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METHODOLOGY FOR DEVELOPING AN AI-BASED ADAPTIVE EXERCISE SYSTEM FOR MOTHER TONGUE INSTRUCTION IN PRIMARY EDUCATION

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Abstract: This study aims to develop an artificial intelligence-based adaptive exercise system for improving reading comprehension in primary school mother tongue lessons. A design-based research approach was employed involving 30 fourth-grade students from Secondary School No. 2 in Baliqchi District, Andijan Region, Uzbekistan. The proposed methodology includes three adaptive learning levels (A, B, and C) that automatically adjust reading tasks according to students' achievement levels. Artificial intelligence tools, including ChatGPT, Quizizz AI, and Wordwall, were used to generate differentiated exercises, provide immediate feedback, and monitor students' learning progress. The findings indicate that the adaptive exercise system improved students' reading comprehension, increased classroom engagement, and supported individualized learning. The study concludes that integrating artificial intelligence into adaptive reading instruction can enhance the effectiveness of primary school mother tongue education and provide practical guidance for teachers implementing learner-centered instructional strategies.

Keywords: artificial intelligence, adaptive learning, adaptive exercise system, reading comprehension, mother tongue education, primary school, personalized learning, educational technology.

Introduction.

Artificial intelligence (AI) has become one of the key drivers of educational transformation, creating new opportunities for improving teaching quality and supporting personalized learning. In primary education, AI technologies enable teachers to design learning activities that accommodate students' individual abilities, learning pace, and cognitive characteristics. Consequently, the integration of adaptive learning approaches into mother tongue instruction has attracted increasing attention from educational researchers and practitioners. "Generative AI has the potential to support teaching, learning and research when it is used responsibly and ethically"[6]. This statement emphasizes that the educational value of artificial intelligence depends not only on technological advancement but also on appropriate pedagogical implementation. Therefore, AI should be viewed as an instructional support system that helps teachers organize adaptive learning environments rather than replacing their professional role.

Reading comprehension is regarded as one of the fundamental competencies in primary school mother tongue education because it directly influences learners' language development, critical thinking, and academic achievement. However, students often demonstrate different levels of reading ability, making it difficult for teachers to provide learning tasks that meet every learner's needs within the same classroom. Traditional instructional materials generally present identical exercises for all students, which may reduce learning efficiency among both high-achieving and low-achieving learners. "Reading literacy is the ability to understand, use, evaluate, reflect on and engage with texts

to achieve one's goals"[2]. Considering this perspective, adaptive exercises supported by artificial intelligence can provide learning experiences that correspond to students' actual reading proficiency and gradually improve their comprehension skills.

Recent developments in artificial intelligence have enabled the creation of adaptive educational systems capable of analysing students' responses and automatically selecting learning activities according to their performance. Such systems offer immediate feedback, monitor learning progress, and recommend personalized instructional pathways. These characteristics make adaptive learning particularly suitable for mother tongue lessons, where students demonstrate diverse linguistic competencies and reading abilities. At the same time, adaptive exercise systems reduce teachers' routine workload and allow them to devote greater attention to instructional guidance and individual support during classroom activities.

Although numerous studies have investigated artificial intelligence in education, most have focused on intelligent tutoring systems, automated assessment, and digital learning environments. Comparatively fewer studies have examined the methodological principles for designing AI-based adaptive exercise systems specifically for developing reading comprehension in primary school mother tongue lessons. This research gap indicates the need for pedagogically grounded methodologies that integrate artificial intelligence with adaptive reading instruction while considering learners' age characteristics and curriculum requirements.

The purpose of this study is to develop a methodology for designing an artificial intelligence-based adaptive exercise system to improve reading comprehension in primary school mother tongue lessons and to evaluate its pedagogical applicability through classroom implementation.

Materials and Methods

This study employed a design-based research approach to develop and evaluate an artificial intelligence-based adaptive exercise system for improving reading comprehension in primary school mother tongue lessons. Design-based research was selected because it enables researchers to create, implement, and refine innovative instructional models within authentic educational settings while simultaneously examining their pedagogical effectiveness. "Design-based research aims to improve educational practices through iterative analysis, design, development, and implementation"[3]. Based on this approach, the proposed adaptive exercise system was designed, implemented, and evaluated in a real classroom environment.

The research was conducted at Secondary School No. 2 in Baliqchi District, Andijan Region, Uzbekistan. The participants included 30 fourth-grade students enrolled in mother tongue classes during the 2025–2026 academic year. The students were selected because fourth grade represents a critical stage in developing reading comprehension skills and independent text interpretation. Before implementing the adaptive exercise system, students completed a diagnostic reading comprehension assessment to determine their initial achievement levels. According to the assessment results, learners were categorized into three adaptive levels (A, B, and C), allowing instructional activities to correspond to their individual learning needs.

