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Articles are published in Uzbek, Russian, and English, ensuring a wide-reaching audience and fostering cross-cultural academic exchange. As a beacon of academic excellence, the "Journal of Transport" continues to serve as a vital conduit for knowledge dissemination, collaboration, and innovation in the transport sector and related fields.

Designing an adaptive test program for knowledge assessment in UML

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Abstract: This study is devoted to the design of an adaptive testing system for knowledge assessment using the Unified Modeling Language (UML). The research integrates modern assessment approaches, particularly Item Response Theory (IRT) and Computerized Adaptive Testing (CAT), with software engineering methodologies. UML diagrams, including Use Case, Sequence, Activity, and Class diagrams, are employed to formally represent the system architecture, processes, and interactions. The proposed system dynamically adapts test questions according to the learner's level of knowledge, thereby improving the accuracy, efficiency, and personalization of the assessment process. Experimental analysis demonstrates that adaptive testing significantly reduces test duration while maintaining a high level of reliability. The results confirm that UML-based system design enhances modularity, scalability, and readiness for practical implementation.

Keywords: adaptive testing, UML, IRT, CAT, knowledge assessment, educational technologies

Bilimlarni baholash adaptiv test dasturini UML tilida loyihalash

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Annotatsiya: Maqola bilimlarni baholash uchun adaptiv test dasturini Unified Modeling Language (UML) yordamida loyihalashga bag'ishlangan. Tadqiqotda zamonaviy baholash yondashuvlari, xususan, Item Response Theory (IRT) va Computerized Adaptive Testing (CAT) usullari dasturiy injiniring metodologiyalari bilan integratsiya qilingan. Use Case, Sequence, Class diagrammalarini o'z ichiga olgan UML diagrammalari tizim arxitekturasi, jarayonlari va o'zaro aloqalarini formal tarzda ifodalash uchun qo'llanilgan.

Taklif etilgan tizim foydalanuvchining bilim darajasiga mos ravishda test savollarini dinamik tarzda moslashtiradi, bu esa baholashning aniqligi, samaradorligi va individualligini oshiradi. Eksperimental tahlillar adaptiv testlash test davomiyligini sezilarli darajada qisqartirgan holda yuqori ishonchlilikni saqlab qolishini ko'rsatdi. Natijalar UML asosida tizimni loyihalash modullilik, kengaytiriluvchanlik va amaliy joriy etishga tayyorlik darajasini oshirishini tasdiqlaydi.

Kalit so'zlar: adaptiv testlash, UML, IRT, CAT, bilimlarni baholash, ta'lim texnologiyalari

1. Kirish

Zamonaviy ta'lim tizimida bilimlarni baholash jarayonini avtomatlashtirish va individuallashtirish dolzarb masalalardan biri hisoblanadi. An'anaviy test tizimlari barcha foydalanuvchilar uchun bir xil savollarni taqdim etadi, bu esa baholash aniqligini pasaytiradi. Shu sababli, so'nggi yillarda adaptiv test dasturlari (ATD), xususan, Item Response Theory (IRT) modeli asosidagi yondashuvlar keng qo'llanilmoqda. Ushbu yondashuv foydalanuvchining bilim darajasiga mos savollarni tanlash orqali baholashni optimallashtiradi.

Adaptiv testlash nazariyasi IRT modelida har bir savol quyidagi parametrlar bilan tavsiflanadi:

- murakkablik darajasi (difficulty)
- diskriminatsiya (discrimination)
- taxmin qilish ehtimoli (guessing)

Computerized Adaptive Testing (CAT) tizimlari ushbu parametrlar asosida foydalanuvchiga individual testlar taqdim etadi.

Kompyuterlashtirilgan adaptiv test (Computerized Adaptive Testing - CAT) tizimlari talabalarga bilimlarni

aniqlashda yuqoridagi parametrlar asosida individual testlar taqdim etadi [1, 2, 3].

CAT tizimlari Item Response Theory (IRT) modeli asosida har bir talabani joriy qobiliyatiga mos savollarni dinamik tarzda tanlaydi. Ayniqsa, 2-parametrlilik logistik model (2PL) diskriminatsiya (a) va qiyinlik (b) parametrlarini hisobga olishi sababli yuqori aniqlikni ta'minlanadi.

