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ZAMONAVIY TA'LIMDA ISLOHOTLAR VA TEXNIK TAFAKKUR

ilmiy jurnali

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“ZAMONAVIY TA'LIMDA ISLOHOTLAR VA TEXNIK TAFAKKUR”

ilmiy jurnali

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MUNDARIJA

Atajanov Otajon Yuldoshevich, AMALIY TAJRIBALAR ASOSIDA TALABALARNING TAHLILIIY VA DIAGNOSTIK KO'NIKMALARINI SHAKLLANTIRISH METODIKASI	10
Tosheva Gulnora Djurayevna, DIZAYNERLIK QOBILIIYATI" TUSHUNCHASINING PEDAGOGIK-PSIXOLOGIK MAZMUNI, TUZILISHI VA FUNKSIONAL XUSUSIYATLARI	17
Sayidaxmedov Ravshan Rajabovich, TALABALARNING TADQIQOT KO'NIKMALARINI BAHOLASHNING MEZONLI-DIAGNOSTIK MODELII	25
Xudayberdiyev Erkin Umedovich, STANDARTLASHTIRISH VA METROLOGIK NAZORAT SOHASIDA HUQUQIY KOMPETENSIYALARNI SHAKLLANTIRISH PEDAGOGIK MUAMMO SIFATIDA	33
Qosimov Fazliddin Tolibovich, YARIMO'TKAZGICHLARNING ZAMONAVIY TEXNOLOGIYALARDAGI O'RNI VA RIVOJLANISH ISTIQBOLLARI	41
Bafoev Asliddin, Ahmadova Garanfil, Mavlonov Shohrukh, SYNTHESIS AND APPLICATION OF PET-DERIVED HYDROGEL ADSORBENTS FOR EFFICIENT TREATMENT OF DYE-CONTAMINATED WATER	46
Bafoev Asliddin, Ahmadova Garanfil, Mavlonov Shohrukh, SYNTHESIS AND APPLICATION OF PET-DERIVED HYDROGEL ADSORBENTS FOR EFFICIENT TREATMENT OF DYE-CONTAMINATED WATER	46
Umedova Ma'mura Nasillo qizi, SUN'IY INTELLEKT TEXNOLOGIYALARIDAN FOYDALANISH ORQALI O'QUVCHILARNING KREATIV TAFAKKURINI RIVOJLANTIRISH	60
Shukrulloeva M.B., RAQAMLI TA'LIM MUHITIDA IJTIMOIIY FAOLLIK VA KOMMUNIKATIV KOMPETENSIYALARNI RIVOJLANTIRISHNING XALQARO TAJRIBASI	66
Sharipov Q.Q., Bekov Bekzod Doniyorovich, QATLAM SUVI pH QIYMATINING GAZNI QAYTA ISHLASH ZAVODI APPARAT VA SIG'IMLARI KORROZIYASIGA TA'SIRI VA KOMPLEKS HIMOYA CHORALARI	83
Hamidova Nozima Sirojiddin qizi, Temirova Matlab Ibodovna, ISHLATILGAN O'SIMLIK YOG'LARINI KIMYOVIY QAYTA ISHLASH ASOSIDA QO'SHIMCHA QIYMATLI MAHSULOTLAR OLISH	93
Muzrabova Feruza Shuxrat qizi, INKLYUZIV SINFLARDA O'QUVCHILARNING IJTIMOIIY INTEGRATSIYASINI TA'MINLASHNING PEDAGOGIK MEXANIZMLARI	99
Sayfiddinov Javlon Bahriddin o'g'li, HUDUDIIY IQTISODIYOTNI RIVOJLANTIRISHDA YASHIL MOLIYALASHTIRISH VA INVESTITSIIYA MEXANIZMLARINI TAKOMILLASHTIRISH	108
Yuldashev G'ulomjon, Qosimov Bekzod Ulug'bek o'g'li, KARKIDON SUV OMBORI HAVZASI TUPROQLARINING LANDSHAFT-GEOKIMYOVIY KATENA MODELII VA ELEMENTLAR MIGRATSIYASI QONUNIYATLARI	114
Kamol Akbarov, 1928–1929-YILLARDA QASHQADARYO OKRUGIDA O'TKAZILGAN YER-SUV ISLOHOTI VA UNING AHOLINING IJTIMOIIY HAYOTIGA TA'SIRI	120
Mansurov D.U, Oydinova Z.R, BIOCHAGA (CHAGA, INONOTUS OBLIQUUS) SUVLI EKSTRAKTINING SICHQON KOLOREKTAL KARSINOMASI (CT26) VA FIBROBLAST (L929) HUJAYRA LINIYALARIGA IN VITRO SITOTOKSIK TA'SIRI	124
Shermatova Xurshida, HAYVONLAR VA HASHAROTLARDAGI AQLIIY QOBILIIYAT UYG'UNLIGI	131
Паноев Э.Р, Г.Д.Нурназарова., Салимов Х.О., ПРОИЗВОДСТВО БИТУМНОЙ МАСТИКИ НА ОСНОВЕ МЕСТНОГО СЫРЬЯ	136
I.R.Goziyev. Umaraliyev.N, TERMOLIZ VA PIROLIZ REJIMIDA ISHLAYDIGAN GAZ GENERATORINI AVTOMATIK BOSHQARISH UCHUN MIKROPROTSESSOR TIZIMINI YARATISH	143
To'xtaraliyev Sohibjon Murodjon o'g'li, Xolmatov D.S., FOSFORIT SHLAMIDAN KLINKER USULDA EKSTRAKSION FOSFAT KISLOTA OLISHDA SULFAT KISLOTASI ME'YORI VA KONSENTRATSIYASINING TA'SIRI	152
F.M.Karomov, H.Salimov, E.R.Panoyev, Sh.U.Axmedova, MAHALLIIY XOMASHYOLAR ASOSIDA YUQORI HARORATGA CHIDAMLI KORROZIYA INGIBITORINI SINTEZ QILISH VA TADQIQ ETISH	161
Temurxo'ja Alisher o'g'li Shodmanov, XORIJLIKLARGA O'ZBEK TILINI ONLAYN O'QITISHDA LINGVOMADANIY YONDASHUV VA RAQAMLI TEXNOLOGIYALAR	164