The adaptive exercise system consisted of three progressive difficulty levels. Level A included literal comprehension tasks requiring students to identify explicit information, recognize vocabulary, and answer factual questions. Level B contained inferential exercises that required learners to determine relationships between ideas, identify the main idea, and explain cause-and-effect relationships. Level C involved higher-order thinking activities such as evaluating the author's viewpoint, drawing conclusions, proposing alternative endings, and solving open-ended reading problems. This three-level structure enabled the artificial intelligence system to recommend learning activities according to each student's performance rather than assigning identical tasks to the entire class.

Artificial intelligence technologies were integrated throughout the instructional process. ChatGPT was utilized to generate differentiated reading comprehension questions and provide immediate textual feedback. Quizizz AI supported adaptive online assessment, while Wordwall was employed to develop interactive reinforcement activities. Students' responses were continuously analysed, allowing subsequent learning tasks to be automatically adjusted according to their demonstrated achievement levels. This adaptive mechanism created individualized learning pathways and reduced unnecessary repetition of previously mastered content.

To evaluate the effectiveness of the proposed methodology, qualitative and quantitative data were collected. Classroom observations, students' reading comprehension performance, teachers' reflective notes, and adaptive assessment reports generated by AI-supported platforms were analysed. The collected data were interpreted using descriptive statistical analysis and comparative evaluation to determine changes in students' reading comprehension achievement after implementing the adaptive exercise system.

Results

The implementation of the artificial intelligence-based adaptive exercise system demonstrated positive changes in students' reading comprehension performance during the experimental period. The adaptive methodology enabled each learner to complete reading activities corresponding to his or her individual achievement level, thereby increasing learning efficiency and reducing the difficulties associated with uniform classroom instruction. Before the intervention, students exhibited considerable differences in reading comprehension abilities, particularly in identifying implicit information, drawing conclusions, and interpreting textual meanings. Following the implementation of the adaptive exercise system, these differences gradually decreased as students progressed through individualized learning pathways.

The initial diagnostic assessment classified the 30 fourth-grade students into three adaptive learning levels. Twelve students (40%) were assigned to Level A because they demonstrated difficulties in identifying explicit information and understanding the main ideas of texts. Ten students (33.3%) were placed in Level B, showing satisfactory comprehension but requiring additional support in inferential reading tasks. Eight students (26.7%) reached Level C, indicating their ability to analyse, evaluate, and interpret reading materials independently. "Assessment should provide evidence that supports students' learning progression rather than simply measure achievement"[1]. Guided by this principle, the adaptive exercise system continuously reassigned students to higher levels according to their learning progress, allowing instructional activities to reflect individual development rather than fixed ability groups.

Table 1. Distribution of students according to adaptive learning levels before and after implementation

Adaptive level	Before implementation	After implementation
Level A	12 (40.0%)	5 (16.7%)
Level B	10 (33.3%)	11 (36.7%)
Level C	8 (26.7%)	14 (46.6%)

The results indicate that the number of students at Level C increased substantially after applying the proposed methodology, while the proportion of learners at Level A decreased. These findings suggest that the adaptive exercise system effectively supported students in progressing from literal comprehension toward inferential and critical reading skills. Furthermore, students demonstrated greater confidence in completing reading tasks and showed increased participation during classroom discussions.

Classroom observations also revealed improvements in students' learning motivation and engagement. Learners expressed greater interest in reading activities because the artificial intelligence

system generated exercises that matched their individual performance levels. Immediate feedback provided through AI-supported platforms enabled students to recognize their mistakes, revise their answers, and monitor their own learning progress. Teachers reported that the adaptive methodology reduced the time required for preparing differentiated instructional materials and allowed more opportunities for providing individualized pedagogical support during lessons. Overall, the experimental findings confirm that the proposed artificial intelligence-based adaptive exercise system contributes to improving reading comprehension, increasing learner engagement, and supporting individualized instruction in primary school mother tongue education. The methodology proved effective not only in enhancing students' academic performance but also in facilitating more efficient classroom management through adaptive instructional planning.

Discussion

The proposed artificial intelligence-based adaptive exercise system demonstrates that reading comprehension instruction can become more individualized when learning activities are organized according to students' actual performance rather than a uniform instructional sequence. Unlike traditional classroom practices, where identical reading tasks are assigned to all learners, the adaptive model continuously modifies the level of difficulty based on students' responses. Such an approach enables learners to progress at their own pace while reducing both cognitive overload and repetitive learning activities. "Differentiation is an organized, flexible way of proactively adjusting teaching and learning to maximize each student's growth"[5]. This principle supports the idea that adaptive exercise systems should respond to learners' diverse educational needs instead of relying on standardized instructional practices. Therefore, the proposed methodology combines artificial intelligence with differentiated instruction to create more effective reading comprehension activities in primary school mother tongue education.

