MUHAMMAD AL-XORAZMIY NOMIDAGI TOSHKENT AXBOROT TEXNOLOGIYALARI UNIVERSITETI HUZURIDAGI TEXNIKA FANLARI BO‘YICHA ILMIY DARAJALAR BERUVCHI DSc.l3/30.12.2019.T.07.01 RAQAMLI ILMIY KENGASH

MUHAMMAD AL-XORAZMIY NOMIDAGI TOSHKENT AXBOROT TEXNOLOGIYALARI UNIVERSITETI

ABDUJALILOV JAVLONBEK ADILOVICH

SUN’IY INTELLEKT VA ROBOTOTEXNIKA ASOSLARINI MAKTAB O‘QUVCHILARIGA O‘QITISH METODIKASINI TAKOMILLASHTIRISH

13.00.02 – Ta’lim va tarbiya nazariyasi va metodikasi (Informatika)

PEDAGOGIKA FANLARI BO‘YICHA FALSAFA DOKTORI (PhD) DISSERTATSIYASI AVTOREFERATI

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Ilmiy rahbar:	**Zakirova Feruza Makhmudovna** pedagogika fanlari doktori, professor
Rasmiy opponentlar:	**Fayziyeva Maxbubaxon Raximjonovna** pedagogika fanlari doktori, professor
	Shoymardonov Tuymurod Turdialiyevich pedagogika fanlari bo‘yicha falsafa doktori (PhD), dotsent
Yetakchi tashkilot:	**Guliston davlat universiteti**

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Dissertatsiya bilan Muhammad al-Xorazmiy nomida Toshkent axborot texnologiyalari universitetining Axborot-resurs markazida tanishish mumkin (_____ raqami bilan ro‘yxatga olingan). Manzil: Toshkent 100084, Amir Temur shox ko‘chasi 108 uy, Tel.: +998712386489; faks: +998712386415

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M.M. Musaev
Ilmiy darajalar beruvchi ilmiy kengash raisi, t.f.d., professor

E.Sh. Nazirova
Ilmiy darajalar beruvchi ilmiy kengash ilmiy kotibi, t.f.d., professor

Dj. B. Sultanov
Ilmiy darajalar beruvchi ilmiy kengash qoshidagi ilmiy seminar raisi, t.f.d., dotsent

KIRISH (falsafa doktori (PhD) dissertatsiyasi annotatsiyasi)

Dissertatsiya mavzusining dolzarbligi va zarurati. Jahonda axborot texnologiyalarining jadal rivojlanishi inson hayotini yanada yaxshilash, ijtimoiy-iqtisodiy imkoniyatlarni kengaytirish, ta’lim jarayonini yanada takomillashtirishda muhim ahamiyat kasb etmoqda. Texnologiyalar doimiy taraqqiyot yo‘lida va yangi sohalarni kashf etish asnosida resurslarning maksimal samaradorligini ta’minlovchi muhim predmetdir. Bu kabi yangi sohalarga sun’iy intellekt va robototexnikani misol qilish mumkin. Sun’iy intellekt va robototexnikaning ta’lim tizimiga kirib kelishiga YUNESKO[1] va bir qancha ta’lim tashkilotlari tomonidan katta e’tibor qaratilmoqda. XXI-asr texnologiyalar asri bo‘lganligi sababli, o‘quvchilarga sun’iy intellekt va robototexnikaga oid zarur bilim, ko‘nikma va malakalarni muntazam yetkazib borish eng dolzarb muammolardan hisoblanadi.

Dunyoda yetakchi mamlakatlar umumiy o‘rta ta’lim maktablarida sun’iy intellekt va robototexnika mavzularini tatbiq etish orqali o‘quvchilarning muammolarni hal qilish, tanqidiy fikrlash va ijodkorlikni o‘z ichiga olgan bir qator ko‘nikmalarini shakllantirishga qaratilgan turli ilmiy tadqiqot ishlari olib bormoqda. Mazkur tadqiqotlarning zamonaviy tendensiyalaridan kelib chiqib, umumiy o‘rta ta’lim o‘quv jarayoniga innovatsion ta’lim texnologiyalarini tatbiq etish, ilg‘or xorijiy tajribalarni o‘zlashtirish va maqsadli yo‘naltirish, sun’iy intellekt va robototexnika mavzularini o‘qitish orqali o‘quvchilarning o‘rgangan bilimlarini amaliyotga joriy etish ko‘nikmalarini shakllantirish hamda raqamli kompetensiyalarga ega kadrlarni tayyorlash dolzarb vazifalardan hisoblanadi.

Mamlakatimizda axborot kommunikatsiya texnologiyalari jadal rivojlanib ilm-fan, ta’lim, ishlab chiqarish sohalariga kirib kelishi natijasida ko‘plab ishlab chiqarish obyektlarida robototexnika qurilmalaridan foydalanish, sun’iy intellekt tizimlarni joriy etish orqali ishlab chiqarish jarayonlarning avtomatlashtirishga katta e’tibor qaratilmoqda. Ushbu globallashuv va axborotlashtirish jarayonida umumiy o‘rta ta’lim tizimida o‘quvchilarga sun’iy intellekt va robototexnikani o‘qitish orqali ularning raqamli kompetensiyalarini shakllantirish zaruratini yuzaga keltirmoqda. Sun’iy intellekt texnologiyalarini 2030-yilga qadar rivojlantirish strategiyasida[2], “…sohada yuqori malakali kadrlar zaxirasini shakllantirish uchun umumta’lim maktablari o‘quvchilariga dasturlashni o‘rgatish bo‘yicha zarur sharoitlar yaratish, sun’iy intellekt yo‘nalishida kadrlar tayyorlovchi oliy ta’lim tashkilotlari bitiruvchilari sonini oshirish, dasturlash tillarini o‘qitish orqali o‘quvchi va talabalarning sun’iy intellekt sohasidagi bilimlarini o‘rta darajaga yetkazish” masalalariga alohida e’tibor qaratilgan. Mazkur vazifalar ta’lim tizimining barcha darajalariga qo‘yiladigan talablarni shakllantirishga ta’sir qiladi. Xususan, umumiy o‘rta maktab o‘quvchilari uchun muhandislik va raqamli mutaxassisliklarning bo‘lajak vakillari sifatida oldindan kasbiy tayyorgarlikka, sun’iy intellekt sohasida ularning raqamli kompetensiyalarini shakllantirishga talab yuqoriligini bildiradi.

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[1] O‘quvchilar uchun Sun’iy intellektni o‘rganish freymvorki, UNESCO tomonidan 2024-yil chop etilgan, ISBN 978-92-3-100709-5 https://unesdoc.unesco.org/ark:/48223/pf0000391105

[2] O‘zbekiston Respublikasi Prezidentining 2024-yil 14-oktyabrdagi PQ-358-son “Sun’iy intellekt texnologiyalarini 2030-yilga qadar rivojlantirish strategiyasini tasdiqlash to‘g‘risida”gi qarori

O‘zbekiston Respublikasi Prezidentining 2024-yil 2-iyuldagi “Maktabgacha va maktab ta’limi sohasida davlat boshqaruvi tizimini takomillashtirish chora-tadbirlari to‘g‘risida”gi PF-98-son, 2023-yil 26-maydagi “Maktabgacha va maktab ta’limi vazirligi hamda uning tizimidagi tashkilotlar faoliyatini samarali tashkil etish chora-tadbirlari to‘g‘risida”gi PF-79-son, 2022-yil 28-yanvardagi “2022-2026-yillarga mo‘ljallangan yangi O‘zbekistonning taraqqiyot strategiyasi to‘g‘risida”gi PF-60-son farmonlari va 2024-yil 14-oktyabrdagi “Sun’iy intellekt texnologiyalarini 2030-yilga qadar rivojlantirish strategiyasini tasdiqlash to‘g‘risida”gi PQ-358-son, 2021-yil 17-fevraldagi “Sun’iy intellekt texnologiyalarini jadal joriy etish uchun shart-sharoitlar yaratish chora-tadbirlari to‘g‘risida”gi PQ-4996-son, 2021-yil 25-yanvardagi “Xalq ta’limi sohasidagi ilmiy-tadqiqot faoliyatini qo‘llab quvvatlash hamda uzluksiz kasbiy rivojlantirish tizimini joriy qilish chora-tadbirlari to‘g‘risida”gi PQ-4963-son qarorlari hamda mazkur sohaga taalluqli boshqa me’yoriy-huquqiy hujjatlarda belgilangan vazifalarni amalga oshirishda mazkur tadqiqot ishi muayyan darajada xizmat qiladi.

Tadqiqotning respublika fan va texnologiyalari rivojlanishining ustuvor yo‘nalishlariga mosligi. Mazkur tadqiqot respublika fan va texnologiyalarini rivojlantirishining I.“Axborotlashtirish va axborot kommunikatsiya texnologiyalarini rivojlantirish” ustuvor yo‘nalishi doirasida bajarilgan.

Muammoning o‘rganilganlik darajasi. So‘ngi paytlarda ko‘plab davlatlarning olimlari tomonidan sun’iy intellekt va robototexnikani turli sohalarga tatbiq qilish yuzasidan ilmiy tadqiqot ishlarini olib borilmoqda, shuningdek, ushbu sohalarni yanada rivojlanishi uchun umumiy o‘rta ta’limda ushbu mavzularni o‘qitish bo‘yicha izchillik bilan shug‘ullanishmoqda. Dissertatsiyaning nazariy konsepsiyasini ishlab chiqishda quyidagi olimlarning olib borgan fundamental ilmiy tadqiqot ishlariga tayanildi:

Respublikamizda zamonaviy axborot va kommunikatsiya texnologiyalarini ta’lim tizimiga joriy etish va ta’limni axborotlashtirish vositalarini yaratish hamda ulardan foydalanishning nazariy asoslari bo‘yicha respublikamiz olimlaridan A.A. Abduqodirov, U.Sh. Begimkulov, M.X. Lutfillaev, M.E. Mamarajabov, F.M. Zakirova va boshqalarning ilmiy-tadqiqot ishlarida o‘z aksini topgan.

Mustaqil davlatlar hamdo‘stligi mamlakatlarida umumiy o‘rta ta’limning turli bosqichlarida sun’iy intellekt va robototexnika asoslarini o‘qitish bo‘yicha S.A. Beshenkov, L.L. Bosova, A.A. Kuznetsov, N.I. Rijova, T.N.Suvorova, N.N. Samilkina va boshqalar izlanishlar olib borishgan.

Xorij mamlakatlarida sun’iy intellekt va robototexnikani o‘qitishni nazariy rivojlanish asoslari bo‘yicha C. Breazeal, J. Makkarti, M. Minski, M.Resnik, A.M. Turing va boshqalar o‘rganishgan.

Tasvirlarni tekshirib bilish va sun’iy intellekt nazariyalari bo‘yicha katta maktab yaratgan akademik M.M. Komilov, axborotni qayta ishlash bo‘yicha akademiklar D.A.Abdullaev, T.F. Bekmuratov ilmiy-uslubiy izlanishlar olib borgan va bu sohaning rivojlanishiga katta hissa qo‘shgan.

Tadqiqot muammosiga doir adabiyotlarni o‘rganish va mavjud nazariy manbalarning tahlili shuni ko‘rsatdiki, umumiy o‘rta ta’lim maktablarida sun’iy intellekt va robototexnika asoslarini o‘qitish metodikasini takomillashtirish yuzasidan alohida ilmiy tadqiqot ishi sifatida o‘rganilmagan.

Tadqiqot mavzusining dissertatsiya bajarilgan ilmiy-tadqiqot institutining ilmiy-tadqiqot ishlari bilan bog‘liqligi. Dissertatsiya tadqiqoti Muhammad al-Xorazmiy nomidagi Toshkent axborot texnologiyalari universiteti ilmiy-tadqiqot ishlari rejasi asosida “O‘zbekistonda mexatronika va robototexnika bakalavriat ta’lim yo‘nalishini innovatsion g‘oyalar va raqamli texnologiyalar asosida modernizatsiya qilish” (loyiha raqami 609564-EPP-1-2019-1-EL-EPPKA2-CBHE-JP) xalqaro amaliy tadqiqot loyihasi doirasida bajarilgan.

Tadqiqotning maqsadi sun’iy intellekt va robototexnika asoslarini maktab o‘quvchilariga o‘qitish metodikasini takomillashtirishdan iborat.

Tadqiqotning vazifalari:

sun’iy intellekt va robototexnika asoslarini umumiy o‘rta ta’lim maktabi o‘quvchilariga o‘qitishning pedagogik-psixologik omillarini aniqlashtirish;

sun’iy intellekt va robototexnika asoslari bo‘yicha o‘quvchining qobiliyatlarini shakllantirish bosqichlarini yoritib berish;

sun’iy intellekt va robototexnika asoslarini o‘qitish metodikasini takomillashtirish;

sun’iy intellekt va robototexnika asoslari bo‘yicha o‘quvchilarni o‘rgangan bilim, ko‘nikma, kompetensiyalarini aniqlashga yo‘naltirilgan formativ va summativ baholash mezonlarini ishlab chiqish.

Tadqiqotning obyekti sifatida umumiy o‘rta ta’lim maktablarida sun’iy intellekt va robototexnika asoslarini o‘qitish jarayoni olinib, Toshkent shahridagi 12 ta tumanda joylashgan 12 ta umumiy o‘rta ta’lim maktablaridan 735 nafar o‘quvchi respondentlar tajriba sinov tariqasida sun’iy intellekt va robototexnika asoslarini o‘qitish uchun jalb qilindi.

Tadqiqotning predmeti sifatida umumiy o‘rta ta’lim maktablarida sun’iy intellekt va robototexnika asoslarini o‘qitish mazmuni, baholash mezoni, metodikasi va vositalari tashkil qiladi.

Tadqiqotning usullari tadqiqot jarayonida adabiyotlar tahlili, qiyosiy tahlil, so‘rovnoma, nazorat ishi, tajriba-sinov, matematik-statistik tahlil, intervyu kabi tadqiqot va tahlil usullaridan foydalanilgan.

Tadqiqotning ilmiy yangiligi quyidagilardan iborat:

sun’iy intellekt va robototexnika asoslarini umumiy o‘rta ta’lim maktabi o‘quvchilariga o‘qitishning pedagogik-psixologik omillari neyrodidaktika tamoyillarini inobatga olgan holda immersiv texnologiyalardan foydalanish, raqamli kompetensiyalarni va ijodiy-texnologik fikrlash qobiliyatlarini shakllantirish asosida aniqlangan;

sun’iy intellekt va robototexnika asoslari bo‘yicha o‘quvchining qobiliyatlarini shakllantirish bosqichlari ijodiy-texnologik fikrlash imkonini beruvchi Arduino muhitida aqlli komponentlarni dasturlashga olib keluvchi elektron sxemalarni yaratish, funksional bloklarni kodlash va generativ sun’iy intellekt texnologiyalar yordamida tekshirish xususiyatlariga ustuvorlik berish asosida takomillashtirilgan;

sun’iy intellekt va robototexnika asoslarini o‘qitish metodikasi guruhli loyihalarni bajarish jarayonida klasterlash, tasniflash va regressiya algoritmlari yordamida ma’lumot to‘plamlarini tahlil qilish, mikrokontrollerlarni yig‘ish va simulyatsiya qilish

jarayonida avtomatik boshqarish asosida takomillashtirilgan;

sun’iy intellekt va robototexnika asoslari bo‘yicha o‘quvchilarning kompetensiyalarini rivojlantirish samaradorligini baholash mezonlari konstruktiv fikrlashga yo‘naltirilgan muammoli vazifalar, guruh loyihalarning mavzulari va ularni bajarish darajasini hisobga olgan holda formativ va summativ usullarni joriy etish asosida takomillashtirilgan.

