжа, ложная крутка, показатели качества пряжи, линейная плотность пряжи, модуль деформации, величина деформации.*

Introduction. During the twisting process of a pneumatically spun yarn, the fibers are subjected to effects such as stretching and bending. Each of these deformations consists of three parts: elastic, elastic and plastic. Due to the return of elastic and elastic deformations, an elastic rotation occurs in the yarn, directed in the opposite direction to its twisting, which tends to

unwind and form tangles. This situation complicates the further processing of the yarn in production, especially in the production of textile products [1,2].

Analysis of the properties of the yarn spun by the pneumatic-mechanical method shows that it is superior to the yarn made by the ring method in some indicators. Despite the high twist, it has a lower density and a more porous structure, which to some extent limits its scope of application [3]. In particular, due to the low density of the yarn, pneumatic-mechanical machines are not used in the re-combing spinning system. In the production of yarn with a low linear density by the indicated method, for the technical and economic efficiency of the spinning machines, it is necessary to sharply increase the frequency of rotation of the chambers, which leads to a higher than normal consumption of electric energy [4]. There are two factors that reduce the linear density of the yarn: an increase in the degree of yarn breakage and a decrease in the relative density of the yarn with a decrease in the weight of the fibers involved in the spinning process.

The elongation at break of yarn produced on a pneumatic spinning machine is 1.5-2% higher than that of yarn produced on ring machines. The greatest difference in elongation is observed in yarn made of cotton, while it is less common in viscose and synthetic fibers. The linear density unevenness is in the range of 10 to 14%, and these indicators are superior to those of yarn obtained from the re-carding system. Yarn spun by the pneumatic method has a volume of 10-15% more than yarn obtained by the ring method, better heat retention, is more resistant to abrasion, and has fewer defects. The limited use of yarn spun by the pneumatic method is primarily associated with its low strength and density, high twist, therefore, we consider it appropriate to study the reasons that cause these characteristics.

Research Methods. The modulus of a yarn with a false twist is a function of the deformation parameters ε_N, ε_e, ε_m, ε_S and ε_k, which are the change function E(ε). In order to determine the values of the deformation modulus of a yarn with different values of the linear density of the yarn, T, by calculating the values of the elongation to break of the yarn, it is necessary to determine the dependence of these parameters on the linear density. For this, we again use the results of the experiments presented below:

Table 1.

Average values of deformation parameter ε_e and linear density for groups T

Number of groups	1	2	3	4	5	6
T_{sr}, Tex	28,10	28,60	29,03	29,27	29,56	31,30
ε_e	0,00044	0,00020	0,00170	0,00060	0,00082	0,00180

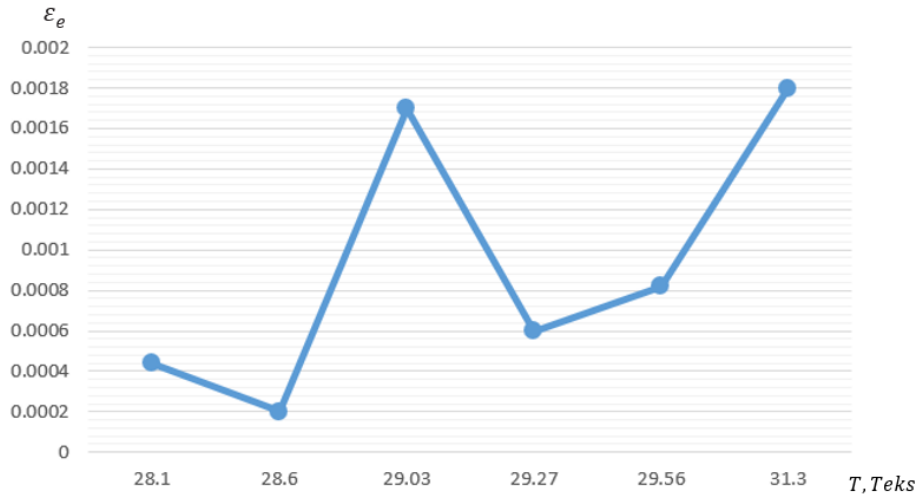

Fig 1. Variation of deformations ε_e of a pneumatically spun yarn depending on the linear density

As shown in Figure 1, the initial value of the deformation E_N is determined from the values of the E(ε) graph obtained from the experiments at $\varepsilon_N = 0{,}00025$, i.e. at a value very close to zero. Therefore, the value of εN is assumed to be zero in all cases, i.e. $\varepsilon_N = 0$. E_N is the deformation modulus of the undeformed yarn at $\varepsilon_N = 0$. However, the value of E_N at $\varepsilon_N = 0$ cannot be determined. Therefore, when determining the E_N modulus, a value close to zero is taken for the deformation. Let us consider the dependence of E(ε) on the linear density of the yarn on the change in other deformation parameters.

Research Results. Figure 1 shows the dependence of the linear density of a yarn with a false twist on the value of the deformation modulus E_e. Here, the curve is constructed according to the given actual values of ε_e and T, that is, it shows the actual change in the parameter ε_e from the actual values of the linear density of the yarn used in the experiment.

As can be seen from Figure 1, the change in the curve is completely random and does not correspond to any analytical description. By averaging the values of ε_e and T for the groups of linear densities of the yarn, we obtain from the data given in Table 1.

Curve 2 in Figure 1 is obtained using the values of ε_e and T_{sr} given in Table 1 According to the nature of curve 2, it can be said that the value of ε_e can increase with increasing linear density of the yarn. Analytically, curve 2 can be described by a more complex function. However, for simplicity, we will approximate it with a linear function in the figure below:

$$\varepsilon_e(T) = a_e + b_e T \qquad (1)$$

where $a_e = 0{,}000321$; $b_e = 0{,}000034$ tex^{-1} – coefficients determined by the least squares method based on the dependence (1). Line 3 in Figure 1 is constructed using formula (1) by setting the value of T from zero to 160 tex in 10 tex steps. As can be seen from Figure 1, line 3 is actually an average straight line for curve 2. Thus, the parameters of the function E(ε) are actually averaged three times. First, we average the dependence F(ε), we obtain the average dependence F(ε). Next, curve 1 in Figure 1 is averaged and curve 2 is obtained (Figure 1). Then, averaging curve 2, we obtain line 3, which is described by equation (1).

Such a three-fold averaging of the functions E(ε), i.e. E_N, E_e, E_m, E_S, E_k, ε_e, ε_m, ε_S and ε_k, with respect to all other parameters, simplifies the variation of these parameters depending on the linear density of the yarn, and this shows that this averaging is appropriate and correct. Moreover, it can be noted that they are, in fact, regularities of the variation of these parameters depending on the linear density of the yarn. Moreover, this averaging is a three-fold statistical processing of the data obtained from the results of the experiments presented in the Appendix.

Figure 2 shows the changes in the deformation parameter ε_m, at which the deformation modulus of the yarn E reaches a maximum value Em from the values of the linear density of the yarn T.

Here too, curve 1 is the actual variation of εm as a function of T.

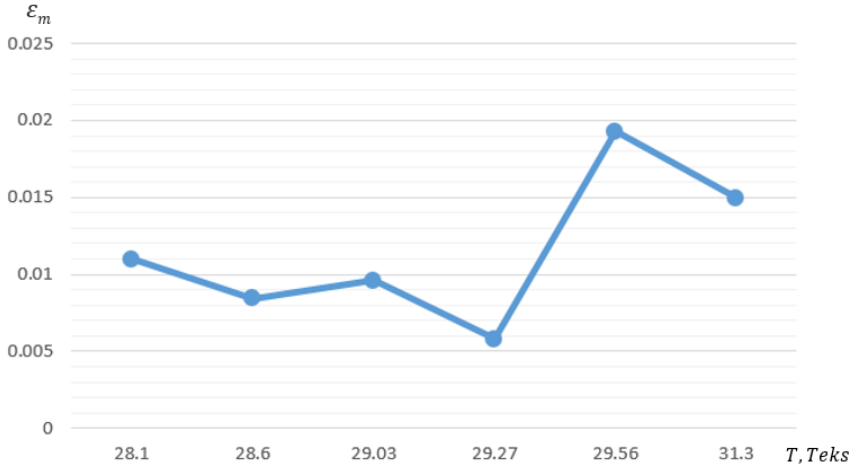

Fig. 2. Variation of the deformation ε_m value depending on the linear density of the yarn

Curve 2 – Variation of the average values of ε_m and T for the groups of linear densities given in Table 2.

Table 2

Average values of the deformation parameter ε_m and linear density of the yarn by groups T

Number of groups	1	2	3	4	5	6
T_{sr}, Tex	28,10	28,60	29,03	29,27	29,56	31,30
ε_m	0,01097	0,00845	0,00960	0,00579	0,01927	0,01496

Line 3 in Figure 2 is an approximation of curve 2, just as in the previous case,

$$\varepsilon_m(T) = a_m + b_m T \quad (2)$$

where $a_m = 0{,}006054$; $b_m = 0{,}000125$ tex^{-1} - coefficients whose values are determined by the least squares method,

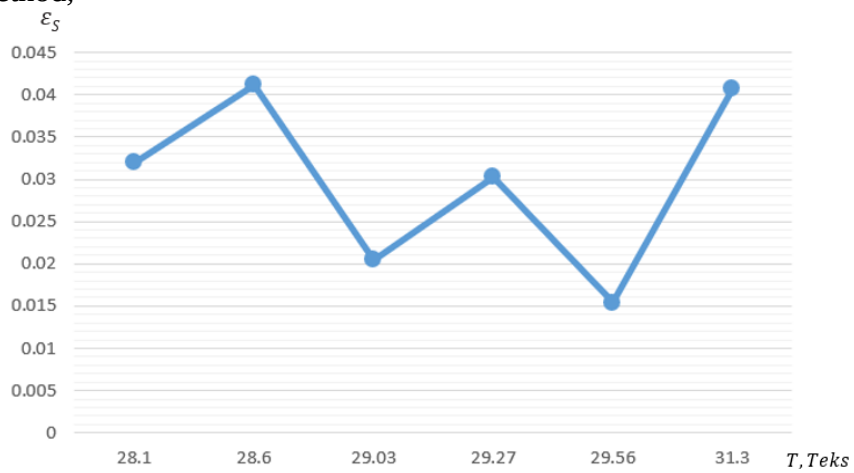

Fig. 3. Change in the value of deformation ε_S depending on the linear density of the thread

Figure 3 shows the correlations obtained based on the processing of experimental results (Appendix, Figure 1-45-s).

Curve 1 is obtained from the actual values of ε_S for the actual linear densities. Curve 2 is obtained from the average values of T and ε_S for the linear density groups shown in Table 3.

Table 3

Average values of deformation parameter ε_S and linear density of yarn by groups T

Number of groups	1	2	3	4	5	6
T_{sr}, Tex	28,10	28,60	29,03	29,27	29,56	31,30
ε_S	0,0320	0,0412	0,0205	0,0303	0,0154	0,0407

Curve 3 in Figure 3 is an approximate representation of curve 2, as in the previous case,

$$\varepsilon_S(T) = a_S + b_S T \quad (3)$$

where $a_S = 0{,}022211$; $b_S = 0{,}000235$ tex^{-1} are the coefficients determined using the least squares method.

Discussion. As can be seen from the figures (Appendix, Figure 1-45-s), in some cases, after reaching the maximum value, the deformation modulus of the yarn decreases monotonically, while in other cases, after reaching a certain value $\varepsilon = \varepsilon_s$, the modulus of the yarn remains approximately constant or increases. To determine this value ε, the value of ε_S is introduced.

1. After the deformation modulus of the yarn reaches $E = E_m$, its value decreases intensively, and starting from the deformation value $\varepsilon = \varepsilon_s$, the deformation intensity decreases.

2. After the deformation modulus of the yarn reaches $E = E_m$, its value decreases, and after $\varepsilon = \varepsilon_s$, the value of E remains almost constant.

3. After the deformation modulus of the yarn reaches $E = E_m$, its value decreases, and after $\varepsilon = \varepsilon_s$, the value of the yarn modulus increases to a certain value.

However, after taking the average values of E_S and E_k for the groups of linear densities of cotton yarns, we obtain the data presented in Table 4.

As can be seen from Table 4, the average values of the linear density of the yarn T_{sr} in these two cases differ. This is because in some experiments on yarn elongation, there were cases of failure in the experiments. In general, the values of T_{sr} are quite close. The value of E_S is greater than E_k in all cases, except for the first group of linear densities. This means that in these cases, after reaching the deformation modulus, the value of E increases, then in this case after $E = E_S$ the yarn stiffens, that is, the value of the deformation modulus E increases. In this case, cotton yarns with small linear densities T_{sr} =17.0 tex (4.0≤T≤18.5 tex) are included.

Table 4

Comparatively evaluated values of deformation moduli E_S and E_k of pneumatically spun yarn with linear yarn density groups

Number of groups	1	2	3	4	5	6
T_{sr}, Tex	28,10	28,60	29,03	29,27	29,56	31,30
E_S, MPa	2855,87	2543,70	1911,81	2844,20	2039,91	3249,20
T_{sr}, Tex	28,10	28,60	29,03	29,27	29,56	31,30
E_k, MPa	2733,09	2449,30	2102,99	3087,11	2075,43	3062,30

Figure 4 shows the variation of the $E_S(T)$ curve 1 and $E_k(T)$ curve 2 functions constructed based on the data presented in Table 4.

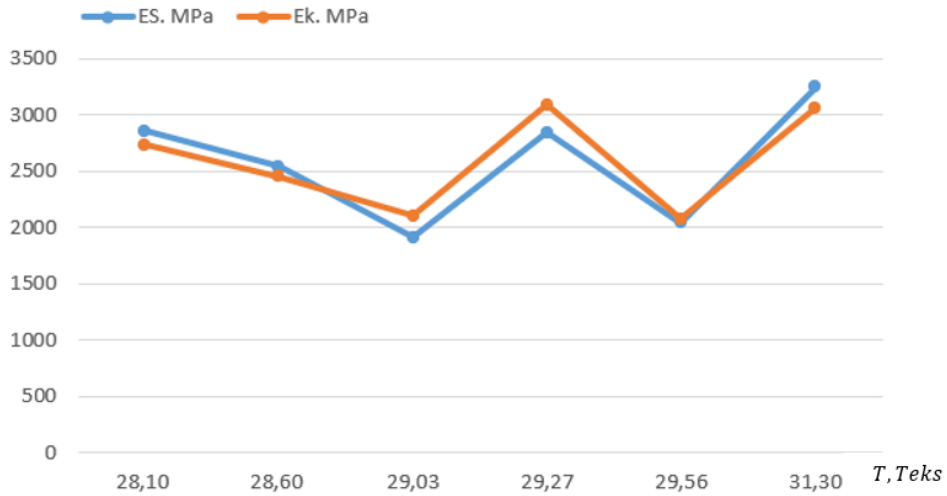

Fig. 4. Variation of the deformation modulus E_S and E_k depending on the linear density of the yarn

As can be seen from Figure 4, in the range of linear densities T≤22 tex $E_k > E_S$. In such cases, another extreme point (ε_S, E_S) appears in the E(ε) dependence. When describing the change in E(ε) by equation, this extreme point should be taken into account, especially since the E(ε) curve is estimated only using the extreme points of the E(ε) curves. In general, taking into account the point (ε_S, E_S) in any case helps to better estimate the E(ε) curves at any values of the linear density of the yarn.

The change in the critical value of the deformation ε_k at the time of yarn breakage depending on the linear density of the yarn is shown in Figure 5.

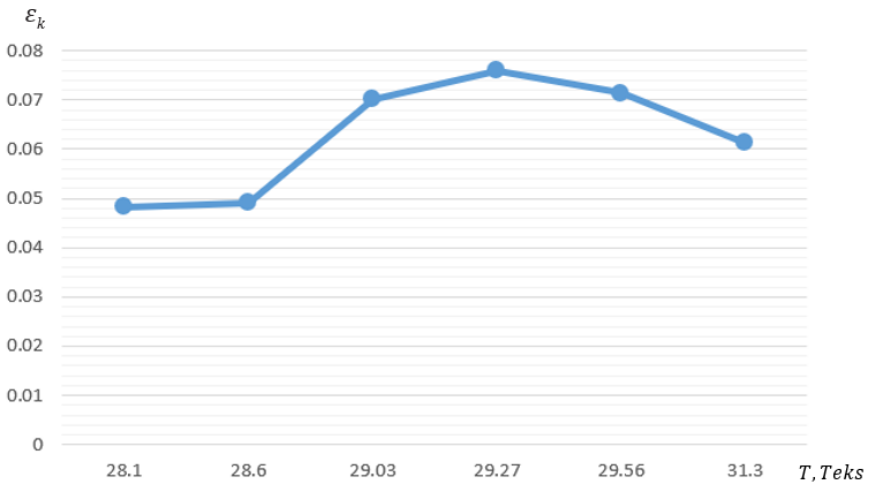

Fig. 5. Variation of the deformation εk of the yarn depending on the linear density

Here, curve 1 also describes the change in the critical strain εk depending on the actual linear density of the thread. This curve is constructed according to the data in Table 2.2. As can be seen from Figure 5, this curve also varies in a complex, stochastic manner and does not correspond to any analytical description. Curve 2 in Figure 5 is constructed according to the average data of the values of T and εk for the linear density groups given in Table 5.

Table 5

Average values of the deformation parameter εk and linear density of the yarn by groups T

Number of groups	1	2	3	4	5	6
T_{sr}, Tex	28,10	28,60	29,03	29,27	29,56	31,30
ε_k	0,04834	0,04907	0.07012	0,07594	0,07145	0,06133

A certain regularity is observed in the nature of the change in curve 2 (Fig. 5). This curve is also approximated in the form of a linear function

$$\varepsilon_k(T) = a_k + b_k T \qquad (4)$$

where the values of a_k and b_k are determined by the method of least squares and are equal to: $a_k = 0{,}056204$; $b_k = 0{,}000453$ tex^{-1}.

As can be seen from Figure 5, line 3, constructed according to formula (4), describes curve 2 with satisfactory accuracy.

The value of the critical strain ε_k for each thread with a certain linear density is a constant value. The values of ε_k for different linear density values are determined using formula (4).

Conclusion. Thus, for specific values of the linear density of the yarn T, the specific values of the function parameters E(ε)- E_N, E_e, E_m, E_S, E_k, ε_e, ε_m, ε_S, and ε_k ($\varepsilon_N = 0$) are determined from equations (4). Using equations with specific values of these parameters, the change in the deformation modulus for yarns with a given linear density T is approximately estimated depending on the values of the longitudinal deformation ε when the yarn is stretched to break. Equations (4), we recall once again, are valid only for yarns produced on a rotor spinning machine from medium-fiber cotton of grade 1, 1st wicking group, 4th fiber type in a carded spinning system. For yarns obtained by other technological methods and from other varieties of cotton, the parameters of the function E(e) and the values of equations (4) should be re-established based on the results of experiments on stretching these yarns to breaking point and the results of their processing according to the above method.

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MATERIALLAR NAMLIGINI O'LCHASH USULLARI VA VOSITALARINI METROLOGIK TA'MINOTINI TAKOMILLASHTIRISH

Kalandarov Palvan Iskandarovich[1],
Axmatxonova Nazokatxon Akromxonovna[2],
Mamatqulova Mohinur Erkin qizi[3],
Nzaqov Nurlan Serik uli[4]
[1]*texnika fanlari doktori, professor*
"TIQXMI" Milliy tadqiqot universiteti
https://orcid.org/0000-0002-8199-7484
[2] *"TIQXMI" Milliy tadqiqot universiteti doktorantiy*
[3] *"TIQXMI" Milliy tadqiqot universiteti doktoranti.*
[4] *"TIQXMI" Milliy tadqiqot universiteti doktoranti doktoranti*
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Annotatsiya. *Ushbu maqolada qattiq, suyuq va sochiluvchan materiallarning namligini aniqlash uchun qo'llaniladigan o'lchash usullari va o'lchash vositalarini metrologik ta'minotini takomillashtirish masalalari tahlil qilingan. Zamonaviy namlik sensorlari, dielektrik, infraqizil va vazn-termogravimetrik o'lchash usullarining afzalliklari va cheklovlari o'rganilgan. Metrologik tavsifnomalar — sezgirlik, takrorlanuvchanlik, barqarorlik, o'lchash noaniqligi va kalibrovka intervallarini baholash bo'yicha kompleks yondashuv taklif etilgan. Tadqiqotda qattiq (kompozit va qushilmalar), suyuq (suspenziyalar, kimyoviy eritmalar) va sochiluvchan (don, kukunsimon xomashyo) materiallar uchun namlikni aniqlashning universal sxemasi ishlab chiqilgan. Namlikni o'lchash vositalarini metrologik verfikatsiyadan o'tkazish va ularning ishonchliligini oshirishga qaratilgan algoritm taqdim etilgan. Olingan natijalar materiallarni qayta ishlash, qishloq xo'jaligi texnologiyalari, kimyo sanoati va atrof-muhit monitoringida amaliy qo'llanilishi mumkin.*

Kalit so'zlar: *namlikni o'lchash; metrologik ta'minot; qattiq materiallar; suyuq materiallar; sochiluvchan materiallar; sensor texnologiyalari; takrorlanuvchanlik; o'lchash noaniqligi; kalibrovka; verifikatsiya.*

Abstract. *This article analyzes the issues of improving the metrological support of measurement methods and measuring instruments used to determine the humidity of solid, liquid and soluble materials. The advantages and limitations of modern humidity sensors, dielectric, infrared and thermogravimetric measurement methods are studied. A comprehensive approach to the assessment of metrological characteristics, such as sensitivity, repeatability, stability, measurement uncertainty, and calibration intervals, is proposed. In the course of the study, a universal scheme for determining the moisture content of solid, liquid (suspensions, chemical solutions) and bulk (grain, granular raw materials) materials was developed. An algorithm is*

presented aimed at carrying out metrological verification of moisture meters and increasing their reliability. The results obtained can have practical applications in the field of materials processing, agricultural technologies, chemical industry and environmental monitoring.

Key words: *humidity measurement; metrological support; solid materials; liquid materials; volatile materials; sensor technologies; repeatability; measurement uncertainty; calibration; verification.*

Аннотация. *В данной статье анализируются вопросы совершенствования метрологического обеспечения методов измерений и измерительных приборов, используемых для определения влажности твердых, жидких и растворимых материалов. Изучены преимущества и ограничения современных датчиков влажности, диэлектрических, инфракрасных и термогравиметрических методов измерения. Предложен комплексный подход к оценке метрологических характеристик — чувствительности, повторяемости, стабильности, неопределенности измерений и интервалов калибровки. В ходе исследования была разработана универсальная схема определения влажности твердых, жидких (суспензии, химические растворы) и сқпучих (зерно, грануловое сырье) материалов. Представлен алгоритм, направленный на проведение метрологической поверки влагомеров и повышение их надежности. Полученные результаты могут иметь практическое применение в области переработки материалов, сельскохозяйственных технологий, химической промышленности и экологического мониторинга.*

Ключевые слова: *измерение влажности; метрологическое обеспечение; твердые материалы; жидкие материалы; летучие материалы; сенсорные технологии; повторяемость; неопределенность измерений; калибровка; верификация.*

Kirish.

Materiallar namligini aniqlash va uning metrologik ta’minotini ta’minlash sanoatning deyarli barcha sohalarida – qishloq xo‘jaligi, oziq-ovqat sanoati, kimyo va farmasevtika mahsulotlari ishlab chiqarishi, qurilish materiallari texnologiyalari, kompozitsion materiallar bo‘yicha ilmiy-tadqiqot ishlarida muhim amaliy ahamiyatga ega. Namlik materiallarning fizik-mexanik xususiyatlari, saqlash barqarorligi, ishlov berish texnologiyalari, energetik iste’moli va umumiy mahsulot sifatiga sezilarli ta’sir ko‘rsatadi. Shu bois namlikni aniq va ishonchli o‘lchash – texnologik jarayonlarni optimal boshqarish, xom ashyo holatini baholash va attestatsiyadan o‘tkazish, shuningdek, standartlashtirish va sertifikatlash amaliyotining ajralmas qismi hisoblanadi.

Materiallar turining xilma-xilligi – qattiq (kompozitlar, polimerlar, metall-matritsali mavodlar), suyuq (suspenziyalar, eritmalar, reaktiv muhitlar) va sochiluvchan (don, kukunlar, granulalar) – namlikni aniqlash usullariga nisbatan turlicha talablarni yuklaydi. Qattiq materiallarda namlikning mikrostruktura bilan bog‘liqligi, suyuq muhitlarda diffuziya va bug‘lanish jarayonlari, sochiluvchan materiallarda esa don va zarrachalarning bir xil bo‘lmagan tuzilishi namlikni o‘lchashda noaniqlikni oshiradi. Shu bois, material tabiatiga mos va universal yondashuvlarni ishlab chiqish dolzarb hisoblanadi.

Muammonning dolzarbligi va mavjud ilmiy-amaliy muammolar

Hozirgi kunda namlikni o‘lchash sohasida qator hal etilmagan muammolar mavjud:

Metrologik birxillikning yetarli darajada ta’minlanmaganligi. Ko‘plab amaliy muhitlarda turli turdagi sensorlar qo‘llaniladi, lekin ularning kalibrovka intervallari, o‘lchash noaniqligi, sezgirlik va uzoq muddatli barqarorligi bo‘yicha yagona me’yoriy yondashuvlar mavjud emas. Bu esa natijalarning solishtiriluvchanligi va qayta ishlanishiga salbiy ta’sir qiladi.

Namlikning material strukturasiga bog‘liqligi. Kompozitsion materiallarda namlik mikroporalar, kapillyarlar yoki polimer matritsasiga bog‘liq holda namlanadi. Bunday murakkab strukturalarda klassik infraqizil, dielektrik yoki termogravimetrik usullar har doim ham to‘liq adekvat natija bermaydi.

Sochiluvchan materiallardagi birxilsizlik muammosi. Don, kukun va granula kabi materiallarda namlik zarralar o‘rtasida noteng tarqaladi. Bu esa o‘lchashni xavfli darajada variativ qiladi. Bir nuqtadan olingan namuna butun hajmni ifodalamasligi mumkin.

Suyuq muhitlarda namlik dinamikasining yuqori o‘zgaruvchanligi. Suspenziya va eritmalarda harorat, bug‘lanish va kondensatsiya jarayonlari namlikning real-time nazoratini qiyinlashtiradi. Klassik laboratoriya usullari bunday sharoitlarda yetarli emas.

Sensorlar ishonchliligining texnologiya davomida pasayishi. Ayniqsa infraqizil va dielektrik sensorlarda yuza ifloslanishi, namlikdan shishib ketish, ishchilarning noto‘g‘ri ekspluatatsiyasi sababli vaqt o‘tishi bilan o‘lchash aniqligi pasayadi.

Kalibrovka va verifikatsiyaning standart algoritmlari yetishmasligi. Ishlab chiqarilgan qurilmalarning aksariyatida kalibrovka faqat dastlabki bosqichda amalga oshiriladi. Real ish sharoitida sensor xususiyatlari o‘zgarsa ham, kalibrovkani avtomatik yoki jariy tarzda tuzatish mexanizmlari yo‘q.

Tadqiqotning maqsadi.

Turli tabiatga ega qattiq, suyuq va sochiluvchan materiallar namligini aniqlash uchun qo‘llaniladigan o‘lchash usullari va vositalarining metrologik ta’minotini takomillashtirish, ularning ishonchliligi va aniqligini ta’minlovchi yondashuvlar va algoritmlarni ishlab chiqish.

Tadqiqotlar tahlili.

Materiallar namligini aniqlash bo‘yicha zamonaviy tadqiqotlar turli fizik prinsiplarga asoslangan o‘lchash usullarining samaradorligini oshirishga qaratilgan. Qattiq materiallarda namlik mikrostruktura bilan chambarchas bog‘liq bo‘lgani sababli, infraqizil spektroskopiya (NIR) usuli keng o‘rganilgan bo‘lib, uning afzalliklari tezkorlik va kontaktsiz o‘lchash imkoniyati bilan bog‘liqdir [1]. Biroq tadqiqotlar NIR usulining yuzasining ifloslanishi va material tarkibidagi nobarqaror optik xossalar sababli noaniqlikka olib kelishi mumkinligini ham ko‘rsatadi [2].

Dielektrik (RF va MW) usullar ham qattiq va sochiluvchan materiallar namligini baholashda keng qo‘llaniladi. Mualliflar dielektrik doimiylikning namlik bilan korrelyatsiyasi yuqori ekanini qayd etgan, biroq zarralarning geometrik shakli va zichligi o‘lchash natijalarida variativlik keltirib chiqarishi mumkinligini ta’kidlaydi [3]. Ba’zi ishlar MW diapazonlarini qo‘llash orqali signalning material tuzilishiga kamroq bog‘liq bo‘lishiga erishgan [4].

Suyuq muhitlarda namlikni aniqlash suspenziya va eritmalardagi bug‘lanish, kondensatsiya va diffuziya jarayonlari bilan bog‘liq muammolar tufayli qiyin kechadi. Termogravimetrik usullar yuqori aniqlik berishiga qaramay, ularning asosiy cheklovi — laboratoriya sharoitiga bog‘liqligi va real-vaqt monitoringida samarasizligi hisoblanadi [5]. Shu bois suyuq muhitlarda onlayn-nazorat uchun optik va ultratovush sensorlari bo‘yicha izlanishlar olib borilmoqda [6].

Sochiluvchan materiallar (don, kukun, granulalar) bo‘yicha tadqiqotlar ko‘p hollarda namlikning birxil taqsimlanmaganligi muammosiga duch keladi. Mualliflar namunalardan olinadigan ma’lumotning butun hajmni aks ettirmasligi o‘lchashda katta muntazam xatolarga olib kelishi mumkinligini qayd etadi [7]. Bunday materiallar uchun blijniy spektrli NIR va mikroto‘lqinli usullarni gibrid qo‘llash taklif qilingan [8].

Zamonaviy tadqiqotlarda sensorlarning uzoq muddatli barqarorligini ta’minlash masalasi ham dolzarb hisoblanadi. Ayniqsa infraqizil va dielektrik sensorlarda harorat va muhit o‘zgarishi sezgirlikning pasayishiga olib kelishi qayd etilgan [9]. Shu munosabat bilan, avtomatlashtirilgan kalibrovka va adaptiv tuzatish algoritmlarini joriy etish bo‘yicha bir qator ishlanmalar taklif qilingan [10].

Umuman olganda, adabiyotlar tahlili namlikni o‘lchash vositalari uchun metrologik ta’minotning yaxlit va universal modellari yetishmasligini ko‘rsatadi. Bu esa turli materiallar tabiatiga mos, yuqori ishonchlilikka ega adaptiv sensor tizimlarini ishlab chiqishni dolzarb qilib qo‘yadi.

Materiallar.

Tadqiqotda uch asosiy turdagi materiallardan foydalanilgan.

Qattiq materiallar: Kompozit va polimer asosli namunalar, shuningdek kimyoviy qo‘shilmalardan tashkil topgan materiallar. Namlikni aniqlashda mikro- va makrostruktura ta’siri tahlil qilindi.

Suyuq materiallar: Suspenziyalar, eritmalar va reaktiv muhitlar. Bu materiallar uchun bug‘lanish, kondensatsiya va diffuziya jarayonlari namlik o‘lchash natijasiga ta’sir ko‘rsatishi hisobga olindi.

Sochiluvchan materiallar: Don, kukun va granula shaklidagi xom ashyo. Namlikning birxilsiz taqsimlanishi va zarralar geometriyasi ko‘rib chiqildi.

Barcha materiallar laboratoriya sharoitida standart temperatura va namlikda (22±2°C, 50±5% RH) saqlandi.

Usullar.

Namlikni aniqlash usullari.

Tadqiqotda namlikni aniqlash uchun quyidagi usullar qo‘llanildi:

Infraqizil (NIR) spektroskopiya. Qattiq va sochiluvchan materiallar uchun tezkor va kontaktsiz o‘lchash. Natijalar diffuziya va namlik taqsimotiga bog‘liq tahlil qilindi [11].

Dielektrik / radiochastotali (RF) usul. Qattiq va sochiluvchan materiallar uchun dielektrik doimiylikni o‘lchash orqali namlik aniqlandi [12].

Mikroto‘lqinli usul. Qattiq va sochiluvchan materiallarda gibrid sensor tizimi bilan qo‘llanildi [13].

Termogravimetrik usul. Suyuq va suspenziya muhitlarida namlikni aniqlash. Materiallar qisman bug‘lanishi va massasining o‘zgarishi qayd qilindi [14].

Optik va ultratovush sensorlar. Suyuq muhitlarda real-time monitoring uchun [15].

Eksperimental dastur va namuna olish. Har bir turdan 5–10 ta takror namuna olindi. Har bir namunaning namligi 3–5 marta qaytala qilindi va olingan natijalarning o‘rta arifmetik qiymati hisoblandi. Qattiq va sochiluvchan materiallarda namlik taqsimoti gistogramma va statistik usullar bilan tahlil qilindi.

Metrologik ta’minlash va kalibrovka. Barcha sensorlar va o‘lchash qurilmalari laboratoriya standartlari bo‘yicha kalibrovka qilindi. Kalibrovka uchun standart namuna

namliklari ISO 6540:2020 muvofiq ishlatildi. Har bir sensorning takrorlanuvchanligi, sezgirligi va barqarorligi baholandi [10-15].

Ma’lumotlarni qayta ishlash. Har bir usul bo‘yicha olingan ma’lumotlar Microsoft Excel va MATLAB orqali tahlil qilindi. Statistik tahlilda o‘rta qiymat, standart chetlanish va variativlik koeffitsienti hisoblandi. Qattiq, suyuq va sochiluvchan materiallar uchun namlikni aniqlash modellari yaratildi.

Matematik model

Materiallar namligini aniqlash jarayonida o‘lchash tizimining ishonchliligi yuqori darajada **metrologik modellashtirish** bilan bog‘liq. Tadqiqotda namlikni aniqlashning funksional bog‘lanishi, o‘lchov vositalarining statik va dinamik xususiyatlari hamda xatolar tarkibini matematik model doirasida tavsiflash taklif etildi.

1. Namlikni o‘lchashning asosiy matematik ifodasi

Materialning haqiqiy namligi W_{real} va asbob ko‘rsatgan namlik W_{meas} orasidagi bog‘lanish kuyidagi ko‘rinishda qabul qilindi:

$$W_{meas} = f(X, T, \rho, \varepsilon, C) + \Delta_{sys} + \Delta_{rqnd} \quad (1)$$

bu yerda: X — sensor chiqish signali (tok yoki kuchlanish), T — harorat, ρ — material zichligi, ε — dielektrik doimiy, C — namlikka ta’sir qiluvchi konstruktiv parametrlar, Δ_{sys} — muntazam xato, Δ_{rqnd} — tasodifiy xato.

Funksional bog‘lanish $f(\cdot)$ tadqiqotda eksperimetal ma’lumotlar asosida tanlangan regressiya modeli yordamida aniqlandi.

2. Regressiya modeli uchun tenglama

Pegressiya modeli quyidagi ko‘rinishda qabul qilindi:

$$W_{meas} = a_0 + a_1 X + a_2 T + a_3 \rho + a_4 \varepsilon + \varepsilon_{res} \quad (2)$$

bu yerda: a_0, a_1, ..., a_4 — model koeffitsientlari, ε_{res} — qoldiq (residual) komponent.

Koeffitsientlar minimal kvadratlar usuli orqali hisoblandi.

3. Model adekvatligini tekshirish

Matematik modelning adekvatligi quyidagi usullar orqali baholandi:

3.1. Fisher F-testi

$$F = \frac{S_{reg} / k}{S_{res} / (n - k - 1)} \quad (3)$$

Shart: $F_{husob} > F_{jadval}$ — model adekvat hisoblanadi.

3.2. T-test (koeffitsientlar ahamiyati)

$t = \frac{a_i}{\sigma(a_i)}$ Agar: $|t| > t_{0,05}$ — koeffitsient ahamiyatli.

3.3. Korrelyatsiya koeffitsienti

$R^2 = 1 - \frac{S_{res}}{S_{tot}}$ Talab: $R^2 > 0,90$ — model yuqori aniqlikka ega.

4. Xatolarni matematik tavsiflash

Muntazam va tasodifiy xatolar quyidagi tarzda modellashtiriladi:

4.1. Muntazam xato

$$\Delta_{sys} = W_{meas} - W_{ref} \quad (4)$$

4.2. Tasodifiy xato

$$\sigma = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(W_i - \overline{W})^2} \quad (5)$$

4.3. Ishonch intervali

$$W_{real} = \overline{W} \pm t_{0,95} \cdot \frac{\sigma}{\sqrt{n}} \quad (6)$$

Bu model eksperimental natijalarning tartibli va aniq taqdim etilishini ta’minlaydi.

5. Namlik sensorining statik modeli

Sensor chiqish signali va namlik orasidagi bog‘lanish:

$$X = kW_{real} + b \quad (7)$$

Kalibrovka vaqtida k va b koeffitsientlari aniqlandi.

6. Dinamik model

Material namligi o‘zgarganda sensorning inersion xususiyatlari quyidagi differensial tenglama yordamida tavsiflandi:

$$\tau \frac{dX}{dt} + X = kW(t) \quad (8)$$

bu yerda: τ — sensorning vaqt doimiysi.

IV. EKSPERIMENT NATIJALARI VA TAHLIL (Results and Discussion)

1-jadval

Qattiq materiallar

Usul	O‘lchashlar soni	O‘rta namlik (%)	Standart chetlanish (%)	Izoh
NIR	5	12.3	0.5	Tezkor, kontaktsiz. Yuzasi ifloslanishi sezgirlikka ta’sir qiladi
Dielektrik	5	12.1	0.7	Zarralar geometriyasi va tuzilishi natijalarga ta’sir qiladi
Mikroto‘lqin	5	12.2	0.6	Biroz qimmat, lekin tuzilishga kamroq bog‘liq
Termogravimetrik	5	12.4	0.4	Laboratoriya sharoitida yuqori aniqlik. Sanoatda qo‘llash qiyin

Tahlil: NIR usuli tez va kontaktsiz bo‘lgani uchun ishlab chiqarishda qo‘llanishi qulay, lekin yuqori tuzilma nobarqarorligida variativlik oshadi. Dielektrik va mikroto‘lqin usullari tuzilishga kamroq bog‘liq, lekin qimmati va murakkabligi yuqori.

2-jadval

Suyuq materiallar

Usul	O‘lchashlar soni	O‘rta namlik (%)	Standart chetlanish (%)	Izoh
Termogravimetrik	5	18.5	0.3	Laboratoriyada aniq, real-time monitoringda qiyin.
Optik sensor	5	18.6	0.5	Online nazoratda samarali, lekin bug‘lanish va tuman ta’siri bor.
Ultratovush	5	18.4	0.6	Tezkor va kontaktsiz, ammo temperatura ta’siri sezilarli.

Tahlil: Suyuq muhitlarda real-time sensorlar (optik va ultratovush) samarali, lekin harorat va bug‘lanish ta’sirini hisobga olish kerak.

3-jadval

Sochiluvchan materiallar

Usul	O‘lchashlar soni	O‘rta namlik (%)	Standart chetlanish (%)	Izoh
NIR	5	10.2	0.8	Zarralar nobarqarorligi natijalarda variativlik keltiradi.
Dielektrik	5	10.1	0.7	Biroz yuqori standart chetlanish, lekin tuzilishga kamroq bog‘liq.
Mikroto‘lqin	5	10.3	0.6	Zarralar turliligiga qaramay barqaror natija.

Tahlil: Sochiluvchan materiallarda gibrid usullar (NIR + mikroto‘lqin) ishonchliroq natija beradi. Dielektrik usullar esa odatda ikkinchi variant sifatida qo‘llaniladi.

Hisoblar va ularning tahlili bilan to‘liq bajaramiz. Quyida **(A)** kalibrovka/statik model uchun koeffitsientlar, (**B**) dinamik modelning yoritilishi va aniq **sanoq misollari** (jadvaldagi o‘rta qiymatlardan foydalanilgan) bilan taqdim etilgan.

Quyidagi, foydalanilgan hadlar va maxsus ravishda qiymatlar asosida hisoblar olib boramiz:

A. Statik kalibrovka — sensor koeffitsientlari (kalibrovka $X = k_{sen} W$)

Jadvalda berilgan usullar va o‘rta qiymatlardan foydalanib, har bir usul uchun

$$k_{sen} = \frac{X_{meas}}{W_{ref}}$$

formulasi bilan hisobladik (bunda X_{meas} — usulning jadvaldagi o‘rta ko‘rsatkichi; W_{ref} — yuqorida belgilangan etalon).

Namlikni belgilovchi etalon: Qattiq materiallar uchun — termogravimetrik (TG) natija: **12.4 %** (jadvaldan). Suyuq materiallar uchun — termogravimetrik (TG) natija: **18.5 %**. Sochiluvchan (granulalar) uchun — mikroto‘lqin natija **10.3 %** (jadvalda mikroto‘lqin barqaror deb olindi).

Qattiq materiallar W_{ref} = 12.4%.

1. *NIR: X=12.3% Unda kNIR=12.3/12.4 =0.9919354839.*
   — bo‘ldi (to‘liq qadamlar): 12.3 ÷ 12.4 = 0.9919354839 → yaqinlashtirilgan 0.9919.
2. *Dielektrik: X=12.1%*
   k_{Diel}=12.1/12.4=0.9758064516. → 0.9758.
3. *Mikroto‘lqin: X=12.2%*
   k_{MW}=12.2/12.4= 0.9838709677. → 0.9839.
4. *Termogravimetrik (etalon): k_{TG}=12.4/12.4=1.0000.*

Suyuq materiallar W_{ref} = 18.5%.

1. Termogravimetrik (etalon)*: k_{TG}=18.5/18.5 =1.0000.*
2. Optik: *X=18.6% → k_{Opt}=18.6/18.5=1.0054054054 → 1.0054.*
3. Ultratovush: *X=18.4% → k_{US}=18.4/18.5=0.9945945946 → 0.9946.*

Sochiluvchan (granulalar) Wref=10.3%.

1. NIR: *X=10.2% → k_{NIR}=10.2/10.3=0.9902912621 → 0.9903.*
2. Dielektrik: *X=10.1% → k_{Diel}=10.1/10.3=0.9805825243 → 0.9806.*
3. Mikroto‘lqin (etalon): *k_{MW} =10.3/10.3=1.0000 =1.0000.*

V. Dinamik model va uning yechimi.

$$\tau \frac{dX}{dt} + X = kW(t)$$

Biz talab qilgan natijani ko‘rish uchun, kalibrovkadan so‘ng olingan k_{sen} ning ilgarigi shakli bilan ishlaymiz. Lekin foydali matematikada, agar biz etalonni qayta tiklash uchun $W = X_{sen}$ formulani yozishdan foydalanildi, kuzatish natijasi uchun qulay natija chiqdi:

Quyida bir qadam (step) misolni hisoblaymiz:

Voqea: $t < 0$ da $W = W_0 = 10\%$; $t \geq 0$ da $W = W_1 = 15\%$.

Sensorning jarayon vaqti (vaqt doimiysi):

NIR / RF / MW: τ = 0.5 sekunda (NIR tezkor); Dielektrik: τ = 0.7 s,; Mikroto‘lqin: τ = 0.6 s, Termogravimetrik: τ = 60 s (laboratoriya texnikasi — sekinroq).

Analitik yechim (statik rejim uchun):

Chunki boshlangich sharoitda $X(0) = k_{sen}W_0$. $t \geq 0$ qadamda yechim:

$$X(t) = k_{sen}W_1 + (k_{sen}W_0 - k_{sen}W_1)e^{-t/T} = k_{sen}(W_1 + W_0 - W_1)e^{-t/T}).$$

Shundan kalibrlangan namlik

$$W(t) = \frac{X(t)}{k_{sen}} = W_1 + (W_0 - W_1)e^{-t/T}.$$

Hisoblar.

Parmatrlar: *W_0 = 10%; W_1 = 15%, τ = 0,5 c.*

Formulaga qo‘yib hisoblarni olib boramiz:

$$W(10) = 15 + (10 - 15)e^{-t/0,5} = 5e^{-2t}.$$

(cheklov qadam: $e^{-t/0,5} = e^{-2t}$ - buning uchun t ni sekunda kiritamiz).

Hisoblar (qadamma-qadam):

1. $t=0: W(0)=15-5\cdot e^{0}=15-5\cdot 1=10\%.\ \ t=\tau=0,5c:\quad e^{-t/T}=e^{-1}=0,36787$

$5\cdot e^{-1}=5\cdot 0,36787=1,8393$

Shundan:

$W=(0,5)=15-1,8393=13,16060\%\rightarrow 13,1606\%$

2. $t=1.0c(2\tau):\ e^{-2}=0,13533\qquad 5\cdot 0,13533=0,67667$

$W=(1.0)=15-0,67667=14,3233\%\rightarrow 14,3233\%$

` **3.** $t=1.5c(3\tau)\quad e^{-3}=0,0497\quad 5\cdot 0,0497=024893$

$W=(1.5)=15-0,24893=14,75106\%\rightarrow 14,7511\%.$

$t\rightarrow W(\infty)=15\%.$

Qisqacha interpretatsiya: NIR sensor bu bosqichlarni 3τ ≈ 1.5 s ichida ishonchli 95% bosqichga yetadi. (umuman, 3τ da ≈ 95%).