Maxkamov Ilxomjon Turdaliyevich, Aminjonova Mushtariyxon Sherzodbek qizi, ADAPTIV MOBIL TA'LIM ILOVALARINING TA'LIM SAMARADORLIGIGA TA'SIRINI BAHOLASH	168
Аминова Мохирахон Мўминжон қизи, НАУЧНО-ТЕХНОЛОГИЧЕСКИЕ ОСНОВЫ СОЗДАНИЯ СЕРОСОДЕРЖАЩИХ ПРЕПАРАТОВ ИЗ ПРОМЫШЛЕННЫХ ОТХОДОВ ДЛЯ ЗАЩИТЫ СЕЛЬСКОХОЗЯЙСТВЕННЫХ КУЛЬТУР	172
Dustova Gulnoza Ashurovna, TEXNIK OLIY TA'LIMDA FANLARARO INTEGRATSIYA TUSHUNCHASINING PEDAGOGIK MAZMUNI VA RIVOJLANTIRISH TENDENSIYALARI.....	178
Turdimurodova Ma'suma Mamarajab qizi, O'ZBEKISTONNING SHO'RLANGAN TUPROQLARIDA O'SADIGAN O'SIMLIK LARNING FIZIOLOGIK – BIOKIMYOVIY MOSLANISH MEXANIZMLARINI TADQIQ QILISH	183
Hasanov Hakimjon Xalil o'g'li, SHARQ MUTAFAKKIRLARI (FOROBIY, BERUNIY, IBN SINO) ASARLARIDAGI TA'LIMIY G'OYALARNING PEDAGOGIK TAHLILI	191
Ergashev Asadbek Ulug'bek o'g'li, MEVA-SABZAVOTLARNI QAYTA ISHLAB CHIQARISHDA IKKILAMCHI RESURLARDAN SAMARALI FOYDALANISH.....	199
Jo'rayeva Yoqutxon A'zamxo'ja qizi, BOLALARDA UZI-NAZORAT OSTIDA REGIONAR BLOKADALAR VA OPERATSIYADAN KEYINGI OG'RIQNI DAVOLASH.....	207
Sharipov Akbarshox Sanjarovich, NEFT-GAZ SOHASINING OBYEKTLARINI METROLOGIK NAZORAT QILISH USLUBIYOTI.....	215
Xakimova Zulfiyaxon Mehmonaliyevna, IJODIY ISH VA LOYIHA ISHI – TAFAKKURNI O'STIRISH VOSITASI.....	222
Shukurova Ozoda Odil qizi, KONSIGNATSIYA ASOSIDA SHAXSIY PLATFORMALARDA XIZMAT KO'RSATISH TARTIBI VA SHARTLARI.....	227
Xakimova Zulfiyaxon Mehmonaliyevna, IJODIY ISHLARNI TASHKIL ETISHDA PSIXOLOGIK VA PEDAGOGIK IMKONIYATLAR.....	232
Allayarova Nilufar Sherali qizi, TABIIY OFATLAR OQIBATLARINI BARTARAF ETISHNING RAQAMLI-MOLIYAVIY MEXANIZMLARI VA XALQARO TAJRIBA	236
Rasulov Inom Mo'ydinovich, Usmanova Gulnoza Xamdamjonovna, RAQAMLI TA'LIM MUHITIDA TA'LIM TIZIMINI BOSHQARISHNING PEDAGOGIK-METODOLOGIK MUAMMOLARI VA MODELI	242
Nurullayev Mirxon Muhammadovich, AGENTLI SI TIZIMLARIDA AXBOROT OQIMLARINING UMUMLASHGAN SXEMASI VA MANBALARNING KO'P O'LCHOVLI ISHONCH PROFILI TASNIFI	245
A.Isashov, N.Yunusaliyev, SUV RESURLARINI BOSHQARISH VA ULARDAN SAMARALI FOYDALANISH MUAMMOLARI.....	257
Yo'ldosheva Dilrabo Sobir qizi, OLIY TA'LIM JARAYONIDA TALABALARNING MUSTAQIL TA'LIM FAOLIYATINI RIVOJLANTIRISHNING PEDAGOGIK SHART-SHAROITLARI.....	260
Nurmurodova Yulduz Bazarovna, O'ZBEKISTONDA JOYLASHGAN TARIXIY MAHALLA MARKAZLARINI QAYTA QURISH TAMOIYILLARINI ISHLAB CHIQISH	271
Ismailova Gulnoza Odiljon qizi, EDGAR ALLAN POE HAMDA WASHINGTON IRVING ASARLARI: XIX ASR AMERIKA ADABIYOTIDA SHARQ VA ISLOM OBRAZLARINING POETIK TRANSFORMATSIYASI	278
Xaydarov Sayfulloh Nodirjon o'g'li, KROSS YUGURISHDA CHIDAMLILIKNI OSHIRISH UCHUN INNOVATSION YONDASHUVLAR VA ULARNING SAMARADORLIGI	285
Aminova Mohiraxon Mo'minjon qizi, FROM INDUSTRIAL SULFUR RESIDUES TO RELIABLE CROP PROTECTION: FEEDSTOCK QUALIFICATION, FORMULATION CONSISTENCY AND FIELD VALIDATION	295
Khudaybergan Abdullayev, RING-TO-DROPLET TRANSITION IN A TWO-DIMENSIONAL DIPOLAR BOSE–EINSTEIN CONDENSATE: A GROUND-STATE SCAN WITH GPELAB	301
Xazratqulova Irodaxon Zokirjon qizi, ISHQORIY YER METALLARI MAVZUSINI O'QITISHDA ILG'OR TA'LIM TEXNOLOGIYALARIDAN FOYDALANISH	308
Шодиева Муаттар Салом қизи, ФОРМИРОВАНИЕ РУССКОЯЗЫЧНОГО ЛЕКСИКОНА У ДЕТЕЙ-БИЛИНГВОВ: МЕХАНИЗМЫ, ФАКТОРЫ И ПЕДАГОГИЧЕСКИЕ СТРАТЕГИИ.....	313
Ubaydova V.E., Abbosova M.O., TRANSFORMATSIYA ELEMENTLARINI QO'LLAB KIYIMLARNI LOYIHALASHNING O'ZIGA XOS QONUNIYATLARI	320
S.Z.Ibodullayeva, BO'LAJAK PEDAGOGLARNING KASBIY KOMPETENSIYALARINI RIVOJLANTIRISHNING PEDAGOGIK SHART SHAROITLARI.....	325