2PL modeli:

$$P(\theta) = \frac{1}{1 + e^{-a(\theta-b)}}$$

bu yerda:

- θ — talabani qobiliyati
- a — diskriminatsiya parametri
- b — qiyinlik parametri

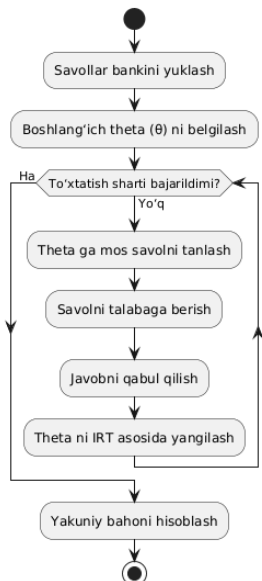
Jahon amaliyotida IRT va CAT tizimlari keng joriy qilingan bo'lib, u katta hajmdagi savollar banki va kalibrovka jarayonlari samarali adaptiv baholashni ta'minlaydi [4, 5].

CAT tizimi uchun ATD algoritmi 2PL-IRT modeli asosidagi ishlab chiqildi (1-rasm). Unda test jarayoni

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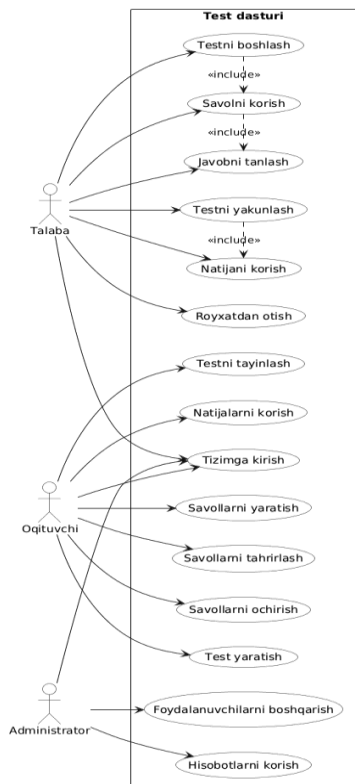
davomida talabaning bilim darajasini (θ - theta parametri) bosqichma-bosqich aniqlash va shu asosda unga mos savollarni tanlash orqali aniq va samarali baholashni ta'minlanadi.



1-rasm. ATD algoritmi 2PL-IRT modeli asosidagi algoritmi

2. Tadqiqot metodologiyasi

Ombor ATD Unified Modeling Language (UML) yordamida modellashtirildi, u dasturni yaratishda aniqlik va strukturaviy yondashuvni ta'minlaydi (2-rasm) [6, 7, 8].



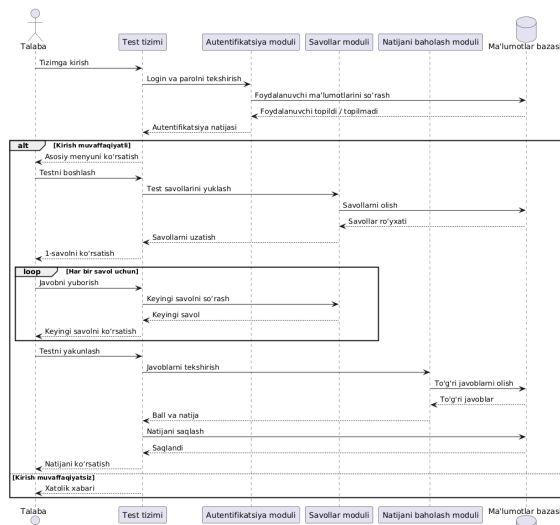
2-rasm. ATD UML "Use Case Diagram" loiyasi

Quyida ATD ni UML diagrammalar loiyhalari keltirilgan:

- Use Case Diagram → foydalanuvchi funksiyalari (2-rasm)
- Sequence Diagram → jarayonlar ketma-ketligi (3-rasm)
- Class Diagram → tizim strukturasi (4-rasm).

2-rasmidagi Use Case diagramma ATD foydalanuvchilari hamda ularning foydalanishi mumkin bo'lgan modullari (funksiyalari) ni, foydalanuvchilarining rollarini va huquqlarini ifodalaydi. Masalan, dastur administratori - dastur foydalanuvchilarini boshqarishi va ularning rollarini aniqlasa, o'qituvchi esa – fanlar va testlarni yaratish va boshqarish modullari bilan ishlaydi, talaba foydalanuvchisi esa – dasturdagi mavjud testlarni bajarish hamda natijalarni ko'rish modullari bilan ishlaydi. Shuningdek, dastur UML diagrammasida barcha foydalanuvchilar uchun umumiy bo'lgan modullar keltirilgan, jumldan tizimga kirish va chiqish kabilar.