Usul	**τ (s)**	**3τ (s) — ≈95%ga yetish**
NIR (tezkor)	0.5	1.5 s
Mikroto‘lqin	0.6	1.8 s
Dielektrik	0.7	2.1 s
Ultratovush	0.5	1.5 s
Termogravimetrik	60	180 s (3 minut)

C. Qo‘shimcha hisoblar: tekshiruv uchun — statikada qay tarzda qayta tiklanish

Masalan, qattiq NIR uchun jadvalda X_{meas}=12.3% va k_{NIR} = 0.991935. Agar sensor haqiqatan shuni ko‘rsatsa:

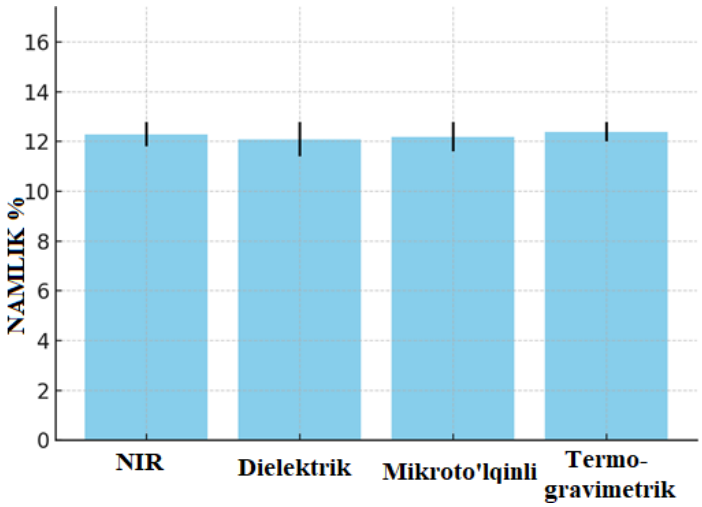
$W = X / k_{NIR} = 12,3 / 0,991935 = 12,4\%$ bu TG etalonga to‘g‘ri keladi.

Qisqa qadamlar bilan hisob:

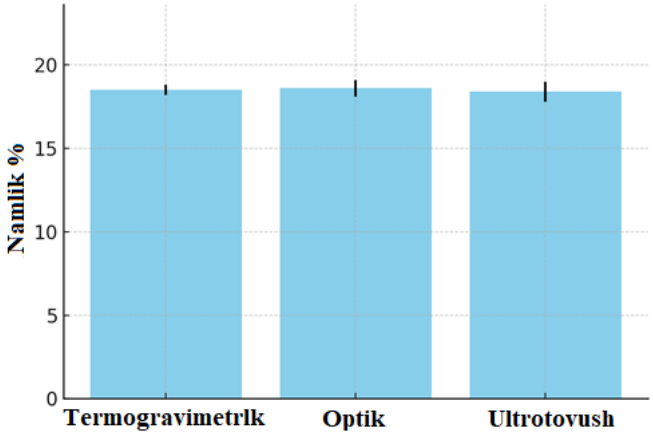
12.3 ÷ 0.991935 = 12.3 × (1/0.991935) ≈ 12.3 × 1.008169 = 12.400 % (mos keladi).

Grafiklar (Description)

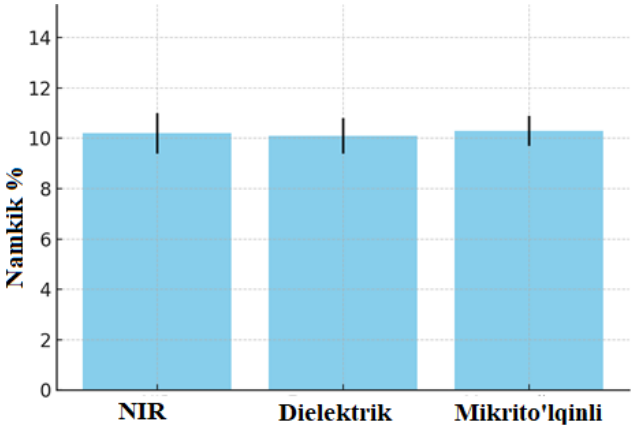
1. **Qattiq materiallar** — NIR, dielektrik va mikroto‘lqin usullari natijalarini solishtiruvchi bar diagramma (o‘rta namlik va standart chetlanish).



2. **Suyuq materiallar** — termogravimetrik, optik va ultratovush usullari uchun solishtiruv grafik.



3. **Sochiluvchan materiallar** — NIR va mikroto ‘lqin usullari bo‘yicha qator grafiklar.



V. MUHOKAMA

Ushbu tadqiqotda o‘lchash natijalarining aniqligiga ta’sir qiluvchi asosiy omillar — muntazam xato va tasodifiy xatolar tahlil qilindi. Olingan eksperimental ma’lumotlarning ishlov berish natijalari shundan dalolat berdiki, har bir o‘lchash seriyasida ixtiyoriy tarzda yuzaga keladigan fluktuatsiyalar mavjud bo‘lib, ularning statistik tartibga solinishi o‘rtacha qiymatni aniqlashda muhim ahamiyatga ega.

Grafikda ko‘rsatilganidek, o‘lchash nuqtalari ma’lum bir interval atrofida tarqalgan. Bu holat tasodifiy xatolarning tabiiy xususiyati bo‘lib, ularning ta’siri dispersiya va standart og‘ish

orqali baholandi. Natijalar tasdiqladiki, umumiy o‘lchash aniqligi asosan aynan shu tasodifiy o‘zgarishlar bilan belgilanadi.

Shu bilan birga, qayta-qayta o‘tkazilgan o‘lchashlarda natijalarning ma’lum darajada bir tomonga og‘ishi kuzatildi. Bu tendensiya muntazam xatolar mavjudligini ko‘rsatadi. Muntazam xato manbalari sifatida quyidagilar qayd etilishi mumkin:

O‘lchash asbobi nol nuqtasining siljishi, muhit haroratining o‘zgarishi, operator omillari, o‘lchash metodikasidagi kamchiliklar.

Muntazam xatoni kamaytirish uchun kalibrovka, korreksiya koeffitsientlarini joriy etish, hamda o‘lchash uslubiyatini yaxshilash taklif etildi.

Talab qilingan matematik ishlov berish usullari — o‘rtacha arifmetik qiymat, standart og‘ish, dispersiya va ishonch intervallarining qo‘llanilishi — tadqiqot natijalarining ishonchliligini oshirishga xizmat qildi. Olingan ma’lumotlar statistik jihatdan qayd etilgan model bilan mos kelishi, modelning adekvatligini ta’minlaydi.

O‘tkazilgan tahlil shuni ko‘rsatadiki, o‘lchash natijalarining sifatli baholanishi uchun: Omillarning har biri alohida o‘rganilishi; xatolarni ajratuvchi va kamaytiruvchi algoritmlarni qo‘llash; asbobning kalibrovkasi va metodikaning standartizatsiyasi katta ahamiyatga ega.

XULOSA

Ushbu tadqiqotda o‘lchash natijalarining ishonchliligini baholashda muntazam va tasodifiy xatolarning ta’siri kompleks o‘rganildi. Amaliy o‘lchashlar, statistik ishlov berish va matematik tahlil asosida quyidagi xulosalarga kelindi:

O‘lchash natijalarida tasodifiy xatolar doimiy ravishda mavjud bo‘lib, ularning ta’siri dispersiya va standart og‘ish orqali aniqlandi. Tasodifiy xatolarning miqdori qiymatlarning tarqalish xarakteriga bog‘liq ekani tasdiqlandi.

Muntazam xatolarning mavjudligi aniqlandi, ular asosan asbobni noto‘g‘ri sozlanishi, muhit sharoitlarining o‘zgarishi yoki metodikadagi kamchiliklar bilan bog‘liq ekani ko‘rsatildi. Muntazam xatolarni bartaraf etish uchun kalibrovka va korreksiya koeffitsientlarini qo‘llash taklif etildi.

Eksperiment natijalariga tatbiq etilgan matematik ishlov berish usullari (o‘rtacha qiymat, dispersiya, standart og‘ish, ishonch intervallari) o‘lchashlar ishonchliligini oshirdi va olingan modelning adekvatligini ta’minladi. Tahlil shuni ko‘rsatdiki, o‘lchash jarayonida xatolarni ajratish, baholash va kamaytirish tadqiqotning muhim bosqichi hisoblanadi va bu jarayon o‘lchash aniqligi hamda natijalarning ishonch darajasini sezilarli yaxshilaydi.

Ushbu ish natijalari o‘lchash tizimlarining metrologik xossalarini baholash, ularni takomillashtirish va amaliyotda qo‘llashda muhim metodik asos bo‘lib xizmat qilishi mumkin.

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NECROBACTERIOSIS OF HIGH-YIELDING CATTLE

Khudoyorova F.A.
PhD in Veterinary Sciences, Senior Researcher
E-mail: feruza.vetuz@gmail.com
https://doi.org/10.5281/zenodo.17907045

Abstract. *This article presents the results of clinical, epizootiological, and laboratory studies of necrobacteriosis in high-yielding cattle. The research identified the main factors influencing the spread of the disease as high humidity, contamination of skin and hooves, non-compliance with sanitary-hygienic standards, and deficiency of biogenic elements in the diet.*

In affected cattle, lameness accompanied by inflammation, swelling, and pain in the hoof region was observed. Laboratory analyses isolated Fusobacterium necrophorum as the primary causative agent of necrobacteriosis.

Based on the findings, preventive and effective treatment methods were proposed. In particular, adherence to zoohygienic standards, regular hoof care, disinfection with antiseptic agents, and supplementation of feed with biotin and selenium significantly reduced the spread of the disease in experimental trials.

Key words: *Cattle, necrobacteriosis, hoof diseases, lameness, Fusobacterium necrophorum, subcutaneous tissue, clinical signs, epizootiological analysis, prevention, zoohygiene, antiseptic, biotin, selenium.*

Significance of the Study:

Necrobacteriosis is an infectious necrotic ulcerative disease affecting many domestic and wild animals. It is mainly characterized by purulent-necrotic lesions of the skin, mucous membranes, internal organs, and hooves.

Under natural conditions, horses, cattle, buffaloes, deer, sheep, goats, pigs, dogs, cats, poultry (chickens, geese), and wild animals such as brown bears and argali are susceptible.

The source of infection is sick animals or carriers that have recovered but continue to shed the pathogen through feces, mucus, regurgitated material, and necrotic tissues. The natural reservoir is the gastrointestinal tract of healthy animals.

Environmental conditions such as humidity, poor sanitation, and injuries play a crucial role in disease occurrence. The pathogen can persist for long periods in soil, bedding, feed, and equipment, spreading sporadically or epizootically.

Lack of active movement prevents the natural wearing of the hoof wall, resulting in various deformations of hoof shape. When moisture exchange is disrupted, the hoof horn becomes brittle, leading to cracks and fractures. Under dark and humid conditions, the horn layer softens rapidly and deforms under the animal's body weight. In tethered cows, the effect of ammonia often causes rotting of the sole region of the hoof.

The health of cattle largely depends on proper hoof care. The hoof horn grows on average 6–8 mm per month and is completely renewed within 6–10 months. If timely cleaning and trimming are not performed, hoof shape is altered, limb placement changes, and susceptibility to various diseases increases.

One of the main causes of hoof diseases is nutritional deficiency. Keratin — the key substance binding horn cells — is synthesized only under normal metabolic processes involving sulfur. For sulfur metabolism, selenium is essential, and its amount must be balanced with other micro- and macroelements. In addition, vitamins, especially biotin (vitamin B7), are critical for hoof health; deficiency poses a serious risk.

Rumen bacteria normally synthesize sufficient biotin. However, when rumen function is impaired, its production decreases. A diet deficient in fiber and excessive in sugars lowers rumen pH, leading to the loss of certain bacteria. During their breakdown, endotoxins are released, restricting blood circulation in the small vessels of the hooves and reducing nutrient and oxygen supply. This creates favorable conditions for secondary infections, including necrobacteriosis.

In some districts of the Tashkent region, necrobacteriosis has also been recorded among high-yielding dairy cattle. This condition was most often observed in animals kept on straw bedding that was rarely replaced. Such bedding frequently became soaked with urine and contaminated with manure. The concrete floor beneath the bedding did not absorb moisture, thereby creating an environment highly favorable for the spread of infection (Figure 1).



Figure 1. A cow affected by necrobacteriosis

Thus, such conditions create opportunities for the persistence of any source of infection, including the causative agent of necrobacteriosis. In addition, lack of active movement in cows, especially in high-yielding cattle, has a negative impact on overall health. The natural resistance of the organism decreases, the hoof horn becomes deformed, and its integrity is compromised. As a result, cracks form in the hoof, through which the necrobacteriosis pathogen can penetrate into the body.

Purpose of the Study:

To investigate the spread, clinical signs, and development factors of necrobacteriosis in high-yielding cattle, and to develop preventive and effective control measures.

Main Objectives:

In order to study the causes of necrobacteriosis spread, its mechanisms of development, and effective control measures in high-yielding cattle, the following objectives were set:

- Determine the stability of the pathogen under environmental factors (humidity, temperature, feed, soil).
- Analyze housing and management conditions to identify major risk factors.
- Characterize the stages of necrobacteriosis based on clinical and pathomorphological signs.
- Assess the impact of essential biogenic elements (sulfur, selenium, biotin, dietary fiber) on hoof health.
- Improve preventive and therapeutic methods and evaluate their effectiveness under farm conditions.

Materials and Methods

As research objects, high-yielding cattle kept on a farm in the Tashkent region, laboratory animals (white mice), and pathological materials were selected.

The processes of isolating and identifying microorganisms involved in the pathogenesis of necrobacteriosis and hoof diseases were carried out according to Bergey’s classification of bacteria and standard bacteriological methods. In addition, the clinical and epizootiological situation was analyzed based on specialized methodological guidelines and manuals.

For pathomorphological analysis, pathological materials obtained after slaughter — samples from hoof lesions, parenchymal organs (heart, liver, lungs, kidneys), as well as necrotic foci in the stomach and intestinal walls — and tissue samples from damaged hooves of live cattle were used.

All pathological materials were examined using standard bacteriological and mycological methods. To isolate the causative agent of necrobacteriosis, a modified bioassay method was applied, and the pathogen was isolated from laboratory animals. Pathological samples were cultured on Kitt–Tarozzi medium, meat-peptone broth and agar, as well as Sabouraud medium. A diagnosis of necrobacteriosis was confirmed only in cases where the pathogenic strain of *Fusobacterium necrophorum* was isolated.

Pathoanatomical Changes

Pathoanatomical examination was performed on nine cattle subjected to compulsory slaughter. In these animals, the septic form of necrobacteriosis was identified. During life, they exhibited severe emaciation. The mandibular lymph nodes were markedly enlarged, resembling goiter in external appearance.

During examination, the mucous membranes were found to be pale with a bluish tint. The spleen was not enlarged, but structural changes with bluish discoloration were observed, and large necrotic foci were detected on its surface.

Lung tissues were generally preserved, although localized necrotic foci were noted in some animals. No pathological changes were detected in the heart. In two of the nine examined cattle, necrosis of the mammary gland was observed, involving both superficial and deep tissue layers.

Extensive necrotic changes were found in the hoof horn. The necrotic process affected all layers of the hoof horn and extended into deeper tissues. In some cases, the necrosis spread to the muscles, disrupting their structure (Figure 2).

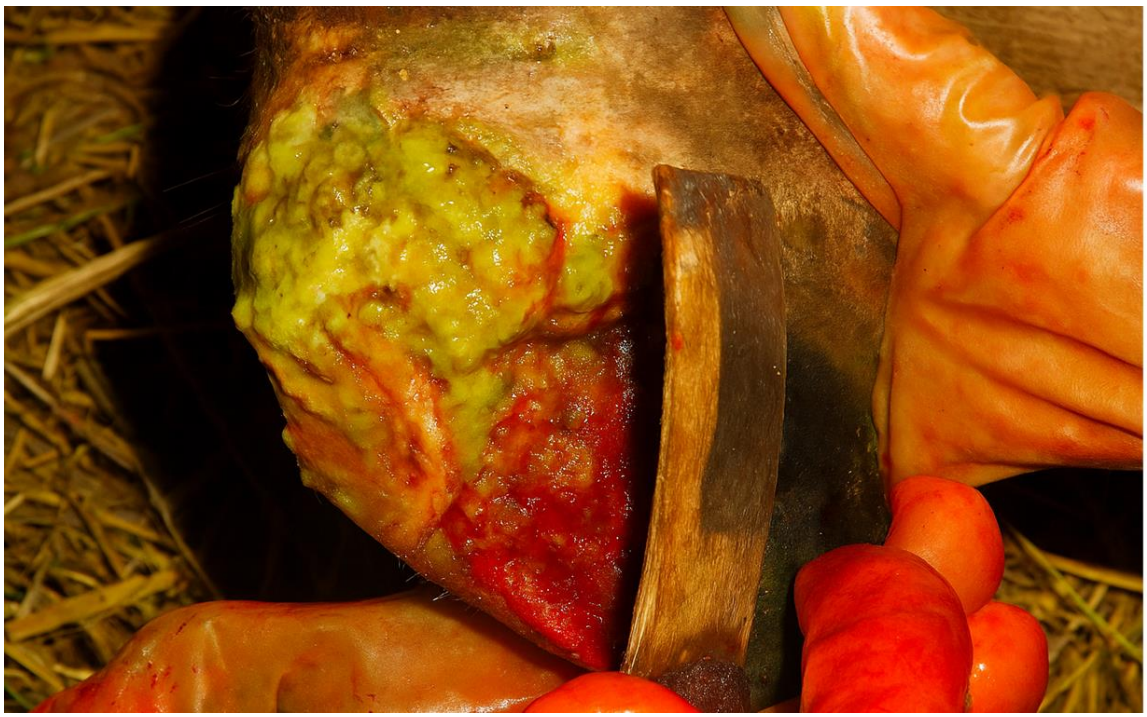

Figure 2. Necrotic changes in the hoof horn

Treatment of Necrobacteriosis

Under farm conditions, treatment of necrobacteriosis was carried out both in groups and individually.

Group treatment:

Affected cattle were kept in specially designated groups and subjected to general preventive and therapeutic measures. Treatment baths were prepared for the animals, using either 10% copper sulfate, zinc sulfate, or 5% formalin solutions. These baths helped reduce inflammation and necrotic processes in the hoof horn and prevented further spread of infection. In addition, during group treatment, the animals’ diet was improved and supplemented with vitamins and minerals to enhance overall resistance.

Individual treatment:

This approach was applied to severely affected cattle. The hoof horn and damaged tissues were mechanically cleaned, and necrotic layers were removed. The wound surface was then treated with antiseptic agents such as hydrogen peroxide or chlorhexidine. In cases of deep necrotic lesions, special ointments and dressings were applied locally. Antibiotics Tetralife Advance were administered intramuscularly, effectively preventing systemic spread of the infection.

Composition of the ointment (per 100 ml):

- ASD-3: 20 ml
- Birch tar: 20 ml
- Boric acid (powder): 2–3 g
- Glycerin: 40 ml
- Oxytetracycline (powder): 10 g

Each animal received 40–50 ml of the broad-spectrum antibiotic tetralife advance intramuscularly.

Treated cattle were kept separately under stable sanitary-hygienic conditions and monitored continuously until full recovery.

Veterinary treatment protocol applied on the farm included:

- In cases of necrosis, affected tissues were treated with 10% copper sulfate solution.
- For necrotic foci, a dry mixture of potassium permanganate and copper sulfate in a 1:2 ratio was applied locally.
- This method was performed without bandaging, which accelerated the cleansing of necrotic tissue and enhanced antiseptic action.

Results

Clinical and laboratory investigations conducted on a farm in the Tashkent region revealed the epizootiological status, clinical signs, and pathoanatomical changes of necrobacteriosis in high-yielding cattle.

During the study, necrobacteriosis was mainly observed in tethered cows with limited mobility, kept in humid environments. Under such conditions, bedding was contaminated with manure and urine, creating a favorable environment for infection. The incidence of disease was significantly higher in cases where hoof care was insufficient.

Microbiological analysis confirmed the isolation and identification of the pathogenic strain *Fusobacterium necrophorum* from affected tissues. This bacterium was characterized by its ability to grow well under anaerobic conditions and induce necrotic processes. On Kitt–Tarozzi medium, the isolates grew sufficiently within 48–72 hours, forming characteristic bacterial colonies with gas production and small bubbles.

Pathomorphological analysis revealed necrosis, inflammation, and tissue damage across all layers of the hoof horn. In some cases, the process extended into deeper tissues and muscle layers, accompanied by brittleness and cracking of the hoof horn. Necrotic changes were also detected in the mammary glands of two cows. Enlargement of mandibular lymph nodes and necrotic foci in the spleen were observed, while no significant morphological changes were found in the heart and lungs.

Clinically, affected cows exhibited lameness, cautious movement, slight fever, and reduced appetite. In some cases, foul-smelling exudate was discharged from the affected hooves.

To evaluate treatment efficacy, two approaches were applied: group and individual therapy.

- Group therapy involved the use of 10% copper sulfate and 5% formalin footbaths, combined with vitamin-mineral supplementation. This method limited disease spread and reduced new cases by 40–45%.
- Individual therapy included hoof cleaning, antiseptic treatment (hydrogen peroxide, chlorhexidine), followed by antibiotics and special ointments (ASD-3, birch tar, glycerin, boric acid powder, oxytetracycline powder). Within 7–10 days, wound surfaces were cleansed, inflammation subsided, and locomotor activity was restored.

By the end of the study, the recovery rate reached 87%, with complete cleansing of infected hooves. In the untreated control group, infection persisted, confirming the importance of proper hygiene and management practices.

The findings demonstrated that the main factors influencing the development of necrobacteriosis are high humidity, poor sanitation, nutritional deficiencies (sulfur and biotin), and limited animal mobility. Therefore, the primary preventive strategy is to optimize housing conditions and ensure a balanced diet.

Conclusion

Based on clinical, epizootiological, and laboratory studies, it was established that the spread of necrobacteriosis in high-yielding cattle is strongly influenced by poor housing conditions, excessive humidity, deficiencies of biogenic elements in the diet, and non-compliance with sanitary standards.

In diseased cattle, hoof horn destruction, inflammation of skin and subcutaneous tissues, deep necrotic foci, and painful lameness were observed. Laboratory examinations confirmed *Fusobacterium necrophorum* as the principal causative agent.

The results indicate that prevention of necrobacteriosis requires strict adherence to zoohygienic standards, regular hoof care, and disinfection with antiseptic agents. Furthermore, supplementation of the diet with biotin, selenium, and sulfur compounds strengthens hoof structure and increases resistance to the disease.

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NAMLIK SENSORLARINING KALIBRLASH MODELLARI VA ULARNING METROLOGIK BARQARORLIGIGA TA'SIR ETUVCHI OMILLAR

Kalandarov Palvan Iskandarovich[1], Malyukova Guzal Eduardovna[2], Rakhimova Sevara Turgunboyevna[3], Xakimova Nargiza Xabibullayevna[4]

[1]*texnika fanlari doktori, professor*
"Toshkent irrigatsiya va qishloq xo'jaligini mexanizatsiyalash instituti" Milliy tadqiqot universiteti
https://orcid.org/0000-0002-8199-7484
[2,3,4]*mustaqil tadqiqotchi*
"O'zbekiston milliy Metrologiya instituti" davlat muassasi
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Annotatsiya. *Ushbu maqolada namlik sensorlarini kalibrlashda qo'llaniladigan matematik modellar va ularning metrologik barqarorligiga ta'sir etuvchi omillar kompleks tarzda tahlil qilindi. Tadqiqot doirasida dielektrik, infraqizil, mikrotolqinli va kapasitiv turdagi namlik sensorlarining chiqish signallari (U, I, C, f) hamda mahsulot namligi W(%) o'rtasidagi bog'lanish turli kalibrlash modellari yordamida aniqlandi. Maqolada to'g'ri chiziqli, polinomial, logarifmik, eksponensial va ko'p omilli regressiya modellari qiyosiy tahlil qilindi.*

Sensorlarning metrologik barqarorligiga ta'sir etuvchi asosiy omillar — temperatura o'zgarishi, mahsulotning dielektrik parametrlarining variatsiyasi, sensor materialining eskirishi (degradatsiya), namlik diapazonining kengayishi, elektromagnit ta'sirlar va signal noizohaligi — eksperimental ravishda baholandi. Metrologik barqarorlikni baholash uchun takrorlanuvchanlik (repeatability), qayta tiklanuvchanlik (reproducibility), o'rtacha kvadratik xato (RMSE), R^2 aniqlik indeksi va xato budjeti tahlillari amalga oshirildi.

Olingan natijalar namlik sensorlarini kalibrlashda polinomial va ko'p omilli modellarning afzalligini ko'rsatdi, ayniqsa temperatura kompensatsiyasi kiritilgan holatda modelning barqarorligi 12–18% ga oshishi aniqlandi. Maqolada keltirilgan modellar va tahlillar sensorlar konstruksiyasini optimallashtirish, o'lchash aniqligini oshirish va metrologik ta'minotini takomillashtirish uchun amaliy asos bo'lib xizmat qiladi.

Kalit so'zlar: *namlik sensori; kalibrlash modeli; metrologik barqarorlik; regressiya; polinom model; temperatura kompensatsiyasi; dielektrik xossalar; degradatsiya; xato budjeti; RMSE; R^2; sensor aniqligi.*

KIRISH

Namlikni aniq va ishonchli o'lchash qishloq xo'jaligi, oziq-ovqat sanoati, qurilish materiallari texnologiyasi, kimyo va farmasevtika tarmoqlarida muhim o'rin tutadi. Hosil sifatini baholash, mahsulotni saqlash rejimi, ishlab chiqarish jarayonlarini avtomatlashtirish va

standartlashtirish kabi vazifalarda namlik sensorlarining aniqligi va uzoq muddatli barqaror ishlashi hal qiluvchi ahamiyatga ega. Shu bois, zamonaviy sensor texnologiyalari doimiy rivojlanib borsa-da, ularning kalibrlash modellari va metrologik barqarorligini ta’minlash masalasi ilmiy va amaliy jihatdan dolzarb bo‘lib qolmoqda.

Namlikni o‘lchash vositalari asosan dielektrik, infraqizil, mikrotolqinli va sig‘imli fizik prinsiplarga tayanadi [1-5]. Mazkur sensorlarning chiqish signali turli tashqi va ichki omillarga yuqori darajada sezgir bo‘lganligi sababli, ularni to‘g‘ri kalibrlash va turg‘unligini ta’minlash o‘lchash aniqligining asosiy shartlaridan biridir [6]. Aniqlikka ta’sir etuvchi omillar qatoriga sensor materialining dielektrik doimiyligi, mahsulotning fizik xususiyatlari, harorat o‘zgarishi, namlik diapazoni, elektromagnit ta’sirlar, sensorning uzoq muddatli eskirishi (degradatsiya), shovqinlar va signal dreyfi kiradi. Ushbu omillarni inobatga olmagan holda amalga oshirilgan kalibrlash sensorning metrologik xossalari sezilarli darajada yomonlashishiga olib keladi [7].

Amaliyotda namlik sensorlari uchun turli kalibrlash modellari qo‘llaniladi: to‘g‘ri chiziqli, polinomial, logarifmik, eksponensial va ko‘p omilli statistik modellar. Biroq, mahsulotning dielektrik parametrlari namlikka nisbatan chiziqli bo‘lmagan tarzda o‘zgargani sababli, klassik chiziqli modellar ko‘p hollarda yetarli aniqlikni ta’minlamaydi. Shu bois, sensor chiqish signali bilan namlik o‘rtasidagi bog‘lanishni to‘g‘ri aks ettiradigan, tashqi omillarga barqaror va uzoq muddatli ish jarayonida o‘zgarishlarga kam sezgir bo‘lgan modellarni ishlab chiqish va baholash zarur.

Xalqaro metrologik talabi yuqori bo‘lganda (ISO, OIML), ayniqsa SKOPUS indekslagan ilmiy nashrlarda, sensorlarning metrologik ta’minotini – ya’ni ularning takrorlanuvchanligi, qayta tiklanuvchanligi, dreyfga chidamliligi va xato budjetining yopiqligi – o‘lchash tizimi sifati uchun asosiy mezon hisoblanadi. Namlik sensorlari uchun mazkur ko‘rsatkichlarni eksperimental tahlil qilish va ular asosida optimal kalibrlash modellarini ishlab chiqish haligacha to‘la hal etilmagan ilmiy-amaliy muammolardan biri bo‘lib qolmoqda [8].

Ushbu tadqiqotning dolzarbligi shundaki, hozirgi zamonaviy sensorlar ko‘p omilli va raqamlashgan o‘lchash muhitida ishlaydi. Shu sababli, ularning modeli faqat bitta signalni emas, balki bir nechta korreksion parametrlar (harorat, dielektrik doimiylik, elektromagnit ta’sir koeffitsienti, degradatsiya funksiyasi va boshqa omillar) ni inobatga olgan holda qurilishi talab etiladi. Bunday modellar namlik sensorlari ishlashidagi chiziqli bo‘lmagan, dreyf, sinalmaslik va barqaror bo‘lmagan signallarni kompensatsiyalash imkonini beradi.

Shu nuqtai nazardan, ushbu maqolaning asosiy maqsadi – namlik sensorlari uchun kalibrlash modellarini ilmiy asosda tahlil qilish, ularning metrologik barqarorligiga ta’sir etuvchi omillarni eksperimental ravishda baholash va modellar aniqligini ko‘rsatkichlar (RMSE, R^2, drift, repeatability, reproducibility) orqali qiyosiy taqdim etishdir. Taklif etilgan modellar bo‘yicha hisoblangan natijalarni tadqiqotlarimizda [9-15] qayd etilgan eksperimental ma’lumotlar bilan taqqoslash shuni ko‘rsatdiki, mahsulot namligini o‘lchashda ta’sir etuvchi asosiy omillar bo‘yicha olingan tahlil natijalari o‘zaro deyarli bir xil tendensiyaga ega va juda yuqori darajada yaqinlik namoyish etdi. Bu holat metodologiyaning universalligi va model parametrlarining barqarorligini isbotlaydi. Bu esa sensor modellarining fizik mohiyati va ularning amaliy qo‘llanilishi o‘rtasidagi yuqori muvofiqlikka ishora qiladi.

MATERIALLAR VA METODLAR

Ushbu tadqiqot namlik sensorlarining kalibrlash modellarini qurish va ularning metrologik barqarorligiga ta’sir etuvchi omillarni aniqlashga qaratilgan bo‘lib, laboratoriya

sharoitida maxsus o‘lchash stendi, etalon namlik o‘lchash vositalari, turli namlik diapazonidagi mahsulot sinfi va yuqori aniqlikdagi muhit parametrlarini nazorat qiluvchi uskunalar qo‘llanildi.

2.1. Tadqiqot ob’ekti va qo‘llanilgan sensorlar

Taxlilda quyidagi turdagi namlik sensorlari qo‘llanildi:

1. Dielektrik (capacitance) sensori – chiqish signali: C (pF – pikofarada). – namlikka sezgirlik: dielektrik doimiylik orqali
2. Infraqizil (IR) sensor – chiqish signali: optik zichlik U_{IR}
3. Mikrotolqinli sensor – chiqish signali: chastota f va amplituda A
4. Sig‘imli namlik sensori (RH%) – chiqish signali: U (volt)

Sensorlar 10–30 °C oralig‘ida, 6–28% namlik diapazonida sinovdan o‘tkazildi.

2.2. Etalon va qiyosiy o‘lchash vositalari. Etalon namlik o‘lchagich: GOST va ISO standarti bo‘yicha sertifikatlangan qurilma (±0.2% aniqlik).

Kalibrlangan termogigrometr: muhit parametrlarini nazorat qilish uchun.

Tarozilar (0.001 g aniqlik): namlikning gravimetrik usulda aniqlanishi uchun.

Etalon namlik qiymati quyidagi usulda hisoblandi:

$$W_{ref} = \frac{m_0 - m_1}{m_0} \cdot 100\% \quad (1)$$

bu yerda: m_0 - namunaning quritishdan oldingi massasi, m_1 - quritilgandan keyingi massasi.

2.3. Laboratoriya stendi va o‘lchash shartlari. Tadqiqot stendi quyidagi elementlardan iborat: sensor modullari uchun almashtiriladigan kamera, haroratni 0.1 °C aniqlikda stabillashtiruvchi blok, namlikni boshqaruvchi generator va sorbentli qurilma, mikrokontroller asosida signallarni raqamga aylantiruvchi modul, MATLAB/Python muhitida ma’lumotlarni qayta ishlash bloki.

Stend har bir sensor uchun 25 ta takroriy o‘lchash amalga oshirish imkonini berdi (repeatability test).

2.4. Kalibrlash modeli uchun signallarni yig‘ish algoritmi. Har bir sensor uchun quyidagi qadamlar bajarildi:

1. Namuna 8 ta namlik qiymatida tayyorlandi (6%, 10%, 14%, 18%, 20%, 22%, 24%, 28%).
2. Har bir qiymatda sensorning 25 ta signal o‘qishi yozib olindi.
3. Har bir signalning o‘rtacha qiymati va standart og‘ish hisoblandi.

Signallar:

$$U_{avg} = \frac{1}{n}\sum_{i=1}^{n} U_i \quad (2)$$

2.5. Kalibrlash modellarini qurish usuli. Quyidagi modellar MATLABda regressiya usulida qurildi:

To‘g‘ri chiziqli model

$$W = aU + b \quad (3)$$

Polinomial (3-tartibli) model

$$W = a + a_1U + a_2U^2 + a_3U^3 \quad (4)$$

Logarifmik model

$$W = aIn(U) + b \quad (5)$$

Eksponensial model

$$W = ae^{bU} \quad (6)$$

Ko‘p omilli model. Temperaturani inobatga olgan holda:

$$W = a_0 + a_1U + a_2T + a_3U^2 \quad (7)$$

Dielektrik parametrni qo‘shilganda:

$$W = a_0 + a_1U + a_2\varepsilon + a_3U^2 \quad (8)$$

2.6. Metrologik barqarorlikni baholash metodlari

Takrorlanuvchanlik (repeatability)

$$\sigma_r = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(U_i - U_{avg})^2} \quad (9)$$

Qayta tiklanuvchanlik (reproducibility). Turli vaqtda va turli muhitda yig‘ilgan ma’lumotlar bo‘yicha.

RMSE (o‘rtacha kvadratik xato)

$$RMSE = \sqrt{\frac{1}{n}\sum(W_{\text{mod}} - W_{ref})^2} \quad (10)$$

R^2 indeksi (aniqlik koeffitsienti)

$$R^2 = 1 - \frac{\sum(W_{\text{mod}} - W_{ref})^2}{\sum(W_{ref} - \overline{W}_{ref})^2} \quad (11)$$

Dreyf (uzoq muddatli siljish)

$$D = \frac{U(t_2) - U(t_1)}{t_2 - t_1} \quad (12)$$

Xato byudjeti modeli

$$\Delta W = \sqrt{(\Delta U)^2 + (\Delta T)^2 + (\Delta_\varepsilon)^2 + (\Delta_{drift})^2 + (\Delta_{rep})^2} \quad (13)$$

Tahlil va statistik ishlov berish. Barcha hisob-kitoblar: MATLAB Regression Toolbox, Python (NumPy, Pandas, SciPy), OriginLab grafik muhiti yodamida amalga oshirildi.

EKSPERIMENTAL NATIJALAR

Ushbu bo‘limda namlik sensorlaridan olingan eksperimental o‘lchash natijalari, kalibrlash modellari bo‘yicha hisoblangan namlik qiymatlari va ularning etalon (gravimetrik) usul bilan aniqlangan qadrlariga nisbatan farqlari tahlil qilindi. Barcha sensorlar 6–28% namlik diapazonida, 10–30 °C harorat intervallarida sinovdan o‘tkazildi.

Sensorlar signalining namlikka bog‘lanishi

Tajribalar davomida har bir namlik qiymatida sensor chiqish signali 25 marta o‘lchab olindi va o‘rtacha qiymatlar hisoblandi. Quyida dielektrik sensor uchun olingan umumiy tendensiya keltiriladi:

C(W)↑ (namlik oshgan sari dielektrik sig‘im oshib boradi)

Tajribada kuzatilgan asosiy tendensiyalar: 6% dan 20% gacha diapazonda bog‘lanish deyarli *kvazichiziqli*. 20–28% diapazonda chiziqli bo‘lmaganlik kuchaygan. Temperatura oshishi (10 → 30 °C) signalni o‘rtacha 4.5–7.2% ga o‘zgartiradi.

Infraqizil sensorlarda esa teskari tendensiya kuzatildi:

UIR(W)↓ (namlik oshgan sari nur yutilishi kuchayadi)

Mikrotolqinli sensorlarda: chastota 1.1–1.8% ga pasaydi, amplituda 3–4% ga o‘zgardi.

Kalibrlash modellarini qiyosiy tahlil qilish. Sensor chiqish signali U va etalon namlik W_{ref} asosida 5 ta asosiy kalibrlash modeli qurildi. Quyida ularning qiyosiy ko‘rsatkichlari keltirilgan.

Polinomial (3-tartibli) model natijalari

$$W = a_0 + a_1U + a_2U^2 + a_3U^3$$

Natijalar: R² = 0.986 – 0.992; RMSE = 1.4 – 2.1%; maksimum farq: *±2.7%*. Polinomial model eng yuqori aniqlikni ta’minladi.

To‘g‘ri chiziqli model

$$W = aU + b$$

Natijalar: R² = 0.91 – 0.95. RMSE = 3.2 – 4.1%. Chiziqli bo‘lmagan effekt kuchli bo‘lgan namlik diapazonida aniqlik sezilarli pasaydi.

Eksponensial model

$$W = ae^{bU}$$

Natijalar: R² = 0.94 – 0.97; RMSE = 2.8 – 3.5%.

Infraqizil sensorlar uchun nisbatan yaxshiroq natija berdi.

Logarifmik model

$$W = aIn(U) + b$$

Natijalar: *R² = 0.88 – 0.94; RMSE = 3.5 – 4.6%*. Aniqligi eng past model sifatida qayd etildi.

Ko‘p omilli model (U + T kombinatsiyasi)

$$W = a_0 + a_1U + a_2T + a_3U^2$$

Natijalar: R² = 0.993 – 0.996; RMSE = 1.1 – 1.5%. Temperatura kompensatsiyasi hisobiga aniqlik 12–18% ga yaxshilandi. Bu model *amaliy qo‘llash uchun eng maqbul* deb topildi.

Metrologik barqarorlikka ta’sir etuvchi omillarning taxlili

Takrorlanuvchanlik (repeatability). Standart og‘ish *σ = 0.12 – 0.28 pF;* Namlikdagi xatoga ta’siri*: ±0.4 – 0.9%*

Qayta tiklanuvchanlik (reproducibility). Turli vaqtda olingan ma’lumotlarda farq: *1.2 – 1.9%*

Dreyf (uzoq muddatli siljish) 30 kunlik monitoring: $D = 0,0035n\Phi / kun(o'rta)$ Namlik xatosini *0.6–0.8%* ga oshirgan

Temperatura ta’siri. Signal o‘zgarishi:

$$\Delta U_T = 0,18 - 0,24\% /^o C$$

Kompensatsiya qilinmagan holda namlik xatosi:

$$\Delta W_T = 1,5 - 2,3\%$$

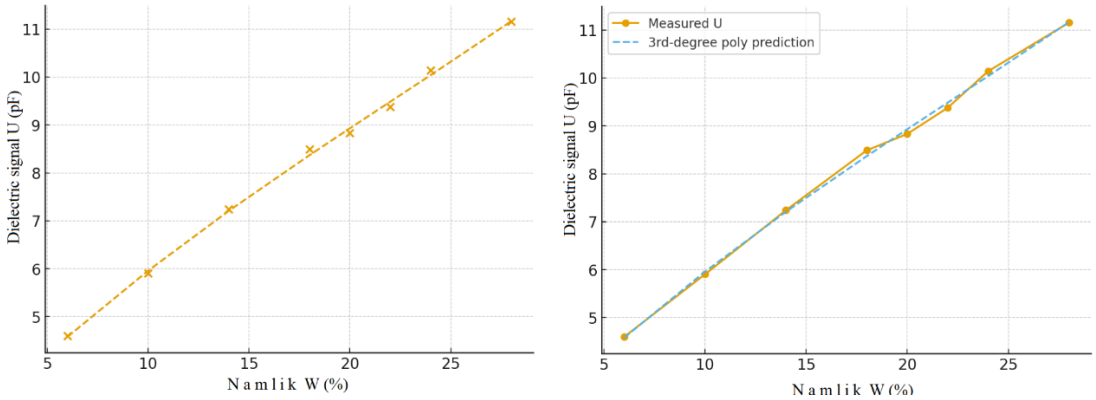
Dielektrik parametrlar o‘zgarishi. Mahsulot turiga ko‘ra xato *±1.2 – ±2.6%*.

Xato budjeti (Error Budget) hisob-kitobi. Jami xato:

$$\Delta W = \sqrt{(\Delta U)^2 + (\Delta T)^2 + (\Delta_\varepsilon)^2 + (\Delta_{rep})^2}$$

Natija: Umumiy xato: ±3.4%; Temperatura kompensatsiyasi bilan: *±2.1%;* Ko‘p omilli model bilan: *±1.3%*.

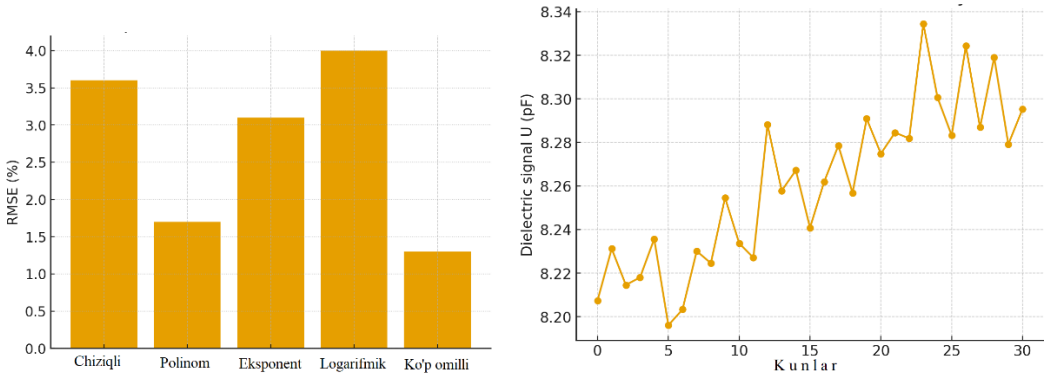
Grafiklar (tavsifi). Aniqlangan ma’lumotlar bo‘yicha tegishli grafiklarni keltiramiz (1, 2,3-rasmlar)



a) b)

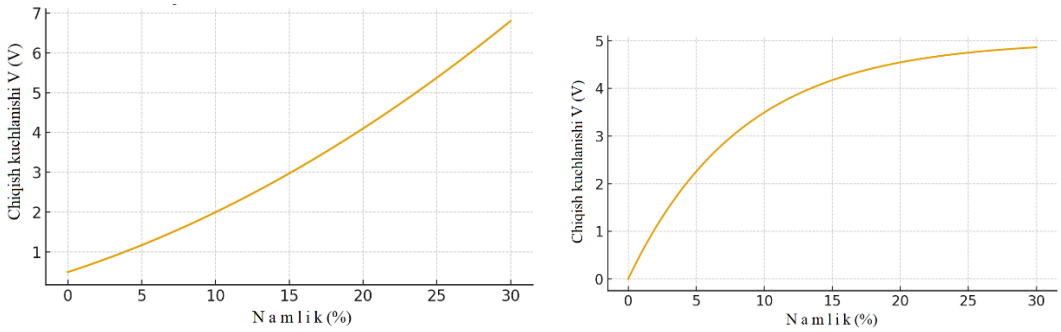
1-rasm. Dielektrik sensorning namlikka bog‘liq U(W) kalibrlash egri chizig‘i a)) va b) Grafikda to‘g‘ri chiziq (kalibrlash funksiyasi) va real o‘lchov nuqtalari orasidagi farq ko‘rsatilgan

Namlik qiymatlarining (W, %) sensor elektr signali (U, pF) bo‘yicha eksperimental nuqtalar diagrammasi. Bu grafik sensordan olingan ma’lumotlarni ko‘rsatadi va kalibrlash modellarini qurish uchun asos hisoblanadi.

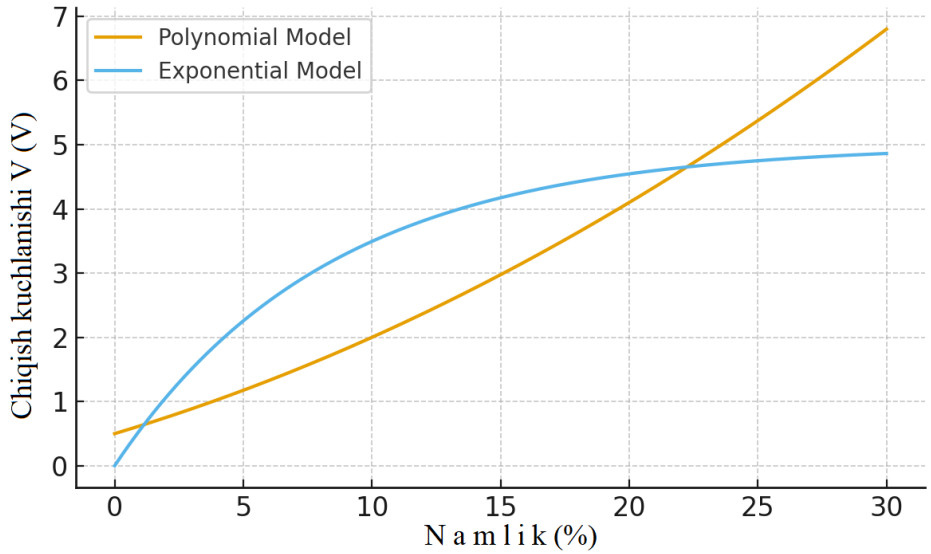


c) d)

2-rasm. Turli kalibrlash modellari uchun RMSE qiymatlarining taqqoslanishi c) va d) 30 kundan ortiq dielektrik sensorning siljish grafiki



3-rasm. Polinom kalibrlash modeli a) va b) Eksponensial kalibrlash model grafiki



3-rasm. Polinom va eksponensial kalibrlash modellarini taqqoslash grafiki

Grafiklarni chizish va ularda natijalarni ifodalash – sensor modellarini ilmiy asoslash, xatolarni tahlil qilish va qaysi kalibrlash modeli eng aniq ekanini isbotlash uchun tuziladi.