Xazratqulova Iroda Zokirjon qizi, Maxkamov Ravshan Raximovich, AROMATIK KARBON KISLOTALARINING SIRT FAOL HOSILALARINI SINTEZ QILISH, STRUKTURA-SPEKTRAL TAVSIFI VA KOLLOID-KIMYOVIY XOSSALARINI O'RGANISH.....	331
Qurbonov Elmurod Botiraliyevich, SADOQAT KONSEPTINING JAMIYAT VA SHAXS MUNOSABATLARIDAGI PRAGMATIK IFODASI (ODIL YOQUBOV ASALARI MISOLIDA)	335
Shukurova Ozoda Odil qizi, RAQAMLI PLATFORMALARINING XIZMAT KO'RSATISH SHARTNOMALARIDAGI FUQAROLIK-HUQUQIY MAQOMI: VOSITACHI YOKI SHARTNOMA TARAFI	339
Jo'rayeva Maxfuza Erkinovna, SIYOSIY DISKURSNING SUN'IY INTELLEKT (AI) YORDAMIDA TADQIQI	345
Yaminov Feruzjon Fayzullo o'g'li, XORIJIY NEFT-GAZ TA'LIMI TAJRIBASIDA KASBIY KOMPETENSIYALARNI RIVOJLANTIRISH MODELLARI VA ULARNI O'ZBEKISTON TA'LIM TIZIMIGA MOSLASHTIRISH IMKONIYATLARI	350
Shirinov Feruzbek Shuxratovich, Maxmudov Jamshid Shuxratovich, OLIY TA'LIM MUASSASALARIDA MAGISTRLIK DISSERTATSIYALARINI TAYYORLASH JARAYONINI RAQAMLASHTIRISHNING ZAMONAVIY YONDASHUVLARI.....	360
Qobilova Dildora Odilboyevna, METEOPARAMETRLAR DINAMIKASI VA MURAKKAB OROGRAFIYA SHAROITIDA ZAHARLI ARALASHMALARNING ATMOSFERADA TARQALISHINI MATEMATIK MODELLASHTIRISHNING NAZARIY VA USLUBIY ASOSLARI: ILMIY ADABIYOTLAR TAHLILI	364
Арслонхонов Косимхон Азиз угли, Арслонхонова Гулнара Давронбек кизи, ГЕОЛОГО-МИНЕРАЛОГО-ГЕОХИМИЧЕСКИЕ ОСНОВЫ ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ СКВАЖИННОГО ПОДЗЕМНОГО ВЫЩЕЛАЧИВАНИЯ УРАНОВЫХ РУД.....	381
Abduvossiyev Asadbek Abdusaid o'g'li, INTELLEKTUAL BOSIM O'ZGARTIRGICHLARIDA DINAMIK XATOLIKLARNI KOMPENSATSIYA QILISH VA O'LCHASH NOANIQLIGINI BAHOLASH	391
Xaydarova Ziyodaxon Azimjon qizi, NOCHIZIQLI GIPERBOLIK SISTEMALAR UCHUN LYAPUNOV MA'NOSIDA TURG'UN OQIMGA QARSHI PARCHALANUVCHI AYIRMALI SXEMA	397
Feruz Yuldashev, O'ZBEKISTONDA DAVLAT VA XUSUSIY OLIY TA'LIM MUASSASALARI TADBIRKORLIK IMKONIYATLARINING MOLIVAVIY SALOHİYATI VA RAQOBAT HOLATINING QIYOSIY EKONOMETRIK TAHLILI	405
Jurayev Vays Narzullayevich, Abduqahhorov Abdurrohman Xasan o'g'li, Botirjonova Mexruza Maqsud qizi, O'ng'arov Jaloliddin Faxriddin o'g'li, KO'MIRNI KOKSLASH JARAYONIDA OLTINGUGURT BIRIKMALARINING O'ZGARISHI VA KAM OLTINGUGURTLI METALLURGIK KOKS OLIISH IMKONIYATLARI	413
Qosimov Oybek Abdumannon o'g'li, GIBRID SHAMOL QUYOSH ELEKTR STANSIYALARINING CHASTOTANI ROSTLASH QOBILIYATINI OSHIRISH	419
Qurbonova Feruza Murod qizi, BANKLARNING RAQAMLI XIZMATLARIDA UZLUKSIZLIK VA TEXNIK BARQARORLIKNI TA'MINLASHNING TASHKILIY-IQTISODIY MEKANIZMLARI	426
Teshaboyev Rivojiddin Ibrohimjon o'g'li, MOYLI KUCH TRANSFORMATORLARINING TEXNIK HOLATINI CHASTOTA TAVSIFI (FRA) ASOSIDA DIAGNOSTIKA QILISH	439
Shirinov Feruzbek Shuxratovich, Jòraqòziyeva Durdonaxon Davronjon qizi, KOMPYUTER TIZIMLARIDA DASTURIY TA'MINOT UNUMDORLIGINI OSHIRISH USULLARI	445
Турсунбаева Диёра Носиржон кизи, МУЛЬТИМОДАЛЬНЫЙ ПОДХОД К ИЗУЧЕНИЮ ЛИТЕРАТУРЫ В НАЦИОНАЛЬНЫХ КЛАССАХ (НА ПРИМЕРЕ СТАРШИХ КЛАССОВ)	449
Eshonqulov Shahzod Ravshan o'g'li, DASTURLASH VA AVTOMATLASHTIRISH (PYTHON) ASOSIDA TALABALARDA TEXNIK TAFAKKURNI SHAKLLANTIRISH METODIKASI	458
Ismatov Baxtiyor Axmad o'g'li, Lutfullaev Sa'dulla Shukurovich, "UZBEKISTAN GTL" MCHJ MINERAL FRAKSIYALARINI TAVSIFLASH VA SINOVDAN O'TKAZISH	465
С. М. Васина, С. У. Насимова, ЭКСТРАКЦИОННЫЕ МЕТОДЫ КОМПЛЕКСНОЙ ПЕРЕРАБОТКИ ПЛОДОВ ОБЛЕПИХИ	482
Soibov Johongir Ergash o'g'li, SANOAT KORXONALARIDA ENERGIYA SAMARADORLIGINI OSHIRISHNING ZAMONAVIY USULLARI VA JAHON TAJRIBASI TAHLILI	492
Худайбердиева Махлиё Абдукаххоровна, ПОВЫШЕНИЕ СТАБИЛЬНОСТИ ФОРМИРОВАНИЯ ТКАНИ ПУТЁМ ОПТИМИЗАЦИИ ПАРАМЕТРОВ РАБОЧИХ ОРГАНОВ ТКАЦКОГО СТАНКА.....	496
Shukurova Ozoda Odil qizi, RAQAMLI PLATFORMALARDA XIZMAT KO'RSATISH SHARTNOMALARI BO'YICHA JAVOBGARLIKNI TAQSIMLASHNING FUQAROLIK-HUQUQIY MUAMMOLARI	501
Ko'chiboyev Alim Ixtiyor o'g'li, IOT QURILMALARIDA AMNESIA ZAIFLIKLARINI ANIQLASH VA BARTARAF ETISH USULLARINI TAKOMILLASHTIRISH.....	509
Makhliyo Abdukahorovna Xudayberdiyeva, EXPERIMENTAL EVIDENCE AND METHODOLOGICAL ASSESSMENT OF MECHANISMS ENSURING STABLE FABRIC FORMATION IN WEAVING LOOMS	521
Gulrux Xudoyorova, ABDULLA O'RIPOV SHE'RIYATIDA BADIY TAFAKKURNING IJTIMOY VAZIFASI	525