Tadqiqotning amaliy natijalari quyidagilardan iborat:

umumiy o‘rta ta’lim maktabi o‘quvchilari uchun sun’iy intellekt va robototexnika asoslari mavzulari bo‘yicha amaliy mashg‘ulotlarni o‘tkazish bo‘yicha uslubiy qo‘llanma ishlab chiqilgan;

umumiy o‘rta ta’lim maktabi o‘quvchilari uchun sun’iy intellekt va robototexnika asoslari mavzulariga doir topshiriqlar va baholash mezonlari ishlab chiqilib amaliyotga tatbiq etilgan;

umumiy o‘rta ta’lim maktabi o‘quvchilariga sun’iy intellekt va robototexnika asoslarini o‘qitishga yo‘naltirilgan “Maktab o‘quvchilariga sun’iy intellekt va robototexnika asoslarini o‘qitishning elektron o‘quv qo‘llanmasi” nomli o‘quv qo‘llanmasi (DGU 45434) yaratilgan va maktablarda tatbiq etilgan.

Tadqiqot natijalarining ishonchliligi qo‘llanilgan nazariy ma’lumotlarning rasmiy manbalardan olinganligi, qo‘llanilgan usullar, muammoga falsafiy, pedagogik-psixologik yondashuvlar hamda respublika va xalqaro ilmiy-amaliy anjuman materiallari to‘plamlari, oliy attestatsiya komissiyasi e’tirof etgan maxsus va xorijiy jurnallarda chop qilingan maqolalar, keltirilgan tahlillar va tajriba sinov ishlari samaradorligining matematik statistika metodlari vositasida asoslanganligi, xulosa, taklif va tavsiyalarning amaliyotda joriy etilganligi, olingan natijalarning vakolatli tuzilmalar tomonidan tasdiqlanganligi bilan izohlanadi.

Tadqiqot natijalarining ilmiy va amaliy ahamiyati. Tadqiqot natijalarining ilmiy ahamiyati sun’iy intellekt va robototexnika asoslarini umumiy o‘rta ta’lim maktabi o‘quvchilarini o‘qitishda immersiv texnologiyalardan foydalanish, raqamli kompetensiyalarni va ijodiy-texnologik fikrlash qobiliyatlarini shakllantirish, Arduino muhitida aqlli komponentlarni dasturlashga olib keluvchi elektron sxemalarni yaratish, funksional bloklarni kodlash va generativ sun’iy intellekt texnologiyalar yordamida tekshirish asosida o‘qitish metodikasini takomillashtirish bilan izohlanadi.

Tadqiqot natijalarining amaliy ahamiyati shundan iboratki, sun’iy intellekt va robototexnika asoslarini umumiy o‘rta ta’lim maktabi “Informatika va axborot texnologiyalari” fani o‘qituvchilarini malakasini oshirish kurslarida qo‘llanilishi mumkin. Shuningdek, “Matematika va Informatika” yo‘nalishida ta’lim beruvchi pedagogika universitetlarida bo‘lajak o‘qituvchilarni tayyorlashda foydalanilishi mumkin.

Tadqiqot natijalarining joriy qilinishi. Sun’iy intellekt va robototexnika asoslarini maktab o‘quvchilariga o‘qitish metodikasini takomillashtirish bo‘yicha tadqiqotning ilmiy natijalari asosida:

sun’iy intellekt va robototexnika asoslarini umumiy o‘rta ta’lim maktabi o‘quvchilariga o‘qitishning pedagogik-psixologik omillari neyrodidaktika tamoyillarini inobatga olgan holda immersiv texnologiyalardan foydalanish, raqamli

kompetensiyalarni va ijodiy-texnologik fikrlash qobiliyatlarini shakllantirish asosida aniqlashga qaratilgan takliflar “Informatika va axborot texnologiyalari” nomli darslik mazmuniga singdirilgan (O‘zbekiston Respublikasi Ta’limni rivojlantirish respublika ilmiy-metodik markazining 2025-yil 12-avgustdagi 01-03/7-422-sonli ma’lumotnoma). Natijada virtual reallik texnologiyalaridan foydalangan holda o‘quvchilarning raqamli kompetensiyalarini shakllantirishga imkoniyat yaratilgan;

sun’iy intellekt va robototexnika asoslari bo‘yicha o‘quvchining qobiliyatlarini shakllantirish bosqichlari ijodiy-texnologik fikrlash imkonini beruvchi Arduino muhitida aqlli komponentlarni dasturlashga olib keluvchi elektron sxemalarni yaratish, funksional bloklarni kodlash va generativ sun’iy intellekt texnologiyalar yordamida tekshirish xususiyatlariga ustuvorlik berish bo‘yicha takliflar “O‘zbekistonda bo‘lajak sun’iy intellekt olimlarini tarbiyalash uchun dasturlash va sun’iy intellekt ta’lim mazmuni va ta’lim modelini ishlab chiqish” bo‘yicha ta’lim sohasidagi xalqaro tadqiqot loyihasida foydalanilgan (2023-2024 yy). (Ta’limni rivojlantirish respublika ilmiy-metodik markazining 2025-yil 12-avgustdagi 01-03/7-422-sonli ma’lumotnoma). Natijada “Informatika va axborot texnologiyalari” fani o‘qituvchilari uchun zamonaviy o‘qitish texnologiyalari va vositalaridan foydalanish samaradorligi oshirilgan;

sun’iy intellekt va robototexnika asoslarini o‘qitish metodikasi guruhli loyihalarni bajarish jarayonida regressiya, tasniflash va klasterlash algoritmlari yordamida ma’lumot to‘plamlarini tahlil qilish, mikrokontrollerlarni yig‘ish va simulyatsiya qilish jarayonida avtomatik boshqarish asosida takomillashtirish bo‘yicha takliflar “O‘zbekistonda bo‘lajak sun’iy intellekt olimlarini tarbiyalash uchun dasturlash va sun’iy intellekt ta’lim mazmuni va ta’lim modelini ishlab chiqish” bo‘yicha ta’lim sohasidagi xalqaro tadqiqot loyihasida foydalanilgan (2023-2024 yy). (Ta’limni rivojlantirish respublika ilmiy-metodik markazining 2025-yil 12-avgustdagi 01-03/7-422-sonli ma’lumotnoma). Natijada “Informatika va axborot texnologiyalari” fani o‘qituvchilarini malakasini oshirishda foydalanish uchun guruhlarda ishlash orqali o‘qitish metodikasi takomillashtirildi.

sun’iy intellekt va robototexnika asoslari bo‘yicha o‘quvchilarning kompetensiyalarini rivojlantirish samaradorligini baholash mezonlari konstruktiv fikrlashga yo‘naltirilgan muammoli vazifalar, guruh loyihalarning mavzulari va ularni bajarish darajasini hisobga olgan holda baholashni takomillashtirish yuzasidan takliflar “O‘zbekistonda bo‘lajak sun’iy intellekt olimlarini tarbiyalash uchun dasturlash va sun’iy intellekt ta’lim mazmuni va ta’lim modelini ishlab chiqish” bo‘yicha ta’lim sohasidagi xalqaro tadqiqot loyihasida foydalanilgan (2023-2024 yy). (Ta’limni rivojlantirish respublika ilmiy-metodik markazining 2025-yil 12-avgustdagi 01-03/7-422-sonli ma’lumotnoma). Natijada o‘quvchilarning kompetensiyalarini baholash imkoniyatlari kengaytirildi.

Tadqiqot natijalarining aprobatsiyasi. Mazkur tadqiqot natijalari 8 ta xalqaro va 2 ta respublika ilmiy-amaliy anjumanlarida muhokamadan o‘tkazilgan.

Tadqiqot natijalarining e’lon qilinganligi. Dissertatsiya mavzusi bo‘yicha jami 7 ta ilmiy ish, O‘zbekiston Respublikasi Oliy attestatsiya komissiyasi tomonidan doktorlik dissertatsiyalari asosiy ilmiy natijalarini chop etish tavsiya etilgan ilmiy nashrlarda 6 ta maqola, jumladan 4 tasi respublika va 2 tasi xorijiy jurnallarda chop

etilgan va 1 ta EHM uchun ishlab chiqilgan dasturiy vositalarni qayd qilish guvohnomasi olingan.

Dissertatsiyaning tuzilishi va hajmi. Dissertatsiya kirish, uch bob, xulosa, 124 sahifa matn, foydalanilgan adabiyotlar ro‘yxati va ilovadan iborat.

DISSERTATSIYANING ASOSIY MAZMUNI

Kirish qismida dissertatsiya mavzusining dolzarbligi va zarurati asoslangan; dissertatsiya mavzusi bo‘yicha respublika va xorijiy ilmiy-tadqiqot ishlari sharhi va muammoning o‘rganilganlik darajasi yoritilgan, tadqiqotning maqsadi va vazifalari, shuningdek, obyekti va predmeti aniqlangan, tadqiqot ishining fan va texnologiyalarni rivojlantirishning muhim yo‘nalishlariga mosligi ko‘rsatilgan hamda tadqiqotning ilmiy yangiligi, natijalarning ishonchliligi, ilmiy va amaliy ahamiyati asoslab berilgan, tadqiqot natijalarning amaliyotga joriy etilgani, e’lon qilingani, dissertatsiyaning tuzilishi va hajmi haqida ma’lumotlar keltirilgan.

Dissertatsiyaning **“Umumiy o‘rta ta’lim maktablarida sun’iy intellekt va robototexnikani o‘qitishning pedagogik asoslari”** deb nomlangan birinchi bobida sun’iy intellekt va robototexnika asoslarini umumiy o‘rta ta’lim maktabi o‘quvchilariga o‘qitish dolzarbligi, sun’iy intellekt va robototexnika asoslarini o‘qitish jarayonida o‘quvchilarni qobiliyatlarini shakllantirish va pedagogik-psixologik omillari to‘g‘risida ma’lumotlar keltirilgan.

Respublikamizda sun’iy intellektni rivojlantirish bo‘yicha bir qancha ishlar amalga oshirilmoqda. Jumladan, ijtimoiy soha va iqtisodiyot tarmoqlarida sun’iy intellekt texnologiyalarini joriy qilish uchun qulay shart-sharoitlar yaratish, mamlakatimizning sun’iy intellekt texnologiyalaridan foydalanuvchi dunyoning yetakchi davlatlari qatoriga kirishiga erishish, shuningdek, “Raqamli O‘zbekiston-2030” strategiyasida belgilangan maqsad va vazifalar ijrosini ta’minlash maqsadida sun’iy intellekt texnologiyalaridan foydalanish bo‘yicha aholining bilim va ko‘nikmalarini oshirish, kadrlar salohiyatini rivojlantirish bo‘yicha sun’iy intellekt texnologiyalarini 2030-yilga qadar rivojlantirish strategiyasi tasdiqlangan[3].

Rivojlangan mamlakatlarda sun’iy intellekt va robototexnika asoslarini umumiy o‘rta ta’lim maktablarida o‘qitish keng joriy etilmoqda. Jumladan, Janubiy Koreyaning umumiy o‘rta ta’lim maktablarida yuqori sinf o‘quvchilar uchun ushbu mavzular bir yilda o‘rtacha 30-40 soat o‘qitiladi. Massachusets Texnologiya Institutining sun’iy intellekt va robototexnikaning ta’limdagi rolini chuqur o‘rgangan olimlardan biri Cynthia Breazeal tomonidan ta’kidlanishicha ushbu mavzular o‘quvchilarda raqamli savodxonlik, ish bozorida raqobatbardoshlik va tahliliy fikrlash ko‘nikmalarini shakllantirishda yordam beradi. Shuningdek, sun’iy intellekt va robototexnika asoslarini maktab o‘quvchilariga o‘qitish kelajakda muhim rol o‘ynaydigan texnologiyalarga tayyorlanishda yordam beradi[4].

Tadqiqot davomida O‘zbekiston Respublikasi umumiy o‘rta ta’lim ta’limda “Informatika va axborot texnologiyalari” va “Texnologiya” fanlarining dasturlari va

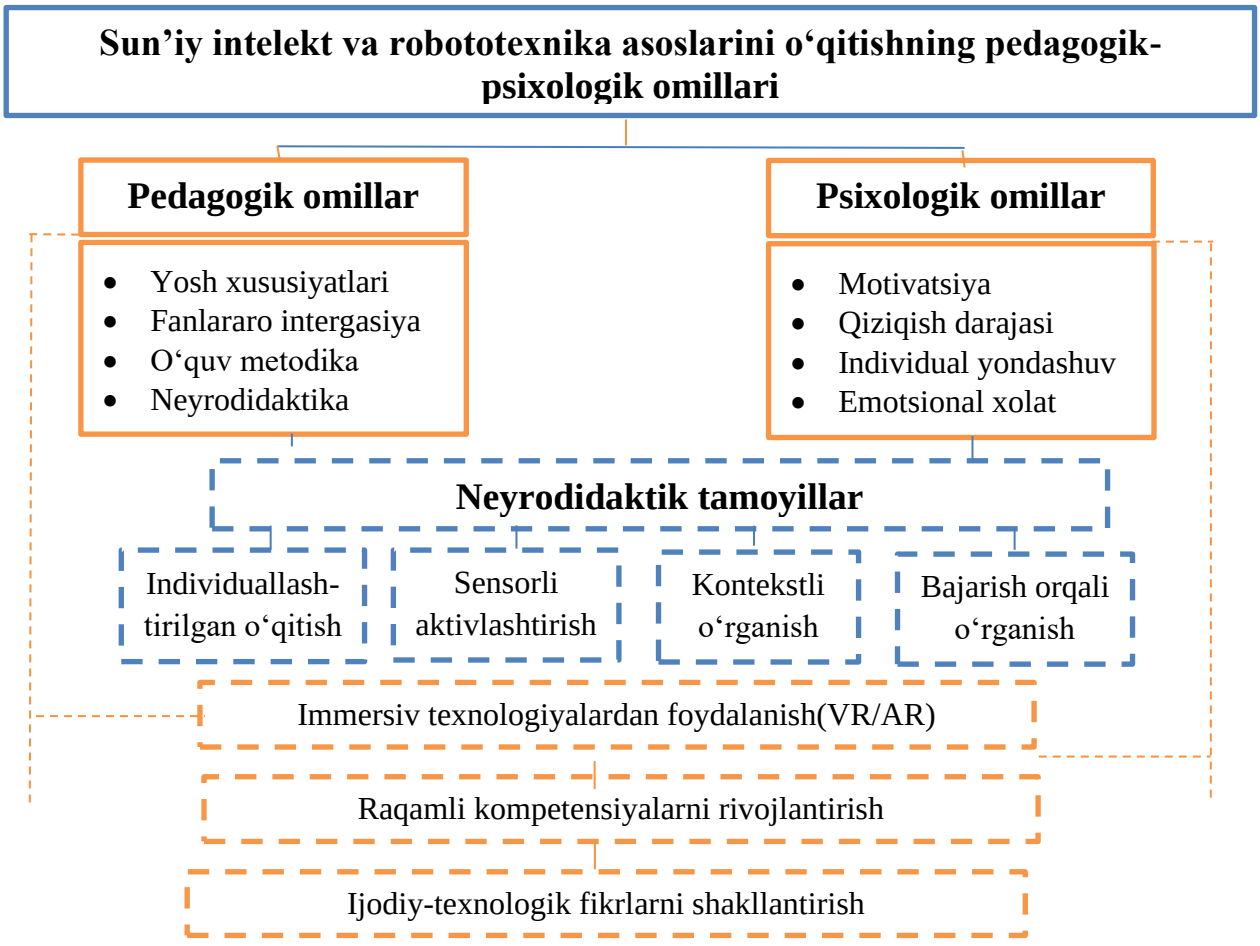
[3] O‘zbekiston Respublikasi Prezidentining 2024-yil 14-oktyabrdagi PQ-358-son “Sun’iy intellekt texnologiyalarini 2030-yilga qadar rivojlantirish strategiyasini tasdiqlash to‘g‘risida”gi qarori

[4] Umumiy o‘rta ta’limda sun’iy intellekt ta’limi https://www.media.mit.edu/publications/impact-ai-thesis/

darsliklari tahlil qilinganda, sun’iy intellekt va robototexnikaga doir mavzular mavjudligi aniqlandi. Ammo “Informatika va axborot texnologiyalari” fanida 2 soat (3%), “Texnologiya” fanida esa 6 soat (9%) sun’iy intellekt va robototexnika asoslari mavzulariga bag‘ishlangan. Bu esa o‘quvchilarning kelajakda sun’iy intellekt texnikalaridan samarali foydalanmasligiga olib keladi. Kelajak avlodning bilim va ko‘nikmalarini oshirish maqsadida sun’iy intellekt va robototexnika asoslarini o‘qitish metodikalari takomillashtirish taklif qilinmoqda.