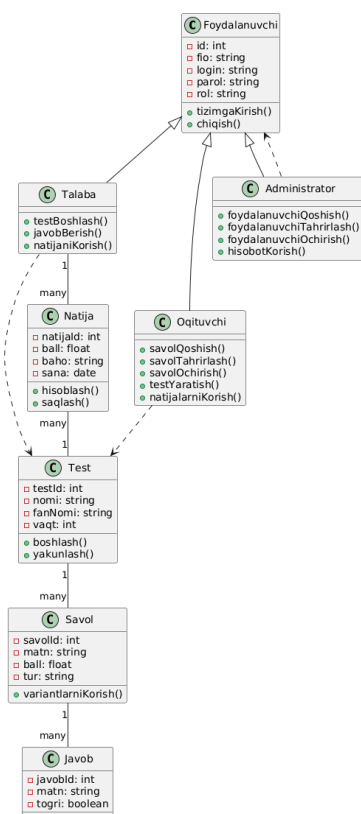
UML tilining "Sequence diagram" usulidan foydalanib, talaba tomonidan test topshirish jarayoni ketma-ketligi ishlab chiqildi, tizimga kirish, testni boshlash, test savollariga javob berish, test natijalarini ko'rish va tizimdan chiqish modullari keltirilgan, shuningdek har bir modulda istisno holatlari ham inobatga olingan, ma'lumotlar bazasining birgalikda qo'llanilishi tasvirlangan (3-rasm).



3-rasm. Test dasturining UML "Sequence diagram" loiyasi

ATD ning UML Class diagrammasi ishlab chiqilgan bo'lib, tizimdagi asosiy obyektlar, ularning atributlari, funksiyalari va o'zaro bog'lanishlarini ifodalaydi. Diagramma test jarayonini tashkil etuvchi asosiy sinflardan iborat bo'lib, unda foydalanuvchilar, testlar, savollar, javoblar va natijalar o'rtasidagi munosabatlar modellashtirilgan. Tizimda barcha ishtirokchilar uchun umumiy asosiy sinf sifatida Foydalanuvchi berilgan, qolgan (Administrator, O'qituvchi, Talaba) rollari esa shu sinfdan me'ros oladi. (4-rasm).





4-rasm. ATD UML “Class diagram” loyihasi

3. Xulosa

Mazkur tadqiqotda bilimlarni baholash jarayonini takomillashtirish maqsadida ATD UML vositalari yordamida loyihalash masalasi kompleks ravishda ko‘rib chiqildi. Tadqiqot davomida adaptiv testlashning nazariy asoslari, xususan, IRT va CAT yondashuvlari tahlil qilinib, ular asosida zamonaviy test tizimini qurishning konseptual modeli ishlab chiqildi.

UML diagrammalari (Use Case, Sequence, Class diagrammalari) yordamida tizimning funksional, dinamik va strukturaviy komponentlari formal tarzda ifodalandi. Xususan, Use Case diagrammasi orqali foydalanuvchilar va tizim o‘rtasidagi o‘zaro aloqalar aniqlashtirildi, Sequence diagrammasi adaptiv test jarayonidagi qaror qabul qilish mexanizmlarini bosqichma-bosqich yoritildi, Class diagrammasi esa tizimning ichki arxitekturasini modellashtirish imkonini berdi.

Taklif etilgan ATD an‘anaviy testlash usullaridan farqli ravishda har bir foydalanuvchining bilim darajasiga moslashgan holda savollarni tanlash imkonini beradi. Bunda IRT modeli asosida har bir savolning murakkablik darajasi va diskriminatsiya ko‘rsatkichlari hisobga olinadi hamda foydalanuvchining bilim parametri dinamik ravishda baholanadi. Natijada test jarayoni yanada aniq, individual va samarali bo‘ladi.

Shuningdek, tizimning UML asosida modellashtirilishi uning:

- Modullilik;
- Kengaytiriluvchanlik;

- qayta foydalanish imkoniyati;
- dasturiy ta‘minotni ishlab chiqishga tayyorligini ta‘minlaydi.

Tadqiqot natijalari shuni ko‘rsatadiki, adaptiv testlash tizimlarini UML asosida loyihalash ta‘lim jarayonini raqamlashtirishda muhim vosita bo‘lib xizmat qiladi va baholash tizimlarining sifatini sezilarli darajada oshiradi.

Ushbu yondashuv oliy ta‘lim muassasalarida talabalar bilimni baholashni avtomatlashtirish, natijalarni chuqur tahlil qilish va individual ta‘lim trajektoriyalarini shakllantirish imkonini beradi.

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