Шамшидинов И.Т., Абдуллаев А.Н., Нажмидинов Р.Ю., Кузибаев Ф.Т., Боситов М.А., Рахимжонов А.Г., ФТОР ВА СУЛЬФАТ ҚЎШИМЧАЛАРИДАН ТОЗАЛАНГАН ЭКСТРАКЦИОН ФОСФАТ КИСЛОТА АСОСИДА ЮҚОРИ СИФАТЛИ ОДДИЙ ФОСФОРЛИ ЎЎИТ ОЛИШ ТЕХНОЛОГИЯСИНИ ТАДҚИҚ ЭТИШИ	529
Олимова Мафтуна Баходир кизи, КОНЦЕПЦИЯ ЛИЧНОСТИ, СВОБОДЫ И НРАВСТВЕННОГО ВЫБОРА В РУССКОЙ ЛИТЕРАТУРЕ XIX–XX ВЕКОВ: Ф. М. ДОСТОЕВСКИЙ, Л. Н. ТОЛСТОЙ И М. А. БУЛГАКОВ	533
To'xtaraliyev Sohibjon Murodjon o'g'li, Xolmatov Dilshod Sottorjonovich, SANOAT TEXNOLOGIK JARAYONLARIDA HOSIL BO'LADIGAN CHANGLI GAZLARNI TOZALASH USULLARINING QIYOSIY TAHLILI VA QURILMALARNI TAKOMILLASHTIRISH ISTIQBOLLARI.....	540
Sayfidinova Zarina Nabijon qiz, XVI–XIX ASRLARDA O'RTA OSIYODA AYOLLARNING IJTIMOIIY-MADANIY HAYOTDAGI O'RNI: YOZMA VA HUJJATLI MANBALAR ASOSIDA	546
Nafosat Rakhmonova Nasim kizi, THE ROLE AND STRATEGIC PROSPECTS OF ARTIFICIAL INTELLIGENCE IN DEVELOPING TOURISM IN UZBEKISTAN.....	552
Yusupova Nasiba Qobuljonovna, EKISH MUDDATLARI VA ME'YORLARI ARPANING FENOLOGIK RIVOJLANISH DAVRLARIGA TA'SIRI	556
Eshtuxtarova Shodiyona Abdizokir qizi, POLIMER MODDALARNING OPTIK XUSUSIYATINI O'RGANISH	560
Nizomiddin G'ulomov, DADAXO'JA SOTTIXO'JAYEVNING IJROCHILIK TALQINI XUSUSIDA	565
Berdiyeva Mohira Nurali qizi, MAHALLIY XOMASHYOLAR VA MODIFIKATSIYALANGAN GIPS BOG'LOVCHILARI ASOSIDA G'OVAKLI NAMLIKKA CHIDAMLI DEVORBOP MATERIALLAR TARKIBINI VA TEXNOLOGIYASINI ISHLAB CHIQISH.....	572
Namazova Luiza Zavqi qizi, SUN'IY INTELLEKT VOSITALARIDAN FOYDALANISHNING TA'LIM SIFATI VA O'QUVCHILAR MUSTAQIL FIKRLASHIGA TA'SIRI	577
Ergasheva Zilola Ko'paysin qizi, MILLIY MUSIQA MEROSI ASOSIDA MAKTABGACHA YOSHDAGI BOLALARNING ESTETIK MADANIYATINI RIVOJLANTIRISH METODIKASI	583
Qobilova Dildora Odilboyevna, METEOPARAMETRLAR DINAMIKASINI VA HUDUDNING MURAKKAB OROGRAFIYASINI INOBATGA OLGAN HOLDA ZAHARLI ARALASHMALARNING ATMOSFERADA KO'CHISHINI MATEMATIK MODELLASHTIRISH	591
Raimov Abdulla, Normurodov Chori Begaliyevich, KO'P CHEGARAVIY QATLAMLI STATSIONAR SINGULYAR QO'ZG'ALGAN TENGLAMALAR UCHUN CHEGARAVIY MASALALARNI SPEKTRAL-TO'R USULI BILAN SONLI MODELLASHTIRISH	598
Nurmuhammad Amonov, O'ZBEK VA TURK TILLARI O'RTASIDAGI TARJIMADA SOXTA EKVIVALENTLAR: “IZLEMEK–IZLAMOQ”, “DÜŞÜNMEK–TUSHUNMOQ” VA “BABA–BOBO” BIRLIKLARI TAHLILI	603
Hasanov Jamshid Shokir o'g'li, O'SMIRLARDA XAVOTIRLANISHNING O'G'IL VA QIZ BOLALAR XULQ-ATVORIDA NAMOYON BO'LISHI VA GENDER TAFOVUTLAR	609
J.A. Turakulov, I.R. Juraev, J.Sh. Norkulov, MATHEMATICAL MODELING OF SUSPENSION FILTRATION IN POROUS MEDIA	617
Saidakbarov Jamshid Nematullo o'g'li, HUDUDIIY BANK FAOLIYATINI BOSHQARISHNI TAKOMILLASHTIRISH: RESURS BAZASI VA KREDIT PORTFELI MUVOZANATI (QASHQADARYO VILOYATI MISOLIDA).....	624
Xomidova Mahliyo Akobir qizi, INKLYUZIV TA'LIM MUHITIDA PEDAGOGIK JARAYONNI LOYIHALASHNING ILMIY-NAZARIY ASOSLARI.....	630
Saidakbarov Jamshid Nematullo o'g'li, MEHNAT RESURSLARINI BOSHQARISH TIZIMIDAGI MUAMMOLAR VA ULARNI TAKOMILLASHTIRISH YO'LLARI (O'ZBEKISTON MISOLIDA)	636
Ergashev Ro'zibek Alisher o'g'li, MIS-PORFIR RUDALARINI FLOTATSION BOYITISHDA MAHALLIY XOMASHYO ASOSIDAGI REAGENTLAR KOMBINATSIYASIDAN FOYDALANISH ISTIQBOLLARI	640
Sh.B. Ashurova, EXCHANGE RATE CHANGES AND REGIONAL EXPORT PERFORMANCE IN UZBEKISTAN	645
Urazova Azadaxan Tursinbayevna, TARJIMASHUNOSLIK MASALALARI	652
Ismoilov Ro'zibek Rajabovich, TOPINAMBUR ILDIZINI EKSTRAKSIYA QILISH JARAYONINING TEXNOLOGIK PARAMETRLARINI AVTOMATIK NAZORAT QILISH TIZIMINI TAKOMILLASHTIRISH	656
Axmedova M.U, YOSHLARDA RAHBARLIK SALOHIIYATINI SHAKLLANTIRISHDA MA'NAVIIY-MA'RIFIY OMILLARNING IJTIMOIIY-PSIXOLOGIK XUSUSIYATLARI	667
Habibova Nasiba Anvarovna, OLIY TA'LIM MUASSASALARIDA RAQAMLI EKOLOGIK BOSHQARUV TIZIMINI SHAKLLANTIRISH METODIKASINI TAKOMILLASHTIRISH	671
Ismatullayeva Mo'tabar Xushvaqt qizi, THE EXPRESSION OF LINGUOCULTURAL UNITS IN HINDI AND UZBEK MEDIA TEXTS: A COMPARATIVE ANALYSIS OF FESTIVAL REPORTAGE IN AMAR UJALA AND KUN.UZ	679





