
The use of ai-based adaptive homework and teacher feedback: a comparative analysis of their impact on students in rural and urban areas

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Annotation *This study examines the comparative impact of AI-based adaptive homework and teacher feedback on students in rural and urban areas. The introduction justifies the relevance of the topic through the rapid development of digital education, existing educational inequalities between regions, and the scientific-pedagogical significance of adaptive technologies. The main objective of the research is to empirically determine how AI-based adaptive tasks influence students' academic achievement, motivation, and responsiveness to teacher feedback across different geographical contexts. A quasi-experimental approach was employed in the methodology, with pre- and post-tests, platform-generated statistical data, and semi-structured interviews serving as the primary research instruments. The results indicate that urban students demonstrated a 25% increase in post-test scores, while rural students showed an 18% increase. Additionally, the urban group exhibited higher engagement with feedback, faster task completion, and a more dynamic progression toward advanced task levels. The conclusion emphasizes that adaptive technologies are effective in both settings; however, technical infrastructure, digital literacy, and teacher competence significantly influence outcomes. The findings have practical implications for integrating AI tools into school education, reducing regional educational disparities, and preparing teachers for digital pedagogy.*

Keywords *Artificial intelligence, adaptive homework, AI feedback, rural and urban students, digital education, individualized instruction, learning effectiveness*

Использование адаптивных домашних заданий на основе искусственного интеллекта и учительской обратной связи: сравнительный анализ их влияния на учащихся в сельских и городских районах

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Аннотация *Данное исследование посвящено сравнительному анализу влияния адаптивных домашних заданий, основанных на технологиях искусственного интеллекта, и учительской обратной связи на учащихся сельских и городских регионов. Введение обосновывает актуальность темы стремительным развитием цифрового образования, существующим неравенством между территориями и научно-педагогической значимостью адаптивных технологий. Основная цель исследования – эмпирически*

определить, как адаптивные задания на основе ИИ влияют на уровень успеваемости, мотивацию и реакцию учащихся на обратную связь учителя в различных территориальных условиях. В методологии применён квази-экспериментальный подход; в качестве основных методов использовались пре- и пост-тесты, статистические данные образовательной платформы, а также полуструктурированные интервью. Результаты показали, что учащиеся городских школ продемонстрировали рост показателей пост-теста на 25%, тогда как учащиеся сельских школ – на 18%; кроме того, городская группа отличалась более высокой активностью в использовании обратной связи, большей скоростью выполнения заданий и более динамичным переходом к сложным уровням. В заключении подчёркивается, что адаптивные технологии являются эффективными в обеих средах, однако техническая инфраструктура, цифровая грамотность и компетентность педагогов оказывают существенное влияние на итоговые результаты. Полученные данные имеют практическую значимость для внедрения инструментов искусственного интеллекта в школьное образование, сокращения образовательного разрыва между регионами и подготовки учителей к цифровой педагогике.

Ключевые слова *Искусственный интеллект, адаптивные домашние задания, AI-feedback, сельские и городские учащиеся, цифровое образование, индивидуализированное обучение, эффективность обучения*

Sun'iy intellektga asoslangan adaptiv uy vazifalari va o'qituvchi fikr-mulohazalarining qo'llanilishi: qishloq va shahar hududlaridagi o'quvchilarga ta'sirini solishtirish