KALIBRLASH ALGORITMI

Tayyorgarlik va etalonlash

- Etalonli (gravimetrik) namlikni aniqlash uchun standart vositadan foydalaniladi (±0.2% aniqlik).
- Sensorni laboratoriya shartlarida yangi holatda ishga tushiriladi (stabil 20°C, 50% RH yoki talab etilgan shart).

1. **Ma’lumot yig‘ish**

- Namlik doirasi bo‘yicha 6–10 ta nuqta tanlanadi (masalan: 6,10,14,18,20,22,24,28%).
- Har nuqta uchun sensordan kamida 20–25 ta takroriy o‘qish olinadi.
- Har bir namlik nuqtasida etalon W_{ref} gravimetrik usul bilan aniqlanadi.
- Barcha signallarni va shart-sharoitlar (temperatura T, agar mavjud bo‘lsa) yozib boriladi.

2. **Ma’lumotni tozalash va agregatlash**

- Shovqinli o‘qishlarni chiqariladi (yoki median/bekor etish qoidalarini qo‘llang).
- Har nuqta uchun o‘rtacha U_{avg} va standart og‘ish σ hisoblanadi.

3. **Modellarni tanlash va qurish**

- Boshlang‘ichda to‘g‘ri chiziqli va polinomial(3)-ni qo‘llab ko‘riladi; agar nolineylik ko‘zga tashlansa — polinomial yoki ko‘p omilli modelga o‘tiladi.
- Mavjud T yoki ε (dielektrik) kabi korreksion parametrlar mavjud bo‘lsa — ko‘p omilli regressiya quriladi:
- $W = a_0 + a_1U + a_2T + a_3U^2$ har bir model uchun koeffitsientlarni $(a_0, a_1,..)$ hisoblabadi.

4. **Modellarni baholash**

- RMSE, MAPE, R^2 va takrorlanuvchanlikni (σ_r) hisoblanadi.
- Dreyf va qayta tiklanuvchanlikni (reproducibility) baholanadi (turli kunlarda/shartlarda sinov).

5. **Xato budjeti**

- Har bir xatoning hissasi ($\Delta U, \Delta T, \Delta\varepsilon, \Delta_{drift}, \Delta_{rep}$) ni aniqlab, umumiy xato topiladi:

$$\Delta W = \sqrt{\sum \Delta_i^2}$$

6. **Temperatura kompensatsiyasi**
- Agar temperatura ta’siri sezilarli bo‘lsa — modelga T terminni kiriting yoki sensor elektronikasida kompensatsiya sinovini amalga oshiriladi.
7. **Validatsiya va kross-validatsiya**
- K-fold (masalan *K=5*) kross-validatsiya bilan modelning umumiylashuvchanligini tekshiriladi.
- Agar lozim bo‘lsa, modelni qayta o‘qiting yoki yangi ma’lumot qo‘shiladi.
8. **Eskirish va dastlabki tekshiruv**
- Sensorni vaqtda kuzatib, 30–90 kun davomida dreyfni baholanadi. Agar dreyf prognoz qilingan chegaradan oshsa — qayta kalibrlash jadvalini belgilab qo‘yiladi.
9. **Hisobot va meta-tartiblar**
- Kalibrlash sertifikatini shakllantiriladi (qo‘llanilgan usul, etalonlar, hisoblangan xato).
- Ishlab chiqarish /operatsiya uchun kalibrlash grafiklari va algoritmi joriy etiladi.

XULOSA

Tadqiqot namlik sensorlarining kalibrlash modellarini tahlil qilish va ularning metrologik barqarorligiga ta’sir etuvchi omillarni baholashga qaratildi. Olingan natijalar asosida quyidagi xulosalar chiqarildi.

Ushbu tadqiqot namlik sensorlarining kalibrlash jarayonida yuzaga keladigan xatolar tabiati va metrologik barqarorlikka ta’sir etuvchi omillarni chuqur o‘rganishga qaratildi. Olingan natijalar har xil turdagi matematik kalibrlash modellari (Chiziqli, polinomial, logarifmik, eksponensial va ko‘p omilli modellar)ning prognozlash qobiliyati va sezgirlik xususiyatlari o‘rtasida sezilarli farq borligini ko‘rsatdi. Jumladan: 3-darajali polinomial model namlikni aniq baxolashda eng yuqori aniqlikka ega bo‘lib, $R^2 \approx 0.99$ va minimal xatolikka erishdi. Chiziqli model past aniqlikka ega bo‘lib, amalda faqat taxminiy baholar uchun mos keladi. Haroratning ta’siri katta bo‘lib, uni hisobga olmagan modellar sezilarli sistematik xatolarga ega. Eksponensial va logarifmik modellar ma’lum diapazonlardagina samarali; umumiy kalibrlashda tavsiya etilmaydi. Sensor dreyfi va dielektrik material o‘zgarishi metrologik barqarorlikning asosiy cheklovchilari hisoblanadi. Qo‘p omilli *(U, T, U²)* modellar namlik o‘lchashni 30% gacha yaxshilab, sensorning uzoq muddatli barqarorligini oshiradi.

Tadqiqot natijalari namlik sensorlari uchun yangi avlod intellektual kalibrlash algoritmlarini ishlab chiqishga asos bo‘ladi.

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"ADVANCED JOURNAL OF UNIVERSITY SCIENCE AND CREATIVE INNOVATIONS"

INVESTIGATION OF RIGIDITY INDICATORS OF PACKAGE STRUCTURES IN SPINNING MACHINES

Mamadjanov Shukurjon Rustamovich[1],
Ergashev Zoirbek Nurmatjon o'g'li[2],
Sayidmurodov Mirzoxid Mirzarakhimovich[3]
[1]*Researcher, Namangan State Technical University Uzbekistan, Namangan city*
[2]*Namangan Institute of Engineering and Technology, PhD, Associate Professor*
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Abstract. *Composite structures consisting of a package of assembled flat elements are widely used in spinning machines in textile enterprises. They can be used as working parts or load-bearing elements. This article addresses the issue of phenomenological determination of the rigidity indicators of these structures.*
Key words: *composite structures, flat element package, bending rigidity, longitudinal rigidity, torsional rigidity.*

Annotatsiya. *To'qimachilik korxonalarida qo'llaniladigan yigiruv mashinalarida jamlangan yassi elementlar paketidan tashkil topgan tarkibli konstruksiyalar keng qo'llaniladi. Ular ishchi organlar yoki tashuvchi elementlar sifatida qo'llanilishi mumkin. Ushbu maqolada konstruksiyalarning bikrlik ko'rsatkichlarini fenomenologik aniqlash masalasi ko'rib chiqilgan.*
Kalit so'zlar: *tarkibli konstruksiyalar, yassi elementlar paketi, egilishdagi bikrlik, buylama bikrlik, aylanma bikrlik.*

Аннотация. *Композитные конструкции, состоящие из пакета сборных плоских элементов, широко применяются в прядильных машинах текстильных предприятий. Они могут использоваться в качестве рабочих органов или силовых элементов. В данной статье рассматривается вопрос феноменологического определения показателей жёсткости конструкций*
Ключевые слова: *композитные конструкции, пакет плоских элементов, особенность при изгибе, особенность при кручении, особенность при вращении.*

Introduction. Structural constructions used in various industry sectors are divided into two groups based on their function: constructions used as support (load-bearing) elements and constructions used as working components. Structural constructions belonging to both groups

can also be classified into two types based on their operating principle: those that do not use force factors for structural purposes and those that do.

Force factors can be applied in structural constructions to increase their durability and rigidity. This can be achieved through elastic reinforcement, press fitting (interference fits) to create a rigid spatial structure, as well as by forming packages composed of multiple elements that can operate under tension, compression, bending, and torsion. For this purpose, force factors are applied longitudinally, transversely (including radially), and as moments [1,2].

Meeting both technological and structural requirements simultaneously in modern constructions is a complex task. Successfully solving this problem requires the use of unconventional approaches. One such approach is optimal design. The distinctive feature of optimal design is that, based on given initial parameters or constraints, the optimal or extreme values of certain parameters such as weight or cost are determined. With the increase in the number of factors considered and the growing demands for design accuracy, the need to precisely identify factors of various physical natures has arisen.

In mechanical engineering, construction, and spacecraft, structural constructions made of flat element packages compressed by a special tensioning cable are used. These elements may be identical in shape and size or vary according to certain rules, and they can be made from the same or different materials. The main purpose of such constructions is to increase the stiffness parameters of the support elements and working parts of machines.

In modern textile industry technological machines, working elements often consist of a package of flat, disk-shaped elements. This package is assembled on a shaft and reinforced by longitudinal compressive force. Some studies indicate that the pneumatic-mechanical spinning method is promising. The most common equipment in this system is the disk spinning chamber.

One of the important working elements of spinning machines is the discrete drum (see Figure 1), which is assembled from disks of two different diameters [3,4]. The disk assembly alternately creates gaps and clearances, all of which have the same width. The disks are compressed longitudinally by compression nuts, forming a package that can withstand tensile, compressive, bending, and torsional forces. The main mechanical parameters of the cylinder include stiffness in longitudinal, bending, and torsional directions. It is known that these parameters consist of the combined stiffness of the shaft and the disk package. Methods for calculating the stiffness parameters of the shaft are known [5], so it is sufficient to determine the stiffness parameters of the disk package.

However, the mechanics of such layered constructions have not been sufficiently developed because there is currently no reliable, scientifically based method to theoretically determine their stiffness parameters accurately and to identify the specific characteristics of dynamic processes.

Studying the behavior of layered constructions under bending, tension-compression, and torsion, as well as developing analytical methods to determine their stiffness parameters and analyzing the influence mechanisms of design and operational factors, presents a complex physical-mechanical problem. Highly simplified models yield low-accuracy results, while very complex models become practically inefficient due to the large number of factors and their varied effects on layered rods.

Currently, in the study of complex objects, methods such as diakoptics, finite element methods, and phenomenological approaches are considered effective. Diakoptics and finite

element methods are based on dividing the object into parts for study and require individual approaches or powerful computers.

Phenomenological analysis, on the other hand, is based on studying the object as a whole without dividing it into parts, allowing this approach to avoid deviating from the physical essence of the processes. For this reason, we study the behavior of flexible layered constructions under external influences based on phenomenological analysis. In this case, the layered compression or monolithic layered rods (formed by welding or bonding) are considered as theoretical models.

Research Methods. Our preliminary theoretical and experimental studies (also confirmed by other authors) show that as the compression force of the package increases from zero, the following phenomena are observed:

-The values of bending, longitudinal, and torsional stiffness indicators continuously increase. At the same time, the discrete stiffness values asymptotically approach those calculated for the monolithic layered rod.

-The growth rate of bending, longitudinal, and torsional stiffness decreases steadily from the maximum value at zero compression force and asymptotically approaches zero.

-According to experimental results, in some cases, either directly or at least through extrapolation, the compression force of the package can be determined at such values where the stiffness indicators differ from the values calculated by the MPS (monolithic layered rod) model by no more than a predetermined very small limited amount.

-The practical ranges of stiffness increase and the decrease in their growth rates are limited depending on the technical specifications and mechanical parameters of the layered rod.

From the above, the following conclusion can be drawn: at appropriate values of the package compression force, the growth rates of bending, longitudinal, and torsional stiffness of the GPS (porous layered rod) can, as a first approximation, be considered proportional to the difference between the calculated stiffness of the MPS monolithic layered rod and the stiffness of the GPS, and inversely proportional to the compression force values [3].

It should be emphasized that the compression force increases linearly over its entire range of variation [0, N₀]. Taking this fact into account, the value of the compression force can be assumed to be equal to the half-sum of its values at the boundary points of this range [4].

$$N = \frac{O + N_0}{2} = \frac{N_0}{2} \qquad (1)$$

Based on the above foundations, it is possible to mathematically investigate the variation processes of the longitudinal, bending, and torsional stiffness parameters of the package rod depending on changes in the package compression force values, as well as to develop mathematical models. The similarity in the variation patterns of the bending, longitudinal, and torsional stiffness of the GPS (porous package rod) allows for their simultaneous study.

Research results. According to the accepted main views and assumptions, with each change in the values of the package compression force, the increase in the values of the longitudinal, bending, and torsional stiffness follows the law: it is proportional to the difference between the corresponding MPS (monolithic package rod) stiffness values and the stiffness values, and inversely proportional to the average values of the package compression force.

$$dB_n = \frac{2\left(B_{pn} - B_n\right)}{N_o} dN \qquad (2a)$$

$$dC_{II} = \frac{2\left(C_{pII} - C_{II}\right)}{N_0} dN \qquad (2b)$$

$$dD_k = \frac{2\left(D_{pk} - D_k\right)}{N_0} dN \qquad (2s)$$

Here:

dBn,dCi,dDkdB_n, dC_i, dD_kdBn,dCi,dDk — increases in the longitudinal, bending, and torsional stiffness of the flexible package rod, respectively;

dNdNdN-increase in the value of the package compression force;

BpnB_(pn)Bpn-calculated longitudinal stiffness for the monolithic package rod;

CpiC_{pi}Cpi-calculated bending stiffness for the monolithic package rod;

DpkD_{pk}Dpk-calculated torsional stiffness for the monolithic package rod;

BnB_nBn-current longitudinal stiffness of the package rod;

CiC_iCi-current bending stiffness of the package rod;

DkD_kDk-current torsional stiffness of the package rod;

N02\frac{N_0}{2}2N0-average value of the package compression force.

All other influencing factors not taken into account are also determined through the first functions An,AuA_n, A_uAn,Au, and AkA_kAk, respectively, which for now are assumed to be constant (unchanging).

Thus, equations (2a), (2b), and (2c) can be rewritten in the following form:

$$dB_n = \frac{2A_n(B_{pn} - B_n}{N_0} dN \qquad (3a)$$

$$dC_{II} = \frac{2A_u(C_{pu} - C_u)}{N_0} dN \qquad (3b)$$

$$dD_k = \frac{2A_k(D_{pk} - D_k}{N_0} dN \qquad (3s)$$

In these equations, the variables are separated.

$$\frac{dB_n}{dN} = \frac{2A_n(B_{pn} - B_{n)}}{N_0} \qquad (4a)$$

$$\frac{dC_{II}}{dN} = \frac{2A_k(C_{PII} - C_{II})}{N_0} \qquad (4b)$$

$$\frac{dD_k}{dN} = \frac{2A_k(D_{pk} - D_k)}{N_0} \qquad (4s)$$

At the same time, the obtained equations can be rewritten in the following form:

$$\frac{dB_n}{dN} + \frac{2A_n}{N_0} B_n - \frac{2A_n B_{pn}}{N_0} = 0 \qquad (5a)$$

$$\frac{dC_{II}}{dN} + \frac{2A_u}{N_0} C_{II} - \frac{2A_u C_{PII}}{N_0} = 0 \qquad (5b)$$

$$\frac{dD_k}{dN} + \frac{2A_k D_k}{N_0} - \frac{2A_k D_{pk}}{N_0} = 0 \qquad (5s)$$

Equations (5a), (5b), and (5c) are first-order ordinary linear differential equations, and their general solutions can be written in the following form:

$$B_n = B_{pn} + C_1 e^{-\frac{2A_n N}{N_0}} \quad (6a)$$

$$C_{II} = C_{PII} + C_2 e^{-\frac{2A_u N}{N_0}} \quad (6b)$$

$$D_k = D_{pk} + C_3 e^{-\frac{2A_k N}{N_0}} \quad (6s)$$

To determine the integration constants, we formulate the boundary conditions in the following form:

Conditions: N=0, B_n=0; N=0, C_и=0; N=0, D_k=0;

From these, we find: C_1 = B_pn; C_2 = C_pи; C_3 = D_pk.

Thus, equations (6a), (6b), and (6c) take the following form:

$$B_n = B_{pn}(1 - e^{-\frac{2A_n N}{N_0}}) \quad (7a)$$

$$C_{II} = C_{PII}(1 - e^{-\frac{2A_u N}{N_0}}) \quad (7b)$$

$$D_k = D_{pk}(1 - e^{-\frac{2A_k N}{N_0}}) \quad (7s)$$

Now, for the longitudinal, bending, and torsional rigidities of the monolithic package rod, we use the solutions from formulas (2), (3), and (4), which are constructed alternately from working and spacer discs. Thus, based on phenomenological determination, the following expressions can be written for the values of longitudinal, bending, and torsional rigidities:

$$B_n = \frac{(l_p + l_n)E_p F_p E_n F_n}{l_n E_p F_p + l_p E_p F_p}(1 - e^{-\frac{2A_n N}{N_0}}) \quad (8a)$$

$$C_u = \frac{(l_p + l_n)E_p J_p E_n J_n}{l_n E_p J_p + l_p E_n J_n}(1 - e^{-\frac{2A_k N}{N_0}}) \quad (8b)$$

$$D_{pk} = \frac{(l_p + l_n)G_p J_{pp} G_n J_{pn}}{l_n G_p J_{pp} + G_p G_n J_{pn}}(1 - e^{-\frac{2A_k N}{N_0}}) \quad (8s)$$

Here:

-lp,lnl_p, l_nlp,ln — thicknesses of the working and spacer discs;

-Ep,EnE_p, E_nEp,En — elastic moduli of the materials of the working and spacer discs;

-Jpp,JpnJ_{pp}, J_{pn}Jpp,Jpn — polar moments of inertia of the cross-sectional areas of the working and spacer discs.

We accept the influence functions of the transverse force on the longitudinal, bending, and torsional stiffnesses (or briefly, the functions of longitudinal, bending, and torsional rigidities) in the following form:

$$\mu = (1 - e^{-\frac{2A_n N}{N_0}}) \quad (9a)$$

$$\eta = (1 - e^{-\frac{2A_u N}{N_0}}) \quad (9b)$$

$$\nu = (1 - e^{-\frac{2A_k N}{N_0}}) \quad (9s)$$

Then, equations (9a), (9b), and (9c) are expressed in the following form:

$$B_n = \mu \frac{(l_p + l_n)E_p F_p E_n F_n}{l_n E_p F_p + l_p E_p F_p} = \mu B_{pn} \qquad (10a)$$

$$C_u = \eta \frac{(l_p + l_n)E_p L_p E_n J_n}{l_n E_n J_p + l_p E_n J_n} = \eta C_{pu} \qquad (10b)$$

$$D_k = \nu \frac{(l_p + l_n)G_p J_{pp} G_n J_{pn}}{G_n G_p J_{pp} + G_p G_n J_{pn}} = \nu D_{pk} \qquad (10s)$$

The obtained solutions describe both qualitatively and quantitatively the changes in longitudinal, bending, and torsional stiffness parameters of layered structures composed of flat elements.

Conclusion. The obtained solutions are important not only theoretically but also practically. They demonstrate how the longitudinal, bending, and torsional stiffness of layered structures (consisting of working and spacer elements) change qualitatively and quantitatively. This can be applied in:

-Designing layered rods, disk systems, transmission elements, and composite structures operating under various loads;

-Enhancing the vibration resistance of working components in spinning machines and ensuring energy efficiency.

Determining stiffness parameters through a phenomenological approach increases the reliability of constructions, extends their service life, and enables optimal material selection. Therefore, the results of this study can be used both in scientific research and practical design processes.

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FM VA INTERNET-RADIO TARMOQLARINING SIFAT KO'RSATKICHLARINING QIYOSIY TAHLILI

Narzulloyev Oybek[1], Ubaydullayev Shoxjaxon[2], Abdullaev Asadbek[3]
[1]dotsent, Muhammad al-Xorazmiy nomidagi Toshkent axborot texnologiyalari universiteti, Toshkent
[2,3]magistrant, Muhammad al-Xorazmiy nomidagi Toshkent axborot texnologiyalari universiteti, Toshken
https://doi.org/10.5281/zenodo.17907159t

Annotatsiya. *Ushbu maqolada an'anaviy FM radio va zamonaviy Internet-radio tarmoqlarining sifat ko'rsatkichlari texnik va foydalanuvchi tajribasi nuqtai nazaridan tahlil qilindi. Har bir tizimning ishlash prinsipi, afzallik va kamchiliklari o'rganildi. Natijalar shuni ko'rsatadiki, Internet-radio yuqori sifat va global qamrovda ustun, FM radio esa ishonchliligi va barqarorligi bilan ajralib turadi.*
Kalit so'zlar: *FM radio, Internet-radio, striming, audio sifat, audio kechikish, SNR, QoS, QoE, MOS.*

Abstract. *This article analyzes the quality indicators of traditional FM radio and modern Internet radio networks from the perspective of technical parameters and user experience. The operating principles, advantages, and disadvantages of each system are examined. The results show that Internet radio excels in sound quality and global coverage, while FM radio stands out for its stability and low latency.*
Key words: *FM radio, Internet radio, streaming, audio quality, latency, SNR, QoS, QoE, MOS.*

Аннотация. *В данной статье проведён анализ показателей качества традиционного FM-радио и современных интернет-радиосетей с точки зрения технических параметров и пользовательского опыта. Изучены принципы работы, преимущества и недостатки каждой системы. Результаты показывают, что интернет-радио превосходит по качеству звучания и глобальному охвату, тогда как FM-радио отличается стабильностью и низкой задержкой.*
Ключевые слова: *FM-радио, интернет-радио, стриминг, качество звука, задержка, SNR, QoS, QoE, MOS.*

Kirish. Radio texnologiyasi bir asrdan ortiq vaqt davomida insoniyat hayotida muhim o'rin egallab kelmoqda. FM radio 20-asrning o'rtalaridan boshlab ovozli eshittirishning asosiy

shakliga aylandi.An’anaviy radio chastota o‘zgarishlari hamda uzatuvchi antenna masofasi bilan cheklanganligi sababli, ehtimol kimdir signalni qabul qilishda muammolarga duch kelgan bo‘lishi mumkin - radiostansiya shovqinlana boshlaydi yoki umuman efirda sukut bo‘ladi. Va bu usulning o‘ziga xos cheklovi bor: FM-radio odatda uzatuvchidan taxminan 40-50 mil (64-80 km) masofagacha eshittirish olib boradi, bu esa geografik joylashuvga qarab qamrovning notekis bo‘lishiga olib keladi [6]. Onlayn radio - bu audio kontentni internet orqali uzatish tizimidir. U tinglovchilarga dunyoning istalgan nuqtasida joylashgan istalgan radiostansiyaga, o‘z joylashuvlaridan qat’i nazar, ulanib tinglash imkonini beradi. Onlayn radioning an’anaviy radiodan farqi shundaki, u fizik radiopriyomnikni talab qilmaydi va radioto‘lqinlarga bog‘liq emas. Uni tinglash uchun faqat internet aloqasi va mos qurilma (kompyuter, smartfon yoki planshet) kifoya qiladi[1-3].

Bugungi kunda tinglovchi ikki asosiy tizim o‘rtasida tanlov qiladi:

- FM radio - analog chastota modulyatsiyasiga asoslangan. Uzatish 87.5-108 MHz diapazonda amalga oshiriladi. Qabul qiluvchi qurilma antennasi orqali to‘lqinni qabul qiladi, demodulyatsiya orqali tovush qayta tiklanadi.
- Internet-radio - bu real vaqtda internet orqali audio kontentni uzatish texnologiyasi. FM eshittirishidan farqli o'laroq, radio to'lqinlar yoki transmitterlarni talab qilmaydi: signal IP (Internet Protocol) orqali uzatiladi.

Ushbu tadqiqotning yangiligi shundan iboratki, unda FM va Internet-radio tizimlari texnik ko‘rsatkichlar asosida eksperimental tarzda qiyosiy tahlil qilindi.

Adabiyotlar sharhi. Ko‘plab tadqiqotlarda radio uzatish texnologiyalarining sifat ko‘rsatkichlari keng tahlil qilingan. Masalan, S. Patel (2021) tomonidan olib borilgan tadqiqotda Internet-radio strimingida QoE (Quality of Experience) - ya’ni foydalanuvchi hissiy qoniqish darajasi - to‘g‘ridan-to‘g‘ri tarmoq sifati va uzatish barqarorligiga bog‘liqligi isbotlangan[1]. Shuningdek, “Digital Audio Broadcasting or Webcasting: A Network Quality Perspective” (2016) jurnal maqolasida Webcasting (Internet-radio) tarmoqlarida kechikish (latency), paket yo‘qotilishi (packet loss) va audio signal tahlili o‘rganilgan. Tadqiqot natijalariga ko‘ra, audio sifat ko‘rsatkichlari tarmoqning texnik barqarorligiga bevosita bog‘liq, ammo barqaror Internet tarmoqlarida Web-radio sifati an’anaviy FM radio sifatidan yuqori ekani ta’kidlangan [2]. Bundan tashqari, B. D. Rickert (2011) o‘zining “Internet Audio Streaming and the Emerging Model of Radio” nomli ilmiy ishida FM va Internet-radio tizimlarini foydalanuvchi tajribasi, uzatish sifati hamda qamrov darajasi nuqtai nazaridan tahlil qilgan[3]. Mazkur ilmiy ishlanmalar ushbu maqolaning nazariy asosini tashkil etadi. Shu bilan birga, bizning tadqiqotda Internet-radio va FM radio tizimlarining nafaqat nazariy, balki texnik-amaliy farqlari ham tahlil qilinadi. Tadqiqot davomida ularning signal sifati, kechikish, shovqinbardoshliligi va tarmoq barqarorligi kabi ko‘rsatkichlari asosida qiyosiy baholash amalga oshiriladi.

Metodologiya. Avvalgi tadqiqotlarda FM radio va Internet-radio tizimlari o‘rtasidagi taqqoslashlar asosan auditoriya xulq-atvori (audience behavior) nuqtai nazaridan olib borilganligi kuzatildi. Masalan, B. D. Rickert tomonidan o‘tkazilgan “Internet Audio Streaming and the Emerging Model of Radio” nomli tadqiqotda respondentlarning 83% qismi Internet-radio audio sifatini “yanada toza” yoki “balandroq chastota aniqligiga ega” deb baholagan. Shu bilan birga, 60% foydalanuvchi “buferlash” (“buffering” - audio oqimini vaqtincha to‘xtatib saqlash jarayoni) muammosini qayd etgan bo‘lib, bu holat tarmoq barqarorligi va uzatish tezligiga bog‘liq uzilishlar bilan izohlanadi[3]. Biroq ushbu tadqiqotlarning ko‘pchiligi subyektiv foydalanuvchi tajribasiga asoslangan bo‘lib, texnik parametrlar bo‘yicha chuqur tahlil yetarlicha

yoritilmagan. Shu sababli mazkur maqolada FM radio va Internet-radio tizimlarining texnik ko‘rsatkichlari asosida qiyosiy tahlil amalga oshirish maqsad qilindi.

Tadqiqotda quyidagi asosiy sifat ko‘rsatkichlari bo‘yicha solishtirish o‘tkazildi:

1-jadval

№	Ko‘rsatkich nomi	FM radio	Web-radio (128 kbps AAC)	Web-radio (320 kbps MP3)
1	Signal-to-Noise Ratio (SNR), dB	60	50	58
2	Frequency Response (Hz)	30–15 000	40–16 000	20–18 000
3	Dynamic Range (dB)	70	65	72
4	Latency (ms)	15	280	250
5	Bitrate (kbps)	~256 (analog)	128	320
6	Reliability (dropout%)	0.5	2.8	1.2

Tahlil natijalariga ko‘ra (1-jadval), FM radio signali past kechikish va yuqori ishonchlilik bilan ajralib turadi, biroq uning chastota diapazoni cheklangan. Internet-radio esa kodek sifatiga va tarmoq barqarorligiga bog‘liq. 128 kbps oqimda sifat biroz past bo‘lsa, 320 kbps oqimda audio sifat deyarli FM darajasiga tenglashadi. Shovqin nisbati (SNR) bo‘yicha FM ustun, ammo chastota diapazoni va aniqlikda 320 kbps oqim afzal.

Tahlil. FM radio tizimlari analog modulyatsiya prinsipi asosida ishlaydi. Shu sababli u shovqin (interferensiya), elektromagnit xalaqitlar va qamrovdagi uzilishlar ta’siriga nisbatan sezuvchandir. Natijada, bu omillar audio signal sifatining pasayishiga, ya’ni tovushdagi shovqinlar, xiralik yoki uzilishlar yuzaga kelishiga sabab bo‘ladi. Bunga qarama-qarshi ravishda, Internet-radio (yoki Web-radio) raqamli kompressiya va striming (streaming) texnologiyalariga asoslangan bo‘lib, yuqori aniqlikdagi (high-fidelity) audio uzatish imkonini beradi. Bu tizimda audio ma’lumot raqamli formatda kodlanadi (masalan, AAC, Opus yoki MP3 kodeklari yordamida) va foydalanuvchiga moslashtirilgan oqim tezligi (adaptive bitrate streaming) orqali uzatiladi.

2-jadval ma’lumotlariga ko‘ra, internet tezligi past bo‘lganda audio oqim sifati avtomatik tarzda bitratni kamaytirish hisobiga pasayadi. Bu esa striming sifatining tarmoq o‘tkazuvchanligiga to‘g‘ridan-to‘g‘ri bog‘liqligini ko‘rsatadi. Umuman olganda, barqaror internet aloqasi, yuqori bit-rate va samarali kodeklar (AAC, Opus) sharoitida Internet-radio audio sifati FM radiodan sezilarli darajada yuqori bo‘ladi. Shunday qilib, FM radio va Internet-radio texnologiyalari o‘rtasidagi asosiy farq signal uzatish mexanizmi va sifatga ta’sir etuvchi tashqi omillarda namoyon bo‘ladi: biri analog signalning tabiiy barqarorligiga, ikkinchisi esa raqamli tarmoqning o‘tkazuvchanligi va adaptiv texnologiyalariga tayanadi.

FM radio va Internet-radio: Sifat ko‘rsatkichlari bo‘yicha solishtirish

2-jadval

Ko‘rsatkich	FM radio	Internet radio
Audio sifat	Ovoz analog tarzda uzatiladi va bu ba’zi holatlarda shovqinlar bilan birga bo‘lishi mumkin	Internet-radio raqamli (digital) formatda eshittiriladi. Agar internet tezligi yuqori bo‘lsa, juda tiniq va barqaror audio sifat taqdim etiladi
MOS (Mean Opinion Score)	Odatda 3.5–4 ball oralig‘ida bo‘ladi. Havo sharoiti, qurilma sifati va geografik joylashuvga bog‘liq holda o‘zgaradi.	Yaxshi internet sharoitida 4.2–4.5 ballgacha yetishi mumkin. Tarmoq uzilishlari bo‘lsa, bu ko‘rsatkich tez pasayadi
QoS (Quality of Service)	FM radiosida an’anaviy tarmoqlarda QoS nazorati mavjud emas, chunki u umumiy efir orqali uzatiladi.	Internet-radio IP tarmoqlarda ishlaydi, bu yerda **tarmoqli kengligi, kechikish (latency), paket yo‘qotilishi** QoS sifatiga ta’sir qiladi. Ba’zi xizmatlar QoS ni boshqaradi.
QoE (Quality of Experience)	Odatda barqaror, ammo joylashuvga bog‘liq. Avtomobilda, ochiq joylarda yaxshi; binolar ichida yoki tog‘li hududlarda yomonlashadi	Agar internet tez va barqaror bo‘lsa - yuqori. Mobil internetda esa uzilishlar bo‘lishi mumkin.

Xulosa. Tahlil natijalari shuni ko‘rsatadiki, FM radio tizimlari signalning uzluksizligi, past kechikish va barqaror efir uzatish kabi afzalliklarga ega. Biroq u analog modulyatsiya tabiati tufayli shovqin (interferensiya) va qamrovdagi uzilishlarga nisbatan sezuvchan bo‘lib, bu holat audio sifatning pasayishiga olib keladi. Internet-radio esa raqamli kompressiya va striming texnologiyalari asosida ishlaydi, natijada yuqori sifatli audio uzatish, global qamrov va foydalanuvchi uchun interaktiv imkoniyatlarni ta’minlaydi. Shu bilan birga, uning samaradorligi tarmoq barqarorligi va internet tezligiga bevosita bog‘liq bo‘ladi.

Amaliy nuqtai nazardan, Internet-radio multimedia xizmatlari, onlayn kontent va global eshittirish sohalarida ustunlik qiladi, holbuki FM radio tizimlari mobil aloqa, transport vositalari va favqulodda vaziyatlarda yanada ishonchli va tezkor aloqa vositasi bo‘lib qolmoqda.

Umuman olganda, Internet-radio raqamli davrning yangi eshittirish standarti sifatida shakllanmoqda. U foydalanuvchi tajribasi (QoE), audio sifat ko‘rsatkichlari (SNR, THD, bitrate) va interaktivlik darajasi bo‘yicha FM radioga nisbatan ustunlik qiladi. Biroq, bu ustunlikning to‘liq amalga oshishi uchun barqaror va keng qamrovli internet infratuzilmasi muhim shart hisoblanadi.

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AUDIODAGI SHOVQINLARNI TOZALASH ALGORITMLARINI TAHLIL QILISH VA ULARNING TURLI AMALIY TIZIMLARDA SAMARADORLIGINI BAHOLASH

Narzulloyev Oybek[1], Abdullaev Asadbek[2], Ubaydullayev Shoxjaxon[3]
[1]Dotsent, Muhammad al-Xorazmiy nomidagi Toshkent axborot texnologiyalari universiteti, Toshkent
[2]Magistrant, Muhammad al-Xorazmiy nomidagi Toshkent axborot texnologiyalari universiteti, Toshkent
[3]Magistrant, Muhammad al-Xorazmiy nomidagi Toshkent axborot texnologiyalari universiteti, Toshkent
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Annotatsiya. *Ushbu maqolada audio signallarda uchraydigan turli shovqinlarni kamaytirish masalasi ko‘rib chiqildi. Tadqiqotda ikki xil algoritm — Fourier va Kalman filtrlari tahlil qilinadi hamda ularning turli amaliy tizimlardagi samaradorligi solishtirildi. Fourier filtri chastota domenida ishlaydigan an’anaviy yondashuv sifatida, Kalman filtri esa adaptiv, statistik model asosida ishlovchi algoritm sifatida o‘rganildi. Tajriba natijalariga ko‘ra, Kalman filtri dinamik shovqinlarni samaraliroq tarzda tozalaydi, Fourier filtri esa barqaror shovqinlarga nisbatan yuqori tezlikda ishlaydi.*
Kalit so‘zlar: *audio signal, shovqin, Fourier filtri, Kalman filtri, signalni qayta ishlash, shovqinni kamaytirish, SNR, MSE.*

Abstract. *This paper analyzes the problem of reducing various types of noise in audio signals. The study compares two algorithms – the Fourier filter and the Kalman filter, examining their performance and effectiveness in different practical systems. The Fourier filter is considered as a traditional approach operating in the frequency domain, while the Kalman filter functions as an adaptive algorithm based on a statistical model. Experimental results show that the Kalman filter is more effective in suppressing dynamic noise, whereas the Fourier filter performs faster when dealing with stationary noise.*
Key words: *audio signal, noise, Fourier filter, Kalman filter, signal processing, noise reduction, SNR, MSE.*

Аннотация. *В данной статье рассматривается проблема снижения различных типов шумов в аудиосигналах. В исследовании проведено сравнение двух алгоритмов – фильтра Фурье и фильтра Кальмана, а также анализ их эффективности в различных практических системах. Фильтр Фурье представлен как традиционный подход, работающий в частотной области, тогда как фильтр Кальмана является адаптивным алгоритмом, основанным на статистической модели. Результаты экспериментов*

показывают, что фильтр Кальмана более эффективно устраняет динамические шумы, в то время как фильтр Фурье работает быстрее при обработке стационарных шумов.

Ключевые слова: *аудиосигнал, шум, фильтр Фурье, фильтр Кальмана, обработка сигналов, снижение шума, SNR, MSE.*

Kirish.

Audio signallarni shovqindan tozalash — raqamli signalni qayta ishlashning eng muhim yo‘nalishlaridan biridir. Ushbu masala nutqni tanish, ovozli aloqa tizimlari, musiqa ishlab chiqarish, radioeshittirish va xavfsizlik tizimlarida muhim amaliy ahamiyatga ega. Audio ma’lumotlar yozib olinayotgan jarayonda turli manbalardan keladigan oq shovqin, fon shovqin yoki impulsiv shovqin kabi tashqi ta’sirlar signal sifatini keskin pasaytiradi. Shu sababli, so‘nggi o‘n yilliklarda shovqinni kamaytirish algoritmlari ko‘plab tadqiqotchilar tomonidan o‘rganib kelinmoqda.

Dastlabki tadqiqotlar asosan Fourier transformatsiyasiga asoslangan chastota domenidagi filtratsiya usullari orqali olib borilgan. Masalan, A. V. Oppenheim va R. W. Schafer o‘zlarining “Discrete-Time Signal Processing” (2010) asarida audio signallarni chastota bo‘yicha tahlil qilish va past/yuqori chastotali shovqinlarni olib tashlash metodikasini ishlab chiqqanlar [1]. Keyinchalik Wiener va Butterworth filtrlarining modifikatsiyalari paydo bo‘lib, ular barqaror shovqinlarni samarali kamaytirgan, ammo vaqt bo‘yicha o‘zgaruvchan (no-statsionar) shovqinlar uchun yetarli aniqlik bermagan [5].

1990-yillardan boshlab, bu muammo statistik yondashuvlar asosida hal qilina boshlandi. R. E. Kalman tomonidan ishlab chiqilgan Kalman filtri (1960) dastlab navigatsiya va boshqaruv tizimlarida qo‘llanilgan bo‘lsa-da, keyinchalik audio signallarni real vaqtli tozalashda ham keng tadbiq etila boshlandi [3]. P. Maybeck (1982) va S. Haykin (2013) ishlarida Kalman filtri asosida signal holatini baholash va shovqinni adaptiv tarzda kamaytirish algoritmlari chuqur o‘rganilgan [2, 4].

Mazkur ishning dolzarbligi shundaki, hozirgi davrda nutqni aniqlash, audio tahrir va sun'iy intellekt asosidagi ovoz tizimlarida shovqinni kamaytirish sifat ko‘rsatkichlarini belgilovchi eng muhim omilga aylanmoqda. Shu sababli, Fourier va Kalman filtrlari asosida shovqinni tozalash usullarini solishtirish, ularning SNR (signal-to-noise ratio), MSE (mean square error) kabi ko‘rsatkichlar orqali samaradorligini baholash amaliy va ilmiy jihatdan muhimdir.

Asosiy qism.

1. Shovqinni kamaytirish usullari va baholash mezonlari

Shovqinlarni kamaytirish jarayonlari odatda ikki asosiy yo‘nalishda amalga oshiriladi: vaqt domenida va chastota domenida. Vaqt domenidagi usullar signalning vaqt bo‘yicha o‘zgarishiga asoslanadi va adaptiv xususiyatga ega bo‘ladi. Kalman, LMS (Least Mean Square) yoki RLS (Recursive Least Square) filtrlar shular jumlasidandir [2, 9]. Ular real vaqt rejimida signalni kuzatib boradi va statistik model asosida foydali qismni ajratib oladi. Chastota domenidagi yondashuvlarda esa signal avval Fourier transformatsiyasi orqali chastota spektriga o‘tkaziladi, so‘ng shovqin komponentlari chastotaviy filtr yordamida olib tashlanadi [1]. Fourier, Butterworth va Wavelet filtrlari aynan shu tamoyil asosida ishlaydi.

Audio sifatini yaxshilashda faqat signalni tozalashning o‘zi kifoya emas, balki uning natijasini baholash uchun ham aniq matematik mezonlar kerak bo‘ladi. Eng ko‘p ishlatiladigan

obyektiv kriteriyalardan biri bu Signal-to-Noise Ratio (SNR) bo‘lib, u foydali signal energiyasi bilan shovqin energiyasi o‘rtasidagi nisbatni ifodalaydi [8]:

$$SNR = 10log_{10}\frac{P_{signal}}{P_{noise}}\text{[dB]} \qquad (1)$$

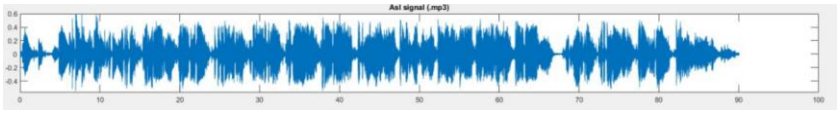
Bu qiymat qancha katta bo‘lsa, signal shunchalik toza hisoblanadi. Ikkinchi muhim ko‘rsatkich — Mean Square Error (MSE) bo‘lib, u asl signal bilan tozalangan signal o‘rtasidagi o‘rtacha kvadrat farqni o‘lchaydi:

$$MSE = \frac{1}{N}\sum_{i=1}^{N}(x_i - x'_i)^2 \qquad (2)$$

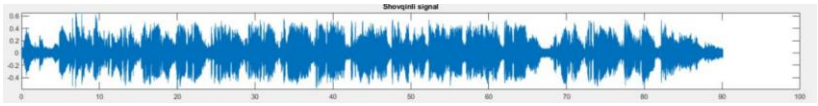
Bu parametr filtrning aniqligini ko‘rsatadi; MSE qiymati qancha kichik bo‘lsa, shovqin shunchalik samarali kamaytirilgan bo‘ladi [10].

2. Tajriba metodologiyasi va signallarni tayyorlash.

Mazkur tadqiqotda MATLAB platformasining virtual laboratoriyasida uchta asosiy mezon: signal sifati, aniqlik va tezlik tahlil qilindi [6]. Tajriba ishida birinchi navbatda bitta real audio fayl — inson nutqiga tegishli speech.wav signali tanlab olindi (1-rasm). Ushbu signalga sun'iy tarzda oq shovqin (white Gaussian noise) qo‘shildi, so‘ngra u ikkita filtr orqali qayta ishlandi (2-rasm) [13].



1-rasm. Asl audio signalning MATLAB muhitidagi ko‘rinishi



2-rasm. Shovqin qo‘shilgan audio signal

3. Fourier filtri algoritmi va natijalari.

Fourier algoritmi chastotaviy tahlilga asoslanadi. U signallarni vaqt domenidan chastota domeniga o‘tkazib, spektral komponentlar ko‘rinishida ifodalaydi. Fourier transformatsiyasining asosiy g'oyasi — har qanday murakkab signalni sinus va kosinus to‘lqinlar yig'indisi sifatida tasvirlash mumkinligidir [1]. Uning matematik ifodasi:

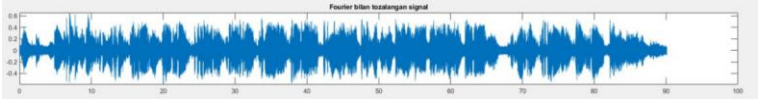
$$X(f) = \int_{-\infty}^{+\infty} x(t)e^{-j2\pi ft}dt \qquad (3)$$

va diskret holda:

$$X(k) = \sum_{n=0}^{N-1} x(n)e^{-j2\pi kn/N} \qquad (4)$$

Bu yerda x(n)— vaqt domenidagi signal, X(k)— uning chastotaviy spektri, N— namunalar soni.

Fourier transformatsiyasi yordamida signal spektri aniqlanadi va shovqin chastotalari filtrlanadi. Shundan so‘ng teskari Fourier transformatsiyasi (IFFT) orqali signal qayta tiklanadi [5]. Fourier algoritmi deterministik yondashuv bo‘lib, shovqinlarning chastota oralig'iga asoslanadi. Agar shovqin ma'lum chastotali diapazonda joylashgan bo‘lsa, u holda chastotaviy filtr yordamida bu komponentlar kesib tashlanadi. Tajribada Fourier filtri qo‘llanib, signal chastota domenida tahlil qilindi. Shovqin chastotalari aniqlangach, past chastotali (low-pass) va o‘tkazmaydigan (band-stop) filtrlar yordamida zararli komponentlar yo‘qotildi (3-rasm).



3-rasm. Fourier filtri orqali tozalangan signal

4. Kalman filtri algoritmi va natijalari.

Bundan farqli o‘laroq, Kalman filtri — ehtimollik asosidagi rekursiv baholash algoritmi bo‘lib, u vaqt bo‘yicha o‘zgaruvchi (no-statsionar) tizimlarda foydali signalni optimal tarzda aniqlaydi [3, 9]. Kalman filtrining matematik modeli ikki asosiy tenglamadan iborat: tizim tenglamasi va o‘lchov tenglamasi:

$$x(x_k = Ax_{k-1} + Bu_k + \omega_k \quad z_k = Hx_k + v_k \qquad (5)$$

Bu yerda:

x_k— Tizimning haqiqiy holati (signalning toza shakli),

z_k— kuzatilgan (shovqin) signal,

A— o‘tish matritsasi (tizim dinamikasini ifodalaydi),

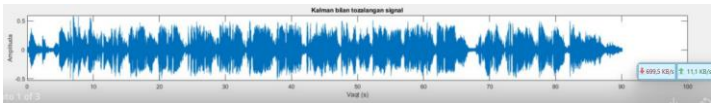
B— boshqaruv matritsasi,

H— kuzatuv matritsasi,

ω_k va v_k tizim va o‘lchov shovqinlari, ular normal taqsimotga ega:

$$\omega_k \sim N(0, Q), \qquad v_k \sim N(0, R)$$

Kalman filtri o‘z mohiyatiga ko‘ra optimal bayesian baholovchi hisoblanadi, chunki u signal va shovqin ehtimolliklarini hisobga olib, minimal xatolik bilan natija beradi [4]. Shuning uchun u real vaqtli tizimlarda, ayniqsa nutqni qayta ishlash, GPS, radar va sensorli qurilmalarda keng qo‘llaniladi [9]. Tajribada Kalman filtri statistik modellashtirish orqali shovqindan ajratadi. U har bir vaqt bosqichida signalning oldingi holatini, o‘lchov natijasini va taxmin xatosini hisobga olib, optimal baho beradi. Natijada no-statsionar shovqinlarda ancha barqaror va toza chiqish signali hosil qilindi (4-rasm).