The three-level adaptive structure (Levels A, B, and C) developed in this study provides a systematic mechanism for organizing reading comprehension exercises according to learners' cognitive readiness. Students initially complete diagnostic activities, after which artificial intelligence analyses their responses and recommends subsequent exercises with an appropriate level of complexity. As students demonstrate improvement, the system gradually introduces more challenging comprehension tasks. This progressive learning pathway allows students to develop reading comprehension skills through continuous support rather than through abrupt increases in task difficulty. Consequently, the adaptive model contributes to sustainable language development and encourages learners to become more confident readers.

Another important advantage of the proposed methodology is the integration of generative artificial intelligence into instructional decision-making. Instead of functioning solely as an assessment tool, artificial intelligence becomes an instructional assistant capable of generating differentiated questions, providing immediate feedback, and recommending individualized learning activities. "Artificial intelligence should augment, not replace, teachers' professional judgement"[6]. From this perspective, the effectiveness of adaptive learning depends on the teacher's ability to interpret AI-generated recommendations and transform them into meaningful pedagogical actions. Accordingly, the teacher remains the central facilitator of learning, while artificial intelligence performs supportive analytical and instructional functions.

The findings of this study are consistent with recent international research emphasizing personalized learning as one of the major directions of digital education. Adaptive educational environments have been shown to increase learner engagement, improve academic achievement, and support inclusive education by addressing individual differences among students. However, implementing adaptive exercise systems also requires careful consideration of ethical issues, including responsible AI use, data privacy, and transparency in automated decision-making. These

considerations are particularly significant in primary education, where students require continuous pedagogical guidance and human interaction throughout the learning process.

The methodological framework proposed in this research differs from many existing studies because it focuses specifically on designing adaptive reading comprehension exercises for primary school mother tongue lessons rather than presenting artificial intelligence as a general educational technology. The integration of diagnostic assessment, adaptive task generation, immediate feedback, and individualized progression into a single instructional model represents the principal methodological contribution of this study. This integrated approach provides teachers with a practical framework that can be adapted to different reading materials and learning contexts while maintaining learner-centered instructional principles.

Conclusion

The findings of this study demonstrate that an artificial intelligence-based adaptive exercise system can significantly improve reading comprehension in primary school mother tongue education by providing individualized learning experiences that correspond to students' cognitive abilities and learning progress. Unlike conventional classroom instruction, the proposed methodology enables learners to receive adaptive reading tasks, immediate feedback, and personalized learning pathways, thereby creating more effective conditions for developing reading literacy.

The implementation of the three-level adaptive exercise model (Levels A, B, and C) contributed to measurable improvements in students' comprehension performance and classroom engagement. The experimental results indicate that adaptive exercises generated through artificial intelligence technologies support learners in progressing from literal comprehension to inferential and critical reading skills. "Artificial intelligence should be designed to enhance human learning and support educational development"[6]. These findings suggest that AI can serve as an effective pedagogical assistant when integrated into carefully planned instructional methodologies rather than functioning as an independent teaching mechanism.

The proposed methodology also provides practical benefits for teachers by facilitating differentiated instruction, reducing the time required to prepare learning materials, and supporting continuous monitoring of students' academic progress. Artificial intelligence enables teachers to make more informed instructional decisions while maintaining their central pedagogical role throughout the learning process. Consequently, adaptive exercise systems can contribute to establishing learner-centered educational environments that promote active participation, independent thinking, and sustainable language development.

Although the present study produced encouraging results, several limitations should be acknowledged. The experimental implementation involved a relatively small sample of fourth-grade students from a single primary school, which may limit the generalizability of the findings. Future studies should examine the effectiveness of the proposed adaptive methodology across different grade levels, educational contexts, and larger participant groups. Further research may also investigate the integration of multimodal artificial intelligence applications, learning analytics, and intelligent tutoring systems to enhance reading comprehension and other linguistic competencies in primary education. Overall, this study contributes to the growing field of artificial intelligence in education by proposing a practical methodology for designing adaptive reading comprehension exercises in primary school mother tongue lessons. The developed framework may serve as a useful reference for teachers, curriculum developers, and educational researchers seeking to integrate artificial intelligence into language education through pedagogically grounded and learner-centered instructional practices.

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