Tadqiqot jarayonida eng avvalo mavzuga doir bo‘lgan zamonaviy pedagogik tajribalar o‘rganildi. Zamonaviy dunyoda VR (virtual reallik) va AR (kengaytirilgan reallik) kabi immersiv texnologiyalardan foydalanish keng tarqalmoqda, bu esa o‘quvchilarning fikrlash ko‘nikmalariga katta ta’sir ko‘rsatmoqda. Natijada neyrodidaktika deb atalgan yangi yo‘nalish paydo bo‘ldi. Ushbu texnologiyalardan foydalanish o‘quvchilarning shaxsiy xususiyatlariga moslangan interaktiv ta’lim muhitini yaratishga imkon beradi. Immersiv texnologiyalar o‘quvchilarning sun’iy intellekt algoritmlari va robototexnika tizimlarining ishlash prinsiplari kabi murakkab tushunchalarni tasavvur qilish orqali yaxshiroq o‘zlashtirishga imkon beradi.

Sun’iy intellekt va robototexnika asoslarini o‘qitishda pedagogik-psixologik omillar hamda neyrodidaktika tamoyillarini inobatga olgan holda virtual reallik texnologiyalar imkoniyatidan foydalanish orqali umumiy o‘rta ta’lim tizimidagi o‘quvchilarning ijodiy-texnologik fikrlash ko‘nikmalari hamda raqamli kompetensiyalarini shakllantirish imkoniyatlari aniqlandi (1-rasmga qarang).



1-rasm. Sun’iy intellekt va robototexnika asoslarini maktab o‘quvchilariga o‘qitishning pedagogik-psixologik omillari

1-rasmda keltirilgan barcha komponentlar sun’iy intellekt va robototexnika asoslarini samarali o‘rgatish uchun integratsiyalashgan yondashuvni aks ettiradi. Ushbu yondashuv o‘quvchilarning nafaqat nazariy bilimlarini, balki amaliy ko‘nikmalarini ham shakllantirishga qaratilgan bo‘lib, ularni zamonaviy texnologiyalar olamida muvaffaqiyatga erishishlariga tayyorlaydi.

Neyrodidaktika tamoyillari asosida individuallashtirilgan o‘qitish har bir o‘quvchining imkoniyatlari va ehtiyojlariga mos dars berish uchun muhimdir. Sun’iy intellekt va robototexnika asoslarini o‘rganishda sensorli aktivlashtirish usuli o‘quv jarayonida ko‘rish, eshitish, teginish kabi sezgi organlarini faol jalb etish orqali axborotni qabul qilish miyada mustahkam nerv aloqalarini hosil qiladi. Kontekstli o‘rganish usuli bilimlarni real hayotiy vaziyatlar bilan bog‘lab o‘rganishda uni eslab qolish va qo‘llash osonlashadi. Bajarish orqali o‘rganish usulida nazariy o‘rganilgan bilimlar darhol amalda sinab ko‘rish, faol harakat orqali bilim hosil qilinadi. Robototexnika darsida faqat robotni ishlash prinsipi haqida gapirish emas, balki uni yig‘ish, dasturlash va simulyatsiyalarga jalb etish orqali ularning bilimlarni yanada chuqur o‘zlashtirishiga ko‘maklashadi.

Virtual reallik (VR) texnologiyasi o‘quvchilarga sun’iy intellekt va robototexnika tizimlarini simulyatsiya qilish imkonini beradi. Masalan, robototexnika jarayonlarini o‘rgatishda VR muhitda murakkab tizimlarni boshqarishni o‘rganish mumkin. Kengaytirilgan reallik (AR) texnologiyasidan foydalanib o‘quvchilar robotlarning ishlash mexanizmini yoki sun’iy intellekt algoritmlarini vizualizatsiya qilish imkoniyatiga ega bo‘lishadi.

Raqamli kompetensiyalarni shakllantirishda pedagogik va psixologik omillarni hisobga olgan holda, o‘quv jarayoni o‘quvchilarning yosh xususiyatlariga, qiziqishlariga va o‘qitishning zamonaviy usullariga mos tarzda tashkil etiladi.

O‘quvchilarning ijodiy-texnologik fikrlash qobiliyatini samarali tarzda shakllantirishda pedagogik va psixologik omillarni hisobga olgan holda, o‘quvchilarning o‘rganishga bo‘lgan motivatsiyasi, mavzuga bo‘lgan tabiiy qiziqishi, har bir o‘quvchining shaxsiy ehtiyojlari va emotsional holati inobatga olgan holda individual yondashuv asosida o‘rgatiladi bu esa ularga kelajakda muvaffaqiyatli mutaxassislar sifatida yetishishga yordam beradi.

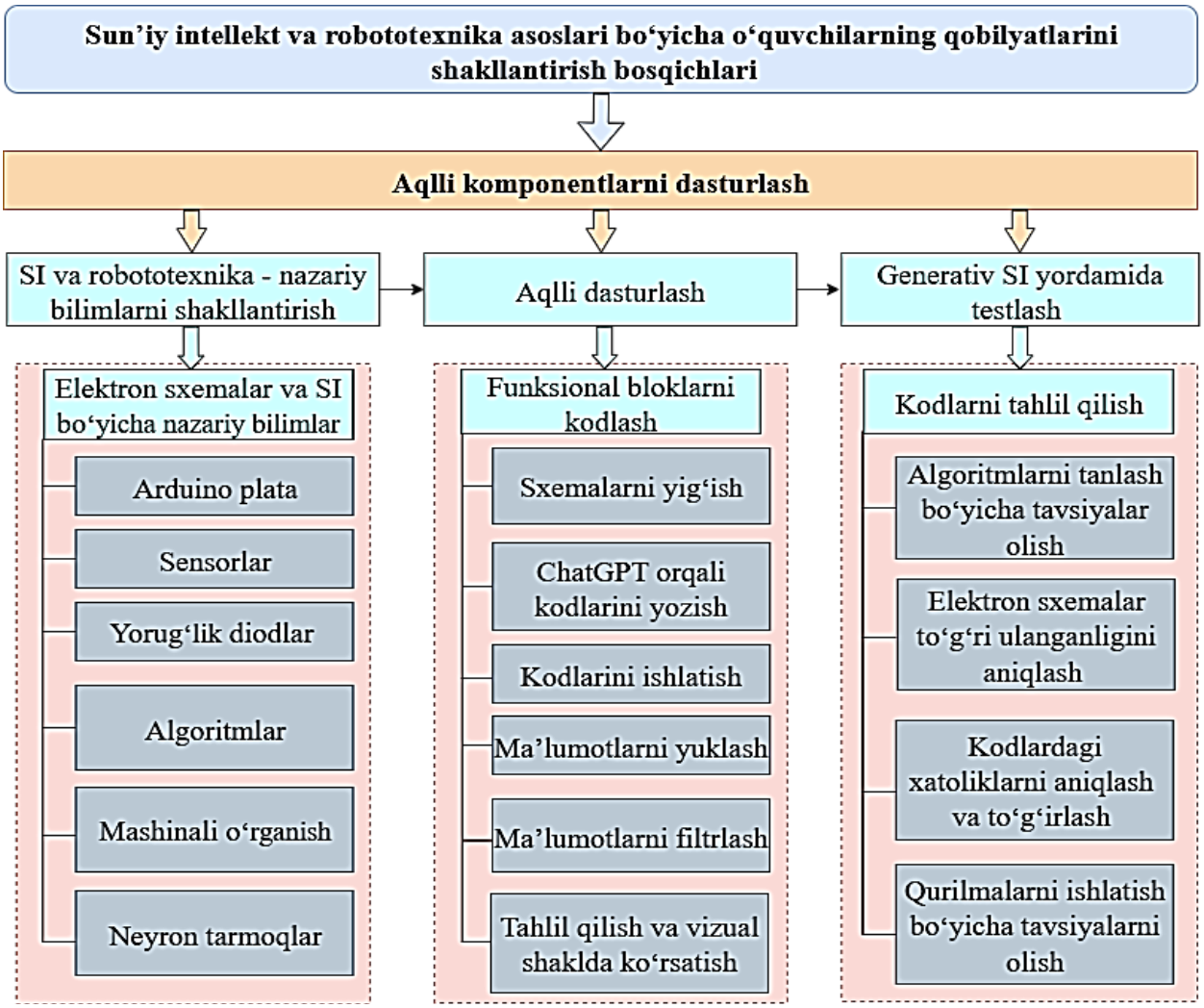
Dissertatsiyaning **“Sun’iy intellekt va robototexnika asoslarini maktab o‘quvchilariga o‘qitish metodikasini takomillashtirish”** deb nomlangan ikkinchi bobida sun’iy intellekt va robototexnika asoslari bo‘yicha o‘quvchining qobiliyatlarini shakllantirish bosqichlari, o‘qitish metodikasi va baholash, usullari yoritilgan.

Sun’iy intellekt va robototexnika asoslari bo‘yicha o‘quvchining qobiliyatlarini shakllantirish bosqichlari nazariy bilim va amaliy ko‘nikma olishni nazarda tutadi va uchta bosqichni o‘z ichiga oladi.

Birinchi bosqichda o‘quvchilar nazariy bilimlarni o‘zlashtiradilar. Masalan sun’iy intellektning asosiy tushunchalari (algoritmlar, mashina o‘rganish, neyron tarmoqlar va h.k.) va robototexnika elementlari haqida ma’lumot oladilar (2-rasmga qarang).

Ikkinchi bosqichda o‘quvchilar o‘rgangan nazariy bilimlarini amaliyotda

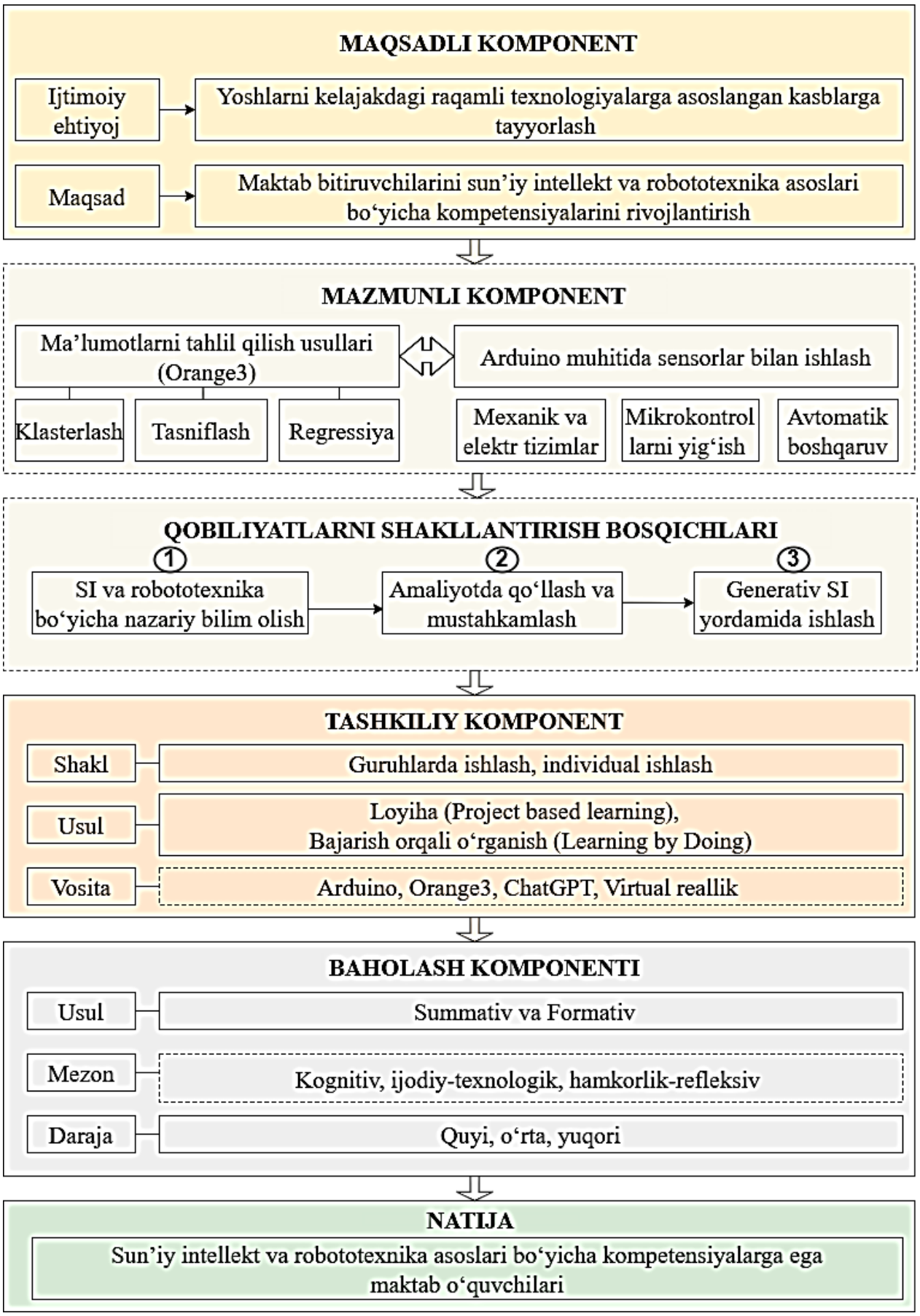
qo‘llash va mustahkamlashni amalga oshiriladi. Bu bosqichda o‘quvchilar aqlli dasturlash orqali amaliy topshiriqlarni bajaradi. Dissertatsiyada robototexnika modellarini yaratish va dasturlash, mustaqil loyiha ishlari va guruh ishlarida ishtirok etish kabi amaliy vazifalarni bajarishi ochib berilgan. Masalan Orange 3 da ma’lumotlarni yuklash, tozalash, tahlil qilish va natijalarni grafik shaklda ko‘rsatish uchun maxsus funksiyalari mavjud. Bu algoritmlarning ishlashini tushunish va natijalarni baholash uchun juda foydalidir. Shuningdek, turli xil mashinani o‘qitish algoritmlari mavjud bo‘lib, ularni klassifikatsiya, regressiya, klasterlash va boshqa masalalar uchun ishlatish mumkin.



2-rasm. Sun’iy intellekt va robototexnika asoslari bo‘yicha o‘quvchining qobiliyatlarini shakllantirish bosqichlari

Uchinchi bosqichda sun’iy intellekt va robototexnika asoslarini o‘rganishda maktab o‘quvchilarining qiziqishini orttirish maqsadida generativ sun’iy intellekt yordamida qurilmalarni ishlatish bo‘yicha tavsiyalarni olish, elektron sxemalarni to‘g‘ri ulanganligini aniqlash hamda robototexnika elementlarini ishlashi holatini tekshirish, vujudga keladigan xatoliklarni aniqlash uchun ChatGPT kabi dasturlardan foydalanib kodlarni tekshirish imkoniyati ko‘rib chiqilgan.

Tadqiqot davomida sun’iy intellekt va robototexnika asoslarini o‘qitishni metodik tizimi takomillashtirildi (3-rasmga qarang).