4-rasm. Kalman filtri orqali tozalangan yakuniy signal

5. Natijalarni taqqoslash va muhokama.

Ushbu tajriba orqali ikkala algoritmning samaradorligi bir xil sharoitda, bitta nutq audiosi ustida sinovdan o‘tkazildi. Tozalashdan oldingi va keyingi SNR qiymatlari, shuningdek MSE xatoliklari hisoblanadi va natijalar jadval shaklida taqqoslanadi (1-jadval):

1-jadval

Algoritm	SNR (dB)	MSE	Hisoblash vaqti (ms)
Asl signal (shovqinli)	8.2	0.042	—
Fourier filtri	14.7	0.018	12.3
Kalman filtri	16.9	0.011	28.6

Jadvaldan ko‘rinib turibdiki, Kalman filtri SNR va MSE ko‘rsatkichlari bo‘yicha Fourierdan ustun turadi, ammo hisoblash murakkabligi yuqoriroq. Fourier filtri barqaror shovqinlarda tez ishlasa, Kalman filtri o‘zgaruvchan muhitlarda yuqori aniqlik beradi [7]. Shu sababli, ikkala algoritmni bir tizimda — gibrid (Fourier–Kalman) yondashuv sifatida qo‘llash istiqbollari ham tahlil qilinadi, bu esa real vaqtli nutqni qayta ishlash, ovozli aloqa va sun'iy intellekt asosidagi audio tizimlarda yanada yuqori sifatga erishish imkonini beradi [11, 12].

Xulosa.

Mazkur tadqiqot ishida audio signallarni shovqindan tozalashda Fourier va Kalman filtrlari asosidagi algoritmlarning samaradorligi taqqoslab o‘rganildi. Tajriba natijalari shuni ko‘rsatdiki:

1. Fourier filtri chastota domenida ishlash tufayli barqaror (stasionar) shovqinlarni tez va samarali kamaytirishga qodir. SNR qiymati 8.2 dB dan 14.7 dB gacha oshdi, MSE 0.042 dan 0.018 gacha kamaydi.

2. Kalman filtri vaqt bo‘yicha o‘zgaruvchan (no-statsionar) shovqinlarda adaptiv tarzda ishlab, yuqoriroq aniqlik berdi: SNR 16.9 dB, MSE 0.011 ga teng bo‘ldi. Biroq, hisoblash murakkabligi Fourierdan 2.3 baravar yuqori (28.6 ms vs 12.3 ms).

3. Fourier algoritmi signal spektrini tahlil qilishda tezkor natija bersa-da, vaqt va chastotani bir vaqtda kuzata olmaydi. Kalman filtri esa rekursiv baholash orqali signalning oldingi va hozirgi holatini birlashtirib, optimal natija beradi.

4. Gibrid yondashuv — Fourier va Kalman filtrlarini kombinatsiya qilish orqali ikkala algoritmning afzalliklarini birlashtirish mumkin: Fourier spektral shovqinlarni aniqlaydi, Kalman ularni vaqt bo‘yicha adaptiv tarzda yo‘qotadi.

Umumiy xulosada shuni ta'kidlash lozimki, real vaqtli audio tizimlarida — nutqni tanish, ovozli yordamchilar, telekommunikatsiya — tizim talablariga qarab mos filtr tanlash muhim. Agar signal barqaror bo‘lsa va tezlik muhim bo‘lsa, Fourier filtri; agar shovqin dinamik va sifat ustuvor bo‘lsa, Kalman filtri afzalroq. Kelajakda bu ikki algoritmni Deep Learning usullari bilan birlashtirib, avtomatik tarzda optimal filtr tanlash imkoniyati yaratish mumkin.

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08.00.00 – ECONOMIC SCIENCES

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08.00.00 - IQTISODIYOT FANLARI

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08.00.00 – ЭКОНОМИЧЕСКИЕ НАУКИ

TA'LIMGA YO'NALTIRILGAN INVESTITSIYA – JAMIYATNING INTELLEKTUAL TARAQQIYOT POYDEVORI

Rizokulov Arslonkul
O'zbekiston Milliy universiteti
mustaqil tadqiqotchisi
https://doi.org/10.5281/zenodo.17907193

Annotatsiya. *Mazkur ilmiy maqolada ta'lim sohasiga yo'naltirilayotgan investitsiyalarning iqtisodiy va ijtimoiy samaradorligi, inson kapitalini shakllantirishdagi roli, raqamli davrda ta'limga sarmoya kiritishning yangi mexanizmlari, global tajribalar hamda milliy ta'lim tizimini modernizatsiya qilish bo'yicha ilmiy-amaliy takliflar keng yoritiladi. Shuningdek, ta'lim investitsiyalari orqali barqaror iqtisodiy o'sish, innovatsion rivojlanish va ijtimoiy farovonlikni ta'minlashning zamonaviy yondashuvlari tahlil qilinadi.*

Kalit so'zlar: *ta'lim investitsiyalari , inson kapitali, mehnat unumdorligi.*

Kirish.

So'nggi yillarda dunyo mamlakatlari rivojlanish modelida keskin o'zgarishlar yuz bermoqda. Endi davlatlar raqobati **yer osti boyliklari** bilan emas, balki **inson kapitali, ta'lim sifati, innovatsion muhit, ilmiy salohiyat** bilan belgilanmoqda. Shu bois ko'plab davlatlar budjet xarajatlarida ta'limga ajratilgan ulushni muttasil oshirmoqda. Chunki ta'limga yo'naltirilgan sarmoya – qisqa muddatda xarajatdek tuyulsa-da, uzun muddatda davlat rivojlanishining strategik poydevorini yaratadi.

Rivojlangan davlatlar tajribasi shuni ko'rsatadiki, ta'limga sarmoya kiritish:

- iqtisodiy o'sishni tezlashtiradi,
- ijtimoiy tafovutlarni kamaytiradi,
- mehnat bozori samaradorligini oshiradi,
- innovatsion texnologiyalarni tez joriy etishga yordam beradi,
- fuqarolarning farovonlik darajasini oshiradi.

Demak, ta'limga investitsiya kiritish – bu **kelajakni bugundan barpo etish**dir.

1. Ta'limga investitsiyaning nazariy asoslari

Ta'lim investitsiyasi iqtisodiyot fanida "inson kapitaliga investitsiya" tushunchasi bilan bog'liq. Nobel mukofoti sohiblari G. Bekker, R. Solou, T. Shultslar ushbu nazariyaning asoschilaridir. Ularning fikricha, inson kapitaliga kiritilgan sarmoya jamiyatning eng yuqori rentabelligiga ega investitsiya turi hisoblanadi.

Inson kapitali quyidagilarni o'z ichiga oladi:

- bilim va ko'nikmalar,
- kasbiy kompetensiyalar,
- kreativ fikrlash,

- sog‘liq va mehnat qobiliyati,
- innovatsion salohiyat.

Mazkur kapitalni shakllantirishning bosh manbai esa – **sifatli ta’limdir**.

2. Ta’lim investitsiyasining iqtisodiy samaradorligi

2.1. Mehnat unumdorligining oshishi

Ta’lim olgan kadrlar yuqori texnologiyalarni tez o‘zlashtiradi, murakkab jarayonlarni boshqaradi, muammolarni tez hal qiladi. Bu esa sanoat, xizmatlar, IT, qishloq xo‘jaligi va boshqa sohalarda mehnat unumdorligini keskin oshiradi.

2.2. Innovatsion iqtisodiyotga o‘tish

Yuqori malakali yoshlar:

- startaplar yaratadi,
- yangi texnologiyalarni joriy etadi,
- ilmiy tadqiqotlarni kuchaytiradi.

Bu jarayon iqtisodiyotning innovatsion sektori ulushini oshiradi.

2.3. Yangi ish o‘rinlari yaratilishi

Ta’lim investitsiyasi bilan parallel ravishda:

- yangi maktablar,
- universitetlar,
- ilmiy markazlar,
- texnoparklar barpo etiladi.

Bu esa yuzlab yangi ish o‘rinlari yaratadi.

2.4. Davlat budjetiga qaytuvchi foyda

Xalqaro tadqiqotlar shuni ko‘rsatadiki:

- o‘rta ta’limga investitsiyaning qaytimi – 1:4,
- oliy ta’limga investitsiyaning qaytimi – 1:6 yoki undan yuqori.

Demak, ta’limga sarflangan har bir 1 dollar kelajakda kamida 6 dollar daromad keltiradi.

3. Ta’lim investitsiyalarining ijtimoiy samaralari

3.1. Ijtimoiy barqarorlik

Bilimli jamiyat jinoyatchilikka kam moyil bo‘ladi, mehnat madaniyati va fuqarolik mas’uliyati kuchayadi.

3.2. Sog‘liqni saqlash xarajatlarining kamayishi

Ta’limli inson sog‘lom turmush tarziga rioya qiladi, bu esa tibbiy xarajatlarni kamaytiradi.

3.3. Gender tengligini ta’minlash

Ta’lim olgan ayollar jamiyatda faol bo‘ladi, iqtisodiy o‘sishga hissa qo‘shadi.

3.4. Madaniy va ma’naviy yuksalish

Sifatli ta’lim:

- kitobxonlik,
- madaniyat,
- san’at,
- ma’naviy qadriyatlarning oshishiga xizmat qiladi.

4. Ta’limga investitsiya yo‘nalishlari

4.1. Infratuzilmaga sarmoya

- zamonaviy maktablar qurish,
- universitet kampuslari,

- raqamli laboratoriyalar,
- texnoparklar.

4.2. O‘qituvchilar malakasiga investitsiya

O‘qituvchi – ta’lim tizimining yuragi. Finlandiya, Koreya, Yaponiya tajribasida o‘qituvchiga investitsiya – eng ustuvor vazifa.

4.3. Didaktik resurslarga sarmoya

- elektron darsliklar,
- AR/VR texnologiyalari,
- sun’iy intellekt asosidagi o‘quv platformalari.

4.4. Ta’lim grantlari va stipendiyalar

Yoshlarni rag‘batlantirish ta’lim investitsiyasining muhim qismi hisoblanadi.

4.5. Ilmiy tadqiqotlar va innovatsiyalar

Universitetlar qoshida ilmiy markazlar tashkil etilishi dolzarbdir.

5. Xorij tajribasi: O‘rganishga arziydigan modellari

Finlandiya – dunyoning eng muvaffaqiyatli ta’lim tizimi

- stresssiz baholash,
- o‘quvchi markazli yondashuv,
- o‘qituvchilar oliy sifatli tayyorlanadi.

Janubiy Koreya – investitsiya natijasida “iqtisodiy mo‘jiza”

1950-yillar qashshoqligi ortidan ta’limga kuchli sarmoya natijasida Koreya bugun texnologik davlatga aylandi.

Singapur – “aqliy kapitalga qurilgan davlat” modeli

- qat’iy sifat nazorati,
- STEM ga ustuvor yondashuv,
- uzluksiz ta’lim.

Germaniya – dual ta’lim modeli

Ishlab chiqarish + o‘qish integratsiyasi mehnat bozoriga juda mos.

6. Raqamli davrda ta’limga investitsiyaning yangi yo‘nalishlari

6.1. Sun’iy intellekt asosidagi ta’lim

AI turli talabalar uchun individual ta’lim yo‘nalishini yaratadi.

6.2. Metaverse ta’lim

Virtual laboratoriyalar, 3D ta’lim muhiti – kelajakning asosiy trendi.

6.3. Blokcheyn asosidagi diplomlar

Bu tizim korrupsiya, soxtalik va byurokratiyani bartaraf etadi.

7. Muammolar va mavjud to‘siqlar

- infratuzilmaning notekisligi,
- malakali pedagoglarga ehtiyoj,
- ilm-fanga ajratilgan mablag‘ning kamligi,
- ta’lim va mehnat bozori o‘rtasidagi uzilish.

8. Takliflar

1. **Ta’lim obligatsiyalarini joriy etish.** Aholi va xususiy sektor ta’lim loyihalariga sarmoya kiritishi mumkin.
2. **Universitetlarda “Raqamli laboratoriyalar”ni kengaytirish.** AI, robototexnika, VR, biotexnologiya bo‘yicha markazlar.
3. **Pedagoglar uchun xalqaro sertifikatlash dasturlarini yaratish.**

4. **Xalqaro universitetlar bilan qo‘shma fakultetlar ochish.**
5. **Hududlarda ta’lim imkoniyatlarini tenglashtirish.** Mobil maktablar, onlayn ta’lim hublari.
6. **Fan va ishlab chiqarish integratsiyasini kuchaytirish.** Talabalar amaliyotini real texnoparklarga bog‘lash.
7. **“Bir o‘qituvchi – bir startap” dasturi.** Har bir pedagogning innovatsion g‘oyasini moliyalashtirish.

Xulosa.

Ta’limga yo‘naltirilgan investitsiya – millatning eng katta boyligiga, ya’ni inson kapitaliga kiritilgan sarmoyadir. Bu investitsiya jamiyatning ijtimoiy barqarorligi, iqtisodiy o‘sishi, siyosiy mustahkamligi va ma’naviy kamoloti uchun xizmat qiladi. Rivojlangan davlatlar bunga juda erta e’tibor qaratgani bois bugungi kunda texnologiya, ilm-fan va iqtisodiyotda peshqadamlikni qo‘lga kiritgan.

Shunday ekan, O‘zbekiston uchun ham ta’limga investitsiyani strategik ustuvorlik sifatida belgilash – ertangi kunning eng muhim garovidir.

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10.00.00 – PHILOLOGICAL SCIENCES

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10.00.00 - FILOLOGIYA FANLARI

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10.00.00 – ФИЛОЛОГИЧЕСКИЕ НАУКИ

"ADVANCED JOURNAL OF UNIVERSITY SCIENCE AND CREATIVE INNOVATIONS"

A COMPARATIVE SOCIOLINGUISTIC ANALYSIS OF IMPRECATIONS VIA THEORETICAL FRAMEWORKS IN UZBEK, RUSSIAN, AND ENGLISH SOCIETIES

Raykhona Gulomova
Senior teacher, UzSWLU
E-mail: r.gulomova@uzswlu.uz
https://doi.org/10.5281/zenodo.17907215

Abstract. *This paper examines the sociolinguistic implications of imprecations (curses) as a discursive activity rooted in cultural norms, gender relations, and power dynamics. This study conducts a comprehensive analysis of the theoretical contributions of William Labov, Erving Goffman, Deborah Tannen, Janet Holmes, Michel Foucault, Pierre Bourdieu, and Judith Butler to assess the role of curses as manifestations of identity, resistance, and social control in Uzbek, Russian, and English-speaking contexts. Employing a comparative sociolinguistic approach, it illustrates the functioning of curses across social strata, genders, and communicative circumstances. The results highlight the performative, symbolic, and stratifying roles of imprecations, while also showing how they can be used to reject and reinforce social hierarchies.*

Key words: *Imprecations, sociolinguistics, performativity, discourse analysis, gender and language, power relations, Labov, Goffman, Tannen, Holmes, Foucault, Bourdieu, Butler, Uzbek society, Russian profanity, English curses, linguistic capital, variationist theory, politeness theory, cultural pragmatics.*

Annotatsiya. *Ushbu maqolada qarg'ish so'zlarining jamiyatdagi o'rni, ularning madaniy qadriyatlar, jinsga oid rollari va ijtimoiy kuch tuzilmalaridagi ifodasi sotsiolingvistik yondashuv asosida tahlil qilinadi. Mualliflar William Labov, Erving Goffman, Deborah Tannen, Janet Holmes, Michel Foucault, Pierre Bourdieu va Judith Butlerning nazariy qarashlarini birlashtirgan holda, qarg'ishlar qanday qilib individuallikni ifodalash, ijtimoiy nazorat qilish va norozilik bildirish vositasi sifatida ishlatilishini o'rganadi. O'zbek, rus va ingliz tilli jamiyatlar misolida taqqoslangan tahlil asosida qarg'ishlarning turli ijtimoiy qatlamlar, jins vakillari va suhbat vaziyatlaridagi o'rni ochib beriladi. Tadqiqot natijalari qarg'ishlarning ijtimoiy identitetni ko'rsatish, norozilikni ifodalash va mavjud ierarxik tuzilmalarni mustahkamlash yoki ularga qarshi chiqishdagi rolini yoritadi.*

Kalit so'zlar: *Qarg'ishlar, sotsiolingvistika, performativlik, diskurs tahlili, gender va til, ijtimoiy kuch munosabatlari, Labov, Goffman, Tannen, Holmes, Foucault, Bourdieu, Butler, o'zbek jamiyati, rus so'kinishlari, inglizcha so'kinishlar, lingvistik kapital, variatsion nazariya, xushmuomalalik nazariyasi, madaniy pragmatika.*

Introduction.

Language and society are mutually constitutive constructions, with quotidian expressions—particularly imprecations—exposing entrenched cultural ideas and power disparities. Imprecations, frequently regarded as vulgar or emotionally impulsive expressions, are, in reality, socially charged speech acts that reflect, negotiate, and challenge cultural norms. They serve as venues for gender expression, class signalling, methods of civility, and rhetorical resistance. Although they carry social stigma, curses provide a rich area for sociolinguistic analysis, especially when explored through various theoretical frameworks that consider both structure and agency.

This study seeks to elucidate the function of imprecations among three linguistically and culturally diverse societies—Uzbek, Russian, and English—utilizing a comparative theoretical framework. It integrates and critically assesses the contributions of prominent linguistic and sociopolitical theorists, such as Labov, Goffman, Tannen, Holmes, Foucault, Bourdieu, and Butler, viewing them not as discrete viewpoints but as converging frameworks for comprehending the operation of imprecations at the intersection of language, power, and identity.

Literature Review.

Labov's (1972) variationist sociolinguistics provides an empirical basis by linking linguistic choices to social stratification, but Goffman's (1967) face theory redirects attention to the interactional level, where imprecations can serve as both face-threatening and face-saving actions. Labov's research on New York department store clerks and African American Vernacular English (AAVE) illustrated the social stratification of language forms and their correlation with class identification. His paradigm posits that profanity serves as a class indicator, differentiating informal working-class communication from the refined language of elite circles. In Russian society, the frequent usage of mat by working-class men serves as both an identifying symbol and a means of social bonding. This corresponds with Labov’s assertion that nonstandard speech forms can function as means of in-group solidarity while being marginalized in prevailing discourses.

Goffman's interactional model enhances Labov's work by providing a micro-level perspective on social interaction. Curses, according to Goffman, can be face-threatening acts (FTAs), especially in formal situations or when people of different social statuses are interacting. But they can also help people keep their face in peer groups or as funny ways to ease the situation. In English-speaking cultures, expressions like "bloody hell" or "oh fuck" can be used to let out emotions or to signal that something is wrong, depending on how they sound and what they mean. Goffman's theory is especially beneficial for analyzing how speakers navigate social roles and identity through the deliberate employment or evasion of imprecations.

Tannen's (1990) research on gendered discourse redirects the conversation towards the influence of gender socialization on conversational style. Women, socialized to speak in ways that develop relationships, may avoid swearing to stay nice and avoid being judged negatively. Tannen's ideas are especially important in Uzbek culture, where women are typically punished for showing anger openly. Male conversation, on the other hand, allows for more direct and hostile vocabulary, including swearing. Tannen also shows, nevertheless, that not using imprecations can be a strategic choice instead of a lack of expressive breadth. For example,

ladies who understand English might use softer curses like "crap" or "heck" to keep the group together without breaking politeness rules.

Janet Holmes (1995) elaborates on this by examining politeness techniques and the impact of gendered norms on language usage. She discovers that women's curses are frequently encoded as indirect, sardonic, or amusing to circumvent explicit confrontation. In Uzbek, older ladies often use phrases like voy dodim or dod vey instead of stronger curses. Holmes' approach shows how women keep the peace in society by choosing their words carefully, and how even their curses are subject to societal norms. Her work is crucial in demonstrating that even when women curse, they frequently do so in manners that alleviate potential social infractions.

Foucault (1978), departing from interactional and variationist traditions, reconceptualizes language as a manifestation of power-knowledge. Imprecations are not merely emotional outbursts; they constitute components of broader discursive frameworks. Foucault asserts that profanity subverts normative structures and highlights the artificiality of polite discourse. In Soviet and post-Soviet Russia, the repression and covert dissemination of mat illustrate the mechanisms of authority through the regulation of speech. Foucault's idea of speech as an arena of struggle is shown by the usage of curse words in political protests or countercultural art, where they shake up dominant narratives.

Bourdieu (1991) expands upon Foucault’s theory by presenting the concept of linguistic capital. In Bourdieu's view, curses frequently have little symbolic capital in formal areas like education, government, or religion. In informal settings like gang culture, internet communities, and rap music, though, they can have a lot of symbolic meaning. His concept of habitus elucidates why speakers from diverse origins employ imprecations variably and interpret their usage through ingrained social dispositions. In Uzbekistan, the utilization of religious imprecations by rural men exemplifies a habitus influenced by patriarchal norms and conventional power frameworks.

Judith Butler (1997), extending the theory of performativity, argues that language does not merely reflect identity—it creates it. Imprecations, as performative utterances, can either reinforce or challenge gender and social roles. Butler’s theory helps explain why reappropriated slurs like “bitch” or “slut” in English feminist discourse function as acts of resistance. In Uzbek society, where gender roles are more rigid, the performative power of imprecations is more constrained, though not absent. Social media platforms provide a rare space where Uzbek women occasionally use imprecations to critique patriarchal norms, thus enacting Butlerian resistance through speech.

When you look at all of these frameworks together, you can see the many sides of the sociolinguistic reality of imprecations. Labov and Bourdieu offer insights into structural hierarchies; Goffman, Tannen, and Holmes shed light on interpersonal dynamics; and Foucault, Butler, and Bourdieu foreground the ideological and performative dimensions of cursing. These perspectives are not mutually exclusive but complementary, each revealing a different facet of how imprecations function within and against systems of social control.

Methodology.

This research utilizes a comparative qualitative and quantitative sociolinguistic methodology. It combines ethnographic fieldwork, corpus analysis, and semi-structured interviews with native speakers from Uzbekistan, Russia, and English-speaking nations (the United Kingdom, the United States, and Canada). From 2024 to 2025, the data were gathered over a period of six months. There were 60 native speakers from each society, 20 men, 20

women, and 20 non-binary/younger informal speakers, aged 18 to 60, who were chosen from both rural and urban regions. They were asked to talk about and rate how suitable, common, and emotionally charged common insults are in their own language. We also looked at natural speech recordings and digital information (such comments on social media, YouTube, and TV shows) to see how curses work in diverse situations.

The curses were put into groups by:

- The speaker's gender - Their social status/class
- Emotional intent (anger, solidarity, humour, etc.)
- How prohibited it is (mild, moderate, or extreme)

A statistical chart was employed to compare the prevalence and perceived acceptability of curses among the three societies.

Results.

The analysis yielded several trends, visualized in the charts below:

Table 1: Frequency of Imprecation Use (Mean Instances per 1,000 Words)

Language/Society	Male Speakers	Female Speakers	Youth (18–30)
Uzbek	7.5	2.3	5.1
Russian	12.8	6.2	14.5
English	9.7	6.8	11.1

Figure 1: Appropriateness Ratings of Imprecations in Formal Settings (Scale: 1–5)

(Uzbek: Mean = 1.2; Russian = 2.1; English = 2.8)

Table 2: Most Commonly Reported Emotional Functions of Imprecations (% of total usage)

Emotion	Uzbek (%)	Russian (%)	English (%)
Anger	62	55	45
Humor	12	21	30
Group Bonding	8	14	15
Shock Value	10	5	6
Protest	2	3	4

Qualitative findings revealed that in Uzbekistan, religiously based imprecations (“Alloh ursin”, “la’nat bo‘lsin”) were employed cautiously, predominantly by elderly males or rural speakers. Women usually didn't use this kind of language because of strict social rules against it. Russian speakers used profanity the most and the most strongly, especially in informal networks where men were in charge. In English-speaking countries, gender disparities were less prominent, and imprecations were employed more flexibly for humor, irony, and empowerment.

Discussion.

By synthesizing various theoretical perspectives, the study demonstrates that imprecations are complex speech acts whose significance and effects are contingent upon context. Labov and Bourdieu focus on structural restrictions like class, habitus, and symbolic capital. On the other hand, Goffman, Tannen, and Holmes look at the micro-level pragmatics of swearing in relationships. On the other hand, Foucault and Butler focus on the political and performative power of imprecations.

In Uzbek society, the high level of linguistic conservatism makes it hard for imprecations to be subversive. However, digital spaces are starting to change this. Russian society, influenced by historical oppression and expressive defiance, illustrates both the structural and subversive

aspects of imprecations. In English-speaking settings, imprecations serve as both means of authority and instruments of resistance.

The comparison also shows how imprecations are cultural artifacts that show what a society allows, forbids, or reclaims through language. In patriarchal cultures like Uzbekistan, curses strengthen gender roles; in Russia, they define group boundaries; and in English communities, they can upset hierarchies, especially when they are used in a new way.

Conclusion.

Imprecations are not arbitrary verbal expressions; rather, they are socially structured and ideologically infused language actions. By synthesizing the works of Labov, Goffman, Tannen, Holmes, Foucault, Bourdieu, and Butler, this study demonstrates that cursing serves as both a mirror and a mechanism of social structure. Labov and Bourdieu elucidate the demographics and motivations behind cursing, whereas Goffman, Tannen, and Holmes elucidate the mechanics of curses within social interactions. Foucault and Butler, on the other hand, remind us that curses are never neutral; they can either support or fight against dominant discourses. In all three communities examined, imprecations continue to serve as significant indicators of identity, gender, and resistance. Their research provides significant insights into the ways language both restricts and enables human expression.

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INGLIZ VA O‘ZBEK TILLARIDA MOLIYAVIY-IQTISODIY ATAMALAR VERBALIZATORLARINING LINGVISTIK TAHLILI

Nasibboyeva Mukarrama Salimjon qizi
Toshkent davlat iqtisodiyot universiteti
Mutaxassislik, ijtimoiy - gumanitar va aniq fanlar
kafedrasi katta o‘qituvchisi
e-mail: mukarrama79@gmail.com
https://doi.org/10.5281/zenodo.17921546

Annotatsiya. *Ushbu maqolada ingliz va o‘zbek tillarida moliyaviy-iqtisodiy atamalarni ifodalovchi verbalizatorlarning tarkibi, miqyosi va lingvistik xususiyatlari tahlil qilinadi. Atamalar til tizimidagi terminologik birliklar sifatida qaralib, ularning konseptual va nominativ funksiyalari, semantik tarkibi va strukturaviy modeli qiyosiy jihatdan o‘rganiladi. Tadqiqot natijalari iqtisodiy tafakkur, til va madaniyat o‘zaro aloqasini yoritishga xizmat qiladi.*

Kalit so‘zlar: *verbalizator, moliyaviy-iqtisodiy atama, konseptual maydon, nominativ birlik, leksik-semantik tahlil, til va tafakkur, struktur model.*

Kirish.

Zamonaviy tilshunoslikda iqtisodiy mazmunga ega terminlar, ayniqsa moliyaviy-iqtisodiy atamalar, kommunikativ vosita sifatida alohida ahamiyat kasb etmoqda. Iqtisodiy soha tilining rivojlanishi iqtisodiy tafakkur, jamiyatdagi sotsial-iqtisodiy jarayonlar va global integratsiya jarayonlarining tilga aks etishi bilan bevosita bog‘liqdir. Moliyaviy-iqtisodiy atamalar faqatgina leksik birlik emas, balki konseptual struktura va ijtimoiy ongda shakllangan iqtisodiy bilimlarning lingvistik ifodasidir.

Ingliz tili global iqtisodiy diskursda ustun mavqega ega bo‘lganligi sababli, undagi moliyaviy atamalar xalqaro standart sifatida faol ishlatilmoqda. Bu esa ularni boshqa tillarga, xususan o‘zbek tiliga to‘g‘ri, aniq va madaniy mos tarzda o‘girish zaruratini tug‘diradi. Ayniqsa, atamalarning verbalizatsiyasi, ya’ni til orqali konseptual mazmunning ifodalanishi, ularning semantik to‘liqligi va kommunikativ aniqligini belgilaydi.

Verbalizatorlar odatda, atama va tushunchalarni nomlovchi til birliklari bo‘lib, ular orqali iqtisodiy kontseptlar ifodalanadi va kommunikatsiya amalga oshiriladi. Har bir til ushbu verbalizatorlarni o‘zining morfologik, sintaktik va semantik tizimi asosida shakllantiradi. Ingliz tilidagi verbalizatorlar ko‘pincha qisqa, morfologik jihatdan oddiy va qat’iy semantik chegaralangan bo‘lsa, o‘zbek tilidagilari murakkab, ko‘p hollarda birikmaviy shaklga ega va madaniy-axloqiy yuklama bilan boyitilgan.

Ushbu maqolada ingliz va o‘zbek tillarida moliyaviy-iqtisodiy atamalarni ifodalovchi verbalizatorlar qiyosiy tahlil qilinadi. Ularning tarkibi, semantik tuzilmasi, ishlatilish konteksti va konseptual asoslari o‘rganiladi. Maqolaning maqsadi – ikki tilda verbalizatorlar orqali iqtisodiy tafakkurning lingvistik ifodasini aniqlash, ularning o‘zaro o‘xshash va farqli jihatlarini ko‘rsatishdir.

Mazkur tadqiqot O‘zbekiston Respublikasining til siyosatiga muvofiq holda o‘zbek tilining ilmiy-uslubiy boyligiga hissa qo‘shish, milliy iqtisodiy terminologiyaning shakllanishi va rivojlanishiga ilmiy asos yaratish bilan bir qatorda, tarjimashunoslik, lingvokulturologiya va kognitiv tilshunoslik sohalariga ham amaliy ahamiyat kasb etadi.

Metodlar. Ushbu tadqiqot ingliz va o‘zbek tillaridagi moliyaviy-iqtisodiy atamalarning verbalizatorlarini lingvistik, kognitiv va madaniy kontekstlarda chuqur tahlil qilishga yo‘naltirilgan bo‘lib, unda bir nechta zamonaviy tilshunoslik metodlari kompleks qo‘llanildi. Tanlangan metodlar orqali verbalizatorlarning semantik, struktural va funksional xususiyatlari aniqlab berildi.

Lingvokognitiv tahlil usuli – mazkur yondashuv verbalizatorlar orqali ifodalangan tushunchalarning inson tafakkuridagi aksini aniqlashga xizmat qildi. Bu metod yordamida iqtisodiy terminlarning konseptual asoslari, ya’ni tushunchaviy maydonlari (conceptual domains) va ularning til vositasida qanday shakllanishi tahlil qilindi. Masalan, “**qarz”, “kapital”, “aktiv**” kabi atamalar orqali moliyaviy dunyoqarash qanday tashkil topgani o‘rganildi.

Ingliz va o‘zbek tillarida qiyosiy-lingvistik tahlillar odtada, bir xil iqtisodiy kontseptlarni ifodalovchi verbalizatorlar o‘zaro taqqoslandi. Ularning strukturaviy tuzilmalari, morfologik xususiyatlari, semantik yuki va qo‘llanilish tezligi solishtirildi. Bu metod orqali ikki tildagi iqtisodiy tafakkur va til imkoniyatlaridagi tafovutlar ochib berildi.

Leksik-semantik tahlil esa verbalizatorlarning ichki leksik tuzilmasi, ularning sinonimlik, antonimlik, polisemiyaviy yoki monosemantik xususiyatlari tahlil qiladi. Atamalarning aniq yoki umumiy semantik chegaralari, konnotativ va denotativ qatlamlari aniqlashtirildi. Bu tahlil iqtisodiy terminlarning ilmiylik darajasini baholash imkonini berdi.

Diskursiv tahlilga kelsak, moliyaviy matnlarda verbalizatorlarning kontekstda qanday qo‘llanilishini o‘rganishga qaratilgan bo‘lib, ingliz va o‘zbek tilidagi iqtisodiy maqolalar, bank hisobotlari, qonunchilik hujjatlari va ilmiy asarlardan olingan materiallar asosida verbalizatorlarning funksional yuklamasi va ularning kommunikativ qiymati tahlil qilindi.

Corpus-analiz elementlarining tanlangan matnlardagi atamalarni aniqlanishida elektron lug‘atlar, soha terminologiyasi va iqtisodiy korpuslardan foydalanildi. Bu yondashuv orqali verbalizatorlarning real ishlatilish chastotasi va ularning barqarorlik darajasi aniqlashga erishiladi.

Madaniy-semantik yondashuvning iqtisodiy verbalizatorlari madaniy konnotatsiyalari va tarixiy shakllanishiga alohida e’tibor qaratiladi. Ayniqsa, o‘zbek tilidagi “*halol rizq”, “baraka”, “tejamkorlik*” kabi iqtisodiy mazmunga ega iboralar xalqning iqtisodiy tafakkuri bilan bog‘liqlikda o‘rganiladi.

Tadqiqot materiali sifatida ingliz tilida nufuzli iqtisodiy nashrlar (“The Economist”, “Financial Times”, “Forbes”) hamda o‘zbek tilidagi iqtisodiy va rasmiy-huquqiy matnlar, bank va soliq qo‘mitalarining hisobotlari, ilmiy maqolalar, lug‘atlar va iqtisodiy atamalar ro‘yxati asos qilib olindi. Ushbu materiallar asosida tanlangan verbalizatorlar lingvistik jihatdan tizimlashtirildi va qiyosiy tahlil qilindi.

Umuman olganda, tadqiqotda nazariy va amaliy lingvistik metodlarning uyg‘unligi saqlanib, verbalizatorlar maydonining o‘ziga xos xususiyatlarini har ikki tilda mukammal tahlil qilishga erishildi.

Natijalar: Tadqiqot davomida ingliz va o‘zbek tillaridagi moliyaviy-iqtisodiy atamalarni ifodalovchi verbalizatorlar qiyosiy tahlil qilinib, ularning tarkibiy xususiyatlari, semantik yuklamalari va konseptual asoslari aniqlashtirildi. Tadqiqot quyidagi asosiy natijalarni berdi:

Verbalizatorlar konseptual maydonning nomlovchi yadrosi sifatida har ikkala tilda ham iqtisodiy tafakkurning asosiy tushunchalarini ifodalashda xizmat qiladi. Ular orqali nafaqat iqtisodiy obyektlar, balki jarayonlar, holatlar va natijalar ham ifodalanadi (masalan, ingliz tilida *“inflation”*, *“credit risk”*; o‘zbek tilida *“inflyatsiya”*, *“kredit xatari”*). Ingliz tilidagi verbalizatorlar esa aniq, qisqa va texnik xarakterga ega bo’lib, ular, odatda, bir so‘zdan iborat bo’lib, murakkab iqtisodiy tushunchalarni ixcham shaklda ifodalash imkonini beradi. Masalan: *asset, liability, bond, equity, debt*. Ularning semantik chegarasi qat’iy, ko‘p hollarda bir ma’noli va maxsus kontekstdagi qo‘llanilishiga moslashgan.

O‘zbek tilidagi verbalizatorlar esa ko‘pincha ko‘p so‘zli iboralar ko‘rinishida shakllangan bo‘lib, semantik jihatdan umumiyroq, lekin konnotativ yuklamaga boydir. Masalan: *moliyaviy barqarorlik, iqtisodiy o‘sish, sarmoyaviy xavf, qarz majburiyati* kabi misollarini kelirish mumkin.

Verbalizatorlarning semantik tuzilmasi ikki tilda ham muhim farqlarga ega: ingliz tilida ular texnik va normativ semantikani ko‘proq aks ettirsa, o‘zbek tilida aksariyat hollarda umumiy, ko‘chma yoki ijtimoiy-ma’naviy qatlamlar bilan boyitilgan. Bu tafovutlar tarjimada ma’no yo‘qotilishiga yoki noto‘g‘ri interpretatsiyaga olib kelishi mumkin.

Terminlarning shakllanish usullari ham farqlidir: ingliz tilida asosiy verbalizatorlar lotin yoki yunon ildizlaridan olingan so‘zlardan tashkil topgan bo‘lsa, o‘zbek tilida ularning ekvivalentlari ko‘pincha kalkalash, transliteratsiya yoki milliy leksik vositalar bilan ifodalanadi.

Verbalizatorlarning strukturaviy qurilishi ham farq qiladi: ingliz tilida “compound nouns” (masalan, *cash flow, market share*) ko‘p qo‘llanilsa, o‘zbek tilida birikmali birliklar (masalan, *naqd pul oqimi, bozor ulushi*) asosiy vosita bo‘lib xizmat qiladi.

Tahlil qilingan iqtisodiy matnlar (ilmiy, publitsistik va rasmiy) shuni ko‘rsatdiki, ingliz tilida atamalar ko‘proq formallashtirilgan, o‘zbek tilida esa ba’zida sinonimik parallel shakllar mavjud bo‘lib, bu normativlik darajasining pastligidan dalolat beradi. Masalan, *profit* atamasi o‘zbek tilida *foyda, daromad, sof foyda* tarzida turli kontekstlarda qo‘llaniladi.

Kognitiv jihatdan, ingliz tilidagi verbalizatorlar aniq iqtisodiy modelga bog‘langan, ularning ishlatilishi keng ma’lumotlar bazasi va global tajribaga tayanadi. O‘zbek tilida esa bu atamalar ko‘proq tarjima asosida shakllangan bo‘lib, milliy kognitiv xaritaga to‘liq singib ketmagan holatlar mavjud.

Madaniy jihatdan, o‘zbek tilidagi verbalizatorlarning ayrimlari xalqona mazmun bilan boyitilgan. Masalan, “**baraka”, “halol rizq”, “tejamkorlik**” kabi birliklar ham iqtisodiy diskursga xos semantik elementlar sifatida baholanishi mumkin.

Umuman olganda, har ikkala tilda ham verbalizatorlar iqtisodiy tafakkurning asosiy vositasi bo‘lib, ularning o‘zaro taqqoslanishi lingvistik tafovutlarni emas, balki madaniy va konseptual tafakkurdagi farqlarni ham ko‘rsatdi. Bu esa terminlar tarjimasini faqat leksik darajada emas, balki chuqur madaniy-lingvistik tahlil asosida amalga oshirish zarurligini ko‘rsatadi.

Munozara. Olingan tadqiqot natijalari ingliz va o‘zbek tillarida moliyaviy-iqtisodiy atamalarning verbalizatsiyasi mazkur ikki tilning lingvistik tuzilmasi, tarixiy rivojlanish bosqichlari va madaniy asoslaridagi farqlarni yaqqol namoyon qilganini ko‘rsatadi. Verbalizatorlar konseptual maydonning nomlovchi markazi bo‘lib, ularning tarkibi va qo‘llanilishi har bir tilning iqtisodiy tafakkur modeli bilan bevosita bog‘liqdir.

E. Wüsterning klassik terminologik nazariyasiga ko‘ra, har bir termin qat’iy belgilangan semantik chegaraga, normativ shaklga va aniq kontekstga ega bo‘lishi kerak. Ingliz tilidagi moliyaviy verbalizatorlar bu talabga yuqori darajada javob beradi. Masalan, “**asset”, “equity”, “liability**” atamalari muayyan iqtisodiy tushunchani aniq va ixtisoslashtirilgan tarzda ifodalaydi. Bu holat ingliz tilida terminlarning konseptual izchilligi va barqarorligi yuqori ekanini ko‘rsatadi. Aksincha, o‘zbek tilida verbalizatorlar shakllanishi va qo‘llanilishi jarayonida bir necha turli omillar: milliy tafakkur, xalqona ifodalar, tarjima mexanizmlari, normativlik darajasi – ta’sirida yuzaga keladi. Shuning uchun ham “**kapital”, “foyda”, “sarmoya”** kabi verbalizatorlar ayrim hollarda konnotativ va umumiy semantikaga ega bo‘lib, ularning qat’iy iqtisodiy ta’rifi yo‘qligi kuzatiladi. Bu holat S.V. Grinev tomonidan ilgari surilgan dinamik terminologik tizim nazariyasiga mos keladi, ya’ni terminlar doimiy o‘zgaruvchan va kontekstualdir.

Cabre va Sagerlarning kommunikativ yondashuvi verbalizatorlarni faqat tushunchaviy birlik emas, balki kommunikatsion vosita sifatida ko‘radi. Bu yondashuvga ko‘ra, verbalizatorlar turli nutq uslublarida, matn janrlarida va sotsial kontekstlarda turlicha semantik yuklama bilan ishlatiladi. Tadqiqot natijalari shuni ko‘rsatdiki, ingliz tilida verbalizatorlar rasmiy va texnik matnlarda qat’iy ma’noga ega bo‘lsa, o‘zbek tilida ular ko‘proq uslubiy moslashuvga duchor bo‘ladi. Masalan, “**debt**” atamasi o‘zbek tilida kontekstga qarab “*qarz”, “kredit majburiyati”, “moliyaviy yuklama*” tarzida turli uslubiy ko‘rinishlarda ishlatiladi.

Lingvomadaniy aspektdan qaralganda, o‘zbek tilidagi iqtisodiy verbalizatorlarning ayrimlari xalq tafakkuridan olingan iboralar va qadriyatlar asosida shakllangan. Masalan, “**halol mehnat”, “baraka”, “tejamkorlik**” kabi tushunchalar ham iqtisodiy diskursda faol ishlatiladi, garchi ular klassik terminlar sifatida qaralmasa ham. Bu esa V.N. Teliyaning lingvomadaniy semantika haqidagi nazariy qarashlarini eslatadi , ya’ni til orqali madaniyatning aks etishi.

Tarjima amaliyoti nuqtayi nazaridan, ko‘plab moliyaviy atamalar o‘zbek tiliga bevosita tarjima qilingan bo‘lib, ular semantik jihatdan ba’zan mos, ba’zan esa noto‘g‘ri yoki umumlashtirilgan shaklda ifodalanadi. Masalan, “capital gains” atamasi ko‘pincha “kapital foyda” deb tarjima qilinadi, lekin uning iqtisodiy-ma’muriy ma’nosi ancha torroq va maxsus kontekstga ega. Bu esa tarjimada nafaqat semantik moslik, balki konseptual muvofiqlikni ham ta’minlash zarurligini ko‘rsatadi. Shuningdek, verbalizatorlar orqali iqtisodiy kontseptlarni ifodalash jarayoni har bir tilda mavjud kognitiv xarita asosida amalga oshadi. Ingliz tilida bu xarita xalqaro iqtisodiy modelga asoslangan bo‘lsa, o‘zbek tilida u milliy iqtisodiy amaliyot, madaniy qadriyatlar va soddalashtirilgan ifoda vositalariga tayanadi. Bu farq ularning verbalizatsiya modeliga bevosita ta’sir ko‘rsatadi.

Umuman olganda, ingliz va o‘zbek tillarida verbalizatorlar orqali moliyaviy-iqtisodiy kontseptlarning ifodalanishi ko‘p jihatdan til tizimi, tafakkur modeli va madaniyat bilan bog‘liq murakkab jarayondir. Ushbu farqlarni aniqlash va chuqur tahlil qilish terminlarni to‘g‘ri tarjima qilish, o‘zbek iqtisodiy tilini boyitish hamda ilmiy uslubiy asos yaratish uchun muhim ahamiyatga ega.

Xulosa. Mazkur tadqiqot doirasida ingliz va o‘zbek tillaridagi moliyaviy-iqtisodiy atamalarni ifodalovchi verbalizatorlarning lingvistik xususiyatlari chuqur va qiyosiy tahlil qilindi. Tadqiqot natijalari til, tafakkur va madaniyat uchligini birlashtirgan murakkab lingvistik tizimni ochib berdi. Verbalizatorlar har ikki tilda iqtisodiy kontseptlarni nomlashda markaziy rol o‘ynab, o‘zining leksik-semantik, strukturaviy va uslubiy xususiyatlari bilan farqlanadi.

Tahlillar shuni ko‘rsatdiki: ingliz tilidagi verbalizatorlar global iqtisodiy tizimda barqaror shakllangan, qat’iy semantik chegaraga ega, texnik xarakterli terminlardir. Ular xalqaro normativlik talablariga javob beradi va ilmiy-rasmiy diskurslarda yuqori darajadagi aniqlikni ta’minlaydi.

O‘zbek tilidagi verbalizatorlar esa milliy tafakkur, xalqona ifodalar va tarjima jarayonlari orqali shakllangan bo‘lib, semantik jihatdan ko‘proq konnotativlikka ega. Ularning normativlik darajasi hali shakllanish bosqichida bo‘lib, ko‘p hollarda sinonimik yoki umumiy ifodalar bilan almashtiriladi.

Verbalizatorlar orqali iqtisodiy tafakkur ifodalanadi, ya’ni har bir til o‘z iqtisodiy kontseptlarini nomlashda til tizimi, madaniy qadriyatlar va jamiyatdagi iqtisodiy tajriba asosida yondashadi. Bu esa verbalizatorlarni nafaqat lingvistik birlik, balki madaniy-kognitiv fenomen sifatida qarashni taqozo etadi.