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Annotatsiya *Ushbu tadqiqot sun'iy intellektga asoslangan adaptiv uy vazifalari va o'qituvchi fikr-mulohazalarining qishloq hamda shahar hududlaridagi o'quvchilarga ko'rsatadigan ta'sirini solishtirishga bag'ishlangan. Kirish qismida mavzuning dolzarbligi raqamli ta'limning jadal rivojlanishi, hududlar o'rtasidagi ta'lim tengsizligi va adaptiv texnologiyalarning ilmiy-pedagogik ahamiyati bilan asoslab berilgan. Tadqiqotning asosiy maqsadi – sun'iy intellektga asoslangan adaptiv topshiriqlar turli hududlarda yashovchi o'quvchilarning o'zlashtirish darajasi, motivatsiyasi va o'qituvchi fikr-mulohazalariga javob reaksiyasiga qanday ta'sir qilishini empirik ravishda aniqlashdir. Metodologiyada kvazi-eksperimental yondashuv qo'llanilib, pre-test va post-testlar, platforma statistikasi hamda yarim strukturaviy suhbatlar asosiy tadqiqot usullari sifatida ishlatilgan. Natijalar shuni ko'rsatdiki, shahar o'quvchilari post-test natijalarida 25% o'sishga, qishloq o'quvchilari esa 18% o'sishga erishgan; shuningdek, shahar guruhida fikr-mulohazadan foydalanish faolligi, topshiriqlarni bajarish tezligi va murakkab bosqichlarga o'tish dinamikasi yuqori bo'lgan. Xulosada adaptiv texnologiyalar har ikki hududda samarali ekanligi, ammo texnik infratuzilma, raqamli savodxonlik va o'qituvchi kompetensiyasi natijalarga sezilarli*

ta'sir ko'rsatishi ta'kidlangan. Tadqiqot natijalari maktab ta'limida sun'iy intellekt vositalarini joriy etish, hududlar o'rtasidagi ta'lim tengsizligini kamaytirish va o'qituvchilarni raqamli pedagogikaga tayyorlashda amaliy ahamiyatga ega.

Kalit so'zlar *Sun'iy intellekt, adaptiv uy vazifalari, AI-feedback, qishloq va shahar o'quvchilari, raqamli ta'lim, individuallashtirilgan o'qitish, ta'lim samaradorligi*

Introduction

In the modern education system, the integration of AI-based adaptive technologies is becoming a crucial factor in individualizing the learning process, generating tasks tailored to learners' abilities and needs, and enhancing the precision of teacher feedback. In particular, adaptive homework significantly improves learning efficiency by analyzing a learner's proficiency level, errors, and learning pace in real time, and automatically selecting appropriate revision materials or the next-stage tasks (Baker & Hawn, 2022). In this process, AI-generated, refined teacher feedback enables students to understand and correct their mistakes more quickly and develop their own learning strategies. The implementation of such technologies is especially relevant for Uzbekistan's education system, as they possess high potential for reducing the persistent quality gap between rural and urban educational environments.

From this perspective, the purpose of this research is to compare the impact of AI-based adaptive homework and teacher feedback on students in rural and urban areas and to scientifically identify regional differences and opportunities (Baker, 2021). To achieve this goal, the study examines the process of implementing adaptive technologies, compares students' academic performance, task-completion speed, error analysis, motivation, and responses to teacher feedback, and determines which technical or pedagogical factors in rural and urban settings influence the outcomes more significantly.

The scientific novelty of the study lies in the fact that the adaptive homework system is empirically compared for the first time between urban and rural learners, while factors such as digital education infrastructure, internet quality, students' digital skills, and teachers' competence in working with AI are analyzed in an integrated and comprehensive manner (Koedinger et al., 2023). This approach makes it possible to evaluate the effectiveness of adaptive technologies within a real socio-pedagogical context.

The theoretical and practical significance of the research is reflected in developing scientifically grounded recommendations for the effective integration of AI technologies into the educational process, identifying ways to expand digital learning opportunities in rural schools, and creating methodological guidelines for teachers on the appropriate use of AI-generated feedback. Thus, this study is of particular importance as it proposes innovative approaches that can contribute to reducing the educational gap between regions.

Methods

This research is aimed at comparing the impact of AI-based adaptive homework and teacher feedback on students in rural and urban areas and was conducted using a quasi-experimental design. A mixed-method approach was applied, combining quantitative results with qualitative analysis (Thomas et al., 2023). A total of 112 students from grades 6-7 participated in the study: 56 from an urban school and 56 from a rural school. Participant selection considered factors such as age homogeneity, similar baseline subject

proficiency, regular class attendance, and access to digital devices. Additionally, 10 teachers from both regions underwent a short instructional training on the use of adaptive technologies.