3-rasm. Sun'iy intellekt va robototexnika asoslarini maktab o'quvchilariga o'qitishni metodik tizimi

Maqsadli komponent yurtimizda raqamli texnologiyalarning rivojlanish tendensiyalarini inobatga olgan holda maktab o‘quvchilarga sun’iy intellekt va robototexnika asoslari bo‘yicha kompetensiyalarini shakllantirish orqali ularni kelajakdagi raqamli texnologiyalarga asoslangan kasblarga tayyorlashni ifodalaydi. Shuningdek, ushbu komponent sun’iy intellekt va robototexnika asoslarini o‘zlashtirishdan kutiladigan natijalarni o‘z ichiga oladi, bu esa ularni o‘rgatish uchun mos ta’lim darajasini aniqlashga yordam beradi.

Mazmunli komponent o‘quvchilar uchun integrativ mavzuli modullar (Orange3 dasturiy vositasi yordamda ma’lumotlarni tahlil qilish, Arduino muhitida sensorlar bilan ishlash) bilan ifodalanadi. Ushbu modullar o‘rtasida bog‘liqlikni o‘rnatish uchun ma’lumotlar bilan ishlashning barcha bosqichlarini o‘z ichiga olgan, jumladan klasterlash, tasniflash va regressiya yordamida ma’lumotlarni tahlil qilish algoritmlarini ishlatishni o‘rganiladi. Shuningdek, Arduino platformasida o‘quvchilar mikroprotsessorlar va turli sensorlar yordamida amaliy loyihalarni yaratishda dasturlash va elektronika asoslarini o‘rganish imkoniyatiga ega bo‘ladilar. Integrativ mavzuli modullar orqali o‘quvchilar zamonaviy texnologiyalar bilan tanishadilar, amaliy bilimlarini mustahkamlaydilar va ularni turli fanlar bo‘yicha o‘zaro bog‘lash imkoniyatiga ega bo‘ladilar. Ushbu ta’lim modullari robototexnika va ma’lumotlar tahlili kabi mavzularni o‘z ichiga olgan bo‘lib, turli dasturiy vositalardan foydalanish ko‘nikmalarini shakllantirishga xizmat qiladi.

Tashkiliy komponent zamonaviy o‘qitish usullarini tanlash imkoniyatini beradi, shu jumladan zarur bo‘lgan o‘qitish shakllari, usullari va vositalarini o‘z ichiga oladi. Loyiha asosida o‘qitishni amalga oshirish uchun o‘quvchilar guruhlarga bo‘lingan va dasturiy vositalarning muhitlaridan foydalanib, turli amaliy dasturlarni tayyorlash vazifasi yuklatilgan. Uslubiy qo‘llanmada har bir modullar uchun dasturiy vositalardan foydalanish bo‘yicha nazariy ko‘rsatmalar tushuntirib berilgan va topshiriqlar ishlab chiqilgan.

Baholash komponenti baholash usullari (formativ baholash va yakuniy baholash), mezonlari va darajalarini o‘z ichiga oladi. Sun’iy intellekt va robototexnika asoslarini o‘rgangan o‘quvchilarni kognitiv, ijodiy-texnologik va hamkorlik-refleksiv qobiliyatlarini baholash mezonlari ishlab chiqildi.

O‘quvchilarda kognitiv bilimlarni shakllanishi o‘quvchining fikrlash, tahlil qilish, mantiqiy fikrlash va qaror qabul qilish qobiliyatlarini o‘sishini o‘z ichiga oladi.

O‘quvchilarda ijodiy-texnologik qobiliyatlarini shaklanishi zamonaviy texnologiyalardan foydalanishni o‘z ichiga oladi. Bu bilimlar o‘quvchiga turli texnik asboblar, qurilmalar va dasturiy ta’minotdan samarali foydalanish imkonini beradi.

O‘quvchilarning hamkorlik-refleksiv ko‘nikmalarini shakllanishi loyiha bo‘yicha o‘quvchilar o‘rtasidagi hamkorlik va o‘zaro fikr almashishni o‘z ichiga oladi.

Dissertatsiyaning **“Pedagogik tajriba-sinov ishlarining natijalari va ularning samaradorligi”** deb nomlangan uchinchi bobida Sun’iy intellekt va robototexnika asoslarini o‘qitish bo‘yicha so‘rovnoma natijalari tahlil qilingan, tajriba-sinovlarni o‘tkazish bosqichlarining tavsifi, tajriba-sinov natijalari va ularni statistik tahlili keltirilgan, sun’iy intellekt va robototexnika asoslarini o‘qitish usullarining samaradorligini tekshirish bo‘yicha pedagogik eksperiment ma’lumotlari tahlil qilingan.

Toshkent shahridagi 12 ta tumanda joylashgan 12 ta maktabning 10-11-sinf

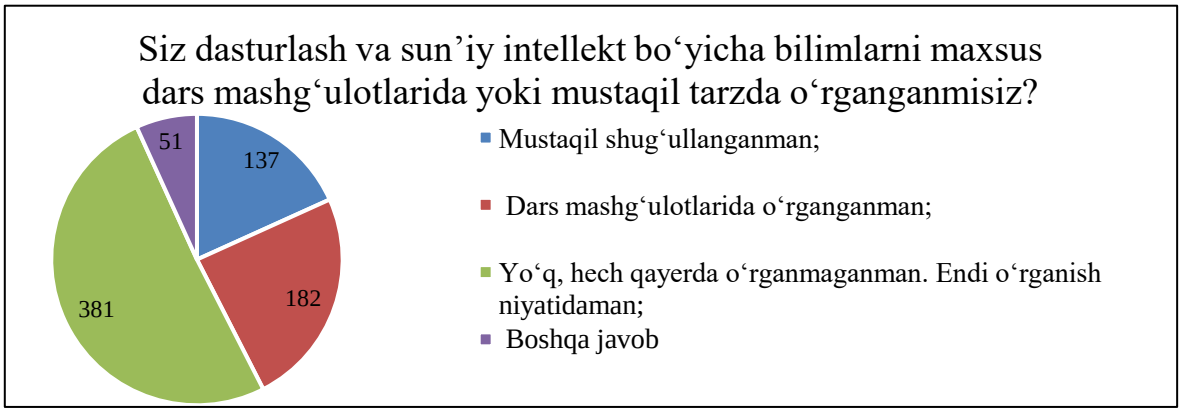
o‘quvchilari, ularning ota-onalari (vasiylari), “Informatika va axborot texnologiyalari” fani o‘qituvchilari va maktab direktorlaridan Sun’iy intellekt va robototexnika asoslarini o‘qitish holati, o‘quvchilarni ushbu mavzularga qiziqishi, ota-onalarning ushbu mavzularni farzandiga o‘qitishga bo‘lgan qiziqishini o‘rganish hamda o‘qituvchilarning ushbu mavzularni o‘quvchilarga o‘qita olish bo‘yicha bilim va ko‘nikmalari borligini aniqlash maqsadida so‘rovnoma o‘tkazildi va natijalari tahlil qilindi.

So‘rovnomada 735 nafar o‘quvchi, 542 nafar ota-onalar (vasiylar), 33 nafar “Informatika va axborot texnologiyalari” fani o‘qituvchilari hamda 12 nafar maktab direktorlari ishtirok etdi. Har bir ishtirokchi uchun “Dasturlash va sun’iy intellektni o‘qitish holati” hamda “Dasturlash yoki sun’iy intellektni o‘qitishni qo‘llab-quvvatlashning zarurati va yo‘nalishi”ni aniqlash yuzasidan savollar (jami 43 ta) ishlab chiqildi.

Ota-onalarning ko‘pchiligi dasturlash va sun’iy intellekt bo‘yicha ta’lim ularning farzandlarining ijodkorligini va boshqa fanlarni o‘zlashtirish darajasini oshiradi deb ishonishadi (542 dan 285 nafari). Ko‘pchilik ota-onalar dasturlash va sun’iy intellekt bo‘yicha ta’lim farzandlarining kelajagiga foydali deb hisoblashadi.

So‘rov o‘tkazilgan maktablardagi “Informatika va axborot texnologiyalari” fani o‘qituvchilari sifatida ro‘yxatga olingan 33 nafar o‘qituvchi treninglarda ishtirok etishga tayyor ekanliklarini bildirishdi. Ulardan sun’iy intellekt va dasturiy ta’minotni o‘qitish bo‘yicha pedagogik ko‘nikmalari haqida so‘raldi. Ular, shuningdek, maktablarda metodik qo‘llab-quvvatlash zarurligini ta’kidlashdi.

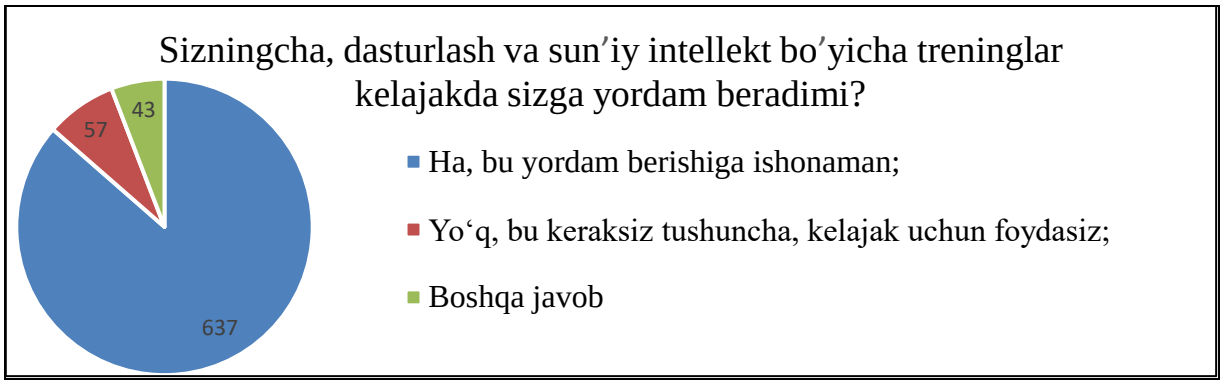
O‘quvchilarning javoblari shuni ko‘rsatdiki, so‘rovnomada ishtirok etgan aksariyat o‘quvchilarning dasturlash va sun’iy intellekt bo‘yicha bilim va tushunchalari past darajada. Taxminan 25% o‘quvchilar mustaqil o‘rganganliklarini, yana 20% esa maktab darslari ularga bilim olishda yordam berganini aytishdi. O‘quvchilarning 50% yuzaki bilimga ega bo‘lib, bundan buyon o‘rganishga qiziqish bildirishgan (4-rasmga qarang).



4-rasm. O‘quvchilarning dasturlash va sun’iy intellektni o‘rganganligini aniqlash bo‘yicha so‘rovnoma javoblari

O‘qituvchilar va maktab direktorlarining sun’iy intellekt va dasturlash bo‘yicha ta’limga munosabati so‘rovnoma natijalariga asosan aksariyat o‘qituvchilar uchun dasturlash va sun’iy intellekt ta’limi istiqbollari Informatika va axborot texnologiyalari sohasida to‘plangan bo‘lib, 87% ni tashkil etadi. Sun’iy intellekt yuqori sinflarda “Informatika va axborot texnologiyalari” fanida kam

yoritilgan mavzulardan biri hisoblanadi. Faqatgina 23% o‘qituvchilar sun’iy intellekt bo‘yicha dars berish tajribasiga ega ekanliklarini bildirganlar. Shu bilan birga, 56% o‘qituvchilar dasturiy ta’minotni o‘qitishda tajribaga ega. Ushbu o‘qituvchilar odatda algoritmlar, funksiyalar, ma’lumotlar bazalari va veb-dasturlash kabi mavzularni o‘rgatishgan (23/32). E’tibor qaratilishi lozim bo‘lgan muammolar sifatida o‘qituvchilar tomonidan jihozlangan sinfxonalar yetishmasligi (12/32), ta’lim va metodik materiallarning yetarli emasligi (14/32), o‘qituvchilardan dasturlash yoki sun’iy intellekt bo‘yicha tegishli o‘quv rejasi kerakmi deb so‘ralganda, 100% respondentlar bu zaruratni bildirishdi. So‘rovnomada ishtirok etgan o‘quvchilarning ko‘pchiligi (637/735) sun’iy intellektga doir treninglarda ishtirok etish ularning kelajagiga yordam berishini ta’kidlagan (5-rasmga qarang).



5-rasm. O‘quvchilarning sun’iy intellekt bo’yicha treninglar ularning kelajagiga ta’sirini o‘rganish bo‘yicha so‘rovnoma natijalari

Umumiy o‘rta ta’lim “Informatika va axborot texnologiyalari” fani dasturida sun’iy intellekt va robototexnikaga doir mavzularga soatlar kam ajratilganligini inobatga olgan holda tajriba-sinov ishlari Toshkent shahrining 12 ta tumanida joylashgan 12 ta umumiy o‘rta ta’lim muassasasida tajriba-sinov tariqasida 10-11-sinf o‘quvchilariga Sun’iy intellekt va robototexnika asoslari yozgi va qishki ta’til davrida 3 hafta davomida o‘qitildi va o‘zlashtirish natijalari tahlil qilindi.

2-jadval.

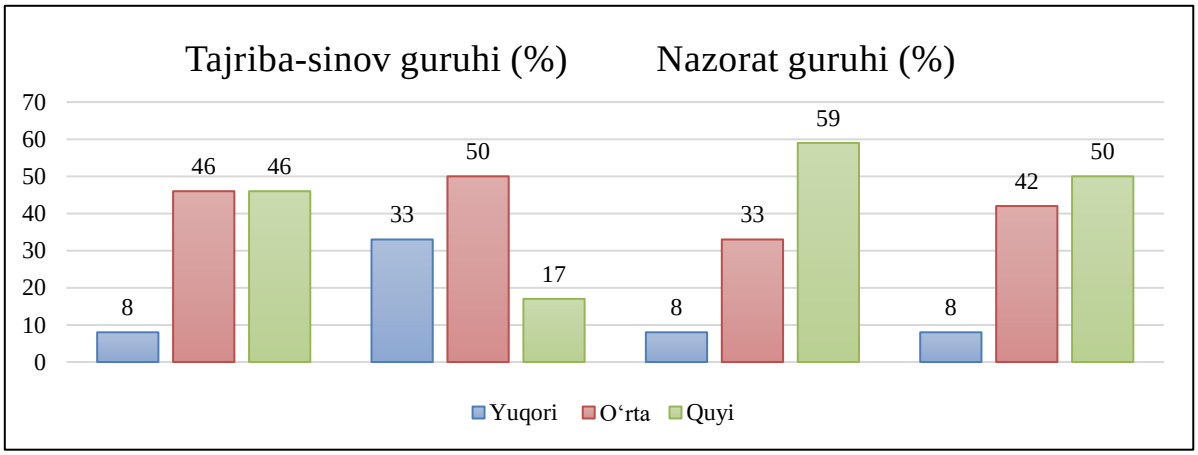
Tajriba va nazorat guruhining natijalari

O‘quvchilarning o‘zlashtirish natijalari	**Tajriba guruhi**				**Nazorat guruhi**			
	Tajriba-sinov boshlanganda o‘quvchilarning soni	%	Tajriba-sinov yakunida o‘quvchilarning soni	%	Tajriba-sinov boshlanganda o‘quvchilarning soni	%	Tajriba-sinov yakunida o‘quvchilarning soni	%
Yuqori	10	8	41	33	11	8	11	8
O‘rta	57	46	61	50	46	33	57	42
Quyi	57	46	21	17	81	59	67	50
Jami	124	100	123	100	138	100	135	100

Tajriba-sinov boshida tajriba guruhda 124 nafar o‘quvchi ishtirok etdi. Ularning dastlabki baholash natijalariga ko‘ra, 10 nafar (8%) yuqori darajadagi, 57 nafar (46%) o‘rta darajadagi va 57 nafar (46%) past darajadagi o‘quvchi mavjud edi. Tajriba-sinov yakunida esa o‘quvchilar natijalari yaxshilanib, 41 nafar (33%) yuqori

baholarga ega bo‘ldi, bu 23% o‘sishni ko‘rsatdi. O‘rta darajali o‘quvchilar soni 61 nafarga (50%) yetib, 4% oshdi, past darajali o‘quvchilar esa 21 nafarga (17%) tushib, 29% kamayishni ko‘rsatdi (2-jadvalga qarang).

