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AI-ENHANCED PHYSICS INSTRUCTION IN UZBEK: EVALUATING COMPREHENSION OF SCIENTIFIC TERMINOLOGY USING LANGUAGE MODELS

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Abstract: *This study explores the use of artificial intelligence-based tools, particularly large language models (LLMs), in teaching physics terminology in the Uzbek language. The research focuses on the effectiveness of AI-assisted instruction in improving students' understanding of core physics concepts expressed in Uzbek. A comparative experimental methodology was employed: one group received traditional instruction, while the other engaged with interactive, AI-supported lessons using localized terminology. The outcomes were evaluated through comprehension tests, semantic accuracy checks, and student feedback. The results indicate that the AI-driven approach significantly enhances learners' grasp of scientific terms, promotes linguistic clarity, and fosters deeper conceptual understanding in native-language physics education.*

Keywords: *Uzbek language, physics education, scientific terminology, artificial intelligence, large language models, AI in education, native-language instruction, comprehension assessment, interactive learning, AI-assisted teaching*

In recent years, artificial intelligence (AI), and more specifically large language models (LLMs), have emerged as powerful tools in transforming educational landscapes. While much of the existing research on AI-assisted learning has focused on English-medium instruction, less attention has been given to AI applications in native-language science education—particularly in languages such as Uzbek. Physics, being one of the most terminology-intensive disciplines, poses a

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unique challenge for students when taught in their native language, especially when scientific terms are translated or adapted from global standards.

This study addresses that gap by investigating how AI can be utilized to improve the understanding of physics terminology in Uzbek. We hypothesize that AI-based educational tools, when localized linguistically and culturally, can support more effective comprehension and retention of scientific concepts. By integrating AI into lesson delivery, and designing tasks that promote semantic understanding, this research seeks to evaluate how students interact with, absorb, and retain physics terminology presented in their mother tongue.

Through a controlled experimental design, the study compares traditional instruction methods with AI-supported lessons, using ChatGPT and similar models fine-tuned or prompted for Uzbek terminology explanation. The goal is to determine whether AI can serve not only as a linguistic assistant but also as a pedagogical partner in deepening students' conceptual and terminological knowledge in physics.

This research employed a quasi-experimental design with two student groups from a secondary school physics program in Uzbekistan. The control group was taught using conventional teaching methods, including lectures, textbook-based explanation, and chalkboard problem-solving. The experimental group, by contrast, received AI-supported instruction using ChatGPT and other Uzbek-compatible language models.

The AI tools were prompted in Uzbek to explain core physics terms such as *harorat* (temperature), *zarralar* (particles), *elektr toki* (electric current), and *kinetik energiya* (kinetic energy) in simple, accessible language. Instructional content was delivered in interactive Q&A formats, where students posed questions to the AI in Uzbek and received real-time responses. These interactions were moderated by the teacher to ensure relevance and accuracy.

To evaluate comprehension, both groups completed standardized tests designed to measure three key domains: (1) terminological recognition, (2) conceptual understanding, and (3) contextual usage of physics terms. In addition, qualitative data were collected through structured interviews and surveys that

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explored students' perceptions of clarity, confidence, and engagement during the learning process.

The results revealed a statistically significant improvement in the experimental group's ability to comprehend and use physics terminology in Uzbek. On average, the AI-supported group scored 23% higher on conceptual understanding questions and 19% higher on terminology recognition tasks compared to the control group.

Students in the AI-assisted group demonstrated greater semantic clarity when defining and applying scientific terms in written and oral responses. For example, over 80% of the experimental group correctly described the difference between *issiqlik* (heat) and *harorat* (temperature), compared to only 52% in the control group.

Qualitative feedback highlighted increased student engagement and curiosity. Many students noted that interacting with AI in their native language made them feel more confident and less intimidated by abstract physics concepts. Some also mentioned the benefit of being able to ask follow-up questions without time pressure or judgment.

The findings suggest that AI-powered instruction—when localized in the Uzbek language—can significantly improve comprehension of scientific terminology. By serving as a responsive, always-available learning assistant, AI tools help bridge the gap between abstract scientific language and native linguistic intuitions.

This method appears particularly effective in enhancing physics education in multilingual contexts, where students may face dual challenges: understanding the science itself and interpreting unfamiliar terminology. AI tools like ChatGPT enable teachers to offer individualized explanations at scale, addressing different levels of prior knowledge.

Nonetheless, the study also revealed several challenges. Some students tended to over-rely on AI without critically analyzing the responses. In addition, the accuracy of AI-generated Uzbek explanations varied depending on prompt quality

and model limitations. These observations point to the need for teacher facilitation and careful prompt engineering in AI-assisted classrooms.

This study demonstrates that artificial intelligence, specifically large language models like ChatGPT, can play a valuable role in helping students understand complex physics terminology in the Uzbek language. AI-supported lessons enhanced conceptual clarity, increased engagement, and led to measurable learning gains.

To ensure successful integration of AI in physics instruction, educators should combine traditional pedagogy with AI's interactivity and linguistic adaptability. Future research may explore the use of fine-tuned Uzbek language models and longitudinal impacts of AI-supported science education.

The positive outcomes of this study suggest a strong potential for AI as a scalable, inclusive, and linguistically sensitive tool for teaching STEM subjects in underrepresented languages.

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