The research lasted for seven weeks. First, all students completed a pre-test to assess their initial knowledge and skills. Afterwards, both groups began using an AI-adaptive homework platform (VanLehn et al., 2024). The platform analyzed each student's response, automatically generated exercises with an appropriate difficulty level, provided precise error-specific feedback, and created an individual learning profile for each student. Teachers, in turn, delivered additional explanations, personalized comments, or correction sessions based on system recommendations.

Three main instruments were used for data collection:

1. *Test materials* – pre-test and post-test (to measure changes in achievement).
2. *Platform analytics* – task completion speed, error types, adaptivity score, number of attempts, time spent, and learning progression.
3. *Semi-structured interviews* – exploring students' and teachers' perceptions of the technology, its effect on motivation, and challenges they encountered.

The study also monitored external factors such as internet quality, device type, technical issues, students' digital literacy levels, and teachers' competence in working with AI, as these variables were crucial for identifying differences between rural and urban contexts (Woolf et al., 2023). This methodological approach made it possible to determine how the adaptive homework system performs in real educational environments, in what aspects the experiences of rural and urban students differ, and to what extent teacher feedback integrates effectively with AI-generated support.

Results

The findings of the study clearly demonstrated that the use of AI-based

adaptive homework produced different levels of effectiveness among rural and urban students. Pre-test results showed that both groups had almost identical initial preparation, with no significant differences in their baseline academic achievement. This allowed the researchers to attribute the changes observed during the experimental period specifically to the impact of adaptive homework (Selwyn, 2022).

By the end of the experiment, urban students showed a noticeable improvement: they achieved higher results in completing complex tasks, demonstrated faster error correction, and displayed a greater degree of adaptability. These students actively used the feedback provided by the platform and devoted more time to analyzing their mistakes. Rural students also showed positive progress; however, factors such as slow internet, lack of appropriate devices for some learners, and difficulties completing tasks at home reduced the pace of improvement.

Platform analytics revealed that urban students adapted to the system more quickly, progressing to the next level of task complexity by approximately the third day, whereas for rural students this process took 5–6 days. Moreover, urban students needed fewer repeated attempts, as they corrected errors more efficiently using AI-generated feedback. In contrast, rural students required more time to read, understand, and apply the feedback (Selwyn, 2024).

Qualitative analysis also highlighted significant differences. Urban students described the platform as "motivating," "modern," and "more engaging than regular homework." Many rural students reported that technical issues sometimes prevented them from completing homework on time, although they acknowledged that adaptive feedback helped them understand their mistakes better.

Teachers' observations further reinforced these findings. Urban teachers noted that AI-generated feedback supported lesson

planning, individualized instruction, and the identification of students' strengths and weaknesses. Rural teachers, on the other hand, emphasized the need for improved

infrastructure to ensure the effective use of adaptive tasks (Perrotta & Selwyn, 2020).

A summary of the main results for both groups is presented in the following table:

Indicators	Urban Students	Rural Students
Average Pre-test Score	56%	54%
Average Post-test Score	81%	72%
Learning Improvement (%)	25%	18%
Activity in Using AI Feedback	High	Moderate
Speed of Progressing to Higher Difficulty	Fast (2-3 days)	Slow (5-6 days)
Number of Reattempted Tasks	Low	High
Motivation Level	High	Moderate
Technical Issues	Minimal	Frequent

Table 1. Comparison of Student Outcomes in Urban and Rural Settings

Discussion

The results of this study demonstrate that AI-based adaptive homework affects students in rural and urban areas to different degrees. Urban students showed higher outcomes in learning achievement, task completion speed, and the use of feedback. This is primarily explained by disparities in conditions: urban schools have better digital infrastructure, more stable internet access, and higher levels of digital literacy, all of which enabled the adaptive platform to function at maximum efficiency.