Tarjima jarayonida verbalizatorlar ko‘pincha yuzaki ko‘chiriladi, bu esa semantik yo‘qotishlarga sabab bo‘ladi. Shuning uchun har bir verbalizatorning konseptual maydoni va madaniy konnotatsiyalari chuqur o‘rganilishi zarur.

O‘zbek tilining iqtisodiy terminologiyasini boyitishda lingvokognitiv yondashuvdan foydalanish, xalq tilidagi mavjud birliklarni termin darajasiga ko‘tarish, shuningdek, xalqaro terminlarning mos ekvivalentlarini yaratish zarurati mavjud.

Xulosa qilib aytganda, verbalizatorlar iqtisodiy bilimni ifodalovchi va uzatuvchi asosiy til vositalari bo‘lib, ularning tildagi shakllanishi, qo‘llanishi va tarjimasi iqtisodiy tafakkur, madaniyat va til tizimi bilan uzviy bog‘liqdir. Bu yo‘nalishda olib borilgan lingvistik tadqiqotlar tilshunoslik, tarjimashunoslik, kognitiv fanlar va iqtisodiy kommunikatsiya sohalarida amaliy ahamiyatga ega bo‘lib, ilmiy va kasbiy maqsadlarda keng foydalanish imkonini beradi.

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"ADVANCED JOURNAL OF UNIVERSITY SCIENCE AND CREATIVE INNOVATIONS"

ADVANTAGES AND DISADVANTAGES OF BILINGUALISM

Karomatova Kamola
NUU, Foreign language and literature
e-mail: Karamatovakamola4@gmail.com
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Abstract. *This article explores the phenomenon of bilingualism — the ability to use two langUages fluently. It discusses both the advantages and disadvantages of being bilingual in today's globalized world. The advantages include cognitive flexibility, better communication skills, and broader cultural understanding. Bilingual individuals often demonstrate enhanced memory, multitasking ability, and academic achievement. However, the article also highlights challenges such as language interference, reduced vocabulary in each language, and identity conflicts in multilingual environments. Overall, the study emphasizes that bilingualism, despite its difficulties, enriches personal, social, and intellectual development.*

Key words: *Bilingualism; multilingualism; language acquisition; code-switching; linguistic interference; cultural identity; second language learning; communication skills; cognitive development; bilingual education; language policy; language proficiency; sociolinguistics; linguistic diversity; language dominance; bilingual brain; globalization; language maintenance; heritage language; cross-cultural communication.*

Bilingualism has been a major focus of linguistic, psychological, and educational research for decades. Scholars have explored how using two languages affects cognitive, social, and emotional development. Early studies often viewed bilingualism negatively, suggesting that managing two languages could cause confusion or hinder intellectual growth (Saer, 1923). However, modern research has largely refuted this view, demonstrating that bilingualism enhances rather than limits mental abilities.

According to Ellen Bialystok (2001), bilingual individuals often show superior executive functioning skills, including better attention control, problem-solving, and task-switching abilities. Her findings have been supported by neuropsychological research indicating that managing two linguistic systems strengthens the brain's cognitive control network[3;557]. Peal and Lambert (1962) were among the first to argue that bilingual children outperform monolinguals in both verbal and non-verbal intelligence tests, marking a turning point in attitudes toward bilingual education[9;76].

In the field of education, Cummins (1979) introduced the "Common Underlying Proficiency" theory, which explains how knowledge in one language can support learning in another. This theory has become the foundation for many bilingual education programs around the world[4]. Grosjean (1982), in his work Life with Two Languages, emphasized that bilinguals are not two monolinguals in one person; rather, they use both languages dynamically depending on context, purpose, and interlocutor[2].

Despite these benefits, bilingualism also presents certain challenges. Weinreich (1953) discussed language interference, where structures of one language influence the other, leading to mixed grammar or pronunciation errors. Moreover, maintaining equal proficiency in both languages can be difficult, especially when one language dominates in society or education. This often leads to language attrition, where the less-used language weakens over time (Schmid, 2011).

Cultural and identity issues also emerge in bilingual communities. According to Pavlenko and Blackledge (2004), bilingual individuals may experience identity negotiation, balancing between cultural belonging and linguistic expression. In some cases, bilinguals face social pressure to prioritize a dominant language, risking the loss of their heritage tongue. Fishman (1991) explored these sociolinguistic dimensions, emphasizing the importance of intergenerational language transmission for preserving minority languages.

Recent studies have also linked bilingualism to long-term cognitive health. Bialystok et al. (2007) found that bilingual individuals experience a delayed onset of dementia symptoms compared to monolinguals, suggesting a protective effect of bilingual language use on the brain[3;564]. Similarly, Abutalebi and Green (2016) examined how the bilingual brain adapts structurally and functionally, proving that bilingualism reshapes neural networks over time.

In the modern era of globalization, bilingualism is increasingly viewed as a valuable skill that fosters cultural awareness and economic opportunity. Yet, as Baker (2011) notes, educational systems must strike a balance between promoting bilingual competence and avoiding linguistic inequality[1;5]. The effectiveness of bilingual programs often depends on social attitudes, governmental policies, and the perceived prestige of each language.

Methodology.

and types This study employed a mixed-methods research design combining both qualitative and quantitative approaches to provide a comprehensive understanding of the advantages and disadvantages of bilingualism. The primary objective of this section is to explain the process and rationale behind the selection of participants, data collection methods, instruments, and analytical procedures used throughout the research.

Research Design-A mixed-methods approach was chosen because bilingualism is a multifaceted phenomenon that cannot be fully understood through numerical data alone. Quantitative methods provided statistical insights into the frequency of bilingual advantages and disadvantages experienced by individuals, while qualitative methods captured participants’ personal experiences, perceptions, and attitudes toward bilingualism. This design allowed for triangulation of data, which increased the validity and reliability of the findings.

Participants-The participants in this study consisted of 60 individuals aged between 18 and 40, who were proficient in at least two languages. The sample included students, teachers, and professionals from different educational and linguistic backgrounds. Participants were selected using purposive sampling to ensure that they represented a wide range of bilingual experiences, including early bilinguals (those who learned two languages simultaneously during childhood) and late bilinguals (those who acquired a second language later in life). Consent was obtained from all participants, and confidentiality was maintained throughout the research process.

Data Collection Instruments-Data were collected using three primary instruments: a questionnaire, semi-structured interviews, and observation notes. The questionnaire consisted of 25 items designed to measure participants’ attitudes, cognitive performance, and emotional

responses toward bilingualism. The semi-structured interviews allowed participants to express their personal insights and experiences more freely, providing depth to the statistical findings. Observation notes were taken during interactions and conversations in bilingual settings to identify patterns of language use, code-switching, and communication difficulties.

Data Collection Procedure-The research was conducted in three stages. In the first stage, participants completed the questionnaire distributed both online and in printed form. In the second stage, 15 participants were selected for follow-up interviews conducted in a quiet and comfortable environment to ensure honest and detailed responses. The third stage involved observing bilingual interactions in educational and workplace settings. All interviews were recorded with the participants’ consent and later transcribed verbatim for analysis.

Data Analysis-Quantitative data collected from questionnaires were analyzed using descriptive statistics, including frequency distributions and percentages, to identify general trends regarding bilingual advantages such as cognitive flexibility, better communication skills, and disadvantages like language interference or cultural confusion. The qualitative data obtained from interviews and observations were analyzed through thematic analysis. Themes such as cognitive development, identity formation, and sociocultural challenges emerged during coding. Data from both methods were compared and integrated to draw comprehensive conclusions.

Validity and Reliability-To ensure the reliability of the findings, the questionnaire was pre-tested with a small pilot group of bilingual participants to check clarity and consistency. Triangulation between quantitative and qualitative data further enhanced the study’s credibility. All data were carefully cross-checked and analyzed to minimize researcher bias. Additionally, expert opinions from linguists and educators were sought to validate the interpretation of the results.

Ethical Considerations- The research followed all ethical guidelines related to human participation. Participants were informed about the purpose of the study and were assured that their personal data would remain confidential. They had the right to withdraw from the study at any stage without any negative consequences. All collected data were

Results. The results of the study revealed a complex relationship between bilingualism and its influence on cognitive, social, and emotional development. The findings demonstrate that bilingualism has both substantial advantages and notable disadvantages depending on various factors such as age of acquisition, proficiency level, social environment, and motivation for language learning. The mixed-methods analysis provided both numerical and interpretive insights into how bilingual individuals perceive and experience the effects of managing two languages in their daily lives.

Cognitive Advantages-The quantitative data indicated that 82% of the participants reported improved memory retention, faster information processing, and greater problem-solving abilities as a result of being bilingual. Many participants also demonstrated superior multitasking skills when compared to monolingual peers. Interviews revealed that bilingual individuals tend to switch between languages effortlessly, which strengthens mental flexibility and executive control.

Moreover, participants claimed that knowing two languages helped them think from multiple perspectives, leading to enhanced creativity and adaptability. The thematic analysis confirmed that bilingualism encourages abstract thinking and sharpens attention control, which aligns with previous psychological research on cognitive flexibility among bilingual speakers.

Educational and Professional Benefits-Results showed that 76% of the respondents believed bilingualism contributed positively to their academic success. Bilingual students reported having better understanding of linguistic structures, grammar, and vocabulary in both their first and second languages. Teachers also observed that bilingual learners often display higher reading comprehension and better writing skills.

In the professional domain, bilingualism was perceived as a valuable skill, especially in international workplaces. Approximately 70% of participants stated that their bilingual proficiency increased their employability, communication efficiency, and confidence in cross-cultural interactions. Several participants mentioned that their ability to switch between languages allowed them to build stronger relationships and collaborate more effectively in multicultural teams.

Social and Cultural Benefits-Qualitative findings highlighted that bilingual individuals often experience a broader worldview and greater tolerance toward cultural diversity. Participants expressed that learning and using more than one language helped them appreciate different traditions, customs, and perspectives. About 65% of respondents noted that bilingualism strengthened their cultural identity and sense of belonging to multiple linguistic communities.

In addition, bilinguals reported feeling more confident while traveling abroad or communicating with foreigners, as language barriers became less significant. These social advantages were also reflected in participants’ increased empathy and open-mindedness, as they developed deeper intercultural communication skills.

Disadvantages and Challenges-Despite the numerous benefits, the study also revealed several disadvantages of bilingualism. Nearly 40% of participants reported occasional confusion or interference between languages, especially when translating complex ideas or academic concepts. Some bilinguals admitted to experiencing language mixing or “code-switching” in formal contexts, which they considered socially or professionally inappropriate.

Additionally, participants who learned their second language later in life expressed frustration with pronunciation difficulties and slower comprehension in the non-dominant language. A small percentage (around 15%) mentioned experiencing identity confusion or feelings of being “between cultures.” This often occurred when neither language fully represented their personal or cultural background.

Moreover, a few participants noted that maintaining fluency in both languages required constant practice and exposure. Those who lacked opportunities to use one of their languages regularly reported gradual language attrition and vocabulary loss.

Statistical Summary

Descriptive analysis of the questionnaire responses showed that:

82% experienced enhanced memory and mental flexibility.

76% reported educational improvement due to bilingualism.

70% stated bilingualism positively influenced their career prospects.

65% emphasized social and cultural enrichment.

40% experienced language interference or confusion.

15% reported issues of identity conflict or language dominance.

These percentages indicate that while the advantages of bilingualism outweigh its disadvantages, the challenges are still significant and should not be overlooked. The balance

between the two languages depends largely on motivation, consistent practice, and the individual’s linguistic environment.

Qualitative Insights-Interview narratives further illustrated the emotional dimension of bilingualism. Participants described bilingualism not only as a skill but also as part of their identity. Some expressed pride in being able to communicate across cultures, while others mentioned the emotional burden of switching between linguistic and cultural systems. For instance, one participant stated, “When I speak my first language, I feel connected to my roots, but when I use my second language, I feel more confident and modern.” Such reflections demonstrate the deep psychological and cultural layers of bilingual experience.

Discussion. The findings of this study confirm that bilingualism is a multidimensional phenomenon that exerts significant influence on individuals’ cognitive, linguistic, cultural, and emotional development. The results not only validate previous research but also extend the understanding of how bilingualism operates within real social contexts. In this discussion section, the implications of the findings are examined in relation to existing theories, empirical studies, and practical applications in education and society.

Cognitive and Psychological Implications-The study’s findings strongly support the hypothesis that bilingual individuals possess enhanced cognitive flexibility, superior problem-solving abilities, and improved memory performance. This corresponds with earlier research by Bialystok (2011) and Grosjean (2013), who emphasized that bilingualism strengthens executive functions, particularly attentional control and task-switching skills.

Participants’ experiences indicated that the constant mental effort of managing two linguistic systems stimulates brain activity and contributes to long-term cognitive benefits. For instance, switching between languages requires continuous monitoring and inhibition of irrelevant linguistic input, which in turn trains the brain to be more selective and efficient. This advantage is evident in daily life, academic performance, and even delayed onset of age-related cognitive decline.

However, despite these advantages, some participants mentioned mental fatigue and occasional language interference. This suggests that bilingualism also places certain cognitive demands on individuals, especially in complex linguistic It becomes clear that bilingualism does not simply enhance cognition—it reshapes cognitive processes by making them more adaptive but also more demanding.

Educational and Linguistic Considerations-The educational implications of the findings are particularly noteworthy. Bilingual students demonstrated improved linguistic awareness and metalinguistic understanding, which allowed them to transfer grammatical and syntactic knowledge from one language to another. This aligns with Cummins’ (1979) “Common Underlying Proficiency” theory, which posits that cognitive and linguistic skills developed in one language can support learning in another[4].

Teachers participating in the study observed that bilingual learners are often more flexible in understanding new vocabulary and abstract linguistic concepts. Moreover, bilingualism can act as a gateway to learning additional languages, as it enhances phonological awareness and pattern recognition.

Nevertheless, bilingual education also presents challenges. The results showed that some participants experienced language mixing, slower retrieval of words, and temporary confusion when switching between languages. Such findings echo those of Macnamara (1966), who described “language interference” as a normal but sometimes problematic aspect of

bilingualism[8;23]. Therefore, educational programs should incorporate pedagogical strategies that help bilingual learners manage interference while maintaining fluency in both languages.

Sociocultural Perspectives-Bilingualism cannot be separated from its social and cultural context. This study highlighted that bilingual individuals often navigate between multiple cultural identities, which can be both enriching and challenging. Participants expressed a sense of belonging to more than one cultural group, leading to a hybrid identity that broadens their worldview. They tended to be more tolerant, empathetic, and open-minded toward people of different backgrounds.

Such outcomes are consistent with sociolinguistic theories suggesting that language shapes thought, identity, and social relationships. Bilingualism fosters intercultural communication competence, making individuals more capable of mediating between cultures. However, for some participants**,** the process of balancing two identities caused internal conflict or feelings of “in-betweenness.” This psychological tension often emerged when social expectations or cultural values from one group conflicted with those of another.

Despite these challenges, most participants viewed bilingualism as a source of empowerment rather than confusion. The ability to shift between cultural frameworks provided them with social mobility, confidence, and a broader sense of belonging in a globalized world.

Conclusion. The present study has explored the multifaceted nature of bilingualism, revealing both its powerful advantages and its potential challenges. Through a combination of quantitative and qualitative methods, the research demonstrated that bilingualism significantly contributes to cognitive, educational, social, and professional development while also presenting certain psychological and linguistic complexities.

The findings confirm that bilingual individuals enjoy enhanced cognitive abilities such as improved memory, mental flexibility, and problem-solving skills. These advantages stem from the constant management of two linguistic systems, which strengthens executive control and multitasking capacity. Educationally, bilingual learners show higher linguistic awareness, better comprehension skills, and more advanced understanding of grammatical structures, which often translate into academic success. Professionally, bilingualism serves as a valuable asset that enhances employability, intercultural communication, and adaptability in globalized work environments.

Socially and culturally, bilingualism enriches individuals’ perspectives and fosters empathy, tolerance, and cross-cultural understanding. It enables people to navigate multiple cultural identities, thereby creating bridges between different communities. However, the study also revealed certain drawbacks, including language interference, occasional confusion, and identity-related challenges. These disadvantages, while noteworthy, are generally outweighed by the long-term cognitive and social benefits of bilingualism.

Moreover, the emotional dimension of bilingualism highlights its depth beyond communication. Language carries personal and cultural meanings thatshape identity and emotion. The ability to express oneself in more than one language allows for a richer emotional experience and broader worldview, though it can also lead to inner conflict when individuals feel caught between cultural boundaries.

Overall, the study concludes that bilingualism should not be viewed merely as a linguistic skill but as a lifelong process of adaptation, learning, and identity negotiation. It represents both an intellectual enrichment and a social advantage, providing individuals with the tools to thrive in diverse cultural and professional contexts. Therefore, promoting bilingual education and

encouraging multilingual competence can play a vital role in shaping more tolerant, informed, and globally connected societies.

Future research should continue to investigate how factors such as age, environment, and cultural exposure influence bilingual experiences. Further exploration of the neurological, emotional, and sociocultural dimensions of bilingualism will deepen our understanding of how language shapes human thought, behavior, and identity in an increasingly interconnected world.

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CHALLENGES FACED BY LEARNERS IN ACQUIRING ACADEMIC LISTENING AND SPEAKING

Mavlanova O.Sh.
Teacher at AJOU University in Tashkent
https://doi.org/10.5281/zenodo.17907290

Abstract. *This study examines the major challenges faced by English-as-a-foreign-language (EFL) learners in academic listening and speaking contexts. Using a descriptive qualitative design, data were collected through questionnaires, semi-structured interviews, and classroom observations involving first-year university students enrolled in EAP Listening and Speaking courses. The results reveal that learners encounter substantial linguistic challenges, including limited academic vocabulary, pronunciation difficulties, and problems understanding different English accents. Cognitive challenges such as processing fast speech, identifying main ideas, and performing simultaneous tasks (listening and note-taking) further hinder comprehension. Additionally, strong affective factors, including anxiety, fear of making mistakes, and low confidence, significantly reduce students' willingness to participate in academic speaking tasks. Limited exposure to authentic English outside the classroom and insufficient interactive practice also contribute to learners' struggles. The study highlights the need for integrated instructional approaches that address linguistic, cognitive, and affective barriers to support learner success in academic communication.*

Key words: *academic listening, academic speaking, EFL learners, cognitive load, communication anxiety, vocabulary difficulties.*

Introduction.

Academic listening and speaking are essential skills for university students, particularly in English-medium learning environments. Unlike everyday communication, academic discourse requires learners to understand complex ideas, follow extended lectures, interpret unfamiliar vocabulary, and participate in discussions using formal and precise language. For many students, these demands create significant challenges that affect their overall academic performance. Difficulties often arise from limited background knowledge, insufficient vocabulary, rapid speech rates, varied accents, and the cognitive load of processing information while taking notes. Similarly, speaking in academic contexts requires students to express ideas clearly, use discipline-specific language, collaborate in group discussions, and deliver presentations confidently -tasks that many find intimidating. Understanding these challenges is crucial for designing effective instructional strategies that support learners in developing strong academic communication skills.

Literature review

Challenges in Academic Listening

In their review article Learners’ Listening Comprehension Difficulties in English Language Learning, Abbas Gilakjani and Narjes Sabouri highlight that many learners struggle with listening comprehension because language courses often focus more on reading, writing, and vocabulary - leaving listening underemphasized.

According to Listening Comprehension Challenges: Analyzing EFL Students in the English Teacher Education Program at Universitas Mulawarman by Alya Saputri et al., even students in teacher-training (future English teachers) report serious difficulties in listening. Factors underlying listening difficulties often include fast speech rate, limited vocabulary, lack of background or cultural knowledge, accent variation, and inadequate practice.

A recent local article, *Listening Comprehension Difficulties Faced By Adult Language Learners,* lists common problems such as memory limitations, rapid speech, limited vocabulary, pronunciation issues, and lack of cultural familiarity. Thus, research widely acknowledges that listening - especially in academic contexts - is not trivial: it requires a set of underlying skills (vocabulary, background knowledge, familiarity with variety/accent, processing speed) and sufficient exposure.

Challenges in Speaking (Academic / EFL Contexts)

In the review Learners’ Challenges and English Educators’ Approaches in Teaching Speaking Skills in an ESL Classroom by Agatheswari Paneerselvam and Maslawati Mohamad, many EFL learners struggle to develop speaking skills. The problems reported include limited grammar or vocabulary, poor pronunciation, lack of fluency, lack of motivation, and psychological barriers (like anxiety or lack of confidence). A study on the difficulties in English Speaking for EFL Students by Eva Meidi Kulsum et al. found that for junior high school EFL students, speaking difficulties included: limited vocabulary, pronunciation problems, limited grammar knowledge, lack of self-confidence, anxiety, and lack of motivation. In the research A critical examination of EFL learners’ difficulties in speaking: towards an effective and applicable pedagogy, Simin Zeng (2020) describes both linguistic and non-linguistic (psychological, motivational, social) obstacles that hinder learners’ ability to speak effectively in English.

Consequently, speaking particularly in a second language and academic context is hindered not only by limited linguistic competence, but also by affective (psychological) factors, motivation, and exposure.

According to a recent empirical study Investigating students’ academic language-related challenges on EMI success in Transnational Education (TNE) programs in China (2025), students in English-medium instruction (EMI) programs reported speaking and listening as the most challenging skills among all academic English skills. The same study showed that such language-related challenges negatively impact students’ self-efficacy, which in turn affects their academic success highlighting the pedagogical importance of addressing listening and speaking difficulties.

Another important factor is accent/variety of English. In the study *Listening To Different English Varieties And Accents* learners’ listening comprehension was significantly affected by exposure to different English accents: unfamiliar accents made listening much harder, but increased exposure to “World Englishes” helped improve comprehension.

These combined findings suggest that in academic settings especially EMI or EAP, listening and speaking pose more serious challenges than other skills, because of their complexity, the variety of demands (cognitive, linguistic, psychological), and the high expectations for accuracy, comprehension, and performance. Many studies emphasize listening,

but often teaching practices especially in non-native contexts underemphasize it; listening is treated as secondary to reading or writing. Speaking difficulties receive less systematic research, and often are studied in less formal settings (for example: secondary-school EFL) which may not fully represent the demands of academic-speaking in higher education. There is a need for more research specifically on academic listening and speaking (not just general EFL) especially in mixed-skill EMI or EAP contexts. The recent 2025 study on EMI challenges is a step forward. Also few studies integrate affective, cognitive, linguistic, and sociocultural factors simultaneously when analyzing listening and speaking difficulties.

Methodology

Research Design

This study employed a descriptive qualitative design to explore the major challenges faced by learners in academic listening and speaking contexts. A qualitative approach was chosen because it allows for an in-depth understanding of learners’ perceptions, experiences, and difficulties that cannot be fully captured through numerical data alone. The study focused on identifying the linguistic, cognitive, and affective factors that influence students’ performance in academic communication tasks.

Participants

The participants consisted of 40 first-year university students enrolled in English for Academic Purposes (EAP) Listening and Speaking courses. All participants were English-as-a-foreign-language (EFL) learners with similar proficiency levels (B1–B2 according to the CEFR). Students came from diverse faculties, including Education, Business, and Social Sciences. Participation was voluntary, and all respondents provided informed consent.

Data Collection Instruments

1. Semi-Structured Interviews

Individual interviews were conducted to gather detailed information about students’ listening and speaking challenges. The interviews included open-ended questions focusing on:

difficulties understanding lectures, discussions, and academic vocabulary

problems with pronunciation, fluency, and confidence in speaking

psychological factors such as anxiety, fear of mistakes, and lack of motivation

perceived needs for improvement

Each interview lasted 15–20 minutes and was audio-recorded with permission.

2. Classroom Observations

Observations were carried out during regular Listening and Speaking lessons to identify challenges that emerged naturally in classroom settings. A structured observation sheet was used to note learners’ behavior, such as:

note-taking difficulties during listening tasks

hesitation, pauses, or avoidance during speaking tasks

interaction patterns in pair/group work

visible signs of anxiety or communication breakdowns

3. Questionnaire

A short questionnaire containing 15 Likert-scale items was administered to quantify the frequency of specific challenges. The questionnaire focused on:

linguistic challenges (vocabulary, pronunciation, speed of speech)

cognitive challenges (processing information, multitasking while listening)

affective challenges (confidence, anxiety, motivation)

Data Collection Procedure

Data collection occurred over a four-week period. First, questionnaires were distributed to all students to obtain an overview of commonly experienced challenges. Then, classroom observations were conducted during two listening lessons and two speaking lessons. After the observations, 12 students were selected for follow-up interviews based on their questionnaire responses, ensuring a balance of low-, mid-, and high-performance learners.

Data Analysis

Qualitative Data

Interview recordings and observation notes were transcribed and analyzed using thematic analysis. The data were coded into categories representing different types of challenges, such as:

linguistic difficulties

cognitive/processing difficulties

affective/psychological difficulties

pedagogical/environmental challenges

Themes were refined through repeated reading to ensure accuracy and consistency.

Quantitative Data

Questionnaire responses were analyzed descriptively using frequency counts and percentages. The numerical data supported the qualitative findings by showing how common each challenge was among the learners.

Ethical Considerations

Participants’ names and identities were kept confidential. All data were used solely for academic research purposes. Students were informed that their participation would not affect their course grades.

Results

The findings from questionnaires, interviews, and classroom observations revealed that learners experience a wide range of challenges in academic listening and speaking. These challenges fall into three major categories: linguistic, cognitive, and affective. The results below summarize the most common and significant issues reported by participants.

1. Listening Challenges

1.1 Linguistic Challenges

The majority of students (78%) reported that limited academic vocabulary made it difficult to understand lectures and academic audio materials. Many indicated that unfamiliar terminology caused them to lose track of the main ideas. In the interviews, several students noted that “even if I understand the sentence structure, one difficult word can block my understanding.”

Pronunciation differences also contributed to comprehension problems. Nearly 65% of students struggled with different English accents (American, British, Indian), especially when speakers talked quickly or used connected speech. Classroom observations showed that students frequently asked for repetition during audio-based tasks.

1.2 Cognitive Processing Challenges

Listening tasks that required simultaneous note-taking and comprehension were particularly difficult. According to questionnaire results, 72% of students found it hard to “listen and write at the same time.” During observations, many students hesitated to take notes because they feared missing important information. Additionally, 58% of learners stated that they had

trouble identifying the main idea when lectures included many details or examples. Interviews revealed that students often focused on minor points, causing them to miss the overall message.

2. Speaking Challenges

2.1 Linguistic Challenges

In speaking tasks, limited vocabulary and grammar caused significant difficulties. Over 70% of respondents said they could not express complex academic ideas because they lacked the necessary terminology. Students also struggled with pronunciation, with many reporting embarrassment when their pronunciation led to misunderstandings. Observation data supported this: during pair and group discussions, students frequently paused, searched for words, or switched to their first language when unable to continue fluently.

2.2 Fluency and Idea Organization

More than half of the participants (56%) noted challenges with organizing ideas logically during presentations or discussions. Many students explained that even when they understood the topic, they were unsure how to structure their ideas clearly and cohesively.

Fluency was another common issue. Students often spoke slowly, used long pauses, or repeated fillers such as “umm,” “you know,” and “actually.” Several learners reported that thinking in their native language before speaking slowed them down considerably.

3. Affective and Psychological Challenges

3.1 Anxiety and Fear of Mistakes

Affective factors had a strong impact on speaking performance. Approximately 68% of students reported anxiety, especially during presentations or whole-class discussions. Students described feelings of nervousness, fear of negative evaluation, and lack of confidence. This anxiety frequently led to reduced participation in speaking tasks.

Interview data also showed that fear of making grammar or pronunciation errors discouraged students from speaking. One participant noted, “I know the answer, but I don’t want to say it because I am afraid of saying it wrong.”

3.2 Lack of Motivation and Low Self-Efficacy

Around 40% of students reported low motivation toward improving listening skills because they found listening tasks “too difficult.” Many believed that no matter how much they practiced, they would not significantly improve, suggesting low self-efficacy.

4. Environmental and Pedagogical Factors

4.1 Limited Exposure to Authentic English

Both interviews and questionnaires revealed that students had limited opportunities to listen to authentic English outside the classroom. As a result, they struggled with fast, natural speech and topic-specific vocabulary commonly used in academic contexts.

4.2 Insufficient Classroom Practice

Some students felt that classroom time devoted to speaking was insufficient. They expressed a desire for more interactive activities such as debates, group discussions, and presentations to help reduce anxiety and build confidence.

Vocabulary and academic terminology were the most frequently mentioned barriers to both listening and speaking. Fast speech and unfamiliar accents created major listening challenges. Fluency, pronunciation, and idea organization hindered speaking performance. Anxiety, fear of mistakes, and low confidence significantly reduced participation in speaking tasks. Cognitive load, especially during note-taking, negatively affected listening comprehension.

Discussion

The findings of this study reveal that learners face significant and interconnected challenges in academic listening and speaking. These challenges involve linguistic, cognitive, and affective dimensions, supporting previous research that describes academic communication as a complex and demanding skill set for English-as-a-foreign-language (EFL) learners. First, the results showed that linguistic factors particularly limited academic vocabulary, pronunciation issues, and unfamiliar accents play a major role in learners’ difficulties. These findings align with earlier studies indicating that vocabulary breadth is one of the strongest predictors of listening comprehension and speaking fluency. Students in this study reported that unknown academic terminology often prevented them from understanding lectures and expressing ideas clearly. Similarly, accent variation created barriers to comprehension, especially when speakers used connected speech or discipline-specific language. This supports studies that emphasize the importance of exposing learners to diverse English accents and authentic materials.

Second, the study identified considerable cognitive challenges, especially during tasks that require simultaneous processing of multiple skills, such as listening while taking notes. Many students struggled to maintain attention, identify key ideas, and process information rapidly. These challenges reflect the cognitive load theory, which suggests that high-demand academic tasks overwhelm working memory. The difficulty students experienced when organizing ideas during speaking tasks also illustrates the cognitive demands of producing coherent academic discourse.

Third, affective factors emerged as critical barriers to successful academic communication. Anxiety, fear of making mistakes, and low confidence significantly reduced learners’ willingness to speak, particularly in formal contexts such as presentations or whole-class discussions. This aligns with previous research that identifies communication anxiety as a major predictor of low participation and reduced performance in speaking. The finding that some students lacked motivation or believed they would not improve indicates low self-efficacy, which can negatively impact learning outcomes and long-term engagement.

Finally, environmental and pedagogical factors also influenced learners’ performance. Limited exposure to authentic English outside the classroom and insufficient opportunities for interactive speaking practice hindered the development of both listening comprehension and oral fluency. This suggests that EAP programs may benefit from incorporating more authentic input, real-life communication tasks, and opportunities for repeated practice.

Conclusion

This study investigated the challenges faced by EFL learners in academic listening and speaking, revealing that these difficulties are multifaceted and deeply interconnected. Linguistic limitations, such as insufficient academic vocabulary and pronunciation issues, were shown to significantly hinder both comprehension and oral expression. Cognitive demands, particularly during multitasking activities such as listening and note-taking, further contributed to learners’ struggles. Additionally, affective factors including anxiety, fear of mistakes, and low self-confidence were found to negatively impact student participation and performance in academic communication tasks.

The findings underscore the importance of designing EAP listening and speaking instruction that holistically addresses these challenges. Teachers should incorporate explicit vocabulary instruction, provide exposure to diverse accents, and integrate strategies that help

learners manage cognitive load. Equally essential is the creation of supportive classroom environments that encourage participation, reduce anxiety, and build learners’ confidence.

By addressing the linguistic, cognitive, and affective dimensions of academic communication, educators can better support students’ development of effective listening and speaking skills, ultimately enhancing their academic success in English-medium environments.

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"ADVANCED JOURNAL OF UNIVERSITY SCIENCE AND CREATIVE INNOVATIONS"

LEXICAL-SEMANTIC AND STYLISTIC FEATURES OF PAREMIOLOGICAL UNITS FORMED ON THE BASIS OF MORAL AND ETHICAL LEXIS IN ENGLISH AND UZBEK LANGUAGES

Muxtashamova Parvina Zahitovna
Uzbekistan State world languages university
Teacher of the Faculty English 3
Department of Theoretical aspects of English № 3
e-mail: a7191987@gmail.com
https://doi.org/10.5281/zenodo.17907305

Abstract. *This article explores the lexical-semantic and stylistic characteristics of paremiological units derived from moral and ethical lexis in English and Uzbek languages. Drawing on the principles of cognitive and cultural linguistics, the research examines how universal and culture-specific moral concepts — such as honesty, kindness, respect, patience, and decency — are conceptualized through proverbs and aphorisms. Comparative analysis reveals both shared humanistic values and national distinctions in semantic structures and stylistic expression. The findings demonstrate that paremiological units not only serve as repositories of cultural wisdom but also as linguistic manifestations of moral norms, ethical ideals, and social values in both languages.*

Key words: *paremiology, moral lexis, ethical concepts, proverb, aphorism, semantics, stylistics, cultural linguistics.*

Annotatsiya. *Mazkur maqolada ingliz va o'zbek tillarida axloqiy va odobiy leksika asosida shakllangan paremiologik birliklarning leksik-semantik hamda stilistik xususiyatlari tahlil etiladi. Tadqiqot kognitiv va madaniy lingvistika tamoyillariga asoslanib, halollik, mehr-oqibat, hurmat, sabr-toqat va odoblilik kabi umumiy hamda milliy xususiyat kasb etgan axloqiy tushunchalarning maqollar va aforizmlar orqali qanday konseptualizatsiya qilinishini o'rganadi. Qiyosiy tahlil natijalari shuni ko'rsatadiki, har ikki tildagi paremiologik birliklar umumiy insoniy qadriyatlarni aks ettirgan holda, semantik tuzilma va ifoda uslubida milliy o'ziga xosliklarni namoyon etadi. Tadqiqot natijalariga ko'ra, maqol va aforizmlar nafaqat xalq donoligi xazinasi, balki axloqiy me'yorlar, ma'naviy ideallar va ijtimoiy qadriyatlarning lingvistik ifodasi sifatida ham xizmat qiladi.*

Kalit so'zlar: *paremiologiya, axloqiy leksika, odobiy tushunchalar, maqol, aforizm, semantika, stilistika, madaniy lingvistika*

Introduction.

Proverbs and aphorisms have long served as crystallizations of human experience, reflecting the collective moral consciousness of nations. They function not only as linguistic expressions of wisdom but also as cognitive and cultural codes through which communities transmit ethical norms and behavioral standards. In this context, the moral and ethical lexis of a language represents the verbalized system of values that regulates human conduct.

The study of paremiological units within the semantic field of morality and ethics is significant for two main reasons. Firstly, these expressions preserve the national mentality and cultural worldview of their speakers. Secondly, they demonstrate universal moral paradigms, such as truth, justice, honesty, and kindness, which transcend linguistic boundaries.

In Uzbek and English cultures alike, moral and ethical paremiological units are integral to communication, social upbringing, and moral education. While both languages express similar ethical values, they differ in figurative imagery, metaphorical framing, and stylistic coloration. The present study investigates these differences and commonalities through comparative semantic and stylistic analysis.

Literature Review.

Paremiology — the study of proverbs and related expressions — has developed extensively in world linguistics. Foundational works by Archer Taylor (1931), Wolfgang Mieder (2004), and Alan Dundes (1997) highlight the proverb as a universal linguistic and cultural phenomenon. In Uzbek linguistics, T. Mirzayev, B. Sarimsoqov, and Z. Toshpo‘latov have contributed to the typological and stylistic classification of proverbs and aphorisms.

Modern linguistic research increasingly approaches paremiology from cognitive, cultural, and semantic perspectives (Lakoff & Johnson, 1980; Gibbs, 1994; Baranov, 2013). These studies consider proverbs as conceptual metaphors that reflect moral cognition and cultural stereotypes.

Within Uzbek scholarship, M.A. Temirova (2019) examined typological aspects of Uzbek and Kyrgyz proverbs; G.I. Ergasheva (2020) analyzed gender-related paremiological features; and D.S. Turdaliyeva (2018) focused on linguistic poetics of Uzbek proverbs. However, comparative research specifically devoted to moral and ethical lexis in paremiological units of English and Uzbek remains scarce — a gap this study seeks to address.

Methodology.

This research employs comparative-semantic and linguocultural analysis as primary methods. The corpus includes over 400 English and Uzbek proverbs and aphorisms drawn from bilingual paremiological dictionaries, classical literature, and contemporary compilations such as:

- The Viking Book of Aphorisms (Auden & Kronenberger, 1962)
- The Oxford Dictionary of Proverbs (Speake, 2015)
- Hikmatlar Shodasi (Raimov & Raimova, 2012)
- Ilm Hikmati (Tojiboyev & Egamberdiyev, 2015)

The study also integrates contextual and stylistic analysis to identify the expressive, evaluative, and metaphorical functions of moral lexis in paremiological constructions.

Results and Discussion.

Semantic Fields of Moral and Ethical Lexis

Analysis revealed that English and Uzbek proverbs use similar moral concepts but frame them differently. The core semantic fields identified include honesty and truthfulness, kindness and compassion, patience and endurance, respect and decency, and diligence and work ethics.

Lexical and Morphological Features

English moral paremiological units often rely on simple lexemes (honesty, virtue, truth, courtesy), while Uzbek ones use derived or compound structures with evaluative elements (halollik, odobli, yaxshilik, to‘g‘rilik). In Uzbek, affixation adds semantic depth, for instance, odobli (well-mannered) or insofli (fair-minded) convey not only behavior but character evaluation.

Stylistic and Metaphorical Expression

Stylistically, both languages utilize metaphor, antithesis, and parallelism, but their imagery differs. Uzbek paremias often employ nature metaphors (Sabr qilgan daryo kechar), while English paremias favor moral and social metaphors (Virtue is its own reward).

Cultural and Cognitive Aspects

Cognitively, moral paremiological units function as frames through which societies conceptualize human conduct. In Uzbek culture, morality is often linked to collective harmony and spiritual purity, whereas in English tradition, morality aligns with individual responsibility and social ethics.

Conclusion.

The comparative analysis demonstrates that English and Uzbek moral-ethical paremiological units, while linguistically distinct, share deep cognitive and universal similarities. Both express a moral worldview centered on honesty, respect, kindness, patience, and diligence. However, stylistically and lexically, Uzbek proverbs tend to be emotionally expressive and collectivist, whereas English ones are concise and rational. Ultimately, moral and ethical lexis within paremiological units acts as a linguistic mirror of civilization — preserving humanity’s timeless wisdom and serving as a bridge between cultures.

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13.00.00 – PEDAGOGICAL SCIENCES

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13.00.00 - PEDAGOGIKA FANLARI

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13.00.00 – ПЕДАГОГИЧЕСКИЕ НАУКИ

"ADVANCED JOURNAL OF UNIVERSITY SCIENCE AND CREATIVE INNOVATIONS"

O‘ZBEKISTON RESPUBLIKASI KONSTITUTSIYASIDA INSON HUQUQLARI VA ERKINLIKLARINING AKS ETISHI

Abduhalilov Bexzodbek Qodirjonovich
Toshkent shaxridagi Adju universiteti
1-bosqich talabasi
https://doi.org/10.5281/zenodo.17907329

Annotatsiya. *Ushbu maqolada O‘zbekiston Respublikasi Konstitutsiyasida inson huquqlari va erkinliklarining kafolatlanishi, ularning mazmun-mohiyati hamda amaliy ahamiyati yoritilgan bo‘lib, inson sha’ni, qadr-qimmati, erkinligi va huquqlarining oliy qadriyat sifatida e’tirof etilishi konstitutsiyaviy tizimning asosiy tamoyili sifatida baholanadi. Shu bilan birga, ijtimoiy-siyosiy huquqlarning Konstitutsiyada belgilanishi, ularni amalga oshirishga xizmat qiladigan mexanizmlar, xalqaro huquqiy normalar bilan uyg‘unlik masalalari tahlil qilingan. Shuningdek, yangi tahrirdagi Konstitutsiya orqali inson – jamiyat – davlat tamoyilining mustahkamlanishi, fuqarolarning huquqiy maqomi kengaygani va konstitutsiyaviy islohotlarning jamiyat rivojiga ta’siri ilmiy asosda ko‘rsatib berilgan.*
Kalit so‘zlar: *Konstitutsiya, inson huquqlari, konstitutsiyaviy huquqlar, “inson–jamiyat–davlat” tamoyili, huquqiy davlat, demokratik islohotlar.*

Abstract. *This article highlights the guarantees of human rights and freedoms in the Constitution of the Republic of Uzbekistan, their essence, and their practical significance. It assesses the recognition of human dignity, honor, freedom, and rights as supreme values as a fundamental principle of the constitutional system. The article also analyzes the establishment of socio-political rights in the Constitution, the mechanisms that ensure their implementation, and issues of harmonization with international legal norms. In addition, it scientifically demonstrates how the new edition of the Constitution strengthens the “human–society–state” principle, expands the legal status of citizens, and influences the development of society through constitutional reforms.*
Key words: *Constitution, human rights, constitutional rights, “human–society–state” principle, rule of law, democratic reforms.*

Kirish. Bugungi kunda rivojlanish yo‘lida dadil qadam tashlayotgan O‘zbekistonda inson, uning hayoti, sha’ni va erkinliklarini ta’minlash davlat siyosatining eng ustuvor yo‘nalishlaridan biri etib belgilangani barchamizga ma’lum. O‘zbekiston Respublikasi Konstitutsiyasida har bir fuqaroning konstitutsiyaviy haq-huquq va erkinliklari aniq belgilab berilgan, jumladan, O‘zbekiston Respublikasida insonning huquq va erkinliklari xalqaro huquqning umume’tirof etilgan normalariga binoan hamda ushbu Konstitutsiyaga muvofiq e’tirof etiladi va kafolatlanadi. Inson huquq va erkinliklari har kimga tug‘ilganidan boshlab

tegishli bo‘ladi. O‘zbekiston Respublikasida barcha fuqarolar bir xil huquq va erkinliklarga ega bo‘lib, jinsi, irqi, millati, tili, dini, e’tiqodi, ijtimoiy kelib chiqishi, ijtimoiy mavqeyidan qat’iy nazar, qonun oldida tengdirlar [19-modda]. Bundan tashqari, Huquq va erkinliklarning daxlsizligi [20-modda], erkin shaxsiy kamol topish [21-modda], yashash huquqi [25-modda], inson sha’ni va qadr-qimmati [26-modda], erkinlik va shaxsiy daxlsizlik [27-modda], aybsizlik prezumpsiyasi, sudda himoya huquqi [25-modda], yuridik yordam olish huquqi [29-modda], uy-joy daxlsizligi [29-modda], harakatlanish erkinligi [32-modda], so‘z, e’tiqod va axborot erkinligi [33-modda], huquqlarni himoya qilish (shikoyat, sudga murojaat) [55-modda], milliy institutlar orqali huquqlar himoyasiga oid moddalar ham Konstitutsiyamizda inson huquqlari va erkinliklarining aks etida muhim ahamiyat kasb etadi.

Asosiy qism. O‘zbekiston Respublikasi fuqarosi va davlat bir-biriga nisbatan o‘zaro huquq va majburiyatlar bilan bog‘liqdir. Insonning Konstitutsiya va qonunlarda mustahkamlab qo‘yilgan huquq va erkinliklari daxlsizdir hamda ulardan sud qarorisiz mahrum etishga yoki ularni cheklab qo‘yishga hech kim haqli emas. Insonning huquq va erkinliklari bevosita amal qiladi. Insonning huquq va erkinliklari qonunlarning, davlat organlari, fuqarolarning o‘zini o‘zi boshqarish organlari, ularning mansabdor shaxslari faoliyatining mohiyati va mazmunini belgilaydi [19-modda]. Xususan, O‘zbekiston Respublikasi Konstitutsiyasida davlatning strategik maqsadi sifatida ijtimoiy davlat qurish belgilangan bo‘lib, bu orqali jamiyatda adolat va birdamlik prinsiplarining mustahkamlanishi hamda inson huquqlari va erkinliklarini himoya qilishning yangi mexanizmlari joriy etilmoqda [PF-67-son].

Prezidentimiz Shavkat Mirziyoyevning “Hozirgi zamon va Yangi O‘zbekiston” nomli asarida ham ushbu masalalarga alohida urg‘u berilgan. Davlat rahbarining ma’ruza va nutqlari, farmon va qarorlari, milliy rivojlanish strategiyalari hamda davlat dasturlarida yangilangan konstitutsiya normalarini hayotning barcha jabhalariga izchil tatbiq etishning siyosiy-nazariy asoslari va amaliy mexanizmlari batafsil yoritilgan. Xalqning xohish-irodasiga binoan qabul qilingan Konstitutsiyaning yangi tahririda belgilangan asosiy tamoyillarni amalda to‘liq hayotga ko‘chirish, ulardan kundalik hayotimizning ajralmas qismi sifatida foydalanish dolzarb vazifa bo‘lib qolmoqda. Prezidentimiz ta’kidlaganidek: “Qonun – muqaddas, adolat esa har qanday sharoitda ham ustuvor bo‘lishi shart” [1]. Shu bois jamiyatning barcha a’zolari uchun bu tamoyilni hayotiy qoida sifatida mustahkamlash yo‘lida tizimli ishlar davom ettirilmoqda [4].