Abdullayev Botir Shuxratovich, NASOS AGREGATLARINI AVTOMATLASHTIRISH VA QAROR QABUL QILISH TIZIMLARINI TAKOMILLASHTIRISH	687
Mustafoeva Intizor Normamatovna, TO'QMON MA'DAN NAMOYONI O'RGANILGANLIGINING TANQIDIY TAHLILI VA TOG' JINSLARIDAGI YASHIRIN MA'DANLASHUVNI ANIQLASH ISTIQBOLLARI	698
T.B.Xakimov, A SYSTEM-LEVEL FRAMEWORK FOR COUPLED THERMAL-ELECTRICAL OPTIMIZATION OF THERMOELECTRIC GENERATORS FOR LOW-GRADE WASTE HEAT RECOVERY	705
Doniyorova Nafisaxon Shukrulloxon qizi, INGLIZ TILIDAGI KO'P MA'NOLI FRAZALI FE'LLARNING O'ZBEK TILIGA TARJIMASIDA KONTEKSTUAL MA'NO MUVOFIQLIGINING CHOG'ISHTIRMA-SEMANTIK TADQIQI	714
Shukurova Saida Qudratovna, MILLIY VA UMUMINSONIY QADRIYATLAR INTEGRATSIYASI ASOSIDA YOSHLARNING MA'NAVIY-AXLOQIY MADANIYATINI RIVOJLANTIRISH	722
Botirjonova Mexruza Maqsud qizi, Abduqahhorov Abdurohman Xasan o'g'li, Abdukarimova Saida Abdujalilovna, IKKILAMCHI POLIETILEN VA POLIPROPILEN ASOSIDAGI POLIMER KOMPOZITSIYALARNI MODIFIKATSIYALASH USULLARI	729
Burqutbayeva M., YAXSHILIK VA YOMONLIK AKSIOLOGIK KONSEPTI TADQIQI	734
Fayziyeva S.F., Norboyev Q.N., BUZOQLAR TOKSIK DISPEPSIYASINING PATOLOGOANATOMIK O'ZGARISHLARI	738
Ismoilov Ro'zibek Rajabovich, TOPINAMBUR ILDIZINI EKSTRAKSIYA QILISH JARAYONIDA OPTIMAL HARORAT REJIMINI ANIQLASH VA AVTOMATIK ROSTLASH ALGORITMINI TAKOMILLASHTIRISH	742
Shaydo Masharipova Ozodboy qizi, XORAZM VILOYATI SHAROITIDA ZA'FARON (Crocus sativus L.) O'SIMLIGINING INTRODUKSIYASI VA MORFO-FIZIOLOGIK XUSUSIYATLARINI BAHOLASH	753
Q.N.Norboyev, Fayziyeva S., YANGI TUG'ILGAN BUZOQLARDA DISPEPSIYASIYANI DAVOLASH TAJRIBA NATIJALARI	758
Mirjamolova Moxira Abdugaffor qizi, SONLAR NAZARIYASI ASOSLARI	763
Shamsiddinov Quvonchbek Azamatovich, SOYA O'SIMLIGINING "MADAD" NAVINING NAVOIY VILOYATI SHAROITIDA RIVOJLANISH BIOLOGIYASI	766
D.R. Jumanazarov, M.R. Ro'zmetova, S.Sh.Ruzimov, SPEKTRAL RENTGEN KT ORQALI RENTGEN YUTILISHINI AJRATISH YORDAMIDA MATERIALLARNI TASNIFLASHNING YAXSHILANGAN PARAMETRIZATSIYASI	770
Mirjamolova Moxira Abdugaffor qizi, GURUHLAR NAZARIYASI	777
Juraeva Maftuna Komilovna, COMMUNICATIVE LANGUAGE TEACHING IN EFL CLASSROOMS: BRIDGING METHODOLOGICAL PRINCIPLES AND CLASSROOM PRACTICE IN UZBEKISTAN	780
Mirjamolova Moxira Abdugaffor qizi, XARAKTERISTIK VA MINIMAL KO'PHADLAR	788
Ayimbetova D.M., INGLIZ, O'ZBEK VA QORAQALPOQ ADABIYOTIDA ANIMALISTIK OBRAZ VA MOTIVLARNING POETIK TRANSFORMATSIYASI: MATNSHUNOSLIK TAHLILI	792
Abdumalikov Ulug'bek Ziyodilla o'g'li, Ismoilov Ilyosbek Isroiljon o'gli, XITOY XIN LU ZAO №78 NAVINI O'RTA TOLALI MAHALIY NAVLAR BILAN DURAGAYLASH NATIJALARI	798
Bobokulova Muhabbat Mahammadiyeva, IKKI ROTORLI SHAMOL TURBINALARINING KONSTRUKTIV PARAMETRLARINI OPTIMALLASHTIRISH ORQALI ENERGETIK SAMARADORLIGINI OSHIRISH	802
Жандуллаева Аксынгуль Жалгасбаевна, МИФОПОЭТИКА И ГЕНДЕРНЫЕ СТРАТЕГИИ В СОВРЕМЕННОЙ ЖЕНСКОЙ ПРОЗЕ (НА МАТЕРИАЛЕ ПРОИЗВЕДЕНИЙ ЛЮДМИЛЫ ПЕТРУШЕВСКОЙ И ТАТЬЯНЫ ТОЛСТОЙ)	808
Jasur Karimjonov, CHALLENGING FACTORS FOR UZBEK TEACHERS IN EFL SPEAKING INSTRUCTION AND THE ROLE OF THE COMMUNICATIVE LANGUAGE TEACHING APPROACH	817
Musayeva Muxtasar Zayirjon qizi, OCT TASVIRLARINI SUN'IY INTELLEKT YORDAMIDA TAHLIL QILISH: GLAUKOMA VA MAKULA KASALLIKLARINI ERTA ANIQLASH IMKONIYATLARI	826
M.A.Yuldashev, SABZAVOTCHILIK MASHINASI URUG'O'TKAZGICHIDAGI URUG'LARNING QIYA TEKISLIKDAGI HARAKATINI MATEMATIK MODELLASHTIRISH VA DUMALASH-SIRPANISH CHEGARAVIY SHARTINI ANIQLASH	831
Razikova Madina G'ofurjon qizi, O'ZBEKISTON HUDUDLARIDA YUQORI TEZLIKDAGI INTERNET INFRATUZILMASINING YANGI RAQAMLI ISH O'RINLARI YARATILISHIGA SABABIY TA'SIRINI BAHOLASH	836
Ayimbetova D.M., TEXTOLOGICAL AND LITERARY SOURCE-STUDY FOUNDATIONS FOR THE STUDY OF ANIMALISTIC IMAGES AND MOTIFS	849
Xakimova Yoqutxon Toxirjon qizi, Muqimova Dilzodaxon Maxsudali qizi, BULUTLI TIZIMLARDA HISOBLASH RESURSLARINI MASHINALI O'QITISH ASOSIDA BASHORATLI BOSHQARISH	855
Raupov Sanjar Zafar o'g'li, OVOZ BOYLAMLARI DISPLAZIYASINI ERTA TASHXISLASH VA MALIGNIZATSIYA XAVFINI BAHOLASHNI TAKOMILLASHTIRISH	863