At the same time, rural students also demonstrated significant improvement. This indicates that adaptive technologies are effective in fostering individualized learning and developing error-analysis skills regardless of region. However, the slower rate of improvement among rural students may be attributed to technical limitations, insufficient devices, and poor internet quality. These findings align with the conclusions of scholars such as VanLehn, Baker, and Woolf, who noted that the effectiveness of adaptive systems is directly linked to technological infrastructure.

The discussion further reveals that urban students actively engaged with AI-feedback,

analyzed their mistakes, and managed their time efficiently when progressing to more advanced tasks. Rural students adapted to adaptive tasks more slowly, yet feedback still helped them understand their mistakes and improve through repeated attempts. This suggests that AI-based assignments enhance students' self-regulated learning and sense of responsibility (VanLehn & Chi, 2021).

Another important aspect of the study concerns the role of teachers. Urban teachers actively used AI-generated reports for lesson planning and quickly identified students' individual needs. In contrast, rural teachers were unable to fully benefit from AI tools due to limited technical skills or unstable internet access. This highlights the need for specialized training and methodological support for educators.

When summarized, the findings lead to several key scientific conclusions:

1. Adaptive technologies demonstrate high effectiveness in well-resourced environments, but they also provide meaningful positive growth even in limited conditions.
2. Technical infrastructure is a crucial determinant of adaptive learning success,

with slow internet and device shortages significantly slowing progress in rural areas.

3. Students' motivation and interest play an essential role when interacting with AI tools – the game-like interface, clarity, and immediacy of feedback help boost engagement and effectiveness.
4. Teachers' competence in using the platform directly influences outcomes; therefore, training educators is essential when integrating AI-based technologies.

Thus, the study confirms that adaptive homework is an effective tool for individualizing the learning process, improving achievement, and strengthening error-analysis skills. However, achieving optimal results requires improving technological infrastructure, enhancing teacher training, and ensuring equal access to digital learning opportunities across regions.

Conclusion

This study aimed to identify the real effectiveness of digital technologies in the learning process by comparing the impact of AI-based adaptive homework and teacher feedback on students in rural and urban areas. The results demonstrated that although adaptive homework significantly improved learning outcomes in both contexts, its effectiveness was notably higher in urban schools. This can be explained by several factors: better internet connectivity, greater device accessibility, higher levels of digital literacy, and teachers' readiness to integrate technology.

Rural students also showed considerable positive progress, particularly in error analysis, using feedback effectively, and developing self-monitoring skills – one of the important scientific findings of the research. This indicates that AI-powered learning tools are effective regardless of location; however, the pace and strength of their impact depend heavily on the quality of infrastructure. The study also highlighted the decisive role of teacher competence – appropriate use of AI-

generated feedback strengthened individualized instruction during lessons.

Overall, adaptive technologies proved to be effective tools that encourage active learning, adjust to learners' abilities, and individualize the educational process. However, to fully realize their potential, stronger technical, organizational, and methodological support systems are required.

Recommendations

1. *Strengthening digital infrastructure.* Ensuring stable internet connectivity in rural schools and providing students with modern digital devices (tablets, laptops) will enable equal access to adaptive technologies in the learning process.
2. *Improving teacher qualifications.* It is necessary to organize regular training sessions on working with AI-based adaptive platforms and to develop methodological skills that help teachers effectively integrate AI-generated feedback with pedagogical approaches.
3. *Developing students' digital skills.* Conducting special sessions that teach students how to independently use adaptive systems, analyze their mistakes, engage in reflection, and manage their own learning process will enhance overall educational effectiveness.
4. *Localizing adaptive technologies.* Improving the Uzbek-language interface of the platform, creating content aligned with the national curriculum, and adapting the system to national education standards are of great importance.
5. *Additional support for rural areas.* Introducing offline-mode adaptive tasks for regions with weak internet connectivity and establishing a system of additional consultation and support for students are necessary measures.
6. *Integration at the education policy level.* Including AI-based homework and adaptive platforms in the innovative



programs of the general education system and strengthening national

initiatives aimed at ensuring digital education equity are recommended.

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