Nazorat guruhida ham 138 nafar o‘quvchi qatnashdi. Ularning boshlang‘ich baholari bo‘yicha 11 nafar (8%) yuqori darajadagi, 46 nafar (33%) o‘rta darajadagi va 81 nafar (59%) past darajadagi o‘quvchi bo‘lgan. Tajriba-sinov yakunida yuqori darajali o‘quvchilar soni 11 nafar (8%) o‘zgarishsiz qoldi, o‘rta darajali o‘quvchilar soni 57 nafarga (42%) yetib, 9% oshdi, past darajali o‘quvchilar esa 67 nafarga (50%) tushib, 9% kamayishni ko‘rsatdi (6-rasmga qarang).



6-rasm. Tajriba-sinov natijalari

Pirsonning Xi kvadrat testi va t-test orqali o‘quvchilarning natijalari tahlil qilindi. Tajriba-sinov tarzida tashkil etilgan sun’iy intellekt va robototexnika asoslarini o‘qitish o‘quvchilarning raqamli kompetensiyalarini an’anaviy o‘quv dasturiga nisbatan sezilarli darajada yaxshilaydimi degan savolni aniqlash uchun quyidagi farazlar qo‘yildi:

O‘qitish usuli (Tajriba guruhi sun’iy intellekt va robototexnika asoslari va nazorat guruhi an’anaviy) raqamli kompetensiyalarni yaxshilashga ta’sir qilmaydi.

O‘qitish usuli raqamli kompetensiyalarni yaxshilashga ta’sir qiladi.

3-jadval.

Tajriba guruhining natijalari

O‘lchovlar	Qiymat
Tajriba guruhidagi o‘quvchilar soni (n)	124
O‘rtacha qiymat (Tajriba-sinovdan oldin)	62.60
Standart og‘ish (Tajriba-sinovdan oldin)	8.98
O‘rtacha qiymat (Tajriba-sinovdan keyin)	68.59
Standart og‘ish (Tajriba-sinovdan keyin)	10.82
O‘rtacha qiymat farqi (d̄)	5.98
Standart og‘ish farqlari (s_d)	7.77
Standart xatolik (SE)	0.70
t (df=123)	8.58
ikki tomonlama p-qiymat	3.47e-14

Tajriba guruhida o‘rtacha qiymat (Tajriba-sinovdan keyin) 68,59 ga teng, bu nazorat guruhidagi o‘rtacha qiymatdan (Tajriba-sinovdan keyin) 59,67 dan yuqori.

Bu shuni anglatadiki, tajriba guruhi natijalari nazorat guruhiga qaraganda 13% yuqori.

4-jadval.

Nazorat guruhning natijalari

O‘lchovlar	Qiymat
Tajriba guruhidagi o‘quvchilar soni (n)	138
O‘rtacha qiymat (Tajriba-sinovdan oldin)	59.33
Standart og‘ish (Tajriba-sinovdan oldin)	8.97
O‘rtacha qiymat (Tajriba-sinovdan keyin)	59.67
Standart og‘ish (Tajriba-sinovdan keyin)	7.97
O‘rtacha qiymat farqi ($\bar{d}$)	5.98
Standart og‘ish farqlari (s_d)	5.55
Standart xatolik (SE)	0.47
t (df=123)	-1.89
ikki tomonlama p-qiymat	0.061

Tajriba-sinovdan oldin har ikkala guruhda ham dastlabki nazorat o‘tkazildi. Ularning boshlang‘ich bilim, ko‘nikma va kompetensiyalari bir xil edi. Tajriba-sinov yakunida esa nazorat va tajriba guruhlarning solishtirma tahlili sun’iy intellekt va robototexnika asoslarini o‘qitishning aniq afzalliklarini ko‘rsatdi. Tajriba guruh yakuniy nazoratlarda nazorat guruhidan **13%** yuqori natijalar ko‘rsatdi, bu sun’iy intellekt va robototexnika asoslarini maktab o‘quv dasturlariga kiritishning ijobiy ta’sirini belgilab berdi.

XULOSA

1. Sun’iy intellekt va robototexnika asoslarini umumiy o‘rta ta’lim maktablarida o‘quvchilarga o‘rgatishda pedagogik va psixologik omillar neyrodidaktika tamoyillari asosida belgilangan bo‘lib, bu jarayonda immersiv texnologiyalardan foydalanish orqali raqamli ko‘nikmalarni va ijodiy-texnologik fikrlash qobiliyatlarini shakllantirish imkoniyatlari aniqlandi. Natijada virtual reallik texnologiyalaridan foydalangan holda o‘quvchilarning raqamli kompetensiyalarini shakllantirishga imkoniyat yaratilgan.

2. Sun’iy intellekt va robototexnika asoslari bo‘yicha o‘quvchilarning qobiliyatlarini shakllantirish bosqichlari ijodiy-texnologik fikrlashga yo‘naltirilgan bo‘lib, Arduino platformasida aqlli qurilmalarni dasturlash, elektron sxemalarni yaratish, funksional bloklarni kodlash va generativ sun’iy intellekt texnologiyalaridan foydalanib sinovdan o‘tkazish orqali amalga oshirish asosida takomillashtirildi. Natijada “Informatika va axborot texnologiyalari” fani o‘qituvchilari uchun zamonaviy o‘qitish texnologiyalari va vositalaridan foydalanish samaradorligi oshirilgan.

3. Sun’iy intellekt va robototexnika asoslarini o‘qitish metodikasi loyihalash asosida tashkil etilgan bo‘lib, guruhli ishlar orqali klasterlash, tasniflash va regressiya algoritmlaridan foydalanib ma’lumotlarni tahlil qilish, tabiiy tilni qayta

ishlash orqali matnlarni tushunish, sensor va aktuatorlar yordamida mikrokontrollerlarni yig‘ish hamda simulyatsiya qilish orqali avtomatlashtirilgan boshqaruv, mexanik va elektr tizimlarini birlashtirish asosida takomillashtirildi. Natijada umumiy o‘rta ta’lim maktablari o‘quvchilari “Informatika va axborot texnologiyalari” fanida o‘rgangan nazariy bilimlarini amaliyotda bajarishi uchun “Sun’iy intellekt va robototexnika asoslari” nomli uslubiy qo‘llanma ishlab chiqildi.

4. Sun’iy intellekt va robototexnika asoslarini o‘rganishda o‘quvchilarning bilim va ko‘nikmalarini baholash mezonlari konstruktiv fikrlashni shakllantirishga mo‘ljallangan bo‘lib, guruh loyihalari mavzulari va ularni bajarish darajasini hisobga olgan holda formativ va summativ baholash usullarini qo‘llash asosida takomillashtirildi. Natijada o‘quvchilarning kompetensiyalarini baholash imkoniyatlari kengaytirildi.

5. Tadqiqot davomida Toshkent shahridagi 12 ta tumanda joylashgan 12 ta umumiy o‘rta ta’lim maktablarida so‘rovnomalar o‘tkazildi, loyihaga asoslangan hamda bajarish orqali o‘rganish metodikasidan foydalanib o‘qitildi va natijalari baholandi. Tajriba-sinov natijalari tajriba guruh yakuniy nazoratlarda nazorat guruhidan **13%** yuqori natijalar ko‘rsatdi, bu sun’iy intellekt va robototexnika asoslarini maktab o‘quv dasturlariga kiritishning ijobiy ta’sirini belgilab berdi.

O‘tkazilgan tadqiqot natijasida quyidagi tavsiyalarni taqdim etamiz:

1. “Matematika va Informatika” fani bo‘yicha bo‘lajak o‘qituvchilarni tayyorlovchi pedagogika Oliy ta’lim tashkilotlarining o‘quv dasturlariga sun’iy intellekt va robototexnika asoslari fanini kiritish tavsiya etiladi.

2. Umumiy o‘rta ta’lim maktablarida veb-frilanser yo‘nalishida ta’lim oluvchi o‘quvchilarga “Informatika va axborot texnologiyalari” fanida sun’iy intellekt va robototexnika asoslarini o‘qitish tavsiya etiladi.

3. Umumiy o‘rta ta’lim “Informatika va axborot texnologiyalari” fani o‘qituvchilarini qayta tayyorlash va malakasini oshirish dasturiga sun’iy intellekt va robototexnika asoslari modulini kiritish tavsiya etiladi.

SCIENTIFIC COUNCIL AWARDING SCIENTIFIC DEGREES DSc.l3/30.12.2019.T.07.01 AT TASHKENT UNIVERSITY OF INFORMATION TECHNOLOGIES NAMED AFTER MUKHAMMAD AL-KHWARIZMI

TASHKENT UNIVERSITY OF INFORMATION TECHNOLOGIES NAMED AFTER MUKHAMMAD AL-KHWARIZMI

ABDUJALILOV JAVLONBEK ADILOVICH

IMPROVING THE METHODOLOGY FOR TEACHING THE BASICS OF ARTIFICIAL INTELLIGENCE AND ROBOTICS TO SCHOOL PUPIL

13.00.02 – Theory and Methodology of Education and Training (Informatics)

DISSERTATION ABSTRACT OF THE DOCTOR OF PHILOSOPHY (PhD) ON PEDAGOGICAL SCIENCES

TOSHKENT– 2025

The theme of doctor of philosophy (PhD) on pedagogical sciences was registered at the Supreme Attestation Commission under the Ministry of Higher education, science, and innovation of the Republic of Uzbekistan under number B2024.4.PhD/Ped8573.

The dissertation has been prepared at Tashkent University of Information Technologies.

The abstract of the dissertation is posted in three languages (Uzbek, English, Russian (resume)) on the website (www.tuit.uz) and on the website of «Ziyonet» Information and educational portal (www.ziyonet.uz.)

Scientific adviser:	**Zakirova Feruza Makhmudovna** doctor of pedagogical sciences, professor
Official opponents:	**Fayziyeva Makhbubakhon Rakhimjonovna** doctor of pedagogical sciences, professor
	Shoymardonov Tuymurod Turdialiyevich doctor of philosophy (PhD) in pedagogical sciences, associate professor
Leading organization:	**Gulistan State University**

The defense of the dissertation will be held «_____» _____ 2025 at _____at the meeting of Scientific council No. DSc.l3/30.12.2019.T.07.01 at Tashkent University of Information Technologies named after Mukhammad al-Khwarizmi (Address: 100084, Tashkent city, Amir Temur street, 108. Ph.: (+99871) 238-64-43, fax: (+99871) 23865-52, e-mail: tuit@tuit.uz).

The dissertation can be reviewed at the Information Resource Centre of Tashkent University of Information Technologies named after Mukhammad al-Khwarizmi (is registered under No._____). (Address: 100084, Tashkent city, Amir Temur street, 108. Ph.: (+99871) 238-64-43, fax: (+99871) 238-65-52).

The abstract of dissertation was sent out on «_____» _____ 2025 y.
(mailing protocol No. _____ on «____» _____ 2025 y.).

M.M. Musaev
Chairman of the Scientific Council awarding scientific degrees, Doctor of technical sciences, professor

E.Sh. Nazirova
Scientific Secretary of Scientific Council awarding scientific degrees, Doctor of technical sciences, professor

Dj.B. Sultonov
Chairman of the Academic Seminar at the Scientific Council awarding scientific degrees, Doctor of technical sciences, associate professor

INTRODUCTION (abstract of PhD dissertation)

Topicality and necessity of the thesis. The rapid development of information technologies worldwide plays a crucial role in improving human life, expanding socio-economic opportunities, and enhancing educational processes. Technology, being on the path of constant progress and discovering new fields, serves as a critical tool for ensuring maximum resource efficiency. Examples of such emerging fields include artificial intelligence (AI) and robotics. Significant attention is being paid to the integration of AI and robotics into the education system by UNESCO[5] and several other educational organizations. As the 21st century is regarded as the era of technology, consistently providing students with essential knowledge, skills, and abilities related to AI and robotics is one of the most pressing issues.

Leading countries around the world are conducting various scientific studies aimed at developing a range of skills in students including problem-solving, critical thinking, and creativity by integrating topics on artificial intelligence and robotics into general secondary schools. Based on the modern trends emerging from these studies, it is considered an urgent task to implement innovative educational technologies in the general secondary education process, to assimilate and strategically adapt advanced foreign experiences, to develop skills that enable students to put their acquired knowledge into practice through teaching artificial intelligence and robotics, and to prepare professionals with digital competencies.

In our country, the rapid development of information and communication technologies and their penetration into science, education, and production have led to significant attention being paid to automating production processes in numerous facilities through the use of robotics devices and the implementation of artificial intelligence systems. These processes of globalization and informatization have created the need to develop students' digital competencies in the general secondary education system by teaching them artificial intelligence and robotics. The strategy[6] for developing artificial intelligence technologies by 2030 places special emphasis on issues such as creating the necessary conditions for teaching programming to general education school students in order to form a pool of highly qualified personnel, increasing the number of graduates from higher education institutions that prepare specialists in the field of artificial intelligence, and raising the level of knowledge in artificial intelligence among school and university students through the teaching of programming languages. These tasks influence the formation of the requirements for all levels of the education system, particularly indicating a high demand for pre-professional training and the development of digital competencies in artificial intelligence among future representatives of engineering and digital specialties in secondary schools.

This research work, to some extent, serves in the implementation of the tasks specified in other normative legal documents related to this field, including the DP-

[5] AI competency framework for students, Published in 2024 by UNESCO, ISBN 978-92-3-100709-5 https://unesdoc.unesco.org/ark:/48223/pf0000391105

[6] Decree of the President of the Republic of Uzbekistan No. PQ-358, dated October 14, 2024, "On the Approval of the Strategy for the Development of Artificial Intelligence Technologies until 2030."

98 decree of the President of the Republic of Uzbekistan dated July 2, 2024, “On measures to improve the state governance system in the field of preschool and school education”, the DP-79 decree dated May 26, 2023, “On measures to effectively organize the activities of the ministry of preschool and school education and its organizations”, the DP-60 decree dated January 28, 2022, “On the development strategy of new Uzbekistan for 2022–2026”, the RP-358 resolution dated October 14, 2024, “On approval of the strategy for the development of artificial intelligence technologies until 2030”, the RP-4996 resolution dated February 17, 2021, “On measures to create conditions for the rapid introduction of artificial intelligence technologies” and the RP-4963 resolution dated January 25, 2021, “On measures to support scientific research activities in the field of public education and the introduction of a continuous professional development system”.

Relevant research priority areas of science and developing technology of the Republic. This research aligns with the I. “Informatization and the development of information and communication technologies” priority direction of the national science and technology development strategy.

Problem development status. Recently, many scientists from various countries have been conducting research on the application of artificial intelligence and robotics across different fields. In addition, they are systematically engaged in teaching these subjects in general secondary education to further develop these areas. In developing the theoretical concept of this dissertation, the fundamental research carried out by the following scholars was relied upon:

In our country, the theoretical foundations for introducing modern information and communication technologies into the education system, as well as for creating and using tools to informatize education, have been reflected in the research works of our scholars such as A.A. Abduqodirov, U.Sh. Begimkulov, M.X. Lutfillaev, M.E. Mamarajabov, F.M. Zakirova, and others.

In the countries of the Commonwealth of Independent States, studies on teaching the fundamentals of artificial intelligence and robotics at various stages of general secondary education have been carried out by S.A. Beshenkov, L.L. Bosova, A.A. Kuznetsov, N.I. Rijova, T.N. Suvorova, N.N. Samilkina, and others.