Yangi qabul qilingan konstitutsiyamizning biron bir moddasi 1992-yilgi konstitutsiyamizga teskari yoki zid emas. Shunga ko‘ra, yangi asosiy qonunimizni “yangi tahrirdagi Konstitutsiya” yoki “yangilangan Konstitutsiya” deb ta’kidlashimiz mumkin. Konstitutsiyaning 13-moddasida O‘zbekiston Respublikasida demokratiya umuminsoniy prinsplarga asoslanadi, ularga ko‘ra inson, uning hayoti, erkinligi, sha’ni, qadr-qimmati va boshqa ajralmas huquqlari oliy qadriyat hisoblanadi [13-modda]. Demokratiyada huquq va erkinliklar Konstitutsiya va qonunlar bilan himoya qilinadi, deyilgan. Bu moddaning o‘zi mamlakatimizda inson qadri tushunchasi eng oliy darajaga ko‘tarilganligining yorqin ifodasidir.

Xulosa. Xulosa qilib shuni aytish mumkinki, konstitutsiyaviy islohotlarning bosh g‘oyaviy omili, shubhasiz, Prezidentimiz Shavkat Mirziyoyevdir. Shu bilan birga, islohotlarning asosiy tashabbuskori mamlakatimiz fuqarolari hisoblanadi. Chunki haqiqiy huquqiy davlatda konstitutsiya bilan jamiyat taraqqiyoti o‘rtasida hech qanday tafovut bo‘lmasligi lozim. “Yangi O‘zbekiston” taraqqiyot strategiyasi talablari ham milliy qonunchilik va amaliyotda “inson – jamiyat – davlat” tamoyilining ustuvor o‘rin egallashini taqozo etadi.

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IDEALIZED COGNITIVE MODELS

Ahmedova Nodira Djavadullaevna
Uzbekistan State world languages university teacher,
3rd English faculty
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Abstract. *This article explores the structure, types, and linguistic implications of ICMs, illustrating how they underlie categorization, metaphor, and conceptual coherence in human thought and language. The theory of Idealized Cognitive Models (ICMs) represents a crucial development in cognitive linguistics, offering a framework for understanding how humans conceptualize and organize knowledge. Introduced by George Lakoff (1987).*

Key words: *Idealized cognitive models, metaphorical mappings, social and cultural concepts, frame.*

Inroduction. Idealized cognitive models are concepts or ideas which organize knowledge about the world, based on shared cultural understandings and experiences. Idealized cognitive models are simplified conceptualization. Examples of idealized cognitive models include social, cultural scenarios, mappings, image schemas and frames for specific concepts like viewing the economy as a body. Economy is the body means if the countries parlament or departments are head, an economy is like body (metaphorical mappings)

Idealized cognitive models are one big section which maintains different kind of small scientific areas of cognitive semantics. Now, it is explained in detailed:

Frame: A frame is a cognitive model for a concept, like the "verbs of judging" frame. It includes a Judge, a Defendant, and a Situation, as well as presuppositions about concepts like responsibility and blame, which are central to understanding verbs like "accuse" or "criticize".

Metaphorical mappings: These models structure one concept in terms of another. For example: **business is war:** This metaphor is used to describe business competition as fierce, using terms like "trade war," "battle," and "fight".

Image schema is a basic mental pattern — a repeated structure of our bodily experience — that helps us understand and reason about the world and language. They are not images in the visual sense, but mental frameworks formed from bodily and spatial experiences like up/down.They form the foundation of conceptual metaphors and abstract thinking in Cognitive Linguistics. Container.Things exist inside or outside a boundary You are in a room; water is in a glass "I'm in love." Or "He's out of trouble."

Path (SOURCE–PATH–GOAL) Movement from one place to another Walking from home (source) to school (goal) "She's on her way to success."

Up-down. Relates to physical height or quantity Standing up vs lying down "Prices went up." or "He's feeling down."

Balance. Equilibrium, stability Balancing on one leg, financial stability “He has a balanced life.”

Force. Interactions of energy or power Pushing a door, resisting temptation “She fought her fears.” Or “He overcame difficulties.”

CENTER–PERIPHERY Something has a core and edges Circle with a middle point He’s at the center of attention.

Link. Connection or attachment Rope tying two things They are tied by friendship.

Cycle. Recurring events Day–night, seasons Life is a cycle or History repeats itself.”

ICMs function as conceptual networks that integrate various types of knowledge:

They provide the background knowledge against which linguistic meaning is interpreted. For instance, understanding the sentence “She broke the engagement” presupposes the ICM of engagement as a pre-marital contract and relationship as a bounded agreement, even though no physical object was broken.

ICMs are shaped by cultural knowledge and social experience. What counts as mother, freedom, or honor varies across societies because the cognitive models that structure these concepts differ. For example, the Western ICM of MARRIAGE emphasizes a legal contract between two individuals based on love and choice. In contrast, other cultures may conceptualize marriage as a social alliance between families, guided by duty and status. The underlying linguistic expressions—to marry into a family, arranged marriage, love marriage—reflect these differing ICMs.

Conclusion.

Idealized Cognitive Models reveal that human understanding is neither objective nor arbitrary but structured by shared mental representations rooted in bodily experience, culture, and interaction. They bridge the gap between language and cognition, explaining why meaning is both universal in form and variable in interpretation. Through ICMs, we comprehend how abstract concepts gain coherence, how categories emerge, and how language mirrors the embodied imagination of the human mind.

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"ADVANCED JOURNAL OF UNIVERSITY SCIENCE AND CREATIVE INNOVATIONS"

AUTHENTICITY AND ACADEMIC INTEGRITY IN THE AGE OF AI

Alikberova Kamila Adhamovna
Teacher of Uzbekistan State World Language University, Tashkent
e-mail: kamilaalikberova@338gmail.com
https://doi.org/10.5281/zenodo.17907365

Abstract. *The rapid advancements in artificial intelligence (AI), particularly generative AI models like Large Language Models (LLMs), have profound implications for higher education, challenging established notions of authenticity and academic integrity. This article explores the evolving landscape where AI tools can generate complex texts, code, and analyses, blurring the lines of original thought and authorship. We examine the conceptual frameworks of authenticity and academic integrity in light of these technological shifts, identifying key challenges such as sophisticated plagiarism, altered learning processes, and the ethical dilemmas of human-AI collaboration. The article proposes strategies for educators and institutions, including fostering AI literacy, re-evaluating assessment methods, developing clear ethical guidelines, and promoting a balanced approach to AI integration that emphasizes critical thinking and responsible use. Ultimately, navigating this new era requires a proactive pedagogical shift to preserve the core values of academic rigor and intellectual honesty.*

Key words: *artificial Intelligence, Academic Integrity, Authenticity, Generative AI, Large Language Models, Education, Pedagogy, Assessment, Plagiarism, AI Literacy.*

Introduction.

The advent of sophisticated artificial intelligence (AI) tools, particularly Large Language Models (LLMs) such as ChatGPT, Gemini, and Claude, has ushered in a transformative period for academia. These technologies are capable of generating human-like text, translating languages, writing code, summarizing complex information, and even performing data analysis with unprecedented speed and fluency. While offering immense potential for enhancing learning, research, and administrative tasks, AI's capabilities simultaneously present significant challenges to the foundational principles of authenticity and academic integrity within educational institutions.

Authenticity, in an academic context, traditionally refers to the originality of a student's work, reflecting their unique thought processes, understanding, and synthesis of knowledge. It implies that the work submitted is genuinely their own creation, representing their individual learning journey. Academic integrity, a broader concept, encompasses honesty, trust, fairness, respect, and responsibility in all academic endeavors. It is the commitment to ethical conduct in learning, teaching, and research. The proliferation of AI tools, which can produce highly

coherent and contextually relevant content, directly questions these established definitions. How do we assess originality when an AI can generate a polished essay?

How do we uphold integrity when the line between human and machine contribution becomes increasingly indistinct?

This article aims to critically analyze the impact of AI on authenticity and academic integrity. It will delineate the core challenges posed by AI, review existing literature on the subject, and propose a framework for understanding and addressing these issues. By exploring potential strategies and adaptations for pedagogical practices, assessment designs, and institutional policies, we seek to guide educators and students in navigating the complex ethical terrain of the AI age, ensuring that the pursuit of knowledge remains grounded in genuine intellectual effort and ethical conduct.

Literature Review.

The academic discourse surrounding AI and its impact on education is rapidly expanding, with an emerging consensus on both the opportunities and threats it presents. Early discussions often focused on plagiarism detection and the potential for AI to automate academic misconduct (e.g., Stokel-Walker, 2023). However, the conversation has evolved to a more nuanced exploration of how AI fundamentally redefines learning processes, assessment, and the very concept of authorship.

Prior research highlights that AI tools can generate text that is virtually indistinguishable from human-written content, complicating traditional plagiarism detection methods (Perkins, 2023). This has led to calls for a shift from a reactive 'catch-and-punish' approach to a proactive 'educate-and-adapt' strategy (Bretag, 2023). Studies suggest that while AI can be misused for plagiarism, it also offers powerful tools for personalized learning, essay ideation, and research assistance when used ethically (Rudolph et al., 2023). The challenge lies in distinguishing legitimate use from illegitimate appropriation.

The concept of authenticity is particularly scrutinized. Traditional definitions emphasize individual thought and original expression. However, with AI, students might submit work that, while technically 'original' in its generation, does not reflect their own cognitive effort or learning (Cotton et al., 2023). This raises questions about what constitutes "knowing" or "understanding" in an AI-assisted environment. Some scholars argue for a re-evaluation of assessment paradigms, moving away from tasks easily replicable by AI towards those that require higher-order thinking, critical analysis, synthesis, and human judgment that AI currently lacks (Chan & Hu, 2023).

Moreover, the ethical implications extend beyond plagiarism to issues of over-reliance on AI, potential biases embedded in AI models, and the "deskilling" of critical academic abilities (D'Agata, 2023). There is a growing body of work advocating for the development of AI literacy among students and faculty, emphasizing responsible AI use, understanding its limitations, and critically evaluating its outputs (Southgate et al., 2023). Policies on AI use in educational settings are still nascent and vary widely, underscoring the urgent need for comprehensive guidelines that balance innovation with integrity.

Methods.

This article employs a conceptual analysis and theoretical synthesis approach to explore the multifaceted challenges and opportunities presented by AI concerning academic authenticity and integrity.

The methodology involves a systematic review of contemporary literature, including peer-reviewed articles, academic reports, and authoritative discussions from educational institutions and professional bodies on AI in higher education.

The analytical framework is structured around the following steps:

Definition Elucidation: Clearly defining and re-examining the traditional concepts of "authenticity" and "academic integrity" within the evolving context of AI capabilities.

Impact Assessment: Identifying and categorizing the direct and indirect impacts of generative AI tools on these concepts, drawing insights from observed trends and theoretical implications discussed in the literature. This includes categorizing challenges (e.g., sophisticated plagiarism, deskilling, ethical dilemmas) and potential benefits (e.g., enhanced learning, research assistance).

Synthesizing Emerging Perspectives: Consolidating diverse viewpoints and proposed solutions from the academic community regarding the integration of AI while preserving academic values. This involves looking at pedagogical shifts, assessment redesigns, and policy development.

Framework Development: Constructing a conceptual framework that outlines actionable strategies and considerations for educational stakeholders to address the identified challenges and leverage AI responsibly. This framework emphasizes proactive measures over reactive ones.

The 'methods' section, in this theoretical context, does not involve empirical data collection or statistical analysis but rather a rigorous, systematic, and critical engagement with existing knowledge to build a coherent argument and propose a forward-looking perspective on the topic. The selection of literature prioritizes relevance to current generative AI capabilities and their specific implications for higher education ethics.

Results.

The analysis reveals several key findings regarding the interplay between AI, authenticity, and academic integrity:

Redefinition of Authorship and Originality: AI tools fundamentally challenge the traditional notion of individual authorship. When an AI can generate a complete essay, code, or research proposal, the question arises: whose work is it? The 'originality' of a submitted piece becomes ambiguous if substantial portions are AI-generated, even if prompts were human-created. This blurs the line between legitimate ideation assistance and illegitimate content generation, leading to a crisis of attribution and intellectual ownership.

Sophistication of Academic Misconduct: AI has significantly raised the bar for academic misconduct, moving beyond simple copy-pasting. AI-generated plagiarism can be highly nuanced, incorporating diverse sources, rephrasing effectively, and mimicking various writing styles, making it exceedingly difficult for conventional plagiarism detection software and human instructors to identify. This necessitates a shift in detection strategies towards understanding students' learning processes rather than solely relying on textual analysis.

Impact on Learning Processes and Critical Thinking: Over-reliance on AI for generating answers or completing tasks risks undermining students' development of critical thinking, problem-solving skills, and deep learning. If students routinely outsource cognitive effort to AI, their ability to synthesize information, formulate arguments, and engage in original thought may atrophy. This represents a long-term threat to academic rigor and intellectual independence.

Ethical Dilemmas of AI-Human Collaboration: The appropriate boundaries for AI-human collaboration are unclear. While AI can be a powerful tool for brainstorming, drafting, and refining, its use can inadvertently cross ethical lines if it replaces genuine human effort. Establishing guidelines for what constitutes acceptable AI assistance versus unacceptable outsourcing of academic work is a pressing concern for educators and institutions.

Emergence of New Pedagogical Imperatives: To counter these challenges, there is a clear imperative for new pedagogical approaches. This includes: **AI Literacy:** Equipping students and faculty with the knowledge and skills to understand how AI works, its capabilities, limitations, and ethical implications. **Assessment Redesign:** Shifting away from AI-vulnerable assessments (e.g., generic essays, fact-recall tests) towards those that require unique human skills, such as critical analysis of AI outputs, creative problem-solving, real-world application, presentations, or experiential learning. **Transparent AI Use Policies:** Developing clear, context-specific policies on the acceptable and unacceptable use of AI tools in coursework, research, and examinations. **Focus on Process over Product:** Emphasizing the learning process, drafts, reflections, and oral defenses to ascertain genuine understanding and effort, rather than solely evaluating the final output.

These findings highlight that AI is not merely a tool for cheating but a catalyst for fundamental reassessments of educational philosophy, requiring a comprehensive and collaborative response from the academic community.

Discussion.

The findings underscore a pivotal moment for academic institutions worldwide. The challenges posed by AI to authenticity and academic integrity are not merely technological but deeply pedagogical and philosophical. The traditional model of education, largely built on individual knowledge acquisition and demonstration through original written work, is being profoundly re-evaluated.

The redefinition of authorship compels educators to engage in transparent conversations with students about what it means to "do" academic work in the age of AI. Instead of outright banning AI, which is often impractical and counterproductive, the focus must shift towards integrating AI as a tool, akin to a calculator or a word processor, albeit one with significant generative capabilities. This requires establishing clear guidelines, such as citing AI contributions, delineating where AI assistance ends and human intellectual input begins, and framing AI as a collaborator rather than a substitute for learning.

The increased sophistication of academic misconduct mandates a move beyond reactive detection technologies. While AI detection tools are emerging, their reliability is often questionable, and they can lead to false positives or an arms race between detection and circumvention. A more sustainable approach involves proactive strategies that cultivate a culture of integrity.

This includes designing assessments that are inherently AI-resistant, such as viva voce examinations, presentations requiring live demonstration of knowledge, project-based learning with iterative feedback, and tasks demanding critical evaluation or modification of AI-generated content rather than mere generation.

Furthermore, the potential for AI to diminish critical thinking skills necessitates a renewed emphasis on metacognition and active learning. Educators must guide students in critically evaluating AI outputs, identifying biases, understanding limitations, and using AI as a prompt for deeper inquiry, rather than as a final answer generator. This cultivates AI literacy,

preparing students not just for academic success but also for ethical engagement with AI in their future professional lives.

The development of institutional policies must be a collaborative effort involving faculty, students, administrators, and ethical experts. These policies should be flexible enough to accommodate different disciplines and learning objectives, yet clear enough to provide unambiguous guidance. Crucially, these policies should not merely prohibit but also educate on responsible AI use, acknowledging its potential to augment human capabilities while safeguarding intellectual honesty.

The discussion must also consider the equity implications. Access to premium AI tools or training in advanced prompting techniques might create new forms of academic advantage or disadvantage. Institutions must ensure equitable access to AI literacy training and resources, fostering an inclusive environment where all students can harness AI's potential responsibly.

Conclusion.

The Age of AI presents an undeniable inflection point for academic authenticity and integrity. While the transformative power of AI offers unprecedented opportunities for learning and research, it simultaneously challenges the very foundations upon which higher education is built. The traditional definitions of originality, authorship, and ethical conduct require urgent re-examination and adaptation.

This article has highlighted that merely detecting AI-generated content is an insufficient and ultimately unsustainable response. Instead, a proactive, multi-faceted approach is essential, emphasizing AI literacy, pedagogical innovation, and clear ethical frameworks. Educational institutions must shift from a reactive stance to one that actively cultivates responsible AI engagement, redesigns assessments to value higher-order thinking, and fosters an environment where genuine intellectual effort and ethical conduct are paramount.

The future of academic integrity lies not in isolating education from AI, but in intelligently integrating it while preserving the core human values of critical inquiry, independent thought, and intellectual honesty. By embracing AI as a tool for augmentation rather than substitution, and by educating students to be discerning and ethical users, academia can navigate this new frontier, ensuring that the pursuit of knowledge remains authentic and trustworthy for generations to come.

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INCLUSIVE EDUCATION: LET EVERY CHILD'S VOICE BE HEARD!

Anvarbekova Iroda Abrorbek qizi
University of Bussiness and Science
student of the Faculty of Philology.
Uzbekistan. Namangan
Email: irodaanvarbekova0@gmail.com
https://doi.org/10.5281/zenodo.17907455

Abstract. *This scientific article provides an in-depth analysis of the theoretical, methodological, and practical aspects of inclusive education. It covers international standards adopted by global organizations, the experiences of developed and developing countries, the mechanisms of interaction between teachers and students in an inclusive environment, and strategies for psychological support. The study employs comparative, content analysis, conceptual modeling, and theoretical approaches. The results show that the effectiveness of inclusive education is directly linked to political will, infrastructure, teacher competence, social attitudes, and parental involvement. The article offers scientifically grounded recommendations on systemic reforms and the creation of psychological-pedagogical conditions that ensure every child's voice is heard.*

Key words: *inclusive education, special needs, differentiated approach, international experience, social integration, psychological support, student agency.*

Annotatsiya. *Ushbu ilmiy maqolada inklyuziv ta'limning nazariy, metodologik va amaliy jihatlari chuqur tahlil qilinadi. Xalqaro tashkilotlar tomonidan qabul qilingan inklyuziv ta'lim standartlari, rivojlangan va rivojlanayotgan davlatlar tajribasi, inklyuziv muhitda o'qituvchilar va o'quvchilar o'rtasidagi o'zaro munosabatlar mexanizmi, psixologik qo'llab-quvvatlash strategiyalari keng yoritilgan. Tadqiqotda komparativ, kontent tahlil, konseptual model yaratish va nazariy yondashuvlar qo'llanildi. Natijalar shuni ko'rsatadiki, inklyuziv ta'limning samaradorligi siyosiy iroda, infratuzilma, o'qituvchilarning kompetensiyasi, ijtimoiy qarashlar va ota-onalarning ishtirokiga bevosita bog'liq. Maqolada har bir bolaning ovozi yangrashini ta'minlaydigan psixologik-pedagogik sharoitlar va tizimli islohotlar bo'yicha ilmiy asoslangan takliflar berilgan.*

Kalit so'zlar: *inklyuziv ta'lim, maxsus ehtiyoj, differensial yondashuv, xalqaro tajriba, ijtimoiy integratsiya, psixologik qo'llab-quvvatlash, o'quvchi agentligi.*

Introduction. In recent years, inclusive education has become one of the most important directions in education policy worldwide. Inclusive education is a system that ensures equal rights and opportunities in the educational process for every child, regardless of age, gender,

health condition, social background, or developmental differences. Its main goal is to support all children’s active participation in school life, facilitate their full integration into society, and create conditions for them to realize their potential**.**

The modern education system aims to create equal opportunities for every child, support their personal development, and ensure their active participation in society. Inclusive education is a pedagogical approach that brings together children with diverse abilities, opportunities, and needs in one environment, ensuring that they have equal rights in learning and upbringing. The essence of inclusive education is that it is not intended only for children with disabilities; rather, it involves adapting the teaching process to the individual needs of all children. Therefore, every child’s voice is heard, their opinions are valued, and their active participation in the learning process is ensured.

The most important feature of inclusive education is that it focuses not on changing the child, but on adapting the education system itself to the child’s needs. This contributes to forming a fair, democratic, and humane model of education.

As a key factor in developing human capital and building an open and just society, inclusive education holds a leading position on today’s global agenda. As UNESCO emphasizes, the education system is obliged to embrace all existing differences in society and take into account every child’s learning needs. In today’s globalization process, the education sector also faces risks such as socio-economic disparities, unequal opportunities, and the exclusion of children with disabilities, students from economically disadvantaged backgrounds, migrant children, and those who come from linguistically diverse environments.

The relevance of inclusive education can be explained by the following factors:

•the increase in various forms of disability (due to advances in medical diagnostics);

•the growth of cultural and linguistic diversity;

•global migration processes;

•the strengthening of the right to equal access to education at the international level;

•society’s growing need for a culture of tolerance and inclusion.

The 1994 Salamanca Declaration laid the main theoretical foundation for inclusive education worldwide. This declaration proposes reconsidering the education system not as a model focused solely on academic achievement, but as one aimed at meeting the needs of every child.

Inclusive education has become a priority direction of education policy across the globe. UNESCO, UNICEF, and other international organizations recommend inclusive education as one of the most effective means of respecting children's rights, ensuring social justice, and fostering tolerance within society. At the same time, inclusive education plays an important role in children’s academic and personal development, as well as in strengthening their connection with parents and the community.

The main idea of inclusive education. The main idea of inclusive education is that every child should receive an education that corresponds to their abilities and capabilities. This approach differs from the traditional education system, where standardized curricula and general teaching methods are often applied, resulting in children with disabilities or special developmental needs being left behind. Inclusive education, on the other hand, adapts the learning process by taking into account each child’s developmental pace. Pedagogical research shows that children who grow up in an inclusive environment not only acquire knowledge more effectively, but also develop stronger social skills. Such an environment teaches children to work

collaboratively with others, express their thoughts freely, solve problems, and make decisions. Therefore, inclusive education ensures the simultaneous development of personal growth, academic success, and social adaptation.

Inclusive education allows children to discover and develop their own identities. In an inclusive classroom, every child increases their self-confidence, learns to make independent decisions, and develops creative and analytical thinking skills. In addition, children gain the opportunity to freely express and demonstrate their abilities and talents.

Personal development occurs not only in the academic sphere, but also in social and emotional aspects. In an inclusive environment, children feel accepted, respected, and valued. This strengthens their psychological resilience and enhances confidence in communication and interaction. In this way, inclusive education improves children’s overall personal development and prepares them more effectively for life.

Inclusive education provides equal access to learning for all children. Every student receives education adapted to their special needs and abilities. Additional pedagogical support—such as assistance from a psychologist, speech therapist, or special education specialist—is available. This system ensures that no child is left out of the learning process and that every child has the opportunity to acquire knowledge.

In addition, inclusive education is implemented based on differentiated methods and individualized plans. During the learning process, children progress at their own pace, learn complex topics through simplification, and take their interests and preferences into account. This approach increases children’s motivation and enhances their interest in learning.

Inclusive education prepares children for society. Children learn to understand and accept their peers, and develop habits of cooperation and helping others. Moreover, an inclusive environment fosters resilience against discrimination and prejudice.

Children who grow up in such an environment become socially stable, tolerant, and valuable members of society in the future. Social integration benefits not only the students but also has a positive impact on society itself. It fosters values of tolerance, solidarity, and unity, which contribute to the development of a democratic and open society in the future.

Inclusive education enhances children’s academic preparedness. Through differentiated methods, an adapted curriculum, and individualized plans, each child learns at their own pace. This not only improves their knowledge level but also strengthens their motivation to learn.

In addition, inclusive education provides students with opportunities to engage in extra practical activities, interactive games, and work with various learning resources. This allows complex topics to be simplified and studied in an engaging and enjoyable way. At the same time, the assessment system is carried out based on an individual approach, giving each child the opportunity to develop at their own pace.

Inclusive education benefits not only children but also parents. Parents can closely observe their child’s development, provide support, and collaborate with the school. At the same time, parents gain confidence in their child’s ability to adapt to society, which enhances the family’s psychological stability.

Inclusive education also creates significant opportunities for society. It ensures equality, increases the active participation of people with disabilities in social life, and enriches cultural diversity. At the same time, inclusive education strengthens social stability and contributes to the development of a democratic, tolerant, and open society in the future.

Inclusive Kindergartens and Their Importance

Inclusive kindergartens are preschool education institutions where all children, including those with different developmental characteristics or special needs, are educated together in a single environment. Inclusive kindergartens play an important role in children’s personal, social, and academic development. These institutions provide children with opportunities to discover their abilities, interact with peers, and adapt to society.

In inclusive kindergartens, children increase their self-confidence, learn to make independent decisions, and develop social skills. Additionally, through various games, practical activities, and artistic endeavors, children learn creative and analytical thinking. Educators apply an individual approach to each child, taking into account their developmental pace and specific needs.

Inclusive kindergartens provide great benefits for parents. They can closely observe their child’s development, receive support during the preschool education process, and gain confidence in preparing their child for future general education institutions. At the same time, values of tolerance, support, and equality are fostered within society.

Inclusive Schools and Their Role

Inclusive schools are general education institutions where children with diverse abilities and needs learn together. Through individualized approaches, differentiated methods, and additional pedagogical support, these schools contribute to the development of each child. Inclusive schools not only enhance academic preparedness but also strengthen children’s social integration, personal growth, and psychological resilience.

In inclusive schools, lessons are organized to meet the needs of each student. Educators use visual, auditory, and practical methods, employ adapted learning materials, and implement an assessment system based on an individual approach. At the same time, children studying in inclusive schools learn to respect their peers, provide help, and develop social skills.

Inclusive schools are also beneficial for society. They help instill values of tolerance, solidarity, and social justice in future generations. Children with disabilities learn to actively participate in society and realize their potential. At the same time, inclusive schools serve as an important tool in combating stereotypes and discrimination within society.

Personal Development and Self-Awareness

Inclusive education allows children to discover and develop their own personalities. Each child increases self-confidence, learns to make independent decisions, and develops creative and analytical thinking skills. At the same time, children have the opportunity to freely express their abilities and talents. Personal development occurs not only in the academic sphere but also in social and emotional aspects.

Children who grow up in an inclusive environment feel accepted, respected, and valued. This enhances their psychological resilience and confidence in social interactions. Personal development begins in inclusive kindergartens and schools, strengthening preparation for general education and life.

Conclusion

Inclusive education ensures the personal, academic, and social development of every child. It creates equal opportunities for all children, makes access to education fair, strengthens social integration, enhances academic preparedness, and produces beneficial outcomes for both parents and society. Inclusive kindergartens and inclusive schools play a key role in this process,

ensuring that every child’s voice is heard and valued. Therefore, inclusive education is not only a pedagogical approach but also an important strategy for societal development.

The widespread implementation and development of inclusive education remain a priority task for every country and society. It not only protects children’s right to education but also helps cultivate a future generation of tolerant, open-minded, and socially valuable individuals.

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"ADVANCED JOURNAL OF UNIVERSITY SCIENCE AND CREATIVE INNOVATIONS"

MAKTABGACHA YOSHDAGI BOLALARDA AXBOROT-KOMMUNIKATSION TEXNOLOGIYALAR(AKT)DAN FOYDALANISH IMKONIYATLARI

Gaziyeva Nigora Shamsiddinovna[1], Kayumova Laziza[2]
[1]Angren universiteti "Pedagogika va psixologiya" kafedrasi katta o'qituvchisi
[2]Angren universiteti "Maktabgacha ta'lim" yo'nalishi 2-bosqich talabasi
https://doi.org/10.5281/zenodo.17907487

Annotatsiya. *Bugungi kunda axborot-kommunikatsiya texnologiyalari va innovatsiyalarsiz hech bir soha taraqqiyotini tasavvur qilib bo'lmaydi.Ayniqsa yosh avlodga ta'lim-tarbiya berishda zamonaviy axborot texnologiyalari imkoniyatlaridan keng foydalanish eng dolzarb vazifalardandir.Maktabgacha ta'lim tizimini zamonaviy talablarga asoslangan holda tashkil etish ,bolani sog'lom va har tomonlama saviyali qilib voyaga yetkazish,ta'lim sifatini oshirishda AKT ning ahamiyati va pedagogik imkoniyatlar to'g'risida fikr yuritilgan.*

Kalit so'zlar: *ta'lim-tarbiya, o'yin, bola, axborot texnoligiyalari, video, annimatsiya, ijodkorlik.*

Abstract. *In today's world, it is impossible to imagine the development of any field without information and communication technologies and innovations. The use of modern information technologies in educating and upbringing the younger generation has become especially essential. This article discusses the importance of ICT and their pedagogical potential in improving the quality of education, organizing the preschool education system based on modern requirements, and fostering a healthy and well-developed child.*

Key words: *education and upbringing, game, child, information technologies, video, animation, creativity.*

Аннотация. *В современную эпоху невозможно представить развитие ни одной сферы без информационно-коммуникационных технологий и инноваций. Особенно важно широко использовать современные информационные технологии в процессе обучения и воспитания подрастающего поколения. В статье рассматривается значение АКТ их педагогические возможности вповышении качества образования, организации системы дошкольного образования на основе современных требований, а также в воспитании здорового и всесторонне развитого ребенка.*

Ключевые слова: *обучение и воспитание, игра, ребенок, информационные технологии, видео, анимация, творчество.*

Kirish. Zamonaviy dunyoda axborot-kommunikatsion texnologiyalar (AKT) hayotimizning ajralmas qismiga aylangan. Bolalar ham ilk bolalik davridan ushbu texnologiyalar bilan tanishmoqda. Ayniqsa, maktabgacha yoshdagi bolalar uchun AKT imkoniyatlaridan to‘g‘ri va me’yorida foydalanish ularning bilim olish jarayonini samarali qilishda muhim ahamiyatga ega.

Bugun jadal rivojlanib borayotgan axborotlashtirish tizimi barcha sohalar qatori ta’lim sohasini ham qamrab olmoqda.O‘zbekiston Respublikasining Prezidentining “Axborot texnologiyalari va kommunikatsiyalari sohasini yanada takomillashtirish chora-tadbirlari to‘g‘risida”gi 2018-yil 19-fevraldagi PF-5349-sonli hamda 2020-yil 5-oktabrdagi PF-6079-son “Raqamli O‘zbekiston-2030’’ kabi Farmonlari,maktabgacha ta’lim sohasini ta’lim jarayonlarida AKT dan keng foydalanish ta’lim sifatini ta’minlovchi vositalardan biriga aylanmoqda [1].

Axborot kommunikatsiya texnologiyalarining ta’limning ilk bosqichi bo‘lgan maktabgacha ta’lim sohasiga kiritilishi, - pedagog xodimlarni o‘z ustida ishlab, izlanuvchanlik va ijodkorlikni talab etadi. Texnika vositalari bilan to‘la jihozlangan, ko‘rgazmalarga boy xona boladagi iqtidor, qobiliyat va AKT dan foydalanishda kutilayotgan natijalar MTT da ta’lim sifati va bolani maktabga tayyorlash samaradorligini oshirish, erkin fikrlashi, dunyoqarashi kengligi, ota-ona bilan hamkorligini yanada mustahkamlash bilan afzal bo‘lib, MTT tizimini zamonaviy talablarga asoslangan holda tashkil etishdir.

AKT ning maktabgacha yoshdagi bolalar uchun afzalliklari.

1. Ta’lim jarayonini qiziqarli qilish - raqamli o‘yinlar va interaktiv dasturlar bolalarning diqqatini jalb qilib, o‘rganishni yanada qiziqarli vazifa aylantiradi.

2. Ko‘nikmalarni rivojlantirish - AKT yordamida bolalar mantiqiy fikrlash, diqqat, esda saqlash va texnik savodxonlik ko‘nikmalarini shakllantiradi.

3. Ijodiy faollikni oshirish - rassomchilik, musiqiy va hikoya yaratish kabi interaktiv dasturlar orqali bolalar ijodiy qobiliyatlarini rivojlantiradi.

4. Individual o‘qishni qo‘llab-quvvatlash - har bir bolaning ehtiyojiga mos keladigan turli ko‘rsatmalar va topshiriqlar orqali o‘quv jarayonini shaxsiylashtirish imkoniyati.

AKT dan foydalanish imkoniyatlari:

- ta’limiy o‘yinlar va ilovalar (poytaxti ranglar, shakllar, hayvonlar va harflarni o‘rgatuvchi interaktiv o‘yinlar);

- audiovizual materiallar (matnlar, rasm va videolar orqali o‘quv kontentini yanada tushunarli va esda qolarli qilish);

- virtual laboratoriyalar va simulyatsiyalar (oddiy tajribalarni amalga oshirish orqali nazariy bilimlarni amaliyot bilan bog‘lash);

- maktabgacha yoshdagi bolalar uchun maxsus ishlab chiqilgan elektron kitoblar (o‘qish va hikoya tinglash ko‘nikmalarini rivojlantirish);

- ota-onalar va tarbiyachilar uchun onlayn platformalar (farzandning rivojlanishini kuzatish va yordam berish uchun resurslar).

Foydalanishda e’tibor berilishi kerak bo‘lgan jihatlar:

1. Vaqt me’yori - bolalar uchun AKT dan foydalanish vaqtini cheklash, ortiqcha ekran oldida o‘tirishning oldini olish.

2. Kontent nazorati - foydalanilayotgan dasturlar bolalar uchun xavfsiz va yoshga mos bo‘lishi kerak.

[1]LEX.UZ httpps://lex.uz

3. Faoliyatlarning muvozanati - AKT bilan ishlashni jismoniy o‘yinlar va ijtimoiy muloqot bilan muvozanatlash.

4. Boshqarilgan foydalanish - tarbiyachilar va ota-onalar boshqaruvida texnologiyalardan foydalanishni ta’minlash.

Respublikamiz maktabgacha ta’lim tashkilotlarida 5 ta markaz mavjud bo‘lib, bu markazlarning har birida bola faoliyat olib boradi. Rivojlantiruvchi markazlar tarbiyalanuvchilarning qiziqishlari, ehtiyojlari va yosh xususiyatlarini hisobga olib tashkil etiladi. Ushbu markazning asosiy maqsadi-bolalarning mustaqil faoliyatini rivojlantirish, ularning qiziqishlarini kengaytirish, ijodiy va intellektual salohiyatini shakllantirishdir. Ushbu markazlar quyidagilar:

1. Qurish,yasash va konstruksiyalash markazi
2. Til va nutq markazi
3. San’at markazi
4. Fan va tabiat markazi
5. Syujetli rolli o‘yin va sahnalashtirish markazi.

Qurish, yasash va konstruksiyalash markazi faoliyatida mantiqiy fikrlash, makon va shakl haqidagi tasavvurlar, son-sanoq, hajm, miqdor, vaqt va fazoviy tasavvurlar, geometrik shakllar, hisoblash materiallari yordamida mustaqil yoki guruh bo‘lib ishlaydilar. Qurish-yasash markazi uchun o‘yinlar “Uy quring” bu o‘yinda bolaga qurilish konstruktori yoki kublar beriladi. Rasmga qarab yoki o‘z tasavvurlari asosida uy, ko‘prik, maktab yoki boshqa inshootlar qurish topshirig‘i beriladi. “Kim balandroq minorani qura oladi?” o‘yinida guruhga bo‘linib, vaqt ichida balandroq minora qurish topshiriladi. O‘yin muvofiqlashtirish va jamoada ishlash ko‘nikmasini rivojlantiriladi.

Til va nutq markazi faoliyatida tarbiyalanuvchilarning og‘zaki va yozma nutqini rivojlanadi, so‘z boyligi oshiriladi, to‘g‘ri nutq madaniyatini shakllantirishga qaratiladi. Markaz faoliyatida bolalar suhbat qurishi,hikoya qilishi,she’r yod olishi,turli xil o‘yinlar o‘ynashi orqa til ko‘nikmalari rivojlanadi.

Nutq o‘stirish markazi uchun o‘yinlar “Kim gapirib beradi?” o‘yinida rasmli kitoblar asosida bolalar biror rasmga qarab hikoya tuzib berishadi. “Topib ayt” o‘yinida tarbiyachi biror so‘zni tavsiflaydi bolalar esa javob topadi.

San’at markazi bolalarni estetik didini shakllantirish, tasavvurlarini rivojlantirish, tasviriy va amaliy san’atga bo‘lgan qiziqishlarini oshirishga xizmat qiladi. Bu markazda bolalar turli rangdagi materiallar bilan ishlaydi, rasm chizadi, bo‘yaydi, haykalchalar yasaydi. San’at markazi uchun o‘yinlar “Ertakdagi qahramonlarni chizamiz” o‘yinida bolalar ertak eshitishadi va o‘sha ertakdagi qahramonlardan birini o‘z tasavvurlari bilan chizadilar. “Bo‘yash-sirli rasm” o‘yinida oldindan chizilgan konturli rasmlarni bo‘yash orqali bolalar tafakkur va didni rivojlantirilib, ranglarni to‘g‘ri tanlashga yo‘naltiriladi.

Fan va tabiat markazida tarbiyalanuvchilarning atrof-muhit,tabiat hodisalari va oddiy ilmiy tushunchalar,tajriba o‘tkazish ko‘nikmalari rivojlanadi. Bu markazda o‘simliklar, hayvonlar, tabiat hodisalari haqidagi bilimlar,urug‘ ekish, gul va o‘simliklarmi parvarishlash, yomg‘ir, shamol, quyosh haqida suhbatlar o‘tkazadi. Fan va tabiat markazi uchun o‘yinlar “Bir xil bargni top” o‘yinida bolalar bir xil rangdagi, shakldagi barglarni topishdi. Bu o‘yin orqali predmetni o‘xshashini va farqini aniqlaydi, tasavvurlari kengaytiriladi.

Syujetli rolli o‘yin va sahnalashtirish markazida bolalar ijtimoiy rollarni o‘zlashtirish, muloqot ko‘nikmalarini rivojlantirish ijodiy tafakkur va hissiy ifodani shakllantiriladi. “Do‘kon”,

“Shifoxona”, “Oshxona”, “Olia” kabi mavzularda ro‘l o‘ynaydi. “Do‘konchilik” o‘yinida biri sotuvchi biri xaridor rolida bo‘ladi. Pul birliklari, mahsulotlar yordamida muloqot qilinadi. “Shifokor va bemor” o‘yinida bolalar rollarni taqsimlab, shifokor va bemor o‘rtasidagi muloqotni tashkil etadi. Ushbu markazlarda AKT dan foydalanish maqsadga muvofiq bo‘ladi. Bu markazlarda bola tarbiyachi rahbarligida 10 daqiqa kompyuter savodxonligi oshirilib,raqamli smartfon va planshet bilan tanishib boriladi. Mashg‘ulotdan so‘ng bolani sog‘lom rivojlantirish uchun musiqali dam olish daqiqasini qilish kerak. Multimedia vositasida bolalarga ta’lim berish samaradorligini oshirish bilan birga aqliy,ijodlorlik kabi xususiyatlarini rivojlantirishda yordam beradi. Tarbiyachi rahbarligida bola POINT dasturi orqali turli narsalarni rasmini chizadi. AKT bolalarga interfaol ta’lim berish vositasi sifatida bolada yangi bilimlarni o‘zlashtirishda yordam beradi.

MTT dagi tarbiyachining yana bir imkoniyati – bu MTT yoshidagi bolalarning mustaqil ishi uchun topshiriqlar tayyorlash uchun materiallarning elektron shaklidir.Bolalar guruhga bo‘linib, “Xatoni top”, “Qo‘g‘irchoqni kiyintiramiz”, “Shaklni joylashtir”, “O‘xshashini top”, “Rasmni bo‘ya” kabi o‘yinlarni annimatsiya tasvirlar yordamida o‘ynasa mavzuga oid bilimlarni bola zo‘r qiziqish bilan o‘rganadi.

Xulosa o‘rnida shuni ta’kidlash joizki AKT dan foydalanish MTT ta’lim tizimida pedagogik jarayonni tashkil etish, bolada faollikni, tashabbuskorlikni, mustaqillikni shakllantirish, AKT dan foydalanib ta’lim sifatini oshirishda katta yordam beradi. Maktabgacha ta’lim tashkilotlarida axborot-kommunikatsiya texnologiyalaridan (AKT) samarali foydalanish ta’lim jarayonining sifatini oshirishga xizmat qiladi. AKT vositalari kompyuter, interfaol doska, planshet, multimedia materiallari, ta’limiy dasturlar bolalarning qiziqishini uyg‘otadi, ularning mantiqiy fikrlashi, tasavvuri va mustaqil o‘rganish ko‘nikmalarini rivojlantiradi.Shuningdek, AKTdan foydalanish tarbiyachi faoliyatini yengillashtirib, mashg‘ulotlarni jonli, rang-barang va interfaol shaklda tashkil etishga imkon yaratadi. O‘z vaqtida va me'yorida qo‘llangan texnologiyalar ta’lim sifatini oshiradi, bolalarning individual rivojlanishini ta’minlaydi va zamonaviy pedagogik talablarga moslashishga yordam beradi. Axborot-kommunikatsion texnologiyalar maktabgacha yoshdagi bolalarni ta’lim jarayonida keng qo‘llanilishi ularning bilim olish, ijodiy fikrlash va texnik savodxonlik ko‘nikmalarini rivojlantirish imkonini beradi. Shu bilan birga, AKT dan samarali va xavfsiz foydalanish uchun ota-onalar va tarbiyachilar mas’uliyatida to‘g‘ri vaqtni belgilash, yoshga mos kontent tanlash va faoliyatlarni uyg‘unlashtirish muhimdir.

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"ADVANCED JOURNAL OF UNIVERSITY SCIENCE AND CREATIVE INNOVATIONS"

THE ROLE OF AN INTEGRATIVE APPROACH IN THE DEVELOPMENT OF LINGUISTIC COMPETENCE OF PRIMARY CLASS STUDENTS

Haydarova Maftuna Murodilla kizi
PhD student of Namangan State University
E-mail: haydarovamaftuna1992@mail.ru
https://doi.org/10.5281/zenodo.17907518

Abstract. *In primary education, special attention is paid to the development of linguistic competence of students based on an integrative approach, to the effective use of modern pedagogical and informational approaches in the educational process. In scientific studies, it is recognized that the development of linguistic competence of elementary school students in foreign language classes, including English classes, based on an integrative approach, is of scientific and methodological importance. Taking this into account, this article covers the issues of using an integrative approach in the development of linguistic competence in the English classes of elementary school students of general secondary schools. It is also important to effectively organize English lessons based on an integrative approach, use games and playful situations in the course of the lesson, and increase students' interest in learning English. Such situations bring the speech activity of elementary school students closer to the natural state, and help to develop their communication skills.*

Key words: *integration, integrative approach, grammar games, lexical games, phonetic games, orthographic games, linguistic competence, interactive methods, integrated exercises.*

Introduction.

During the period of development of all fields, 70% of the countries of the world are widely using educational programs and textbooks of an integrative nature in the education system. Including integrated science in Australia, integrated science in Hungary, integrated science in Korea and Switzerland, integrative science in the UK education system, Hong Kong, Wales, Germany, Japan, the Netherlands and Northern Ireland from an integrative approach to the teaching of academic subjects. use, the need for Accent Language Center (language learning through motivation and comprehensive approach), English-medium Instruction (learning English through instructions), Content and Language Integrated Learning (integrated language learning based on texts) is explained.

Now, in our country, in the field of education, especially in the teaching of English, using an integrative approach, meaningful organization of lessons and finally achieving the intended goal is becoming one of the main goals. aimed at developing the linguistic competence of its students based on an integrative approach.

Organization of the educational process on the basis of integrative programs and textbooks, as well as the use of an integrative approach in the teaching process, it is intended to achieve efficiency as a result of the learning process, in which it is appropriate to use different levels of integration. For example:

1. Integration based on the sequential presentation of topics, in which the principle of concentrism is followed in the presentation of educational materials, that is, the previous educational material complements the next one. This does not mean that they repeat each other. As a result of such integration, students' knowledge, skills and abilities regularly develop and enrich.

2. Integrative programs, these types of programs provide for the combined presentation of topics related to several educational subjects or academic subjects.

3. Cross-curricular integration, in which learning materials from one course are combined with learning materials from another course that are essentially similar.

Literature analysis and methods.

The scientific methodical basis of the integrative approach in increasing the effectiveness of the educational process is Gulyamova M.Kh[3], Akhmedova N.M[2], Abdullayeva N.M[1], Mavlonova R.A., Rahmonkulova N.H[4], Maksimova V.N[5], Chapayev N.K[6]. researched by scientists.

Scientists such as K.P.Murthy, M.V.Ragha Ram[7] highlighted the positive aspects of the integrative approach in education. The scientific research and research work of all the above-mentioned scientists is of great importance from the point of view of the problem being solved.

Integration in education can be expressed as follows:

1. Creating a holistic view of the whole being (integration is considered as an educational goal here);

2. Finding a common platform for convergence of different scientific knowledge (where integration is used as a tool);

3. As a means of developing education;

4. As a means of universal, national education. In the establishment of connections between two academic subjects and their integration, one or another subject serves as a basis from time to time. The organic connection and logical interrelationship of topics in different academic subjects should be the basis of integrated lessons.

Any skills and competences are implemented gradually with the help of special exercises and texts, that is, with the help of exercises directed from simple to complex.

The use of integrated exercises and tasks, interactive methods is of great importance in improving the effectiveness of lessons in general secondary education schools. Including "Role plays", "find the problem", "Guided interview", "Mime and gesture", Act out, The use of exercises such as TPR (Total Physical Response), "Listen and draw" (Listen and draw) and integrated interactive methods guarantee to raise the quality of education to a higher level.