Mingboyeva Tursunoy , USE THE CORPUS OF CONTEMPORARY AMERICAN ENGLISH COCA IN TEACHING ENGLISH AS A FOREIGN LANGUAGE FOR STUDENTS WHO ARE STUDYING IN SECONDARY SCHOOL IN UZBEKISTAN	870
Sirojev Xurshed Xo'jayevich , ANJIR MEVASINI VAKUUMLI MUZLATIB QURITISHDA BIOLOGIK FAOL MODDALARNI SAQLASH IMKONIYATLARINI TADQIQ ETISH	875
Mansurxo'jayev Majidxon Abbosxo'ja o'g'li , QOBIQ QUVURLI ISSIQLIK ALMASHINISH QURILMALARINI TAKOMILLASHTIRISHNING KONSTRUKTIV YO'NALISHLARI VA ULARNI BAHOLASH MEZONLARI	881
Iroda Berdiyeva Shuhrat qizi, Gavhar Sultonova Karimovna , DIGITAL SOLUTIONS FOR EFFICIENT CUSTOMS CLEARANCE: REDUCING DELAYS AND COSTS.....	885
Ayimbetova D.M. , ANIMALISTIK OBRAZ VA MOTIVLAR AKS ETGAN MATNLARNING TARIXIY SHAKLLANISHI VA SAQLANISH XUSUSIYATLARI	893
O'rinov Sherali Xayrullayevich , O'RIK DANAGI QOBIG'INI CHAQISH VA MAG'ZINI AJRATIB OLISH JARAYONIGA QOBIQ QALINLIGI HAMDA NAMLIKNING TA'SIRI	900
Sh.B. Ashurova , TRADE OPENNESS AND REGIONAL ECONOMIC DISPARITIES IN UZBEKISTAN.....	913
Шаробиддинова Гулшода Рустамжон кизи , ДИНАМИЧЕСКИЕ СВОЙСТВА КВАДРАТИЧНЫХ ГОМЕОМОРФИЗМОВ СИМПЛЕКСА.....	920
Behzod Baxodir o'g'li, Esanov Odil , JAMOAT BINOLARIDA QO'LLANILADIGAN GIBRID ISITISH VA HAVO ALMASHTIRISH TIZIMINING MATEMATIK MODEL.....	928
Mahkamov Ilhomjon Turdaliyevich, Madumarova Nilufarxon Ma'murjon qizi , GENERAL SUN'IY INTELLECT VOSITALARI ASOSIDA TALABALARNING MUSTAQIL TA'LIM FAOLIYATINI RIVOJLANTIRISH METODIKASI.....	934
Baxshilloev Habibulloxon Umarovich , UNSW-NB15 DATASETIDA TARMOQ HUYUMLARINI MASHINALI O'QITISH BILAN TOIFALASH: RANDOM FOREST VA XGBOOST MODELLARINI TAQQOSLASH VA CHEGARA SEZGIRLIGI TAHLILI.....	937
Sh.B. Ashurova , EXPORT DIVERSIFICATION AND REGIONAL ECONOMIC GROWTH IN UZBEKISTAN	942
Rasulova Oygul Salom qizi , PROBIOTIK MIKROORGANIZMLARNING INSON SALOMATLIGIDAGI AHAMIYATI	951
Ramazonov Azizbek Chori o'gli , SABZAVOTLARNI IMPULSLI BOSIMLAR FARQI ASOSIDA QURITISH JARAYONINI TAKOMILLASHTIRISH.....	959
Axmetov Shoxdavlat Ulug'bek o'g'li , GLOBALLASHUV SHAROITIDA TRANSFERT NARXLAR NAZORATINI TAKOMILLASHTIRISH	968
Jo'rayeva O'g'li Abduraxim qizi, Eshoqulov Ravshan Abdurazakovich , QARSHI SHAHRIDA YOMG'IR SUVLARINI BOSHQARISHNING RAQAMLI MODEL VA IQLIM O'ZGARISHIGA MOSLASHUV TIZIMINI ISHLAB CHIQUISH	977
Karomatov Shahzod Ilhomovich , KERATINNING ERUVCHI MODIFIKATSIYASINI OLISH	985
G.B.To'liqinova, B.G'.Jo'rayev , QURILISHDA ENERGIYA SAMARADORLIGINI TA'MINLOVCHI ZAMONAVIY KONSTRUKTIV YECHIMLAR VA TAHLILI.....	991
Usmonov Botir Shukurillayevich, Begmurodov Asomiddin Faxriddin o'g'li , TEXNOLOGIK JARAYONLARDA HAMKORLIKDAGI ROBOTLAR (COBOT) XAVFSIZLIGI VA SAMARADORLIGINI BAHOLASH METODIKASI VA BOSHQARUV ALGORITMI	999
Мусаева Гозал Махсетаевна , ПРОБЛЕМА ПОВЫШЕНИЯ КАЧЕСТВА ШКОЛЬНОГО ОБРАЗОВАНИЯ В УЗБЕКИСТАНЕ И ЕЕ РАЗРЕШЕНИЕ НА СОВРЕМЕННОМ ЭТАПЕ.....	1008
Xudayberdiyeva O'g'li Hasan qizi , O'ZBEKISTONNING KESKIN KONTINENTAL IQLIM SHAROITIDA QUYOSH FOTOELEKTRIK MODULLARINING ENERGETIK SAMARADORLIGIGA HARORAT VA CHANGLANISHNING KOMPLEKS TA'SIRINI TADQIQ ETISH	1016
Bayniyazova Nargiza Polatovna , QORAQALPOG'ISTON QADIMIY QAL'ALARINING ME'MORIY-KOMPOZITSION XUSUSIYATLARI VA NUKUS JAMOAT MAKONLARINI LOYIHALASHDAGI TALQINI	1024
Danabayeva Mohigul Baxtiyarovna , SAID AHMAD HIKOYALARIDA QAHRAMON XARAKTERI VA RUHIY KECHINMALAR TASVIRI (mustaqillik davri hikoyachiligi kontekstida).....	1032
Valiyeva Feruza Telmon qizi , TO'DAKO'L SUV OMBORI GIDROFIL QUSHLARI FAUNASINING TUR TARKIBI VA EKOLOGIK XUSUSIYATLARI	1037
Shamsiyev Jonibek Oybek o'g'li , GENERATIV SUN'IY INTELLEKTNING ILMIY TADQIQOTLARDAGI O'RNI: YANGI IMKONIYATLAR VA AKADEMIK HALOLLIK MASALALARI	1042
Tuxtamurodova Gulnura Jamoliddin qizi , SUN'IY INTELLEKT BIZGA YORDAMCHIMI YOKI «XO'JAYIN»?.....	1050
Sharipova Shakhruza Nusrat qizi , EFFECTIVE METHODS OF DEVELOPING TECHNICAL THINKING THROUGH DIGITAL TECHNOLOGIES IN THE HIGHER EDUCATION SYSTEM.....	1057