In foreign countries, the theoretical foundations for the development of artificial intelligence and robotics education have been examined by C. Breazeal, J. Makkarti, M. Minski, M. Resnik, A.M. Turing, and others.

Academic M.M. Komilov, who established a prominent school in image analysis and artificial intelligence theories, along with academics D.A. Abdullaev and T.F. Bekmuratov, who have conducted significant scientific and methodological research in information processing, have made substantial contributions to the development of this field.

A review of the literature on the research problem and an analysis of existing theoretical sources indicate that the methodology for teaching the fundamentals of artificial intelligence and robotics in general secondary schools has not been studied as a separate scientific research topic.

Relevance of the dissertation research with the plans of the scientific

research works of the higher educational or scientific research institutions where the dissertation has been conducted. The dissertation research was carried out within the framework of the international applied research project "Modernization of mechatronics and robotics for bachelor degree in Uzbekistan through innovative ideas and digital technology" (project number 609564-EPP-1-2019-1-EL-EPPKA2-CBHE-JP) based on the research plan of the Tashkent University of Information Technologies named after Muhammad al-Khwarizmi.

The aim of the research work is to improve the methodology for teaching the fundamentals of artificial intelligence and robotics to school students.

The tasks of the research work:

clarify the pedagogical-psychological factors of teaching the fundamentals of artificial intelligence and robotics to general secondary school students;

explain the stages of developing students' abilities in the fundamentals of artificial intelligence and robotics;

improve the methodology for teaching the fundamentals of artificial intelligence and robotics;

develop formative and summative assessment criteria aimed at determining the knowledge, skills, and competencies that students have acquired in the fundamentals of artificial intelligence and robotics.

The object of the research work is the process of teaching the fundamentals of artificial intelligence and robotics in general secondary schools was selected. A total of 735 student respondents from 12 general secondary schools located in 12 districts of Tashkent city were involved as an experimental trial for teaching the fundamentals of artificial intelligence and robotics.

The subject of the research work comprises the content, assessment criteria, methodology, and tools used in teaching the fundamentals of artificial intelligence and robotics in general secondary schools.

Methods of the research work include the use of research and analysis methods such as literature analysis, comparative analysis, surveys, tests, experimental trials, mathematical-statistical analysis, and interviews.

The scientific novelty of the research consists of the following:

identified the pedagogical-psychological factors of teaching the fundamentals of artificial intelligence and robotics to general secondary school students based on the use of immersive technologies that take into account the principles of neurodidactics, as well as on the development of digital competencies and creative-technological thinking skills;

enhanced the stages of forming students' skills in the fundamentals of artificial intelligence and robotics by prioritizing the creation of electronic circuits in the Arduino environment which fosters creative-technological thinking coding of functional blocks, and testing through generative artificial intelligence technologies;

improved the methodology for teaching the basics of artificial intelligence and robotics based on the analysis of data sets using clustering, classification, and regression algorithms during group projects, and automatic control during the assembly and simulation of microcontrollers;

enhanced the criteria for assessing the effectiveness of developing students' competencies in the fundamentals of artificial intelligence and robotics by introducing formative and summative assessment methods that take into account problem-based tasks aimed at constructive thinking, the topics of group projects, and the level of their execution.

The practical outcomes of the research are as follows:

a methodological guide has been developed for conducting practical lessons on the fundamentals of artificial intelligence and robotics for general secondary school students;

assignments and assessment criteria related to the fundamentals of artificial intelligence and robotics for general secondary school students have been developed and implemented in practice;

an electronic textbook titled "Electronic learning guide for teaching the fundamentals of artificial intelligence and robotics to school students" (DGU 45434) has been created and introduced in schools.

Authenticity of the research results. the theoretical information used in the study was obtained from official sources, the applied methods and the philosophical, pedagogical, and psychological approaches to the problem were based on credible frameworks, the research findings were supported by materials from national and international scientific-practical conferences, as well as articles published in specialized and international journals recognized by the higher attestation commission, the presented analyses and experimental trials were validated using mathematical statistical methods, the conclusions, proposals, and recommendations were implemented in practice, the obtained results were confirmed by relevant authoritative institutions.

Scientific and practical value of the research results. The scientific significance of the research results lies in the improvement of the teaching methodology for the fundamentals of artificial intelligence and robotics in general secondary schools. This includes the use of immersive technologies, the development of digital competencies and creative-technological thinking skills, the creation of electronic circuits leading to the programming of smart components in the Arduino environment, coding functional blocks, and verifying them using generative artificial intelligence technologies.

The practical significance of the research results is that they can be applied in professional development courses for teachers of the "Information and communication technologies" subject in general secondary schools. Additionally, the findings can be utilized in teacher training programs at pedagogical universities specializing in "Mathematics and Informatics."

Implementation of the research results. Based on the scientific findings of the research on improving the methodology for teaching the fundamentals of artificial intelligence and robotics to school students:

proposal for pedagogical-psychological factors in teaching the fundamentals of artificial intelligence and robotics in general secondary schools were identified with consideration of neurodidactic principles, the use of immersive technologies, and

the development of digital competencies and creative-technological thinking skills was utilized in the content of the textbook “Informatics and Information Technologies” (Reference No.01-03/7-422 of the Republican Scientific and Methodological Center for the Development of Education dated 12th August 2025). As a result, opportunities were created to develop students' digital competencies through the use of virtual reality technologies;

proposal for enhancing the stages of forming student's skills in the fundamentals of artificial intelligence and robotics by prioritizing the creation of electronic circuits in the Arduino environment which fosters creative-technological thinking coding of functional blocks, and testing through generative artificial intelligence technologies were used in the international research project on “Educational cooperation project to develop Software and Artificial Intelligence educational content and educational model to foster future AI scientists in Uzbekistan” (2023-2024). (Reference No.01-03/7-422 of the Republican Scientific and Methodological Center for the Development of Education dated 12th August 2025). As a result, the effectiveness of using modern teaching technologies and tools for “Informatics and Information Technologies” teachers was enhanced;

proposal for improving the methodology for teaching the basics of artificial intelligence and robotics in the process of implementing projects through group work, analyzing data sets using regression, classification and clustering algorithms, assembling microcontrollers, automatic control in the process of simulation were used in the international research project on “Educational cooperation project to develop Software and Artificial Intelligence educational content and educational model to foster future AI scientists in Uzbekistan” (2023-2024). (Reference No.01-03/7-422 of the Republican Scientific and Methodological Center for the Development of Education dated 12th August 2025). As a result, the methodology for teaching in groups was improved for use in improving the qualifications of teachers of the subject “Informatics and Information Technologies”;

proposal for the criteria of assessing the effectiveness of developing students’ competencies in the basics of artificial intelligence and robotics, taking into account the problem tasks focused on constructive thinking, the topics of group projects and the level of their implementation were used in the international research project on “Educational cooperation project to develop Software and Artificial Intelligence educational content and educational model to foster future AI scientists in Uzbekistan” (2023-2024). (Reference No.01-03/7-422 of the Republican Scientific and Methodological Center for the Development of Education dated 12th August 2025). As a result, the possibilities for assessing students’ competencies were expanded.

Approbation of the research results have been discussed and reviewed at 8 international and 2 national scientific-practical conferences.

Publication of the research results. A total of 7 scientific works have been published on the dissertation topic, including 6 articles in scientific journals recommended by the Higher Attestation Commission of the Republic of Uzbekistan for publishing key scientific findings of doctoral dissertations. Among these, 4

articles were published in national journals, and 2 in international journals. Additionally, one certificate of registration for software developed for electronic computing machines (ECM) has been obtained.

The outline of the thesis. The dissertation consists of an introduction, three chapters, a conclusion, 124 pages of text, a list of references, and appendices.

MAIN CONTENT OF THE DISSERTATION

The introduction substantiates the relevance and necessity of the dissertation topic. It highlights the connection of the research with priority directions in science and technology and provides a review of national and international scientific research, outlining the extent to which the problem has been studied. The research objectives and tasks, as well as the object and subject of the study, are clearly defined. Furthermore, the introduction demonstrates the alignment of the research with key directions in the development of science and technology and justifies the scientific novelty, reliability of results, and scientific and practical significance of the study. It also provides information on the practical implementation of the research results, their publication, and details regarding the structure and volume of the dissertation.

The first chapter, titled **"Pedagogical foundations for teaching artificial intelligence and robotics in general secondary schools"** discusses the importance and relevance of teaching the fundamentals of artificial intelligence and robotics to school students. It also provides information on the development of students' abilities during the learning process and examines the pedagogical and psychological factors influencing the teaching of these subjects.

Several initiatives are being implemented in Uzbekistan to advance artificial intelligence. These include creating favorable conditions for the integration of AI technologies into social sectors and economic industries, positioning the country among the world's leading nations that utilize artificial intelligence, and ensuring the implementation of the goals and objectives outlined in the "Digital Uzbekistan-2030" strategy. Additionally, to enhance public knowledge and skills in AI technologies and develop human resource potential, the Strategy for the development of artificial intelligence technologies until 2030 has been approved[7].

In developed countries, the teaching of artificial intelligence and robotics fundamentals is widely implemented in general secondary schools. For example, in South Korea, high school students receive an average of 30–40 hours of instruction on these topics per year. Cynthia Breazeal, one of the leading researchers at the Massachusetts Institute of Technology (MIT) specializing in the role of AI and robotics in education, emphasizes that these subjects help students develop digital literacy, competitiveness in the job market, and analytical thinking skills. Furthermore, teaching artificial intelligence and robotics fundamentals to school students prepares them for technologies that will play a crucial role in the future[8].

[7] Decree of the President of the Republic of Uzbekistan No. PQ-358, dated October 14, 2024, "On the Approval of the Strategy for the Development of Artificial Intelligence Technologies until 2030."

[8] AI education recommended by MIT professor https://www.media.mit.edu/publications/impact-ai-thesis/

During the research, an analysis of the curricula and textbooks for the subjects "Informatics and Communication Technologies" and "Technology" in Uzbekistan's general secondary education system revealed the presence of topics related to artificial intelligence and robotics. However, it was found that only 2 hours (3%) of the "Informatics and Communication Technologies" course and 6 hours (9%) of the "Technology" course are dedicated to the fundamentals of AI and robotics. This limited coverage may hinder students' ability to effectively utilize AI technologies in the future. To enhance the knowledge and skills of future generations, it is proposed to improve the teaching methodologies for AI and robotics fundamentals.

During the research process, modern pedagogical practices relevant to the topic were thoroughly studied. In today's world, the use of immersive technologies such as Virtual Reality (VR) and Augmented Reality (AR) is becoming increasingly widespread, significantly influencing students' thinking skills. As a result, a new field called neurodidactics has emerged. The use of these technologies allows for the creation of interactive learning environments tailored to students' individual characteristics. Immersive technologies help students better grasp complex concepts, such as the principles of artificial intelligence algorithms and robotics systems, by enabling them to visualize and engage with these ideas more effectively.

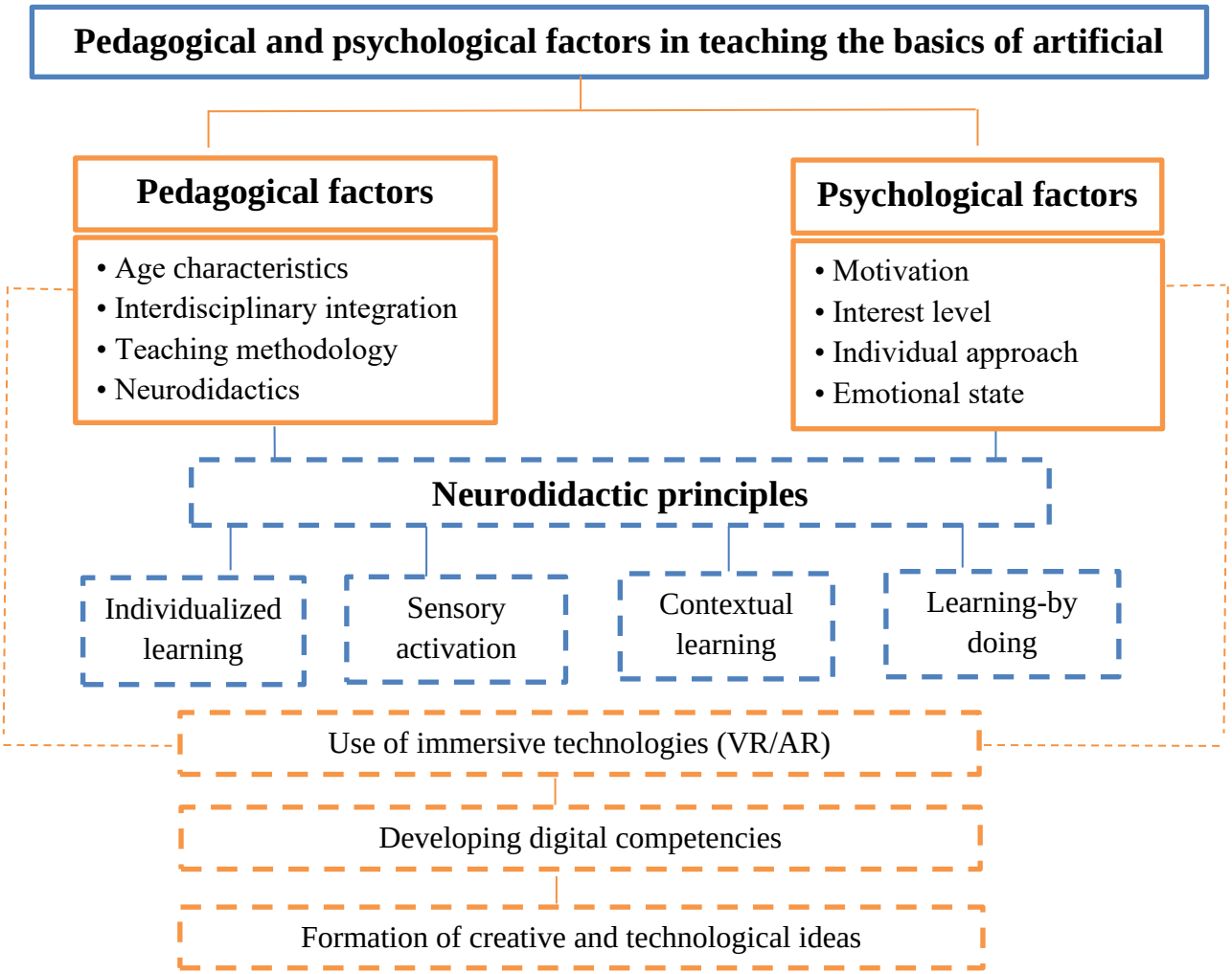


Figure 1: Pedagogical and Psychological Factors in Teaching the Fundamentals of Artificial Intelligence and Robotics to School Students

In the process of teaching the fundamentals of artificial intelligence and robotics, the possibilities of developing students' creative-technological thinking skills and digital competencies in the general secondary education system were identified. This was achieved by incorporating pedagogical-psychological factors and neurodidactic principles, while utilizing virtual reality technologies (see Figure 1).

All components presented in Figure 1 reflect an integrated approach to effectively teaching the fundamentals of artificial intelligence and robotics. This approach aims not only to develop students' theoretical knowledge but also to enhance their practical skills, preparing them for success in the world of modern technologies.

Based on the principles of neurodidactics, individualized teaching is important for delivering lessons tailored to each student’s abilities and needs. In studying the fundamentals of artificial intelligence and robotics, the method of sensory activation plays a significant role. By actively engaging sensory organs such as sight, hearing, and touch during the learning process, information reception creates strong neural connections in the brain.

The contextual learning method facilitates the retention and application of knowledge by connecting it to real-life situations. In the learning-by-doing approach, theoretically acquired knowledge is immediately tested in practice, allowing students to gain understanding through active engagement. For example, in a robotics class, it is not enough to merely discuss how a robot works; assembling, programming, and engaging in simulations help students master the material more deeply.