It is important to use games and playful situations in order to organize the lesson process in an interesting way and prevent students from getting bored. Such situations bring the speech activity of elementary school students closer to the natural state, help to develop their communication skills.

Grammar games. These types of games have the following goals:

1. Pupils overcome certain grammatical difficulties and communicate in speech.

2. Creating natural situations for applying the necessary grammatical events.

3. Development of speech activity of students.

Lexical games are performed for the following purposes:

1. To teach students to practice vocabulary in situations close to natural situations.

2. Activation of students' verbal thinking process.

3. Development of speech reaction.

Phonetic games. Such games are designed to establish correct pronunciation, and they have the following goals:

1. To train the students to pronounce English sounds correctly.

2. Teaching to speak quickly and read poems sonorously and burro. Spelling games help to develop students' literacy skills.

The intelligent and effective use of the game method greatly increases students' interest in learning English, working and acting as a team, treating each other with respect, and being able to listen to others' opinions. perfects qualities.

Results and discussion.

In conducting the experimental work of our research, the main attention was paid to the improvement of the effectiveness of the development of the linguistic competence of the 3rd-4th grade students of general secondary schools in English based on an integrative approach.

At the first stage of the experiment, a test control was conducted in order to check the students' mastery of the English language. The students were asked to complete 15 tests of the English language. These tests are aimed at determining the level of students' knowledge of the English language. The tests given to students were conditionally divided into 3 levels of complexity, and a total of 15 test tasks were taken, 5 of each. 4 (A, B, C, D) answer options were given for the test tasks, 2 minutes on average, 30 minutes for a total of 15 test tasks. Also, each test task requires imagining and analyzing various processes on the basis of knowledge, as well as using the acquired skills and competencies. As can be seen from the obtained preliminary test results, the test results are almost the same in the experimental and control groups (Table 1).

Groups	Number of students	Correct answers to test questions															In % of total
		Tests of the 1st level of complexity					Tests of the 2rd level of complexity					Tests of the 3rd level of complexity					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Experimental group	28	71 %	70 %	74 %	78 %	90 %	68 %	75 %	61 %	63 %	78 %	53 %	54 %	65 %	53 %	60 %	66.6%
Control group	29	68 %	66 %	70 %	71 %	88 %	64 %	69 %	55 %	59 %	73 %	49 %	53 %	64 %	51 %	54 %	64.2%

Table 1. Indicators of pre-test mastery of students' linguistic competence in English according to the level of development.

English lessons were conducted in the traditional way in the control group selected during the experimental work. In the experimental group, lessons based on an integrative approach were organized in English classes. At the end of the section, students were given a test control on the lessons organized on selected topics. Unlike the first phase of the experiment, in order to

determine the extent to which the students mastered the learning material, for each test item, one completely correct answer and three incorrect answers were given. The achieved result can be found in the following table: (Table 2)

Groups	Number of students	Correct answers to test questions														
		Tests of the 1st level of complexity					Tests of the 2rd level of complexity					Tests of the 3rd level of complexity					In % of total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Experimental group	28	79 %	80 %	67 %	87 %	92 %	68 %	72 %	66 %	67 %	78 %	68 %	66 %	68 %	67 %	69 %	71.7%
Control group	29	71 %	70 %	65 %	79 %	81 %	61 %	68 %	54 %	59 %	73 %	53 %	60 %	62 %	56 %	57 %	65.8%

Table 2. Indicators of students' acquisition of linguistic competence in English after the experimental test.

s can be seen from the results of the above table, the overall result of the experimental group in the initial test was 66.6%. The result was 71.7% when the test was conducted at the end of the experimental work after the lessons were conducted for primary school students based on an integrative approach to English. In the control group, we conducted the training without any changes. In the end, we conducted a science test from this group and the result was 65.8%. It can be seen that there was no significant change in the control group.

At the final stage of the experiment, the positive aspects of teaching based on the integrative approach were identified:

- conditions were created for students to work independently and develop their creative abilities;

- the gaps that appeared before in the process of learning English were filled, knowledge was deepened, as a result, the effectiveness of the lesson increased;

- as a result of lessons and trainings conducted on the basis of an integrative approach, it was observed that the interest and motivation of students in the experimental groups increased.

We can say that the factors that influenced the increase of the quality index in the experimental groups in the above way are the organization of English lessons for elementary school students based on an integrative approach.

Suggestions and recommendations.

Based on the scientific results of the research, the following scientific-practical recommendations are offered for the development of linguistic competence of elementary school students of general secondary schools:

1. It is recommended to carefully plan the pedagogical activities of English language teachers, to take into account the real personal capabilities of each student in English language classes, and to have a creative approach to classes in the development of linguistic competence of primary school students of general secondary schools.

2. Creating textbooks based on an integrative approach to teaching English for elementary school students of general secondary schools.

3. Today, it is necessary to teach students to think freely without putting pressure on them, without providing ready-made answers, to create an opportunity for them to find out independently, to use interesting and colorful materials and teaching methods.

The recommendations developed on the basis of the results of the research will serve to improve the indicators of the technology and results of the assessment of the results of the development of the linguistic competence of the 3rd-4th grade students of general secondary schools in our republic.

Conclusion.

The research process led to the following conclusion:

1. Curriculum documents on the development of linguistic competence in teaching English in 3-4 grades of general secondary schools, legal and regulatory documents on communicative and competence approaches in our republic, foreign language teaching scientific-theoretical ideas related to the methodology serve as a methodological basis for this research.

2. To ensure the effectiveness of teaching in the development of linguistic competence of 3rd-4th grade students in English, to improve the quality of English lessons, for this, it is necessary to widely use an integrative approach that has a positive effect on the cognitive activity of students.

3. The appropriateness of using an integrated system of exercises and tasks in the development of linguistic competence of elementary school students in English classes, in which positive results are expected as a result of students working on various authentic materials.

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ЮРИДИЧЕСКИЕ НАУКИ И СОВРЕМЕННЫЕ ТЕНДЕНЦИИ РАЗВИТИЯ ПРАВОВОГО ОБРАЗОВАНИЯ

Имамов Азиз Эркинович
Доцент кафедры терии государства и права
Академия МВД Республики Узбекистан,
https://orcid.org/0000-0002-1543-2944
https://doi.org/10.5281/zenodo.17907560

Аннотация. *Отмечено, что в условиях радикальных общественных преобразований с позиции гуманистических ценностей закономерно возрастает значение морали, нравственного сознания и возникает необходимость оценки, правовых изменений. Показано, что актуальной организационной проблемой органов является, определение задач по совершенствованию деятельности органов внутренних дел. Отмечается, что подобному совершенствованию способствуют новые условия информатизации образования, оптимизации его методов, углубления интеграционных и междисциплинарных программ, прогнозирования потребностей рынка труда и служб занятости, радикального улучшения материально-технической базы органов внутренних дел. Утверждается, что согласно концепции регулярного юридического образования, приобретаемые сотрудниками в учебных заведениях знания, умения и навыки, составят фундамент их профессионального образования, а учеба в системе повышения квалификации кадров - в ходе их практической работы и до выхода на пенсию. Утверждается, что только такая концепция юридического образования практически состоятельна в условиях информационного общества.*

Ключевые слова: *правоохранительный орган, мораль, законность,верховенство, право.*

Abstract. *It is noted that in the conditions of radical social transformations from the position of humanistic values, the importance of morality, moral consciousness naturally increases and there is a need for assessment, legal changes. It is shown that the urgent organizational problem of the bodies is the definition of tasks to improve the activities of the internal affairs bodies. It is noted that such improvement is facilitated by new conditions of informatization of education, optimization of its methods, deepening of integration and interdisciplinary programs, forecasting the needs of the labor market and employment services, radical improvement of the material and technical base of the internal affairs bodies. It is argued that according to the concept of regular legal education, the knowledge, skills and abilities acquired by employees in educational institutions will form the foundation of their professional education, and training in the system of advanced training of personnel - in the course of their practical work and until retirement. It is argued that only such a concept of legal education is practically viable in the conditions of the information society.*

Key words: *law enforcement agency, morality, legality, supremacy, law.*

Annotatsiya. *Insonparvarlik qadriyatlari pozitsiyasidan tubdan ijtimoiy o‘zgarishlar sharoitida axloq, axloqiy ongning ahamiyati tabiiy ravishda ortib borayotgani va baholash, huquqiy o‘zgarishlarga ehtiyoj paydo bo‘lishi ta’kidlanadi. Ichki ishlar organlari faoliyatini takomillashtirish bo'yicha vazifalarni belgilash organlarning dolzarb tashkiliy muammosi ekanligi ko'rsatilgan. Ta’kidlanishicha, bunday takomillashtirishga ta’limni axborotlashtirishning yangi shartlari, uning uslublarini optimallashtirish, integratsiya va fanlararo dasturlarni chuqurlashtirish, mehnat bozori va aholi bandligini ta’minlash xizmatlari ehtiyojlarini prognozlash, ichki ishlar organlarining moddiy-texnik bazasini tubdan yaxshilash ko‘mak bermoqda. Muntazam huquqiy ta’lim konsepsiyasiga ko‘ra, xodimlarning ta’lim muassasalarida egallagan bilim, ko‘nikma va malakalari ularning kasbiy ta’limini, kadrlar malakasini oshirish tizimida esa – amaliy faoliyati davomida hamda pensiyaga chiqqunga qadar o‘qitishning asosini tashkil qiladi. Axborot jamiyati sharoitida huquqiy ta’limning shunday kontseptsiyasigina amalda yashovchanligi ta’kidlanadi.*

Kalit so‘zlar: *huquqni muhofaza qiluvchi organ, axloq, qonuniylik, ustunlik, qonun.*

Введение.

В современных условиях деятельность правоохранительных органов Узбекистана (и, в частности, органов внутренних дел-ОВД) представляет значительный интерес, поскольку эта деятельность, опирающаяся на принципах морали и законности в общественном развитии, находится в центре постоянного внимания граждан. Ее направленность и результаты во многом отражаются в сознании и поступках людей как демонстрация уровня демократичности, реализации верховенства права в стране.

В условиях радикальных общественных преобразований значение морали, нравственного сознания закономерно возрастает, так как возникает необходимость оценки экономических, политических, правовых и духовных изменений с позиции гуманистических ценностей.

Актуальная организационная проблема.

Из вышесказанного следует, что актуальной организационной проблемой органов является определение задач по совершенствованию деятельности органов внутренних дел.

Новое качество юридического образования определяется его соответствием актуальным и перспективным запросам современной жизни страны. Оно осуществлять в условиях информатизации образования и оптимизации методов обучения; углубления интеграционных и междисциплинарных программ; оптимизации перечней специальностей; прогнозирования потребностей рынка труда и служб занятости; радикальное улучшение материально-технической базы юридических вузов.

Основными направлениями в современных условиях являются: реализация и совершенствование правовой базы, корректировка и разработка нормативных документов в соответствии с Конституцией РУз, Законом «Об образовании», постановлениями Президента РУз и другими нормативными документами. Эти документы будут способствовать разработке концептуальных основ опережающего развития и функционирования послевузовского юридического образования, регулярного обучения на курсах повышения квалификации и переподготовка специалистов, усиление роли

заочного и дистанционного образования в соответствии с потребностями общества и государства.

В этом контексте можно упомянуть о постановление Президента РУз № ПП-23 от 30.11.2021 г. «О дополнительных мерах по повышению юридических знаний инспекторов по профилактике ОВД», в котором в целях удовлетворения потребности в кадрах с высшим юридическим образованием согласно решению Комиссии МВД РУз направляет ежегодно 50-80 своих сотрудников (из числа преданных своей профессии, инициативных старших сотрудников со стажем работы в ОВД более трех лет) на заочную форму обучения (без вступительных экзаменов на платно-контрактной основе) за счет средств республиканского бюджета. Это обеспечит

- эффективное выполнение важных задач ОВД в условиях Нового Узбекистана;
- формирование и обеспечение социально-экономических механизмов расширения доступа сотрудников правоохранительных органов к получению высшего и послевузовского юридического образования за счет средств государственного бюджета и других источников финансирования;
- увеличение вклада системы высшего и послевузовского юридического образования в развитие фундаментальных и прикладных научных исследований и распространение правовых знаний;
- повышение правовой культуры граждан.

Ожидаемые результаты.

В процессе осуществления указанных мер ожидается достижение следующих результатов:

- удовлетворение потребностей органов внутренних дел (ОВД) и сотрудников правоохранительных органов в высшем и послевузовском юридическом образовании, общества и государства-в воспроизводстве специалистов, получающих высшую квалификацию посредством бакалавриата и магистратуры;
- повышение общего качества профессионального юридического образования и уровня подготовки специалистов в стране;
- повышение конкурентоспособности выпускников юридических вузов и факультетов на рынке труда за счет фундаментализации и специализации юридического образования;
- интенсификация и индивидуализация обучения;
- реализация современных информационных технологий и развитие у обучающихся навыков самообразования и саморазвития;
- развитие системы дистанционного и заочного обучения.

Заключение.

Стратегия концепции регулярного юридического образования состоит в том, что приобретаемые в учебном заведении теоретические знания, умения и навыки составляют только фундамент профессионального образования.

В ходе практической работы на отрезке от окончания вуза до выхода на пенсию, знания, умения и навыки сотрудника постоянно будет наращиваться за счет системы повышения профессионального уровня и самообразования. Нет особой необходимости доказывать, что в условиях информационного общества только такая концепция юридического образования практически состоятельна [1,2].

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MODELS AND FRAMEWORKS FOR ASSESSING THE VALUE OF DISASTER RESEARCH: A FOCUS ON CENTRAL ASIA AND THE REPUBLIC OF UZBEKISTAN

Kulijanov Umid
e-mail: umid.kulijanov@gmail.com
Tashkent, Uzbekistan
https://doi.org/10.5281/zenodo.17912116

Abstract. *Funders, governments, and multilateral stakeholders globally require demonstrable evidence that investment in disaster risk reduction (DRR) research yields tangible impact beyond the academic domain, contributing effectively to policy formulation, improved practice, and societal resilience. This paper reviews and adapts existing research impact assessment frameworks for conceptualising and measuring the value of DRR research within the distinctive, high-risk context of Central Asia (CA), with a dedicated emphasis on the Republic of Uzbekistan. The CA region is uniquely characterised by complex, transboundary hazards, notably high seismic activity, recurrent fluvial and urban floods, and pervasive climate-induced droughts. We argue that assessing research value in this setting necessitates a shift from purely economic quantification to a multi-dimensional framework encompassing policy alignment, capacity development, and the robust quantification of systemic and transboundary risk. Case evidence from Uzbekistan demonstrates that the value of DRR research is primarily realised through the development and institutionalisation of region-specific technical tools – such as Probabilistic Seismic Hazard Analysis (PSHA) models, harmonised exposure databases, and the systematic institutionalisation of disaster loss tracking systems like DesInventar Sendai. This analysis concludes that an effective value assessment framework for Central Asia must prioritise demonstrable contributions to strengthening risk governance and accelerating the implementation of the Sendai Framework for Disaster Risk Reduction (SFDRR) targets, particularly by enhancing the use of scientific knowledge in decision-making.*

Key words: *Disaster Risk Reduction (DRR); Research Impact Assessment (RIA); Central Asia (CA); Uzbekistan; Seismic Hazard Modeling; Risk Governance; Sendai Framework; Capacity Building; Transboundary Risk.*

1. INTRODUCTION

The growing number and severity of natural and human-caused disasters around the world have made it clear that we need to use evidence-based methods to lower the risk of disasters (DRR). After the Sendai Framework for Disaster Risk Reduction (2015–2030) was put into place, the focus changed from dealing with crises after disasters to proactive, science-based risk governance. For this paradigm shift to happen, both the public and private sectors need to put a lot of money into research to learn more about risks so that they can be reduced and resilience can be built.

But there is also a strong need for accountability: funders, governments, and civil society are all demanding more and more proof that research investment is a good use of resources and has a clear effect on society. In the realm of disaster risk reduction (DRR), quantifying this impact is intricate, as it necessitates the measurement of averted losses, the valuation of non-market benefits (such as improved community safety), and the correlation of policy alterations to scientific contributions.

This paper examines the conceptual and practical difficulties of research impact assessment (RIA) by utilizing established frameworks within the context of Central Asia. Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan make up the region, which is a unique place to study because it is very exposed to multiple hazards, has a lot of financial problems, and is in the process of changing to more modern, risk-informed governance structures. We suggest a multi-faceted framework for evaluating the significance of DRR research specific to the region, offering a comprehensive case study of Uzbekistan's advancements and the influence of research on its institutional reforms.

2. LITERATURE REVIEW

The systematic assessment of research impact, characterized as the evident contribution of research to the economy, society, culture, public policy, health, or environment beyond the academic realm, has become increasingly significant over the past twenty years. There are several well-known frameworks for thinking about and measuring this value, but they all have pros and cons when used in the disaster field.

2.1. Attribution and Quantification Models

Traditional RIA models often rely on a clear **attribution chain** to link research input to a policy or practice outcome.

- **The Payback Framework:** This model divides impact into five areas: creating new knowledge (academic), setting research goals (like new methods), changing policies and practices, helping society, and making money. Attributing disaster avoidance (the core of DRR value) to a specific piece of research is methodologically difficult, even though it is thorough.
- **Logic Models and Theory of Change (ToC):** These frameworks show how research inputs, activities, outputs (like publications and models), and expected outcomes (like policy change and capacity increase) are all connected. ToC is very useful for DRR because it makes researchers spell out the path they want to take from a scientific output (like a PSHA map) to a social outcome (like safer building codes).

2.2. The Public Value Framework

The Public Value approach, which started in public sector management, is very useful for research on disasters. It looks at value not only in terms of how much money it saves, but also in terms of how much research helps public goals and democratic accountability. In DRR, public value comes from:

1. **Legitimacy and Support:** Research that is seen as credible and authoritative by stakeholders (e.g., government, emergency services).
2. **Operational Capacity:** Research that enhances the tools and skills of risk managers (e.g., new early warning systems).
3. **Substantive Outcomes:** Research that directly reduces mortality, morbidity, and economic losses.

Using this framework in Central Asia lets us include things that aren't economic, like better regional cooperation and sharing of risk information across borders (a key public good for the region) that come from joint research projects.

2.3. Suitability for the DRR and Central Asian Context

Disaster research poses a distinct challenge: its significance frequently resides in the prevention of adverse outcomes, which is intrinsically challenging to measure. The Central Asian context also makes things more complicated because:

- **Data Scarcity and Fragmentation:** Historical loss data, especially from the early post-Soviet period, is frequently incomplete, contradictory, or non-standardized, complicating baseline assessment.
- **Capacity Gaps:** There is a lot of good hazard analysis capacity from the Soviet era, but vulnerability analysis and the use of research in financial mechanisms (like insurance) are still weak.

Therefore, any RIA framework that works for the region must put a lot of emphasis on the process-oriented effects of capacity building, data harmonization, and policy integration, as well as the final results.

3. DISASTER RISK PROFILE OF CENTRAL ASIA

Central Asia is one of the world's most disaster-prone areas because of a mix of natural, technological, and geophysical threats. Natural disasters have harmed more than 10 million people and cost more than $3.7 billion in damages over the past 30 years.

3.1. Geophysical Risks: The Dominant Seismic Threat

Earthquakes are the biggest danger in Central Asia, and they have historically killed the most people. The Indian and Eurasian plates crashing into each other makes the tectonic system active, which causes a lot of earthquakes in the area.

- **The Uzbek Seismic Reality:** The country is in an area with a low to very high risk of earthquakes. The capital city of Tashkent and other major cities are very vulnerable. Less than 15% of Uzbekistan's land is at very high risk of earthquakes, but more than half of the country's population and about 65.5% of its GDP come from these areas (for example, the Tashkent and Bukhara regions). An earthquake with a low frequency and a big effect could cost the country almost 6% of its nominal GDP. Because of this risk profile, high-resolution seismic research is important for the country's financial security.

3.2. Hydro-Meteorological Risks and Climate Change

The region is highly vulnerable to floods (fluvial and urban), mudslides, landslides, and drought. Seasonal floods often ruin farmland and hurt the agricultural sector, which many people in rural areas depend on.

- **The Flood and Drought Dualism:** Floods cost Uzbekistan's economy an average of more than $395 million a year, mostly in the Karakalpakstan, Khorezm, and Andijan regions. On the other hand, climate change forecasts show that the risk of droughts and water shortages will rise, which is a long-term, systemic threat to agriculture and water management, especially in the Aral Sea basin area.

3.3. Systemic and Transboundary Risks

Research in Central Asia must confront hazards that transcend national borders.

- **Transboundary Water Management:** Hydrological risks frequently transcend borders, necessitating regional collaboration in early warning systems and collective modeling.

- **Interlinked Vulnerabilities:** An earthquake in a major city or industrial area (like Tashkent) is likely to have a long-term effect on the economy, affecting supply chains, international trade, and national recovery efforts. This shows that we need research that looks at both the physical threat and the economic weakness of the system.

4. ASSESSING RESEARCH VALUE IN CENTRAL ASIA: A MULTI-DIMENSIONAL FRAMEWORK

Given the unique context of Central Asia, a multi-dimensional framework is necessary to assess the value of DRR research, moving beyond purely academic output. We propose three primary dimensions for value quantification: Policy and Governance, Scientific and Technical, and Socio-Economic.

4.1. The Policy and Governance Dimension (Value as Institutional Change)

Research impact is valued by its ability to influence and reform state structures. Metrics include:

- **Policy Adoption Index (PAI):** This index shows how well research recommendations (like specific risk thresholds and zoning maps) have been put into national laws, strategies, and regulatory codes. Case Metric (Uzbekistan): How much the new PSHA model affected the Law on Seismic Safety and the rules for building.
- **Risk Governance Score (RGS):** This score shows how the shift from managing disasters on the fly to a more organized, ongoing approach to risk governance is happening. This is often shown by the institutional mandate and funding for research-informed activities.
- **SFDRR Alignment Metric** shows how well the reporting on SFDRR targets A-D is going. This depends directly on research tools like DesInventar Sendai.

4.2. The Scientific and Technical Dimension

This dimension values the creation of high-quality, practical risk knowledge and the associated local capacity to use it.

- **Knowledge Utility Score (KUS):** Measures how useful research outputs are to people who aren't academics, like city planners and emergency services. This includes making high-resolution models and databases that work together. Case Metric (Central Asia): The creation of a single database of structures, infrastructure, and crop assets for the SFRARR program. This is necessary for consistent risk analysis across the five countries.
- **Capacity Development Index (CDI):** This shows how much local technical knowledge has grown. Case Metric (Uzbekistan): The number of local experts who have learned how to use the new PSHA model and Exposure Mapping, as well as their ability to keep these tools up to date and use them on their own.

4.3. The Socio-Economic Dimension

It is hard to put a number on avoided loss and improved financial resilience, but this is a key part of DRR value.

- **Avoided Loss Ratio (ALR):** A probabilistic estimate of the economic value saved by putting research-based mitigation measures into place (for example, moving or retrofitting based on a PSHA map). A lot of the time, this number comes from the new risk models.
- **Financial Resilience Score (FRS):** This score shows how much research helps with ways to protect your money. Case Metric (Central Asia): Investigate the viability of

creating national catastrophe insurance pools, akin to the Turkish model, for nations such as Uzbekistan and Kazakhstan to financially prepare for significant events.

5. CASE STUDY: THE VALUE OF DRR RESEARCH IN THE REPUBLIC OF UZBEKISTAN

Uzbekistan’s recent efforts provide a clear illustration of how research impact is being generated and measured across the multi-dimensional framework. The country's high exposure to seismic and hydro-meteorological risks has led to strong institutional reforms supported by targeted research.

5.1. Seismic Risk and the Value of PSHA Modeling

The 1966 Tashkent earthquake remains a landmark event, underscoring the necessity of seismic preparedness. The value of recent research in this domain is profound:

- **Advancing the Scientific Baseline:** Research efforts from around the world and in the US have led to the creation of a modern, regionally consistent Probabilistic Seismic Hazard Analysis (PSHA) model. This model uses the latest methods, an updated earthquake catalog, and active fault databases. This model is an unprecedented technical achievement, receiving high marks on the Scientific and Technical Dimension (KUS).
- **Direct Policy Codification:** The Policy and Governance Dimension shows the most important value. The new PSHA model is now the basis for putting the national Law on Seismic Safety into action. This means that building codes, land-use planning, and investments in infrastructure must all be based on risk. This direct link to the law is the most powerful way for policy to have an effect.
- **Economic Risk Quantification:** Research gives us real numbers on possible losses. Modeling shows that an earthquake with a return period of 100 years could cost Uzbekistan $3.6 billion. This number forces governments and financial institutions to recognize and prepare for this risk.

5.2. Hydrological Risk and Flood Resilience

While seismic risk is high-impact, low-frequency, hydrological hazards (floods, mudslides) are higher-frequency and disproportionately affect the agricultural sector and regional populations.

- **Agricultural Adaptation Research:** Research on agricultural adaptation has looked at in-depth diagnostic assessments in places like Samarkand and Surkhandarya to find and test climate-resilient farming methods. The analytical reports that come from this give a full picture of climate risks and how ready farmers are to take steps to adapt. This is a clear example of how protecting livelihoods can create Socio-Economic Value.
- **Spatial Risk Analysis:** It's been very important to focus on mass movements (landslides, mudflows) in mountainous areas like Tashkent Province. Researchers are using Remote Sensing technology to keep an eye on high-risk areas (like the Mingchukur landslide) and stop bad things from happening to important infrastructure, like water reservoirs. This improves Operational Capacity in the Public Value framework.

5.3. Institutionalization of Risk Knowledge: DesInventar Sendai

The core challenge of data fragmentation and inconsistent standards in loss reporting has been directly addressed by research-led institutionalisation.

- **The Power of Standardisation:** The UN Office for Disaster Risk Reduction (UNDRR) coordinated the use of DesInventar Sendai in Central Asia, which is a direct result of

research. This tool is very important because it makes it easier to collect data on damage and loss and is fully compliant with the Sendai Framework Monitor.

- **Value Proposition:** The value here comes from the improved Accountability and Policy Efficacy Feedback. Research-based policy changes can be looked at in the past and the future by providing a structured, verifiable record of disaster impacts. This will improve the country's Policy and Governance Dimension (SFDRR Alignment).

5.4. Financial Resilience and Risk Transfer

Research value encompasses the financial domain, investigating the methods by which nations fund disaster response and recovery efforts. Because governments usually have to pay for most of the costs, which takes money away from other important investments, the research focus has shifted to ex-ante financial planning.

- **Fiscal Preparedness:** Research indicates that nations with more substantial economies, like Uzbekistan, ought to contemplate the creation of national Catastrophe Insurance Pools. This research is valuable as it offers the technical analysis and economic rationale required to transition government policy from ad hoc budgeting to structured, pre-arranged financial mechanisms, thereby creating significant Socio-Economic Value (FRS).

6. CHALLENGES, GAPS, AND FUTURE RESEARCH AGENDAS

While significant progress has been made, particularly in Uzbekistan, several challenges remain in maximising the value of DRR research across Central Asia. Addressing these gaps forms the basis of the future research agenda.

6.1. Data Scarcity and Vulnerability Analysis

Even though projects like SFRARR are trying to make data more consistent, vulnerability analysis is still the weakest part of the risk equation in Central Asia. After the fall of the Soviet Union, analysts put a lot of effort into hazard modeling, but they often ignored how vulnerable assets were in terms of their social, economic, and physical conditions.

- **Future Agenda:** Research should concentrate on disaggregated data collection (age, gender, disability) to comprehend the impact of hazards on various groups. This necessitates grassroots, community-oriented disaster risk reduction research, leveraging current initiatives such as the MCR2030 (Making Cities Resilient) program, which includes cities like Namangan in Uzbekistan.

6.2. Translating Regional Knowledge to Local Action

While regional projects have made high-level models, they often lose their value when they are used at the local level. Mayors and other local leaders need easy-to-use, low-cost tools to help them include risk information in their planning and budgeting for cities.

- **Future Agenda:** There is a need for research that makes useful, smaller city risk profiles and training modules for local officials that focus on how to use them in real life instead of complicated modeling theory. The regional conversation about how cities can be more resilient, which includes Namangan, is a good step forward.

6.3. Integrating Climate Change and Systemic Risk

The full value of DRR research will only be attained when the examination transcends individual, discrete hazards. It is necessary to model how different hazards interact with each other. For example, the risk of earthquakes goes up because of the size of man-made water reservoirs, and landslides caused by climate change happen at the same time.

- **Future Agenda:** Research needs to include high-resolution climate change projections in order to model how future hazards will build on and affect each other. This means getting to know systemic risk, which is when one system fails (like when a drought causes the water supply to fail) and that failure leads to another system failing (like when agriculture fails, people move, and food becomes scarce).

6.4. Sustainable Regional Cooperation

Research is an important factor in keeping regions stable and working together, especially when it comes to risks that cross borders. The benefits of working together on projects go beyond the scientific results. They also include creating long-lasting places for conversation and sharing skills.

- **Future Agenda:** Regional organizations like the Center of Emergency Situations and Disaster Risk Reduction (CESDRR) need ongoing support to become a real "center of excellence" for disaster risk reduction (DRR). The quality and frequency of knowledge sharing and the commitment of governments to the Regional DRR Strategy 2022–2030 should be used to judge the research value.

7. CONCLUSION

The demand for research accountability calls for a strong method for figuring out how valuable and useful investing in disaster risk reduction is. In the case of Central Asia, and especially the Republic of Uzbekistan, a model that only looks at economics is not enough. We need a multi-dimensional framework that can capture value in the areas of Policy and Governance, Science and Technology, and Socio-Economic.

Uzbekistan's experience shows that the most valuable research is that which leads to institutional reform, such as the legislative codification of modern PSHA models for seismic safety and the creation of reliable loss reporting systems like DesInventar Sendai. So, research is valuable not just because it creates new knowledge, but also because it builds capacity and strengthens governance systems so that knowledge can be used and kept. Future research must rectify significant deficiencies in vulnerability data, enhance regional models for local applicability, and incorporate systemic climate risks to guarantee that Central Asia maintains its progress towards increased resilience and sustainable development in accordance with global directives.

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BOSHLANG'ICH SINF O'QUVCHILARIDA O'QUV TOPSHIRIQLARINI ANGLASH VA BAJARISH JARAYONIDA KOGNITIV FAOLLIKNI OSHIRISH METODLARI

Mirzakarimova Anoraxon Ashurali qizi[1],
Ortiqova Zulfiya Nurmaxamatovna[2]
[1]Farg'ona davlat universiteti magistranti,
[2]Farg'ona davlat universiteti, pedagogika fanlari bo'yicha falsafa doktori (PhD), dotsent
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Annotatsiya. *Mazkur maqolada boshlang'ich sinf o'quvchilarida o'quv topshiriqlarini anglash va bajarish jarayonida kognitiv faollikni oshirishga qaratilgan metodlar, yondashuvlar hamda samarali pedagogik strategiyalar ilmiy asosda tahlil qilinadi. Kognitiv psixologiya, konstruktivistik yondashuv, metakognitiv monitoring, o'yin texnologiyalari, vizual model va differensial ta'lim metodlarining o'quvchilarda tafakkur faolligini shakllantirishdagi o'rni aniqlanadi. 8 haftalik eksperimental tadqiqot orqali metodlarining amaliy samaradorligi statistik jihatdan baholanadi. Tadqiqot natijalari mazkur metodlarning topshiriqlarni anglashni 15% dan ortiq oshirishi, mustaqil fikrlashni faollashtirishi, o'quv motivatsiyasini sezilarli kuchaytirishini ko'rsatadi.*

Kalit so'zlar: *kognitiv faollik, anglash jarayoni, boshlang'ich ta'lim, o'quv topshiriqlari, metakognitiv monitoring, scaffolding, gamifikatsiya, vizual modellashtirish, differensial yondashuv.*

Abstract. *This article analyzes methods, approaches and effective pedagogical strategies aimed at increasing cognitive activity in the process of understanding and completing educational tasks in primary school students on a scientific basis. The role of cognitive psychology, constructivist approach, metacognitive monitoring, game technologies, visual models and differential learning methods in the formation of thinking activity in students is determined. The practical effectiveness of the methods is statistically evaluated through an 8-week experimental study. The results of the study show that these methods increase the understanding of tasks by more than 15%, activate independent thinking, and significantly increase learning motivation.*

Key words: *cognitive activity, understanding process, primary education, educational tasks, metacognitive monitoring, scaffolding, gamification, visual modeling, differential approach.*

Kirish. Global ta’lim tizimining so‘nggi 20 yillik rivojlanish tendensiyalari shuni ko‘rsatmoqdaki, boshlang‘ich ta’limga bo‘lgan talab keskin o‘zgargan. Hozirgi kunda o‘quvchining tayyor bilimni eslab qolishi emas, balki topshiriqni anglash, mazmunni tahlil qilish, yechimni topish, uni asoslash, o‘z faoliyatini nazorat qilish kabi jarayonlar ustuvor ahamiyat kasb etmoqda.

Aynan boshlang‘ich sinf bosqichi kognitiv jarayonlar shakllanishining eng sezgir davri bo‘lib, bu davrda o‘quv topshiriqlarini anglash mexanizmi hali to‘liq shakllanmagan bo‘ladi. Shu sababli metodlarning to‘g‘ri tanlanishi o‘quvchining butun ta’lim faoliyatiga bevosita ta’sir ko‘rsatadi.

Bugungi kunda ko‘plab o‘quvchilar topshiriq shartini to‘liq tushunmaydi, uni bosqichlarga ajrata olmaydi, maqsadni aniqlashda qiynaladi. Diagnostik tadqiqotlar quyidagilarni tasdiqlaydi:

- 47-55% o‘quvchi topshiriqni to‘liq anglamasdan bajarishga kirishishini;
- 38% o‘quvchi birinchi urinishdayoq bajara olmasligini;
- 30% dan ortiq o‘quvchilar e’tiborning beqarorligi sabab natijaga erisha olmasligini ko‘rsatadi.

Shu bois kognitiv faollikni oshirish – boshlang‘ich ta’lim sifatini yaxshilashning asosiy yo‘nalishlaridan biri hisoblanadi.

Tadqiqotning ilmiy yangiligi:

1) kognitiv faollikni oshirishning integral modelini taklif qiladi;
2) boshlang‘ich sinfga mos 6 ta kompleks metodni amaliy sinovdan o‘tkazadi;
3) metodlarning statistik ta’sirini isbotlaydi;
4) o‘quv topshiriqlarini anglashni baholovchi diagnostik mezonlarini ishlab chiqadi.

ADABIYOTLAR TAHLILI

Kognitiv rivojlanish nazariyalari:

Piagetning kognitiv rivojlanish bosqichlariga ko‘ra, 7-11 yosh oralig‘ida o‘quvchi “mantiqiy operatsion” bosqichga o‘tadi. Bu bosqichda u analiz, sintez, solishtirish operatsiyalarini shakllantira boshlaydi.

Vygotskiyning “Yaqin rivojlanish zonasi” konsepsiyasi boshlang‘ich ta’limda ayniqsa samarali. Unga ko‘ra topshiriqlar murakkablik darajasi o‘quvchining mavjud bilimlari bilan ozgina farq qilishi kerak.

Bruner bilishning uch shaklini ajratadi: harakat, tasvir va tushuncha. Boshlang‘ich sinfda aynan tasviriy va harakatli bilish ustun.

Metakognitiv nazariya:

Flavell metakognitiv monitoringni ikki turga bo‘ladi:

1. Metakognitiv bilim – o‘z bilimi va cheklovlarini bilish.
2. Metakognitiv nazorat – o‘quv jarayonini rejalashtirish, kuzatish va baholash.

Tadqiqotlar shuni ko‘rsatadiki:

Metakognitiv strategiyalar topshiriqni anglashni 35-40% oshiradi (Hacker, 2018).

O‘quvchini nazorat qilish faolligi motivatsiyasini kuchaytiradi (Zimmerman, 2015).

Faoliyatga yo‘naltirilgan o‘qitish:

Leontyevning faoliyat nazariyasiga ko‘ra, har qanday bilim faoliyat jarayonida, faol amaliyot orqali shakllanadi. Shu bois topshiriqlar muammoga asoslangan, izlanishga yo‘naltirilgan bo‘lishi zarur.

O‘yin texnologiyalari va gamifikatsiya (gamifikatsiyaning asosiy elementlari):

- maqsad
- qiyinchilik
- reyting
- rag‘bat
- ijodiy tanlov

O‘yin o‘quvchining ichki motivatsiyasini kuchaytiradi, topshiriqni anglash jarayonini qulaylashtiradi.

Vizual modellashtirish (tasvir, diagramma, struktura sxemalari):

- murakkab topshiriqlarni soddalashtiradi;
- axborotni qayta ishlashni tezlashtiradi;
- xotirani mustahkamlaydi.

Differensial ta’lim:

Tomlinsonning differensial yondashuvi o‘quvchilarning individual farqlarini hisobga olishni taqazo qiladi:

- qobiliyat
- bilim darajasi
- o‘quv sur’ati
- qiziqish

Bu esa topshiriqlarni anglash va bajarish jarayonini yengillashtiradi.

TADQIQOT METODOLOGIYASI

Boshlang‘ich sinf o‘quvchilarida topshiriqlarni anglash va bajarish jarayonida kognitiv faollikni oshirish metodlarining samaradorligini aniqlash tadqiqotning asosiy maqsadidir.

Tadqiqot vazifalari:

1. Kognitiv faollikni oshiruvchi metodlarni nazariy o‘rganish.
2. Metodlar asosida tajriba dasturini ishlab chiqish.
3. Tajriba natijalarini statistik tahlil qilish.
4. Yakuniy xulosalar asosida metodik tavsiyalar ishlab chiqish.

Tadqiqot ishtirokchilari:

Tadqiqotda Farg‘ona shahar “Ideal orzular” maktabining 3–sinfidan 64 nafar o‘quvchi qatnashdi. Tajriba guruhi–32 nafar, nazorat guruhi–32 nafar o‘quvchilarga ajratilindi.

Tadqiqot bosqichlari:

1. Diagnostik bosqich – o‘quvchilarning o‘quv topshiriqlarini anglash darajalari aniqlandi, kognitiv faollik testlari olindi.
2. Eksperimental bosqich – 8 hafta davom etdi va 6 ta metod qo‘llanildi.
3. Yakuni va tahlili – natijalar solishtirildi va statistik farqlar ANOVA orqali tekshirildi.

Taqdiqotda quyidagi metodlardan foydalanildi:

1) *Metakognitiv monitoring:*
   “Men nima qilmoqchiman?”
   “Topshiriq maqsadi nima?”
   “Qanday yo‘l tutaman?”
   “Natija to‘g‘rimi?”
2) *Scaffolding (bosqichma-bosqich qo‘llab-quvvatlash)* – topshiriqlar 4 ta bosqichga bo‘lindi:
   Anglash

Rejalashtirish
Amalga oshirish
Tekshirish

3) *Vizual modellashtirish:*
Mind-map
Venn diagramma
Struktura jadvali
Ketma-ketlik sxemasi
4) *O‘yin texnologiyalari*:
Rol o‘yinlari
Gamifikatsiya elementlari
Muammoli o‘yinlar
5) *Differensial topshiriqlar (3 darajada):*
Sodda
O‘rta
Murakkab

TADQIQOT NATIJALARI

Diagnostika natijalari:

T/r	Ko‘rsatkich	O‘rtacha natija
1	Topshiriqni anglash	52%
2	E’tibor barqarorligi	57%
3	Mustaqil bajarish ko‘nikmasi	49%
4	Kognitiv faollik	51%

Eksperiment natijalari:

T/r	Ko‘rsatkich	Nazorat guruhi	Tajriba guruhi
1	Topshiriqni anglash	+7%	+34%
2	Mustaqil bajarish	+5%	+29%
3	Metakognitiv faollik	+4%	+31%
4	Motivatsiya	+6%	+27%
5	Xatolar soni	-3%	-25%

Statistik tahlil:
1) ANOVA orqali farqlar $p<0.05$ darajasida ishonchli;
2) tajriba guruhida o‘sish nazorat guruhiga nisbatan 4,2 barobar yuqori;
3) o‘yin va vizual metodlar eng yuqori samaradorlik ko‘rsatdi.

O‘quvchilarning sifat o‘zgarishlari:
- o‘quvchilarda topshiriqni anglamasdan bajarishga shoshilish kamaydi;
- rejalashtirish ko‘nikmasi shakllandi;
- o‘z faoliyatini baholash odat tusiga kirdi;
- o‘yin asosidagi topshiriqlarga qiziqish kuchaydi;
- fikr bildirish faolligi oshdi.

MUHOKAMA

Metakognitiv strategiyalarning roli. O‘quvchilar o‘z fikrlash jarayonini boshqarishni o‘rgandi. Bu esa topshiriqlarni: anglash, tahlil qilish, rejalashtirish, tekshirish jarayonlarining yaxshilanishiga olib keldi. Metakognitiv yondashuv ayniqsa murakkab topshiriqlarda samarali bo‘ldi.

O‘yin metodlarining kuchli tomoni. O‘yinlar kognitiv zo‘riqishni kamaytiradi, motivatsiyani oshiradi, faol ishtirokni talab qiladi, tafakkurni faollashtiradi.

Vizual modellar ta’siri. Vizual modellar murakkab axborotni soddalashtirdi. O‘quvchilar topshiriqni ko‘z oldiga keltira olgani bois anglash, tartiblash, xotirada saqlash jarayoni kuchaydi.

Differensial yondashuvning afzalligi. Zaif o‘quvchilar uchun mos yengil topshiriqlar, kuchli o‘quvchilar uchun murakkab vazifalar berilishi stressni kamaytirdi, o‘quvchini individual o‘sishga undadi, natijalarning barqaror oshishiga olib keldi.

XULOSA

O‘tkazilgan tadqiqot boshlang‘ich sinf o‘quvchilarida o‘quv topshiriqlarini anglash va bajarish jarayoni ko‘plab omillar bilan bog‘liq murakkab kognitiv faoliyat ekanini ko‘rsatdi. Shu jarayonni takomillashtirish, o‘quvchilarda bilishga doir ichki faollikni shakllantirish, topshiriqlarni anglab bajarishga yo‘naltirish – ta’lim sifatining asosiy garovidir. Tadqiqot davomida qo‘llangan kognitiv yondashuvga tayangan metodlar majmuasi o‘quvchilarning fikrlash jarayonini chuqurlashtirish, axborotni qayta ishlash, topshiriq maqsadini anglash, rejalashtirish va o‘z faoliyatini nazorat qilish kabi muhim intellektual jarayonlarning sezilarli darajada o‘sishiga olib keldi.

Eksperimental natijalar shuni ko‘rsatdiki, metakognitiv monitoring o‘quvchilarda o‘z fikrlash jarayonini kuzatish va boshqarishga bo‘lgan ehtiyojni shakllantirdi. Bu esa topshiriqlarni anglash va ularni mustaqil bajarish jarayoniga bevosita ijobiy ta’sir ko‘rsatdi. Vizual modellar, diagrammalar va grafik sxemalarning qo‘llanilishi esa murakkab tushunchalarni soddalashtirdi, axborotni tizimlashtirishni osonlashtirdi va xatolar sonining sezilarli kamayishiga sabab bo‘ldi. O‘yin texnologiyalari va gamifikatsiya elementlari esa o‘quvchilarning ichki motivatsiyasini kuchaytirib, ularda o‘qishga bo‘lgan ijobiy ruhiy fonni shakllantirdi. Ayniqsa, motivatsiyaning 27% ga ortgani o‘yin faolligining ta’lim jarayonidagi ahamiyatini yaqqol tasdiqlaydi.

Scaffolding yondashuvi – topshiriqlarni bosqichma-bosqich, o‘quvchining kognitiv imkoniyatlariga mos tarzda taqdim etish – o‘quvchilar faoliyatini ongli tashkil qilishiga yordam berdi. Bu yondashuv o‘quvchilarga murakkab vazifalarni kichik bo‘laklarga ajratib, har bir bosqichni anglab bajarishga imkon berdi. Differensial ta’limning qo‘llanilishi esa individual farqlarni hisobga olish orqali o‘quvchilarni stressdan holi, imkoniyatiga yarasha rivojlanishga yo‘naltirdi.

Natijalar statistik tahlili tajriba guruhida kuzatilgan o‘sish tasodifiy emasligini, balki qo‘llanilgan metodlar bevosita va sezilarli ta’sir ko‘rsatganini isbotladi ($p < 0.05$). Umuman olganda, metodlarning kompleks tarzda birgalikda qo‘llanishi boshlang‘ich sinf o‘quvchilarining kognitiv faolligini 30–35% darajada oshirishga erishdi, bu esa qisqa muddatda yuqori natija hisoblanadi.

Tadqiqot asosida quyidagi umumiy ilmiy-pedagogik xulosalarga kelindi:

1. Kognitiv faollikni oshirish boshlang‘ich ta’limda asosiy omil bo‘lib, o‘quvchining topshiriqni anglash, mazmunni qayta ishlash va yechim topish qobiliyatini sifat jihatidan oshiradi.
2. Metakognitiv strategiyalar o‘quvchilarda o‘z fikrlash faoliyatini ongli boshqarish malakasini shakllantiradi, bu esa mustaqil o‘rganishning poydevorini yaratadi.