EFFECTIVE METHODS OF DEVELOPING TECHNICAL THINKING THROUGH DIGITAL TECHNOLOGIES IN THE HIGHER EDUCATION SYSTEM

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Abstract: This article analyzes effective methods for developing technical thinking in students based on digital technologies in the higher education system from a scientific, theoretical and practical perspective. The role and importance of technical thinking in the process of training technical specialists in the context of digital transformation are highlighted, and the didactic possibilities of modern tools such as virtual laboratories, digital modeling, simulation programs, and artificial intelligence-based learning platforms are revealed. The research substantiates pedagogical methods aimed at developing technical thinking based on a competency-based and systematic approach. The results of the article serve to improve the quality of education in higher education institutions.

Keywords: digital technologies, technical thinking, higher education, virtual laboratory, simulation, pedagogical methodology, competency-based approach.

Аннотация: В данной статье с научной, теоретической и практической точек зрения анализируются эффективные методы развития технического мышления у студентов на основе цифровых технологий в системе высшего образования. Подчеркивается роль и значение технического мышления в процессе подготовки технических специалистов в контексте цифровой трансформации, а также раскрываются дидактические возможности современных инструментов, таких как виртуальные лаборатории, цифровое моделирование, программы моделирования и обучающие платформы на основе искусственного интеллекта. Исследование обосновывает педагогические методы, направленные на развитие технического мышления на основе компетентностного и системного подхода. Результаты статьи служат для повышения качества образования в высших учебных заведениях.

Ключевые слова: цифровые технологии, техническое мышление, высшее образование, виртуальная лаборатория, моделирование, педагогическая методология, компетентностный подход.

Annotatsiya. Mazkur maqolada oliy ta'lim tizimida raqamli texnologiyalar asosida talabalarda texnik tafakkurni rivojlantirishning samarali usullari ilmiy-nazariy va amaliy jihatdan tahlil qilinadi. Raqamli transformatsiya sharoitida texnik mutaxassislarni tayyorlash jarayonida texnik tafakkurning o'рни va ahamiyati yoritilib, virtual laboratoriyalar, raqamli modellashtirish, simulyatsiya dasturlari, sun'iy intellektga asoslangan o'quv platformalari kabi zamonaviy vositalarning didaktik imkoniyatlari ochib beriladi. Tadqiqotda kompetensiyaviy va tizimli yondashuv asosida texnik tafakkurni rivojlantirishga yo'naltirilgan pedagogik usullar asoslab berilgan. Maqola natijalari oliy ta'lim muassasalarida ta'lim sifatini oshirishga xizmat qiladi.





Kalit soʻzlar: raqamli texnologiyalar, texnik tafakkur, oliy taʼlim, virtual laboratoriya, simulyatsiya, pedagogik metodika, kompetensiyaviy yondashuv.

Introduction

Today's globalization and digitalization processes are having a serious impact on the higher education system, as well as on all sectors. Developing technical thinking is one of the urgent tasks, especially for students studying in technical and engineering fields. Modern production and technological processes require a high level of analytical thinking, modeling of problem situations, and the effective use of digital tools. (UNESCO, 2023; Abdurashidova et al., 2023).

In a situation where traditional teaching methods are not sufficiently effective in developing technical thinking, there is a need to improve teaching methodologies based on digital technologies. Therefore, it is important to identify and scientifically substantiate effective methods for developing technical thinking through digital technologies in the higher education system.

Global overview: The recent literature review provides a global overview of the development of technical thinking (CT) — there is a broad analysis of the digital tools used to teach CT (visual programming, simulations, games) and their role in the educational context.

- Digital Literacy & CT: The article examines digital literacy as a tool for developing CT skills in young learners — the level of digital literacy plays an important role in building 21st century skills.

Integration Research: Recent research articles explore methodological approaches to integrating CT into education by integrating teachers' pedagogical, technological, and content knowledge.

Shuchi Grover is an Indian-American learning scientist known for his research on computer science education and computational thinking. He has authored numerous articles and abstracts on the deep learning and integration of CT into the learning process.

Eric Klopfer is an MIT professor who works on building complex systems and CT skills through educational technology and educational games.

Kentaro Toyama is a researcher in technology and global development: he studies the impact of information and communication technologies on social development, ICT4D projects (ICT for Development).

Stamatis Papadakis is a researcher who has worked on international CT and pedagogy projects, and has participated in international projects on CT.

Tomaso A. Poggio is a scientist who studies cognitive science, artificial intelligence and learning systems, with fundamental work on the impact of these technologies on human thinking.





David De Roure is a researcher who has made significant contributions to the field of digital humanities and e-research.