Virtual Reality (VR) technology enables students to simulate artificial intelligence and robotics systems. For instance, when teaching robotics processes, students can learn to operate complex systems in a VR environment. Using Augmented Reality (AR) technology, students can visualize the working mechanisms of robots or the algorithms of artificial intelligence.

In developing digital competencies, the learning process is organized in accordance with students’ age characteristics, interests, and modern teaching methods, taking into account both pedagogical and psychological factors.

In effectively fostering students’ creative and technological thinking skills, teaching is carried out through an individual approach that considers pedagogical and psychological factors, such as students’ motivation to learn, their natural interest in the subject, their personal needs, and their emotional state. This, in turn, helps them grow into successful professionals in the future.

The second chapter, titled **“Improving the methodology for teaching the fundamentals of Artificial Intelligence and Robotics to school students”** explores the stages of developing students' abilities, teaching methodology, and assessment methods in artificial intelligence and robotics education.

Stages of developing students’ abilities in AI and Robotics, the development of students’ abilities in artificial intelligence and robotics fundamentals involves acquiring both theoretical knowledge and practical skills and consists of three stages.

First stage theoretical knowledge acquisition, at this stage, students learn fundamental AI concepts such as algorithms, machine learning, and neural networks, as well as the basic components of robotics (see Figure 2).

Second stage practical application and reinforcement, in this stage, students apply their theoretical knowledge in practice through hands-on programming tasks. The dissertation discusses practical activities such as creating and programming robotic models, independent project work, and participation in group projects. For example, in Orange 3, students can upload, clean, analyze data, and visualize results using specialized functions. This is highly beneficial for understanding how algorithms work and evaluating outcomes.

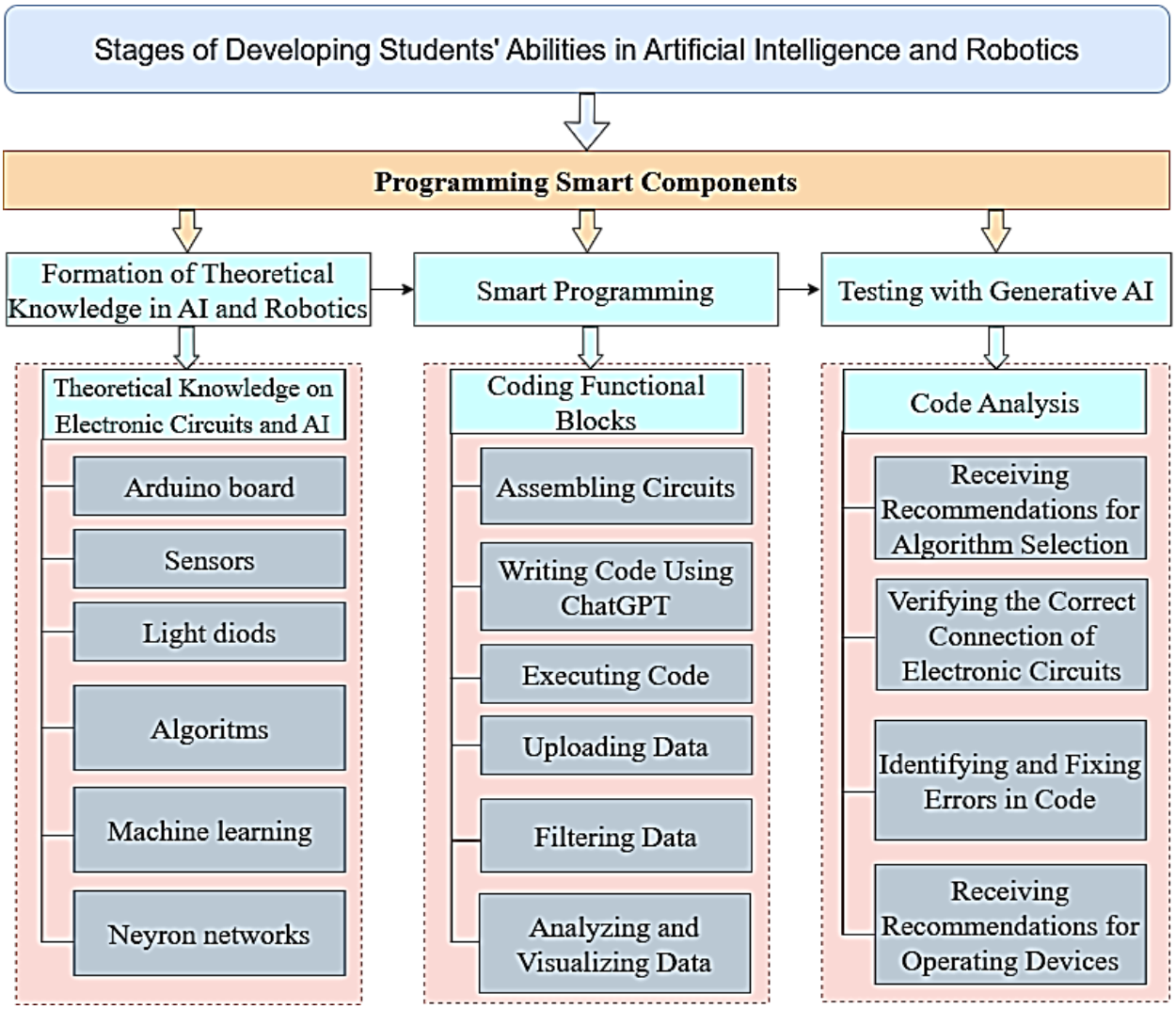


Figure 2: Stages of Developing Students' Abilities in Artificial Intelligence and Robotics

At the third stage, to increase students' interest in learning the fundamentals of artificial intelligence and robotics, the research explores the use of generative AI for receiving recommendations on operating devices, verifying the correct connection of electronic circuits, checking the functionality of robotics components, identifying errors and debugging code using AI tools such as ChatGPT.

During the study, the methodological system for teaching the fundamentals of AI and robotics was improved (see Figure 3).

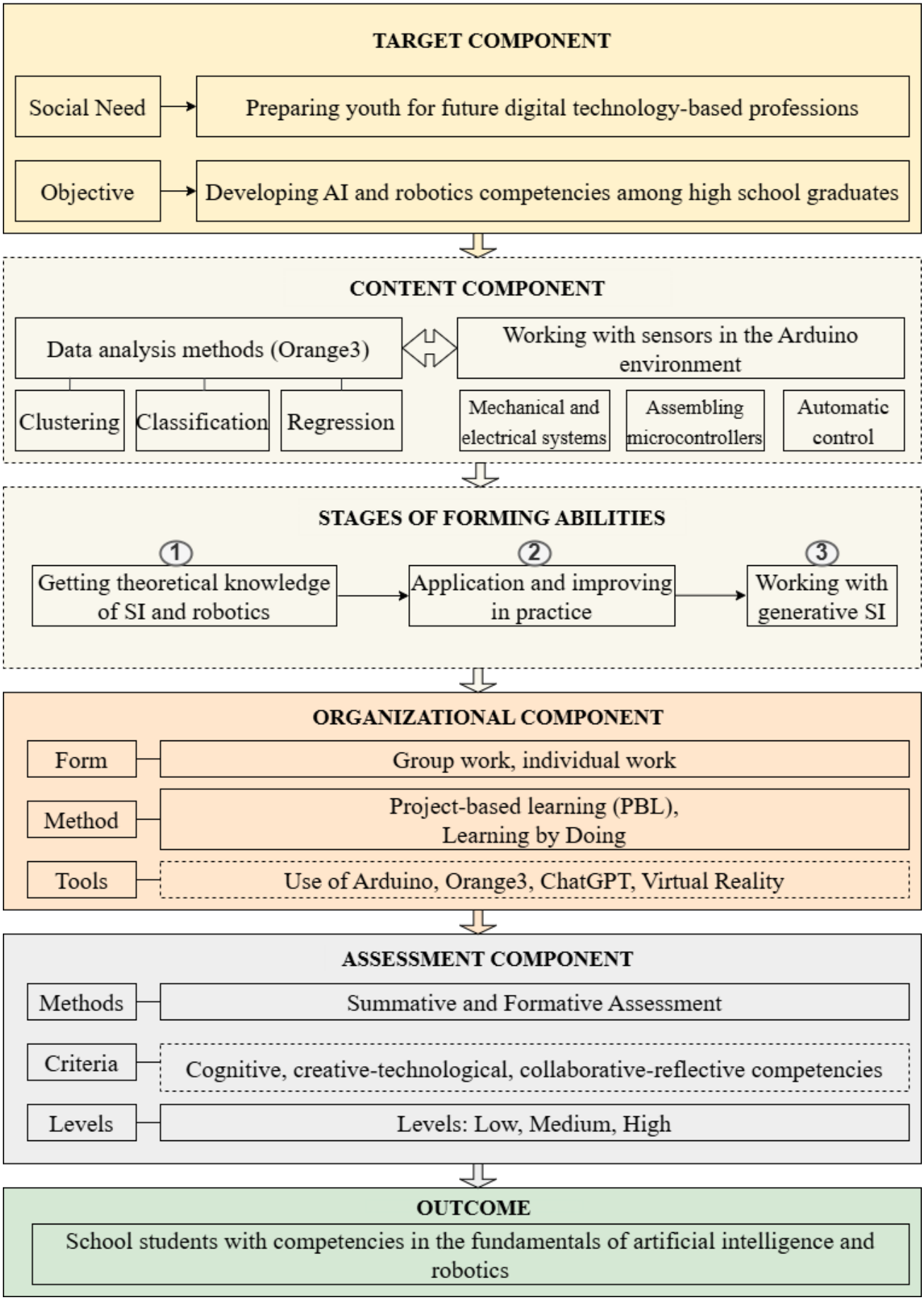


Figure 3: Methodological system for teaching the fundamentals of artificial intelligence and robotics to school students

The target component reflects the goal of preparing school students for future digital technology-based professions by developing their competencies in artificial intelligence and robotics, considering the trends in digital technology development in the country. This component also defines the expected outcomes of learning AI and robotics, helping to determine the appropriate level of education for effective instruction.

The content component is represented by integrative thematic modules for students, including data analysis using Orange3 software, working with sensors in the Arduino environment, to establish connections between these modules, students learn all stages of data processing, including Clustering, Classification, Regression. These techniques enable students to analyze data using algorithms and develop a deeper understanding of AI and robotics. Additionally, on the Arduino platform, students have the opportunity to learn the basics of programming and electronics while creating practical projects using microprocessors and various sensors. Through integrative thematic modules, students become familiar with modern technologies, strengthen their practical knowledge, and gain the ability to connect different subjects. These educational modules cover topics such as robotics and data analysis, helping to develop skills in using various software tools.

The organizational component allows for the selection of modern teaching methods, including different teaching formats, methods, and tools, Project-based learning (PBL), students are divided into groups and assigned tasks to develop various practical applications using software tools. A methodological guide provides theoretical instructions on using the software tools for each module and includes practical assignments for hands-on learning.

The assessment component includes evaluation methods (formative and summative assessment), criteria and levels of assessment, assessment criteria have been developed to evaluate students' cognitive, creative-technological, and collaborative-reflective abilities in AI and robotics.

Cognitive Competencies includes the development of thinking, analysis, logical reasoning, and decision-making skills.

Creative-Technological Competencies encompasses the ability to use modern technologies effectively, enabling students to work with various technical devices, tools, and software solutions.

Collaborative-Reflective Competencies involves teamwork, collaboration, and idea exchange among students when working on projects.

The third chapter, titled **“Results of pedagogical experiments and their effectiveness”** presents an analysis of survey results related to teaching the fundamentals of artificial intelligence and robotics. It also describes the stages of conducting experimental trials, provides the results of these experiments along with statistical analysis, and examines the effectiveness of AI and robotics teaching methods through pedagogical experiments.

A survey was conducted among 10th- and 11th-grade students from 12 schools in 12 districts of Tashkent, as well as their parents (guardians), Informatics and IT teachers, and school principals. The survey aimed to assess the current state of AI

and robotics education in schools, students' interest in these subjects, parents' attitudes towards their children learning AI and robotics, teachers' knowledge and skills in teaching these subjects. The collected data was analyzed to determine trends and identify areas for improvement in AI and robotics education.

The survey involved 735 students, 542 parents (guardians), 33 Informatics and IT teachers, and 12 school principals. A total of 43 questions were developed for each participant, focusing on the current state of programming and artificial intelligence education, the necessity and direction of supporting programming and AI education.

Key findings shows parental perspective, a majority of parents believe that programming and AI education enhances their children's creativity and improves their understanding of other subjects (285 out of 542 parents). Many parents consider AI and programming education beneficial for their children's future.

Teacher perspective, all 33 IT teachers from the surveyed schools expressed willingness to participate in training programs. They were asked about their pedagogical skills in teaching AI and programming. Teachers emphasized the need for methodological support in schools.

Student Perspective shows the survey responses indicated that most students had low levels of knowledge and understanding in programming and AI. 25% of students reported self-learning AI and programming. 20% said that school lessons helped them gain knowledge. 50% had superficial knowledge but showed interest in learning more (see Figure 4).

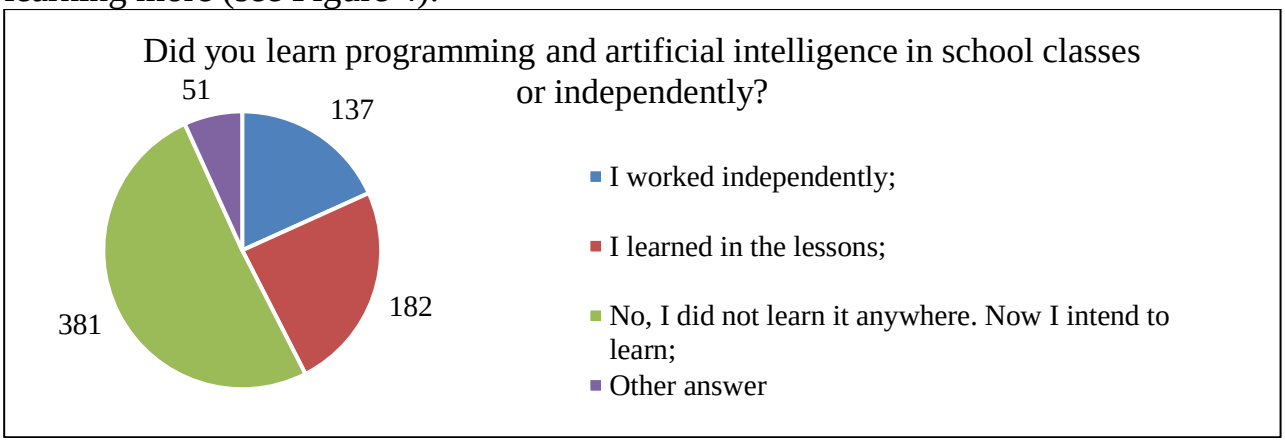


Figure 4. Student Responses on Learning Programming and Artificial Intelligence

Based on the survey results, teachers and school principals expressed their views on AI and programming education 87% of teachers believe that AI and programming education holds strong potential in the Informatics and IT field. AI is one of the least covered topics in high school Informatics and IT courses. Only 23% of teachers reported having experience in teaching AI. However, 56% of teachers have experience in teaching software development, mainly covering algorithms, functions, databases, and web programming (23 out of 32 teachers). Challenges identified by teachers highlighted the following challenges in AI and programming education, lack of well-equipped classrooms (12 out of 32 teachers), insufficient educational and methodological materials (14 out of 32 teachers), 100% of teachers

agreed that a specialized curriculum for teaching programming and AI is necessary.

Student Perspective on AI Training, a majority of students (637 out of 735 respondents) stated that participating in AI-related training programs would benefit their future (see Figure 5).