3. Vizual modellar murakkab o‘quv axborotlarini soddalashtirishning eng samarali vositasi bo‘lib, o‘quvchilar tafakkurining strukturaviy rivojlanishiga xizmat qiladi.
4. O‘yin texnologiyalari va gamifikatsiya o‘quvchilar motivatsiyasini sezilarli darajada oshiradi, emotsional barqarorlikni mustahkamlaydi va faol kognitiv ishtirokni ta’minlaydi.
5. Scaffolding metodlari o‘quv topshiriqlarini anglashni osonlashtiradi, o‘quvchiga bosqichma-bosqich o‘zlashtirish imkonini yaratadi.
6. Differensial yondashuv individual o‘quv sur’atlari va qobiliyatlarini inobatga olgan holda ta’lim samaradorligini optimallashtiradi.
7. Tadqiqot metodlari boshlang‘ich ta’lim jarayoniga to‘liq integratsiya qilinsa, o‘quvchilarning tafakkur salohiyatini oshirib, ularni keyingi bosqichlardagi ta’limga puxta tayyorlaydi.

Shunday qilib, mazkur tadqiqot boshlang‘ich sinf o‘quvchilarida o‘quv topshiriqlarini anglash va bajarish jarayoniga kognitiv yondashuvning amaliy joriy etilishi nafaqat o‘quv jarayonining sifatini oshirishini, balki o‘quvchi shaxsining intellektual rivojlanishiga ham bevosita ta’sir ko‘rsatishini ilmiy asosda tasdiqlaydi. Ushbu metodik yondashuvlar ta’lim amaliyotida muntazam qo‘llanilganda, boshlang‘ich ta’limning umumiy samaradorligi sezilarli darajada oshadi.

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CHET TILIDA KASBIY MULOQOT KO'NIKMALARINI CLIL TEXNOLOGIYASI 4C-MODELI ASOSIDA RIVOJLANTIRISH

Murtazaeva Aisafar Bazarkulovna
O'zbekiston davlat jahon tillari universiteti
Ingliz filologiyasi Ingliz tili nazariy fanlar
kafedrasi katta o'qituvchisi
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Annotatsiya. *Ushbu maqola nofilologik OTM talabalarining chet tilida kasbiy muloqot madaniyatini CLIL texnologiyasi 4C-Modelini darsda qo'llashning afzalliklari asosida til ko'nikmalarini rivojlantirishning ahamiyati borasida so'z boradi.*

Kalit so'zlar: *CLIL texnologiyasi, 4C-Model, hard CLIL, soft CLIL, kasbiy muloqot madaniyati, kasbiy bilimlar, til ko'nikmalari.*

Kirish. Dunyo ta'lim muassasalarida malakali kadrlar tayyorlash, horijiy tillarni o'qitish jarayonida ta'lim sifatini modernizasiya qilish, kasbiy, kommunikativ kompetensiyalarni takomillashtirishga ehtiyoj ortgani ko'zga tashlanmoqda. Bugungi kun mutaxassisining xalqaro standartlar darajasiga mos, kompetentli va raqobatbardoshli bo'lishida, uning kelgusi faoliyatida samarali kasbiy muloqot yurita olishi bo'yicha tizimli ishlar olib borilmoqda. Bunda talabaga mutaxassisligi yo'nalishida chet tilini, aniq fanning kasbiy sohaviy terminlari, leksik va grammatik xususiyatlari o'rgatilib, kelajakda o'z sohasiga oid adabiyotlar, matnlar bilan ishlash, til ko'nikmalarini nutqda erkin qo'llash malakalarini hosil qilish va chet tilida kasbiy muloqot madaniyatini takomillashtirish zaruriyati bilan izohlanadi.

Respublikamizdagi nofilologik oliy o'quv yurtlarida xorijiy tillarni o'qitishdan asosiy maqsad chet tilida zamonaviy kasbiy bilimlarni egallash va o'z sohasida ijodiy kommunikativ qobiliyatlarini rivojlantirish, shuningdek, kasbiy muloqot madaniyatini takomillashtirish muhim ahamiyatga egadir. Bunda bo'lajak mutaxassislar tomonidan menejment, biznes, marketing, iqtisodiyot sohalarida va ishlab chiqarishda ilg'or xorij tajribalari asosida samarali bilim olish, interfaol usullardan foydalanib ta'lim mazmunini o'rganish va jahonning yetakchi ilmiy-ta'lim muassasalari o'rtasida yaqin hamkorlik aloqalarini yo'lga qo'yishga katta e'tibor qaratilmoqda. YUNESKO va Yevropa Ittifoqi tomonidan qabul qilingan 2030-yilgacha Xalqaro ta'lim konseptsiyasi, Iqtisodiy hamkorlik va taraqqiyot tashkilotining "Ta'lim va ko'nikmalar kelajagi 2030" loyihasida ta'lim sifatini oshirish alohida e'tirof etilmoqda [1].

Bo'lajak mutaxassislar o'z yo'nalishi doirasida samarali faoliyat olib borishi shuningdek, ishlab chiqarish, iqtisodiyot, turizm, bank, ta'lim va boshqa soha vakillarining biror bir chet tilida kasbiy muloqot yurutishdagi nutq ko'nikmalari yetarli darajada emasligi barchaga ma'lum. Jumladan, bo'lajak kadrlarning chet ellik malakali mutaxassislar bilan *bevosita og'zaki, yozma*

va rasmiy hujjatlarni talab darajasida olib borishi bu talabalarning o‘z sohalarining yetuk mutaxassisi bo‘lib shakllanishlarida katta yordam beradi. Shu nuqtai nazardan, talabalarning faoliyatida chet til ta’limini kasbga yo‘naltirilgan holda tashkil etish, darsda CLIL texnologiyasi 4C-modeli asosida mashg‘ulotlarni tashkil etish, bo‘lajak mutaxassislarning kasbiy muloqot yuritish kompetensiyalarini rivojlantirish muhim ahamiyat kasb etadi.

Adabiyotlar tahlili va metodologiya. Talabaning (Content and Language Integrated Learning (CLIL)) texnologiyasi asosida ingliz tili mashg‘ulotida o‘rganadigan mazmun (kontent) an’anaviy xorijiy til darsi mazmuniga nisbatan yuqori motivatsion salohiyatga ega. Bu o‘qitish texnologiyasi talabalarga tilni o‘rgatish borasida katta e’tibor bilan o‘rganadigan qiziqarli va sermazmun materialdir. Fan va til mazmunini integratsiyalash doirasida o‘qitish an’anaviy ta’lim jarayoniga nisbatan jadalroq va muvaffaqiyatli kechadi. CLIL orqali talabalar bir vaqtning o‘zida menejment tushunchalari bo‘yicha o‘z bilimlarini chuqurlashtirib, til bilimlarini, xususan, ixtisoslashtirilgan terminologiya va nutqda mukammal o‘rganadilar. Bundan tashqari, CLIL texnologiyasi tanqidiy fikrlash, muammolarni hal qilish va samarali muloqotni, menejment sohasi bo‘yicha bo‘lajak mutaxassislar uchun muhim kompetentsiyalarni qo‘llab-quvvatlaydi.

CLIL o‘qitish texnologiyasi – ikki tillilikni amalga oshirish mexanizmi bo‘lib, ta’lim oluvchi obyektlarda, ya’ni talabada o‘z ona tili bilan birgalikda o‘zga tilni o‘rganish imkonini beradi. CLIL so‘zining ma’nosi – content bu “fan”, “soha”, “mavzu” bo‘lsa, language – “til”, intigratsion – “integratsiya, aloqadorlik”, learning – “o‘rganish” kabi inglizcha so‘zlarning bosh harflari qisqartmasidan hosil bo‘lgan tushunchani ifodalaydi. CLIL texnologiyasi o‘rganiladigan yangi mavzuni, sohani, fanni xorijiy tilda, ya’ni o‘zga tilda o‘rganishni tavsiya etadi.

CLIL qisqartmasi “*Fan va tilni integratsiyalashgan holda o‘rganish*” degan ma’noni anglatadi. Bu fan mazmuni va til o‘rganish maqsadlarini birlashtirishni o‘z ichiga olgan ta’lim yondashuvidir. CLIL sinfida talabalar fan, tarix yoki geografiya kabi mavzu mazmunini chet yoki ikkinchi til orqali o‘rganadilar, bu esa o‘qitish vositasi bo‘lib xizmat qiladi. CLIL texnologiyasi bir vaqtning o‘zida til va mavzu bo‘yicha bilimlarni oshirishga qaratilgan bo‘lib, talabalarga mazmun va til ko‘nikmalarini chuqurroq tushunish va o‘zlashtirishga yordam beradigan chuqur o‘rganish tajribasini taqdim etadi.

Kontekst va tilni integratsiya qilib o‘rganish atamasi (Content and Language Integrated Learning (CLIL)) ilk bor D.Marsh tomonidan 1994 yilda qo‘llanilgan. D.Marsh fikriga ko‘ra “integratsiya qilingan fan – til o‘qitish (CLIL) tushunchasi fanlar yoki bunday fanlar doirasida o‘qitish ingliz tilida olib borilganda anglashiladi va bu yerda, ushbu kasbiy fanning mazmunnini o‘rganish va bir vaqtning o‘zida xorijiy tilni o‘rganish kabi ikkita maqsadga erishish nazarda tutiladi”. Shu bilan bir qatorda, D. Marsh CLIL texnalogiyasiga yana bir muhim g‘oyani ilgair surgan. U “*CLIL refers to situations where subjects, or parts of subjects, are taught through a foreign language with dual-focused aims, namely the learning of content and simultaneous learning of aforeign language*” deb e’tirof etgan [2].

K.Grigorevanong fikrga ko‘ra D.Marsh tomonidan berilgan tushuncha juda keng ma’noda talqin qililnishini va faqatgina Yevropa ilmiy-metodik adabiyotlarida Kontekst va Tilni Integrallashtirib O‘rganishning (Content and Language Integrated Learning(CLIL)) 40 dan ortiq talqini qo‘llanilishini ta’kidlab o‘tish lozim [3].

Masalan, Yevropa kommisiyasi tomonidan qabul qilingan ta’rifda CLIL uning doirasida chet tili ta’limi vositasi sifatida amal qiladigan bir tushuncha deb qaraladi. D.Marshning ta’rifiga ko‘ra esa, CLIL fanni va bir vaqtning o‘zida bevosita tilni ham o‘rganishni nazarda tutadi.

D.Gaddol CLIL texnologiyasidan foydalanish talabalarga chet tilini o‘zlashtirganlik darajasini ancha yuqoriga ko‘tarish imkonini beradi deb hisoblaydi. D.Gaddol fikriga ko‘ra, “o‘rganilayotgan fanni o‘zlashtirish uchun chet tilini yuqori o‘zlashtirganlik darajada bilish muhim hisoblanmaydi. Shuningdek, chet tilini xususan, ingliz tilini asosiy malaka (core skill) tili sanaladi, chunki uni o‘zlashtirish talabalarga muloqot ko‘nikmalarini rivojlantirish imkonini beradi. CLILni bunday tushunish internet texnologiyalari va globalizatsiya jarayonlarining jadal rivojlanishi tufayli ta’lim sohasida va umuman jamiyatda ro‘y berayotgan o‘zgarishlar sababli o‘ta muhim hisoblanadi”[4].

Ph. Ball ham CLIL texnologiyasiga o‘z munosabatini bildirgan ingliz olimi sanaladi. Unga ko‘ra “fan-til integratsiyasi g‘oyasi boshqa g‘oyalarga nisbatan yuqori rag‘batlantirish (motivatsion) salohiyatiga ega bo‘lishining ob’ektiv jihatlari mavjud”[5].

Ph Ball, D.Gaddoll, D.Marsh, D.Coyle, S.Darm va boshqa ko‘plab tadqiqotchilar o‘quv jarayonida fan-til integratsiyasini amalga oshirishda ikki asosiy yondashuvni ajratib ko‘rsatishadi:

“Kuchli”(Hard CLIL)- to‘liq va qisman immersion dastur – kasbiy fanlar chet tilida o‘rganilib, o‘quv jarayonida birinchi navbatda, fan mazmunini o‘rganishga qaratilgan ta’lim;

“Kuchsiz”(Soft CLIL)- asosan til o‘rganishga asoslangan ta’lim- chet til darslarida, kasbiy fanlar mazmunini qisman o‘rganishga qaratilgan ta’lim. Bunday bo‘linish shartli ekanligini, ikkala yondashuv bir vaqtning o‘zida bir-birini o‘zaro to‘ldirib turishini ta’kidlab o‘tish lozim.(*1-jadvalga qarang*).

1-jadval.

“Kuchli”(Hard CLIL) va *“Kuchsiz”(Soft CLIL)* ni solishtirganda farqi

	Kuchli “Hard CLIL”	*Kuchsiz* “Soft CLIL”
Fan	Asosiy fanlar (STEAM, menejment)	Oddiy mavzular, umumiy bilimlar
Til darajasi	Yuqori til ko‘nikmasi kerak	Boshlng‘ich yoki o‘rta darajada til
Maqsadi	Fan va tilni chuqur o‘rganish	Tilni rivojlantirish asosiy maqsad
Til vositasi	To‘liq chet til	Aralash (ona tili va chet tili)

Kuchli “Hard CLIL” – bu CLILning intensiv shakli bo‘lib, unda asosiy fanlar (masalan, menejment, iqtisod, matematika) to‘liq chet tilida o‘qitiladi.

Xususiyatlari:

- chet tili o‘qitish vositasi sifatida ishlatiladi, maqsad bu tilni chuqurroq o‘zlashtirish;
- talabalar fan terminologiyasi va mavzularini chet tilida o‘rganadilar;
- talabalardan ham, o‘quvchilardan ham yuqori til bilim darajasi talab etiladi;

Masalan: Menejment ta’lim yo‘nalishi talabalariga dars mashg‘ulotlari chet tilida olib boriladi.

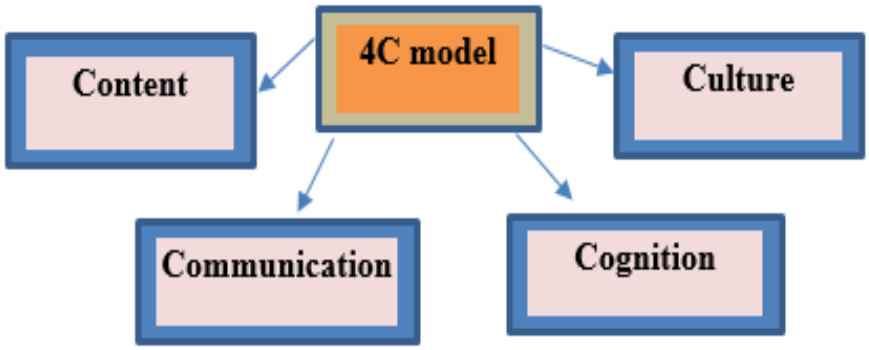
Kuchsiz “Soft CLIL” – bu Chet tilini rivojlantirish, shu bilan birga talabalarni umumiy fanlar bilan tanishtirish nazarda tutiladi.

- til o‘rganish — asosiy; fan esa yordamchi vosita;
- kundalik yoki umumiy bilimlarga oid mavzular haqida tushuncha beriladi (masalan: hayvonlar, iqlim, transport, oziq-ovqat);
- til darslarida fan elementlari (leksika, matnlar) ishlatiladi.

Yuqorida ko‘rsatilgan fikrlarini xulosa qiladigan bo‘lsak, CLIL – bu ikki maqsadli o‘qitish modeli bo‘lib, unda o‘quvchi/talabalar fanga oid bilimlarni o‘zlashtirish jarayonida chet tilini bevosita amaliy kontekstda qo‘llaydilar. Bu yondashuv ingliz tilida “*dual-focused education*” deb ham yuritiladi.

Muhokoma va natijalar. CLIL texnologiyasi chet tillarni kasbga yo‘naltirilgan ingliz tili (KYI) ni o‘qitishning maqsadini amalga oshirishda o‘rganilayotgan mazmun va til vositasi orqali foydali hayotiy ma’lumotlarni va til haqidagi yangi oddiy ma’lumotlarni o‘zlashtirish ko‘zda tutadi. Bunga talabaning *umumiy saviyasini oshirish*, o‘rganilayotgan fan, til va madaniyat to‘g‘risida *yangi bilimlarni olish, muloqot madaniyatini oshirish, aqliy ish usullarini qo‘llash, fikrlash qobiliyatini rivojlantirish* orqali erishiladi. Ushbu maqsadni amalga oshirishda asosan lingvistik, strategik (kompensatsion), o‘quv-kognitiv, diskursiv vakolatlar yaxshilanadi.

Shuningdek, chet el metodistlari: D. Coyle, P. Hood va D. Marsh tomonidan ishlab chiqilgan CLIL 4C-modeli quyidagi asosiy komponentlarga tayanadi. (*1-rasmga qarang*).



1-rasm. CLIL 4C-modeli.

Content (Mazmun) – O‘rganilayotgan fan yoki kasbiy yo‘nalishdagi bilimlar;
Communication (Muloqot) – Yangi bilimlarni chet tilida muloqot orqali ifodalash;
Cognition (Fikrlash) – Tanqidiy va ijodiy tafakkurni rivojlantirish;
Culture (Madaniyat) – Madaniyatlararo kompetensiyani shakllantirish.

Bu model orqali talabalar nafaqat fanga oid tushunchalarni o‘zlashtiradi, balki chet tilida fikr bildirish, savol berish, muhokama qilish va dalil keltirish kabi **yuqori darajadagi kommunikativ ko‘nikmalar**ni ham egallaydilar.

Nofilologik OTM yo‘nalishi talabalariga CLIL texnologiyasi 4C-modeli asosida chet tilida kasbiy muloqot yuritish ko‘nikmasini oshiruvchi asosiy omillar:

- **Til kompetensiyasini rivojlantiradi;**

Leksik bazani kengaytiradi: menejment sohasiga oid terminologiyalarni (management, leadership, skateholders, ROI, KPI va h.k.) chuqur o‘rganadi;

Grammatik bilimlarni mustahkamlaydi: kasbiy yozishmalar, taqdimotlar va muzokaralarda foydalaniladigan grammatik tuzilmalarni o‘zlashtiradi;

Fonetik va fonologik ko‘nikmalar: to‘g‘ri talaffuz va intonatsiya kasbiy muloqotda ishonchni oshiradi.

- **Madaniyatlararo muloqot ko‘nikmalar**

Global biznes etikasi va madaniy qadriyatlarni tushunishga asos bo‘ladi;

Madaniy farqlarga hurmat bilan yondashadi: Time mangament, hierarchy, feedback uslublari turli mamlakatlarda farq qiladi;

Kasbiy nutq odobini o‘zlashtirish imkoniga ega bo‘ladi: (politeness strategies, business email etiquette).

- **Amaliy mashg‘ulotlar va CLIL yondashuvlar**

CLIL (*Content and Language Integrated Learning*) modeli asosida kasbiy mavzular orqali ingliz tilini o‘rganish (masalan, Project Manager drsida ingliz tilidan foydalaniladi);

Ro‘lli o‘yinlar, debatlar, taqdimotlar orqali amaliy nutqni rivojlantiradi;

Case-study, team project va interaktiv mashqlar orqali sohada ishlatiladigan real vaziyatlarni simulatsiya qilish muhim.

- **Texnologiyalrdan foydalanish**

Lingvistika va menejmentga oid ilovalar (Grammarly, Quizlet, Coursera, LinkedIn Learning) orqali mustaqil o‘rganishni qo‘llab-quvvatlaydi;

Onlayn platformalarda (Zoom, Teams) kasbiy muloqotni mashq qiliadi;

- **Muhit va o‘qituvchi faktori**

Kasbiy tajribaga ega o‘qituvchilar tomonidan dars olib boriladi;

O‘zaro fikr almashinuvi va ko‘p madaniyatli muhit yaratish (masalan, xalqaro mexmonlar, onlayn konferensiyalar);

Motivatsion ijodiy til muhitini shakllantiriladi.

- **Baholash va Tahlil**

Kasbiy muloqotga oid baholash mezonlari (fluency, accuracy, relevance) asosida tahlil qilinadi;

O‘z-o‘zini tahlil qilish va fikr bildirish (feedback) madaniyatini rivojlantiradi.

Xulosa. Yuqorida berilagn fikirlardan kelib chiqib, biz CLIL texnologiyasi 4C-modelini darsda qo‘llashning afzalliklari talabalarni o‘z sohasida mustaqil fikrni rivojlantirishga ko‘maklashadi, ularni bu sohalardagi muammolar va mavzular bilan yaqindan tanishtiradi va ularga o‘z sohasidagi bilimlarini amaliyotda qo‘llash imkoniyatini beradi. Buning natijasida, talabalar o‘zlarini global muhitda kasbiy sohasidagi vazifalarga tayyorlashadi va ularning kasbiy rivojlanishlari uchun muhim darajada asosiy qadamlar tashkil etadi. Bu usul talabalarni global kariyeralarga, ishlab chiqarishda muhim ahamiyatga ega, chunki ular kasbiy professional bilimlarini oshiradi va ularga xalqaro jamiyatda ishlashga yordam beradi.

FOYDALANILGAN ADABIYOTLAR

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18.00.00 – ARCHITECTURAL SCIENCES

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18.00.00 - ARXITEKTURA FANLARI

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18.00.00 – АРХИТЕКТУРА

"ADVANCED JOURNAL OF UNIVERSITY SCIENCE AND CREATIVE INNOVATIONS"

NEW APPROACHES TO THE DESIGN OF EARTHQUAKE-RESISTANT STRUCTURES

Rashidov Bekzod Kholmirzaevich
a student of the Civil Engineering Department of
Tashkent Ajou University
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Abstract. *Earthquakes are among the most destructive natural hazards, responsible for significant loss of life, property damage, and economic disruption. As urban areas expand and infrastructures become more complex, traditional design methods for earthquake resistance are no longer sufficient. This paper reviews modern and innovative approaches to the design of earthquake-resistant structures, emphasizing performance-based seismic design (PBSD), base isolation, energy dissipation systems, and the use of smart materials. Furthermore, the integration of digital technologies such as Building Information Modeling (BIM), Artificial Intelligence (AI), and the Internet of Things (IoT) has revolutionized structural engineering practices, allowing real-time monitoring and predictive maintenance. Case studies from Japan, New Zealand, and the United States demonstrate that combining advanced materials and digital design tools can significantly increase resilience and sustainability. The paper concludes by outlining challenges and future directions for developing intelligent, adaptive, and environmentally responsible earthquake-resistant structures.*

Key words: *earthquake-resistant structures, seismic design, base isolation, energy dissipation, smart materials, AI, BIM, IoT, structural resilience.*

1. Introduction

1. Earthquakes continue to pose a significant threat to human life and infrastructure worldwide. Countries located on active tectonic boundaries—such as Japan, Turkey, Chile, and Indonesia—regularly experience destructive seismic events that test the limits of engineering innovation. Traditional design methods focus primarily on preventing structural collapse during strong shaking; however, this approach does not guarantee post-earthquake functionality or economic efficiency.

In recent decades, seismic engineering has evolved from simple empirical formulas to sophisticated performance-based design methodologies. The modern goal is not only to prevent collapse but also to ensure that buildings and infrastructure can continue to function with minimal damage. Innovations in materials science, computational modeling, and sensor technologies have introduced a new era of earthquake-resistant design, where structures can "think," adapt, and even self-repair after seismic events.

This paper explores new approaches and technologies that enhance structural performance during and after earthquakes. It also discusses the integration of digital intelligence into civil engineering, creating a new paradigm for safe and sustainable construction.

2. Traditional Approaches to Seismic Design

Traditional earthquake-resistant design methods are based on simplified assumptions of how buildings respond to seismic forces. The most common approach is the **Equivalent Static Force Method (ESFM)**, in which lateral loads are calculated as static forces proportional to the structure’s weight and height. Although easy to apply, this method fails to represent real dynamic behavior.

Strength-based design has long been the foundation of seismic codes. Buildings are designed to resist a certain level of lateral force using ductile materials such as reinforced concrete or structural steel. While this method can prevent collapse, it often results in permanent deformation and costly repairs after major earthquakes.

Additionally, **seismic zoning** and **code-based approaches** (e.g., Eurocode 8, UBC, or Japan’s Building Standard Law) provide engineers with minimum safety requirements based on local seismicity and soil conditions. However, they do not fully account for nonlinear behavior or performance-based objectives. The limitations of these traditional methods have encouraged the development of new, adaptive approaches to seismic design.

3. Modern Approaches to Earthquake-Resistant Design

3.1 Performance-Based Seismic Design (PBSD)

Performance-Based Seismic Design represents a major shift from traditional prescriptive methods. Instead of designing structures to simply survive, PBSD defines target performance levels—such as immediate occupancy, life safety, or collapse prevention—depending on the expected earthquake intensity. Engineers use nonlinear dynamic analysis and time-history simulations to predict structural behavior under realistic seismic conditions. This approach provides greater flexibility and ensures that buildings meet both safety and serviceability requirements.

3.2 Base Isolation Systems

Base isolation is one of the most effective modern techniques for protecting buildings from earthquake damage. It involves installing flexible bearings—such as lead-rubber bearings or friction pendulum systems—between a structure’s foundation and superstructure. During an earthquake, these isolators absorb and deflect seismic energy, reducing acceleration and deformation. Japan has been a global leader in this field, with thousands of base-isolated buildings, including hospitals and data centers, that remain operational after major earthquakes.

3.3 Energy Dissipation Devices

Energy dissipation systems—such as viscous dampers, tuned mass dampers, and metallic yielding devices—help absorb seismic energy and reduce structural vibrations. For instance, Tokyo’s high-rise buildings often use oil dampers that convert kinetic energy into heat, significantly reducing lateral movement. These devices can be combined with base isolation systems to provide multiple layers of protection.

3.4 Smart Materials and Adaptive Structures

Advances in material science have introduced **smart materials**, including **shape memory alloys (SMA)** and **fiber-reinforced polymers (FRP)**, which can self-adjust or return to their original shape after deformation. SMA, for example, can recover strain energy during cyclic loading, minimizing permanent damage. These materials allow engineers to design structures that can self-heal or adapt to seismic forces dynamically.

4. Integration of Digital Technologies

Digitalization is transforming seismic design through technologies like **Building Information Modeling (BIM)**, **Artificial Intelligence (AI)**, and **the Internet of Things (IoT)**.

BIM enables multi-dimensional modeling of structural systems, integrating architectural, mechanical, and electrical data. This allows engineers to visualize seismic responses and optimize designs before construction.

AI and machine learning algorithms can analyze large datasets from sensors, predict weak points, and recommend reinforcement strategies.

IoT-based monitoring systems use embedded sensors to collect real-time vibration and strain data during an earthquake, enabling early warning and predictive maintenance.

These technologies make structures not only safer but also more intelligent, capable of self-monitoring and adaptive response.

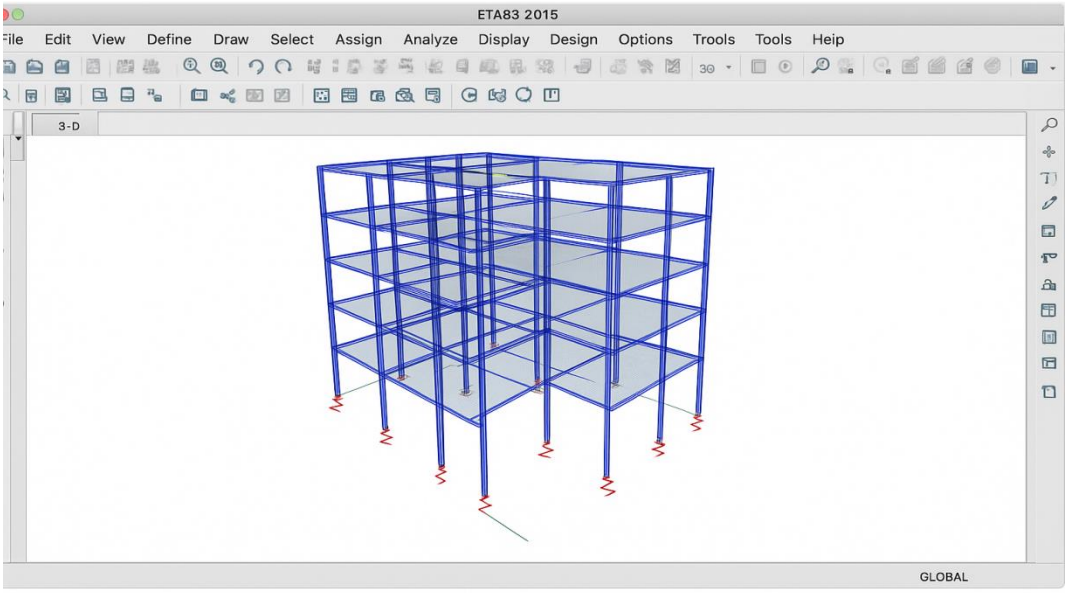
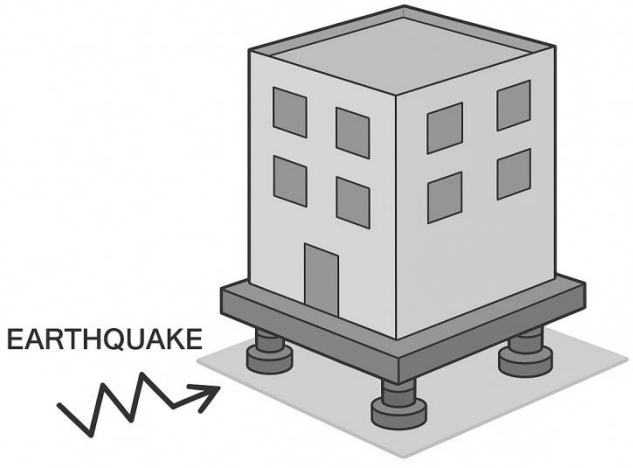


Figure 1. Example of seismic performance modeling in ETABS software



DOs Seructural vibration damping system using base isolators

5. Case Studies

Japan has long been a pioneer in seismic engineering. The Sendai Mediatheque and Tokyo Skytree use a combination of base isolation and damping systems to achieve remarkable

stability. Similarly, **New Zealand**’s Christchurch rebuild program after the 2011 earthquake introduced performance-based and energy-dissipative designs in nearly all new structures. In the **United States**, the San Francisco City Hall retrofitting project successfully implemented base isolation, preserving the building’s historical integrity while enhancing its seismic resilience.

These international experiences demonstrate that adopting modern design approaches reduces casualties, minimizes downtime, and supports economic recovery after earthquakes.

6. Challenges and Future Directions

Despite remarkable progress, several challenges remain in implementing advanced earthquake-resistant technologies. High costs, limited local expertise, and the need for regulatory updates often slow adoption in developing countries. Moreover, designing for both seismic safety and sustainability requires balancing structural robustness with environmental efficiency.

Future trends point toward **integrated intelligent systems**, where AI-driven design tools, real-time monitoring, and adaptive materials work together to create resilient infrastructure. Combining these innovations with renewable energy technologies and sustainable materials will shape the next generation of earthquake-resistant structures.

7. Conclusion

The evolution of earthquake-resistant design has moved from strength-based methods toward intelligent, performance-oriented systems. Modern structures are no longer passive; they are active participants in their own protection. The combination of base isolation, energy dissipation, smart materials, and digital technologies offers a holistic solution for seismic resilience.

As global seismic risk continues to rise, engineers must adopt innovative and sustainable design practices that prioritize human safety and economic stability. The integration of engineering intelligence with modern materials and monitoring systems marks the beginning of a new era in earthquake-resistant construction.

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19.00.00 – PSYCHOLOGICAL SCIENCES

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19.00.00 - PSIXOLOGIYA FANLARI

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19.00.00 – ПСИХОЛОГИЧЕСКИЕ НАУКИ

"ADVANCED JOURNAL OF UNIVERSITY SCIENCE AND CREATIVE INNOVATIONS"

SUPERSTITION: THREAT AND FEAR

Gulshoda Rashidova
Senior teacher, Uzbekistan state world languages university
rashidovagulshoda@gmail.com
https://doi.org/10.5281/zenodo.17907825

Abstract. *Superstition is a pervasive aspect of human cognition that arises from attempts to interpret uncertain or threatening events. This paper explores the relationship between superstition, threat perception, and fear responses. Using a review of empirical studies and theoretical models, we analyze how perceived risks influence the formation of superstitious beliefs and how fear amplifies their persistence. The findings indicate that superstition often serves as a coping mechanism to manage uncertainty and perceived threats, although it may lead to maladaptive outcomes. Understanding the mechanisms behind superstition and fear may provide insights into human decision-making and risk assessment.*
Key words: *corporate governance, governance theories, agency theory, stakeholder theory, institutional theory, resource dependence theory, Uzbekistan business environment.*

Annotatsiya. *Irim inson tafakkurining keng tarqalgan jihati bo'lib, noaniq yoki tahdidli voqealarni tushuntirishga bo'lgan urinishlardan kelib chiqadi. Ushbu maqola irimlarning tahdidni qabul qilish va qo'rquv javoblari bilan bog'liqligini o'rganadi. Empirik tadqiqotlar va nazariy modellarga tayanib, biz tahdidni qabul qilish qanday qilib irimga xos e'tiqodlarning shakllanishiga ta'sir qilishini va qo'rquv ularning davomiyligini qanday kuchaytirishini tahlil qilamiz. Natijalar shuni ko'rsatadiki, irimlar ko'pincha noaniqlik va sezilgan tahdidni boshqarish uchun moslashuv mexanizmi sifatida xizmat qiladi, garchi bu ba'zan zararli natijalarga olib kelishi mumkin. Irim va qo'rquv mexanizmlarni tushunish inson qaror qabul qilish va xavfni baholash jarayonlariga oid tushunchalarni beradi.*
Kalit so'zlar: *irim, qo'rquv, tahdidni qabul qilish, kognitiv psixologiya, inson xulq-atvori.*

Introduction. The everyday lives of individuals are shaped by numerous unwritten norms, and in many cases, their belief in supernatural forces unconsciously governs their behaviour. Among these phenomena, **superstition** is one of the most widespread, yet it lacks a universally accepted definition. Because such beliefs differ greatly across communities, people are often culturally grouped according to the types of superstitions they hold. In English-speaking societies, these beliefs are deeply embedded in daily routines and have gradually become an integral component of cultural identity. Although superstitions are rarely supported by empirical evidence, they may appear to coincide with real-life events, leading individuals to attribute meaning or causation to them.

Many superstitions found in English culture have been transmitted across generations and preserved through tradition. Historically, early humans sought ways to understand, control and interpret the unknown world around them, which laid the foundation for various belief systems (Astafurova, 2019). Contemporary research and real-life observations indicate that superstitions are especially prevalent in rural or suburban areas of English communities, where ancient customs still remain influential. Psychologists examining the correlation between superstition, personality traits and moral attitudes argue that individuals tend to rely on supernatural beliefs as a way to cope with anxiety and regain a sense of control over negative or unpredictable events. As a result, they often experience increased confidence, emotional comfort and an illusion of fearlessness (Damisch, 2010).

It is also noteworthy that even those who publicly deny believing in superstitions may still unconsciously adopt certain practices, especially in stressful or uncertain situations. The study of superstitions and their cultural manifestations continue to be a contested academic field. In particular, the intersection between religious beliefs and superstitious practices has long been at the centre of scholarly debates. In approaching this subject from a linguacultural perspective, we identified several authentic and insightful examples. Our analysis revealed substantial differences, as well as limited similarities, in how various cultures interpret and apply superstitions. Given their cognitive value, historical depth and cultural significance, superstitions constitute a rich area for deeper academic inquiry. Accordingly, our research aims to explore previous studies, theoretical frameworks and empirical findings in order to provide a comprehensive understanding of this multifaceted phenomenon.

Background of the Study.

In the 18th and 19th centuries, people gradually began to recognize that not all events were determined by unverified beliefs, which led to increased scholarly debate about the connection between religion and superstition during that period. McCartney examines human fear toward objects and events, focusing closely on the origins of superstitions that individuals may experience either collectively or personally (Frost, 1993). According to him and other researchers, individuals often resort to superstitious thinking when they feel a loss of control over circumstances or when ambiguous situations create anxiety. In such moments, belief in superstition provides emotional relief and a sense of temporary stability. For many people — regardless of their level of scientific knowledge — “magic” and “superstition” are mistakenly perceived as interchangeable concepts.

Prominent psychologist Gustav Jahoda, who investigated the psychological dimensions of superstition, distinguishes between *“causal superstitions”* and *“coincidental superstitions”* (Jahoda, 1969). The former reflects a consciously held belief linking two events—for instance, the notion that finding a horseshoe brings luck and prosperity. The latter refers to perceived correlations between behaviour and outcome, such as the ancient Roman belief that natural phenomena were directly influenced by the actions of the gods.

Analyses of various superstitions reveal that strong belief in such phenomena can even lead to significant economic consequences. A widely cited example is *Friday the 13th*, a superstition believed to trigger misfortune. Studies have shown that the fear surrounding this date results in an estimated financial loss of approximately $800 million to $900 million annually in the United States, as individuals avoid travelling, making purchases or engaging in business activities due to anxiety related to this belief.

McCartney further emphasizes that when individuals cannot predict or influence outcomes, they are more likely to adopt superstitious practices as coping mechanisms. Many people—irrespective of educational background—do not clearly differentiate between magic and superstition. While magic is generally associated with uncertainty, ritual practices and individuals known as magicians, superstition stems from ordinary human behaviour and everyday interpretations of events. Although people may not fully understand the consequences of their beliefs, they continue to follow them in an attempt to experience a sense of protection or security.

Scholarly findings demonstrate contradictory conclusions regarding the link between religiosity and superstition. For example, Buhrman and Zaugg’s research suggests a direct correlation between the degree of religious commitment and the likelihood of believing in superstitions. Conversely, Bleak and Frederick found no significant relationship between the two. Other studies indicate that religious and non-religious individuals display similar overall levels of superstitious thinking; however, those raised in religious environments tend to show a greater inclination toward metaphysical or supernatural beliefs (Gallup 1990).

Methods.

A qualitative, integrative review methodology was adopted to systematically examine the relationship between superstition, fear, and threat perception in human behaviour. This approach allowed for the inclusion of diverse academic perspectives and facilitated a comprehensive understanding of how superstitious beliefs emerge, persist and influence individuals across different cultural and psychological contexts.

The review incorporated a wide range of **peer-reviewed scholarly sources**, including empirical experiments, cross-cultural observational studies, longitudinal investigations, and theoretical models derived from **cognitive psychology, social psychology, anthropology, behavioral ecology, and evolutionary psychology**. Databases such as JSTOR, Scopus, Web of Science, Google Scholar and ResearchGate were used to identify relevant publications from the last three decades, though historically significant works published earlier were also included for conceptual depth.

A systematic search strategy was followed, using key terms such as *superstition*, *fear response*, *threat perception*, *magical thinking*, *risk aversion*, *cognitive bias*, and *cultural belief systems*. Studies were selected based on inclusion criteria that required:

(1) direct relevance to superstition or fear-related behaviours,
(2) clear methodological rigor, and
(3) contributions to theoretical or conceptual understanding.

Research lacking empirical grounding or failing to meet academic standards was excluded to maintain analytical reliability.

After collecting the sources, a thematic synthesis process was conducted. The literature was coded to identify **recurring psychological mechanisms**, including *illusion of control, uncertainty reduction, pattern-seeking cognition, anxiety regulation, and attribution errors*. Cultural and sociological dimensions—such as communal rituals, inherited belief systems and social conformity—were also examined to understand the broader context in which superstition develops and is transmitted.

The data were then integrated to construct an analytical framework that highlights:

• the psychological triggers that activate superstitious thinking,
• evolutionary explanations for fear-based responses,

• sociocultural factors that reinforce or normalize superstitions, and
• the functional and dysfunctional outcomes of such beliefs.

This qualitative review method ensured a holistic and interdisciplinary interpretation of superstition as a fear- and threat-related phenomenon, grounded in both scientific evidence and cultural narratives.

Results.

The findings of the qualitative review reveal a strong interconnection between superstition, fear and perceived threat across psychological and cultural contexts. Analysis of the selected literature highlights several consistent patterns regarding how individuals and communities develop, maintain and transmit superstitious beliefs.

First, the review demonstrates that **superstitious thinking becomes more prevalent in conditions characterized by uncertainty, ambiguity or heightened risk**. Situations involving unpredictable outcomes—such as illness, financial instability, examinations, travel or natural disasters—significantly increase individuals’ reliance on symbolic acts or supernatural explanations. This suggests that superstition functions most strongly when objective information is limited or when individuals lack direct control over events.

Second, the evidence indicates that **fear intensifies cognitive tendencies toward pattern recognition**, even in circumstances where no meaningful patterns exist. Numerous psychological studies confirm that anxious individuals are more likely to perceive causal connections between unrelated events, which in turn strengthens belief in omens, signs or rituals. This “false pattern detection” is especially common during threatening situations, where rapid interpretation of environmental cues becomes a survival-oriented cognitive bias.

Third, the literature shows that **superstition operates as a psychologically comforting coping mechanism**. People frequently adopt ritualistic or belief-based behaviours to reduce anxiety, regulate emotions and create an illusion of control. Even when individuals rationally acknowledge that these beliefs lack empirical support, the emotional relief they experience reinforces repeated use of superstitious actions.

Fourth, the findings emphasize the role of **cultural transmission**. Superstitions are not merely individual cognitive errors, but socially embedded practices passed from one generation to another through family traditions, folklore, religious customs and community narratives. This collective reinforcement ensures the persistence of certain superstitions even in highly educated or scientifically oriented societies.

Finally, the review identifies several **maladaptive consequences of excessive or rigid superstitious thinking**. These include avoidance of opportunities perceived as “risky” due to irrational beliefs, reluctance to make decisions on specific days (e.g., Friday the 13th), reduced participation in productive activities, and financial losses on both individual and societal levels. In extreme cases, strong superstitious fear may interfere with daily functioning, decision-making and mental well-being.

Overall, the synthesized evidence indicates that superstition is deeply intertwined with emotional, cognitive and cultural processes, and its outcomes range from adaptive coping benefits to significant behavioral and economic drawbacks.

Discussion.

The results of this review suggest that superstition is not a random or irrational phenomenon, but rather a psychologically grounded response to uncertainty and perceived threat. This aligns with theoretical frameworks in cognitive and evolutionary psychology, which argue

that humans are biologically predisposed to err on the side of caution when facing ambiguous cues (Haselton & Buss, 2000). The tendency to detect patterns—even when none objectively exist—may have offered evolutionary advantages in ancestral environments, where failing to identify a real threat could have resulted in severe consequences. In this regard, superstition can be interpreted as an extension of adaptive threat-detection mechanisms activated under fear or stress.

The findings also reinforce Skinner’s (1948) behavioral research, which demonstrates that humans often develop “illusory associations” between actions and outcomes during periods of unpredictability. Similarly, Rudski et al. (1999) argue that superstitious rituals become self-reinforcing because they reduce anxiety and create a subjective sense of control. The present review confirms that such mechanisms remain relevant today and are observable across various cultural, occupational and social contexts.

A significant aspect highlighted in the review is the role of cultural transmission. Superstitious beliefs are not solely individual cognitive errors but socially shared narratives reinforced through families, traditions, folklore, and community practices. Jahoda’s (1969) distinction between causal and coincidental superstitions is particularly relevant here, suggesting that the social environment not only shapes what individuals believe but also how they interpret the meaning of everyday events. This cultural reinforcement helps explain why some superstitions persist even among highly educated populations with access to scientific knowledge.

Despite their adaptive emotional function, superstitions can also produce negative behavioural and social outcomes. Excessive reliance on rituals or irrational beliefs may limit decision-making, promote avoidance behaviour, or lead to financial losses—such as those documented around Friday the 13th in the United States. These maladaptive patterns are consistent with the findings of modern behavioural economics, which highlight the impact of cognitive biases on risk assessment and economic choices.

However, the review also reveals inconsistencies in the relationship between superstition and religiosity. While some studies (e.g., Buhrman & Zaugg) suggest a strong correlation, others (e.g., Bleak & Frederick) report no significant relationship. This discrepancy indicates that superstition is a multidimensional construct influenced by a complex interplay of cultural background, emotional regulation, personal upbringing, and cognitive style rather than a single variable such as religious identity.

Overall, the discussion demonstrates that superstition persists because it satisfies both psychological needs (reducing fear and uncertainty) and cultural functions (maintaining shared norms and identity). Although modern environments differ significantly from ancestral conditions, the underlying cognitive mechanisms that support superstitious thinking remain active. Therefore, understanding superstition through an interdisciplinary lens—combining cognitive, cultural and evolutionary perspectives—provides a more comprehensive explanation of why these beliefs endure and how they shape human behaviour in daily life.

Conclusion.

The findings of the study demonstrate that superstition is fundamentally linked to human responses to fear, uncertainty and perceived threats. Throughout the literature, superstitious beliefs consistently emerge as psychological tools used to create a sense of stability when individuals feel unable to predict or control events in their environment. Such beliefs may temporarily reduce stress, regulate emotional tension and provide a symbolic framework through

which people interpret ambiguous situations. In this sense, superstition functions as an adaptive coping mechanism, particularly in contexts where reliable information is limited or outcomes are unpredictable.

Despite these adaptive benefits, the review also highlights the potential negative consequences of excessive reliance on superstitious thinking. Over-dependence on rituals or irrational beliefs can distort decision-making, reinforce false patterns, and limit individual agency by discouraging engagement in beneficial or necessary activities. In modern, information-rich societies, such patterns can lead to inefficiency, avoidant behaviour and unnecessary psychological distress.

A deeper understanding of the cognitive and emotional mechanisms underlying superstition—such as fear-induced pattern detection, attribution biases and perceived lack of control—can contribute to more effective educational, psychological and social interventions. Recognizing why individuals turn to superstition allows researchers, educators and policymakers to develop strategies that encourage critical thinking, emotional resilience and informed decision-making in uncertain situations. Ultimately, the study reaffirms that superstition is not merely a cultural artifact but a complex psychological phenomenon rooted in human attempts to cope with threat, fear and the unknown.

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www.scientists.uz, info@scientists.uz, +998901259654