In recent years, scientists from the CIS (including Russia, Ukraine, Belarus, Kazakhstan, Uzbekistan) have also been conducting scientific work on technical thinking, digital pedagogy, ICT integration and digital educational technologies:

Local research studies the digitization process, digital educational methods and effective approaches to transferring scientific literature to electronic format. For example, there are articles on scientific literature digitization technologies and their advantages.

Uzbek scientists are conducting applied research on the development of creative thinking and student skills through digital technologies.

Participation of CIS academics in conferences and international scientific meetings also covers the topics of digital technologies and innovations (Bukhara Conference).

The purpose and objectives of the study

The purpose of the study is to identify effective pedagogical methods for developing technical thinking in students using digital technologies in the higher education system and to develop their scientific and methodological foundations.

Research objectives:

- a) analyze the content and essence of the concept of technical thinking;
- b) identify the didactic potential of digital technologies in the development of technical thinking;
- c) study of modern digital tools used in higher education;
- d) substantiate effective methods aimed at developing technical thinking;
- e) develop recommendations for the implementation of research results into practice.

Technical thinking and its importance in higher education

The development of technical thinking is one of the urgent tasks facing society today. At a time when the pace of mastering digital technologies and the demand for the quality of technical specialists is increasing, traditional educational methods alone are losing their effectiveness. It is at this point that online and distance learning technologies create new opportunities and provide broad opportunities for the development of technical thinking. The most important aspect of distance learning is the globalization of education and an individualized approach. Today, every student, sitting anywhere in the world, has access to the latest technologies and educational resources. This not only expands the scope of knowledge, but also strengthens the skills of working with technology. Through virtual laboratories and simulations, the opportunity to repeat real-life experiences is created, which plays an important role in the formation of practical knowledge. At





the same time, along with the advantages of online and distance learning, there are also some problems. In particular, the lack of sufficient technological infrastructure and the inability to effectively use the Internet still remain obstacles for many students. In addition, the lack of live communication between the teacher and the student can negatively affect student motivation. Therefore, to increase the effectiveness of online education, it is necessary to improve pedagogical approaches along with technologies. The advantage of the blended learning model in developing technical thinking is manifested as a solution to these problems. The student receives knowledge through online education, and consolidates practical experience in traditional or virtual laboratories. Such an approach teaches students not only to think intelligently, but also to think creatively and independently solve problems. The results obtained during the discussion show that in order to develop technical thinking, it is necessary to use interactive methods, project-based learning, and develop critical thinking to effectively organize online and distance learning. When students are directed to find solutions to real-life technical problems, their technical thinking develops and their confidence in their knowledge increases. For example, solving engineering problems in virtual laboratories or managing complex processes through simulations encourages students to be active.

Technical thinking is a thinking activity aimed at understanding, analyzing, modeling and solving problems of technical objects, processes and systems. In the higher education system, technical thinking is an important component of preparing students for professional activity. The related idea of computational thinking also emphasizes abstraction, decomposition, and systematic problem solving (Wing, 2006; Grover & Pea, 2013).

Technical thinking includes the following components:

- technical problem identification;
- logical and algorithmic thinking;
- modeling and simulation;
- skills for working in a digital environment;
- technical decision-making.

The role of digital technologies in the formation of these competencies is incomparable.

The main task of digital technologies is to develop the knowledge, skills and competencies of students by organizing the educational process in an effective, flexible and interactive way. In the higher education system, digital technologies are emerging as an important pedagogical tool that complements and improves traditional teaching methods.

The main tasks of digital technologies are:





increasing the understanding of the educational process through visualization and modeling of complex technical concepts;

encouraging students to think independently and creatively, developing technical thinking;

ensuring an individual and differentiated approach to the educational process;

increasing the effectiveness of practical training through virtual laboratories and simulation programs;

developing skills in quickly searching, processing and analyzing information;

creating the opportunity to monitor the quality of education and analyze results;

preparing for professional activities in a digital environment.

Thus, digital technologies serve to develop technical thinking in the higher education system, improve the quality and efficiency of education, and train competitive specialists.

Digital technologies create broad opportunities for the development of technical thinking in the higher education process. In particular:

Virtual laboratories allow students to study complex technical processes in a safe and interactive way. This method develops technical thinking through experimentation, error analysis, and modeling of results. Reviews of virtual laboratories report their value for experimentation and visualization while stressing the importance of sound instructional design (Potkonjak et al., 2016; May et al., 2023).

Through programs such as MATLAB, AutoCAD, SolidWorks, students acquire skills in designing and analyzing technical objects.

Artificial intelligence and adaptive platforms. AI-based learning systems offer tasks that are appropriate to the student's level of knowledge and provide an individual approach.

Effective methods for developing technical thinking. According to the results of the study, the following methods are considered the most effective:

- Problem-based learning method - giving tasks based on real technical problems;
- Project-based learning - developing team projects in a digital environment;
- Blended learning - combining traditional and digital education;
- Interactive simulations - visual modeling of technical processes;
- Digital portfolio - assessing students' technical developments.

Scientific novelty of the research

• An integrated model of digital technologies in the development of technical thinking was developed;

• Pedagogical criteria for the development of technical thinking for higher education were determined;





- Effective methodological recommendations based on the use of digital tools were developed.

Analysis of foreign experience.

Germany. The German technical education system is based on a dual education model, combining theoretical knowledge with the practice of producing knowledge. This model serves to effectively form technical thinking and professional skills in students (Müller, 2020).

South Korea. In South Korea, special attention is paid to robotics and programming within the framework of STEM education. Teaching based on problem situations has a positive effect on the development of technical thinking (Kim & Choi, 2022).

Finland. The Finnish education system prioritizes project-based and interactive approaches, and students develop creative and critical thinking through collective technical projects (Sahlberg, 2019).

Expected results

- Students' technical thinking skills increase;
- Independent and creative thinking develops;
- Professional competencies are formed;
- The effectiveness of the educational process increases;
- Skills for working in a digital environment are developed.

Research approach and limitations. The article is based on a focused analysis of scholarly literature and a comparative review of digital learning tools used in technical higher education. The discussion synthesizes published findings on computational thinking, active and problem-based learning, and virtual laboratories. Since the present version does not report a participant sample, measurement instruments, or original experimental data, the proposed outcomes should be interpreted as methodological expectations rather than as empirically measured effects. Further work should pilot the methods in engineering courses and compare student performance before and after implementation.

Conclusion

In conclusion, the development of technical thinking through digital technologies in the higher education system is one of the priorities of modern education. The effective use of digital tools helps to develop students' technical thinking and prepare them as competitive specialists. The results of the study serve as an important scientific and methodological basis for their implementation in higher education practice.

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