Considering the limited hours allocated to topics related to artificial intelligence and robotics in the general secondary education curriculum for the subject "Informatics and Information Technology," experimental and trial studies were conducted in 12 general secondary education institutions located in 12 districts of Tashkent city. As part of the trial, the fundamentals of artificial intelligence and robotics were taught to 10th and 11th-grade students during the summer and winter holidays for three weeks, and the learning outcomes were analyzed.

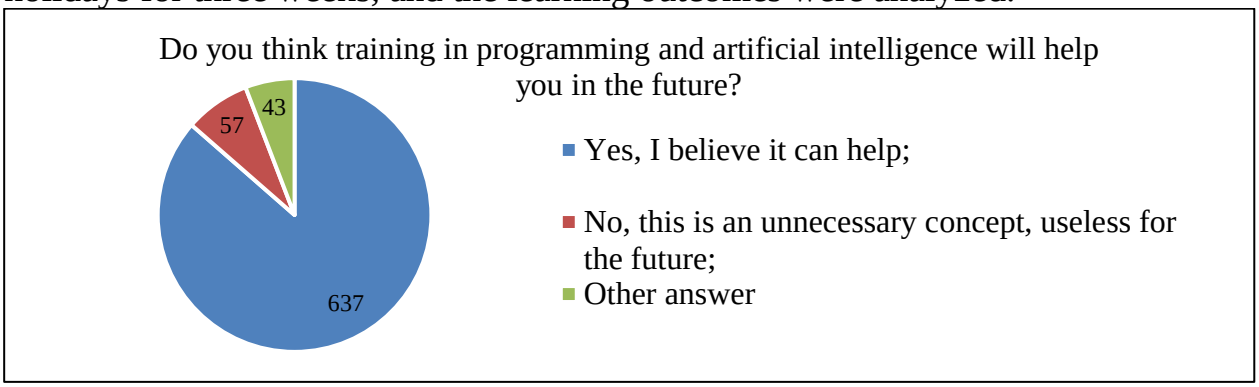


Figure 5. Survey results on the impact of ai training on students' future

Experimental trial results show at the beginning of the experimental trial, a total of 124 students participated in the experimental group. Their initial assessment results were as follows 10 students (8%) were at a high level, 57 students (46%) were at an intermediate level, 57 students (46%) were at a low level. By the end of the trial, student performance improved, with 41 students (33%) achieving a high level—showing a 23% increase, 61 students (50%) reaching an intermediate level - a 4% increase, Low-level students decreased to 21 (17%), marking a 29% decline (see Table 2).

Table 2.

The experiment results of experiment and control group

Performance of students	**Experimental group**				**Control group**			
	Number of students at the beginning of the experiment	%	Number of students at the end of the experiment	%	Number of students at the beginning of the experiment	%	Number of students at the end of the experiment	%
High	10	8	41	33	11	8	11	8
Medium	57	46	61	50	46	33	57	42
Low	57	46	21	17	81	59	67	50
Total	124	100	123	100	138	100	135	100

In the control group, 138 students participated. Their initial assessment results were 11 students (8%) at a high level, 46 students (33%) at an intermediate level, 81

students (59%) at a low level. By the end of the trial, results in the control group showed no change in the number of high-level students (still 11 or 8%), intermediate-level students increased to 57 (42%), reflecting a 9% increase, Low-level students decreased to 67 (50%), marking a 9% decrease (see Figure 6).

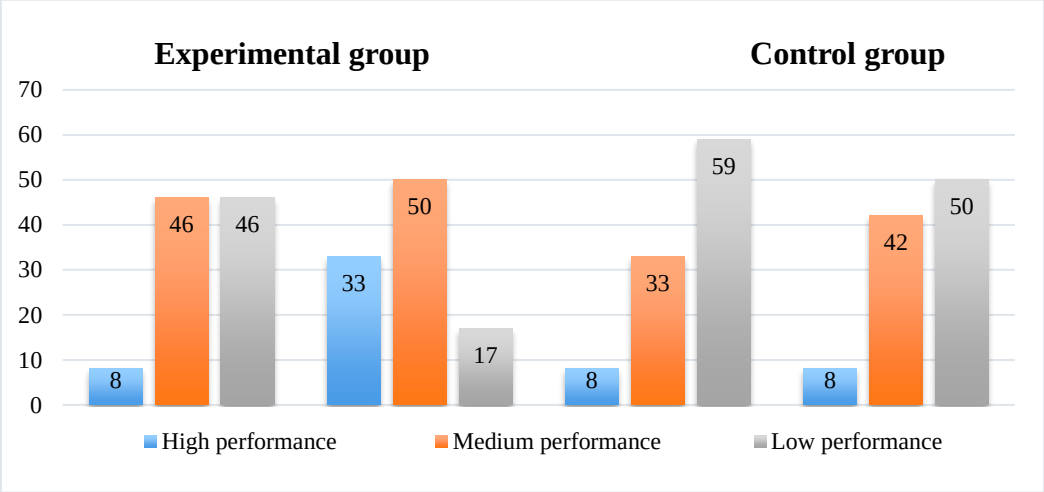


Figure 6. The experimental result.

We used Pearson's chi-squared and t-test to define the effectiveness of proposed teaching method of AI and robotics and instructions of new topics. To define the proposed method of teaching AI and robotics and instructional topics significantly improve the digital competencies of 10th- and 11th-grade students compared to the existing traditional theory-based curriculum? We defined the following hypotheses:

- the teaching method (AI & robotics vs. traditional) does not affect the improvement of digital competencies.
- the teaching method influences the improvement of digital competencies

Table 3.

Results of experimental group

Measure	Value
Number of pupil in experiment group (n)	124
Mean (Before experiment)	62.60
SD (Before experiment)	8.98
Mean (After experiment)	68.59
SD (After experiment)	10.82
Mean difference ($\bar{d}$)	5.98
SD of differences (s_d)	7.77
Standard error (SE)	0.70
t (df=123)	8.58
Two-tailed p	3.47e-14

In the experiment group Mean (after) is equal to 68.59 which is higher than control group Mean (after) 59.67. It means that experiment group results is 13% higher than control group.

Table 4.

Results of control group

Measure	Value
Number of pupil in control group (n)	138
Mean (Before experiment)	59.33
SD (Before experiment)	8.97
Mean (After experiment)	59.67
SD (After experiment)	7.97
Mean difference ($\bar{d}$)	5.98
SD of differences (s_d)	5.55
Standard error (SE)	0.47
t (df=137)	-1.89
Two-tailed p	6.72e-01

As a result, we found that our proposed teaching method (AI and robotics) significantly influences the improvement of digital competencies among students. Before the experimental trial, an initial examine was conducted in both groups. The students in both groups had similar baseline knowledge, skills, and competencies. By the end of the trial, a comparative analysis of the control and experimental groups demonstrated the clear advantages of teaching artificial intelligence and robotics fundamentals. The experimental group outperformed the control group in the final exams by 13%, confirming the positive impact of integrating AI and robotics into the school curriculum.

CONCLUSION

1. Pedagogical and psychological factors in teaching the fundamentals of artificial intelligence and robotics in general secondary schools were determined based on neurodidactic principles. The use of immersive technologies was found to be effective in developing digital skills and creative-technological thinking among students.

2. The stages of developing students' abilities in AI and robotics were enhanced with a focus on creative-technological thinking. Improvements were made through activities such as programming smart devices on the Arduino platform, creating electronic circuits, coding functional blocks, and testing using generative AI technologies.

3. The teaching methodology for AI and robotics was improved by integrating project-based learning, enabling students to analyze data using clustering, classification, and regression algorithms, comprehend text through natural language processing, and assemble and simulate microcontrollers with sensors and actuators for automated control, mechanical, and electrical system integration.

4. Assessment criteria for AI and robotics education were refined to foster constructive thinking. The implementation of formative and summative assessment methods considered group project topics and students' performance levels.

5. During the research, surveys were conducted in 12 general secondary schools across 12 districts of Tashkent, followed by training using project-based learning and hands-on methodologies. The results showed that the experimental group outperformed the control group by 13% in the final exams, confirming the positive impact of integrating AI and robotics into the school curriculum.

As a result of the research, we propose the following recommendations:

1. It is recommended to include a course on the fundamentals of AI and robotics in the curricula of pedagogical higher education institutions that train future teachers of Mathematics and Informatics.

2. The teacher retraining and professional development programs for Informatics and IT teachers in general secondary schools should include a dedicated module on AI and robotics to enhance their knowledge and teaching capabilities.

3. In general secondary schools, it is advised to introduce AI and robotics education as part of the "Informatics and Information Technologies" subject for students specializing in web freelancing and other IT-related fields.

НАУЧНОГО СОВЕТА DSc.l3/30.12.2019.T.07.01 ПО ПРИСУЖДЕНИЮ УЧЕНЫХ СТЕПЕНЕЙ ПРИ ТАШКЕНТСКОМ УНИВЕРСИТЕТЕ ИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ ИМЕНИ МУХАММАДА АЛ-ХОРАЗМИЙ

ТАШКЕНТСКОМ УНИВЕРСИТЕТЕ ИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ ИМЕНИ МУХАММАДА АЛ-ХОРАЗМИЙ

АБДУЖАЛИЛОВ ЖАВЛОНБЕК АДИЛОВИЧ

СОВЕРШЕНСТВОВАНИЕ МЕТОДИКИ ПРЕПОДАВАНИЯ ОСНОВ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА И РОБОТОТЕХНИКИ УЧАЩИМСЯ ШКОЛ

13.00.02 – Теория и методика обучения и воспитания (информатика)

АВТОРЕФЕРАТ ДИССЕРТАЦИИ ДОКТОРА ФИЛОСОФИИ (PhD) ПО ПЕДАГОИЧЕСКИМ НАУКАМ

Ташкент – 2025

Тема диссертации доктора философии (PhD) по педагогическим наукам зарегистрирована в Высшей аттестационной комиссии при Министерстве высшего образования, науки и инноваций Республики Узбекистан за № B2024.4.PhD/Ped8573.

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Автореферат диссертации на трех языках (узбекском, английском, русском (резюме) размещен на веб-странице Научного совета (www.tuit.uz) и информационно-образовательном портале «Ziyonet» (www.ziyonet.uz).

Научный руководитель:	**Закирова Феруза Махмудовна** доктор педагогических наук, профессор
Официальные оппоненты:	**Файзиева Махбубахон Рахимжоновна** доктор педагогических наук, профессор
	Шоймардонов Туймурод Турдиалиевич доктор философии по педагогическим наукам (PhD), доцент
Официальные оппоненты:	**Гулистанский государственный университет**

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С диссертацией можно ознакомиться в информационно-ресурсном центре Ташкентского университета информационных технологий имени Мухаммада аль-Хорезми. (зарегистрирована за №___). Адрес: 100202, г. Ташкент, ул. Амира Тимура, дом 108. Тел.: (99871)238-65-44.

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М. М. Мусаев
председатель Научного совета по присуждению ученых степеней, доктор технических наук, профессор

Э. Ш. Назирова
ученый секретарь Научного совета по присуждению ученых степеней, доктор технических наук, профессор

Дж. Б. Султанов
председатель научного семинара при Научном совете по присуждению ученых степеней, доктор технических наук, доцент

ВВЕДЕНИЕ (аннотация диссертации доктора философии (PhD))

Целью исследования является совершенствование методики преподавания основ искусственного интеллекта и робототехники учащимся школ.

Объектом исследования является процесс преподавания основ искусственного интеллекта и робототехники в общеобразовательных школах. В рамках экспериментального исследования было привлечено 735 учащихся из 12 общеобразовательных школ, расположенных в 12 районах города Ташкента, для изучения основ искусственного интеллекта и робототехники.

Научная новизна исследования заключается в следующем:

определены педагогико-психологические факторы преподавания основ искусственного интеллекта и робототехники учащимся общеобразовательных школ с учетом принципов нейродидактики, использования иммерсивных технологий, формирования цифровых компетенций и креативно-технологического мышления;

усовершенствованы этапы формирования способностей учащихся в области основ искусственного интеллекта и робототехники за счет приоритета создания электронных схем в среде Arduino, программирования интеллектуальных компонентов, кодирования функциональных блоков и тестирования с помощью генеративных технологий искусственного интеллекта;

усовершенствована методика преподавания основ искусственного интеллекта и робототехники путем анализа данных с использованием кластеризации, классификации и регрессионных алгоритмов, а также автоматического управления при сборке и симуляции микроконтроллеров в процессе выполнения групповых проектов;

усовершенствованы критерии оценки эффективности формирования компетенций учащихся по основам искусственного интеллекта и робототехники путем внедрения формативных и суммативных методов, ориентированных на развитие конструктивного мышления, с учетом тематики групповых проектов и уровня их выполнения.

Внедрение результатов исследования. На основе научных результатов исследования по совершенствованию методики преподавания основ искусственного интеллекта и робототехники школьникам:

педагогико-психологические факторы преподавания основ искусственного интеллекта и робототехники учащимся общеобразовательных школ были определены с учетом принципов нейродидактики, использования иммерсивных технологий, формирования цифровых компетенций и креативно-технологического мышления. Предложения по данному направлению были использованы в содержании учебника «Информатика и информационные технологии» (справка № 01-03/7-422 Республиканского научно-методического центра развития образования от 12 августа 2025 года). В результате была создана возможность формирования цифровых компетенций учащихся с использованием технологий виртуальной реальности;

этапы формирования способностей учащихся в области искусственного интеллекта и робототехники были усовершенствованы с учетом креативно-

технологического мышления, программирования интеллектуальных компонентов в среде Arduino, создания электронных схем, кодирования функциональных блоков и тестирования с помощью генеративных технологий искусственного интеллекта. Данные методики были использованы в международном прикладном исследовательском проекте «Проект образовательного сотрудничества по разработке образовательного контента в области программного обеспечения и искусственного интеллекта, а также образовательной модели для подготовки будущих специалистов в области искусственного интеллекта в Узбекистане». (справка Республиканского научно-методического центра развития образования № 01-03/7-422- от 12 августа 2025 г.). В результате повысилась эффективность использования современных технологий и инструментов преподавания для учителей предмета «Информатика и информационные технологии»;

методика преподавания основ искусственного интеллекта и робототехники была усовершенствована путем внедрения проектного подхода и групповой работы, анализа данных с использованием алгоритмов регрессии, классификации и кластеризации, сборки и симуляции микроконтроллеров а также интеграции автоматического управления. Эти предложения были внедрены в международном прикладном исследовательском проекте «Проект образовательного сотрудничества по разработке образовательного контента в области программного обеспечения и искусственного интеллекта, а также образовательной модели для подготовки будущих специалистов в области искусственного интеллекта в Узбекистане». (справка Республиканского научно-методического центра развития образования № 01-03/7-422- от 12 августа 2025 г.). В результате была усовершенствована методика группового обучения, используемая в процессе повышения квалификации учителей информатики и ИТ;

критерии оценки эффективности формирования компетенций учащихся по основам искусственного интеллекта и робототехники были усовершенствованы путем внедрения формативных и суммативных методов, ориентированных на развитие конструктивного мышления, а также с учетом тематики групповых проектов и уровня их выполнения. Предложения по данному направлению были использованы в международном прикладном исследовательском проекте «Проект образовательного сотрудничества по разработке образовательного контента в области программного обеспечения и искусственного интеллекта, а также образовательной модели для подготовки будущих специалистов в области искусственного интеллекта в Узбекистане» (2023-2024 гг.). (справка Республиканского научно-методического центра развития образования № 01-03/7-422- от 12 августа 2025 г.). В результате были расширены возможности оценки компетенций учащихся.

Структура и объем диссертации. Диссертация содержит 124 страницы и состоит из введения, трех глав, заключения, списка использованной литературы, списка условных обозначений и терминов, приложения.

E’LON QILINGAN ISHLAR RO‘YXATI
СПИСОК ОПУБЛИКОВАННИХ РАБОТ
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II bo‘lim (I часть, Part I)

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