WORLD CONFERENCE ON STUDENT - CENTERED LEARNING APPROACHES

GENERATIVE ARTIFICIAL INTELLIGENCE-BASED METHODOLOGY FOR CREATING DIFFERENTIATED TASKS IN INFORMATICS EDUCATION

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Abstract: Generative Artificial Intelligence (Generative AI) and Natural Language Processing (NLP) technologies are transforming modern educational environments through adaptive and competency-based learning approaches. This study proposes an AI-supported differentiated instruction methodology for Informatics education based on Bloom's Taxonomy, competency mapping, adaptive learning, and JSON/CSV-based lesson architecture. The methodology integrates AI-generated terminology dictionaries, level-based theoretical questions, practical assignments, tests, and independent learning activities for A-, B-, and C-level learners. The framework was experimentally implemented on the aimetodika.uz platform for 68 Informatics lessons based on the Cambridge curriculum using NLP-driven text complexity analysis and semantic educational generation mechanisms. The reliability of the proposed framework was evaluated through 5-fold cross-validation, achieving an overall classification accuracy of 0.894 and a macro-average F1-score of 0.883 ± 0.006. Experimental results additionally demonstrated a 14% improvement in learning effectiveness compared to the control group, confirming the effectiveness of AI-supported differentiated instruction and adaptive assessment mechanisms. A sample implementation of the proposed methodology for the topic "Security Protocols, Antivirus, and Firewall" in a 9th-grade Informatics course is also presented in this

study.

Keywords: Generative Artificial Intelligence, NLP, Differentiated Learning, Adaptive Learning, Competency-Based Education, Educational Technology, AI-Assisted Assessment, Generative Methodology, Personalized Learning, JSON-Based Learning Architecture

I. INTRODUCTION

The rapid development of Generative Artificial Intelligence technologies is transforming modern educational environments and pedagogical practices. Large Language Models, such as GPT-4 and other NLP-based systems, can generate adaptive and contextually relevant educational content in real time, creating new opportunities for adaptive learning, intelligent assessment, automated instructional support, and differentiated instruction within competency-based education. Informatics education, including programming, computational thinking, cybersecurity, and data literacy, is characterized by significant differences in learners' prior knowledge, analytical abilities, and learning motivation. Traditional "one-size-fits-all" instructional approaches often fail to support beginner learners while simultaneously limiting advanced students. Differentiated instruction addresses this issue by adapting learning content, instructional processes, and assessment tasks according to learner readiness and competency levels. However, manual creation of differentiated educational materials requires substantial pedagogical effort and instructional time.

Recent studies demonstrate that Generative AI technologies can effectively generate quizzes, programming exercises, explanatory materials, and adaptive learning resources. However, many existing approaches remain limited to isolated task generation and lack comprehensive pedagogical frameworks for structured multi-level differentiated learning in Informatics education. This study proposes a Generative AI-based methodology for differentiated task creation using competency mapping, Bloom's Taxonomy principles, adaptive instructional design, and structured JSON-

and CSV-based lesson architectures. The methodology integrates terminology dictionaries, differentiated theoretical questions, practical assignments, tests, and AI-supported independent learning activities for A-, B-, and C-level learners.

The methodology was implemented on the aimetodika.uz educational platform for 68 Informatics lessons based on the Cambridge curriculum. To support competency-oriented differentiation, NLP-based text complexity analysis was applied using Average Sentence Length (ASL), Sentence Length Standard Deviation (SD), Proportion of Long Sentences (PLS), and Average Word Length (AWL). The reliability of the proposed framework was evaluated through 5-fold cross-validation, achieving an overall classification accuracy of 0.894 and a macro-average F1-score of 0.883 ± 0.006. An experimental implementation using the topic “Security Protocols, Antivirus, and Firewall” demonstrated the effectiveness of AI-supported differentiated instruction and adaptive assessment in secondary Informatics education.

II. LITERATURE REVIEW

Recent studies indicate that Generative AI significantly supports adaptive learning, differentiated instruction, programming exercise generation, and AI-assisted educational content development globally, within CIS countries, and in Uzbekistan. Research by Wang and Zainuddin [1], Akdeniz et al. [2], Zhou et al. [3], Sarsa et al. [4], Ta et al. [5], Denny et al. [6], and Khan et al. [7] demonstrated the effectiveness of AI-supported educational content generation, adaptive programming exercises, personalized feedback systems, and competency-oriented learning environments. These studies showed that Large Language Models can generate theoretical explanations, practical assignments, quizzes, and programming tasks adapted to different learner levels and cognitive abilities.

Within CIS countries, Ivakhnenko and Nikolsky [8], Informatics.ru [9], Yandex Education [10], and educational reforms in Kazakhstan [11], [12] emphasized the growing role of AI in adaptive and competency-based instruction. Their research

highlighted the importance of prompt engineering, intelligent educational platforms, and AI-supported pedagogical design in modern secondary and higher education systems.

In Uzbekistan, national digital transformation initiatives and studies conducted by the OECD AI Policy Observatory [13], the Presidential Resolution on AI development [14], Anvarova and Kungratov [15], the Development Strategy Center [16], and UNESCO ICHEI [17] highlighted the strategic importance of integrating artificial intelligence technologies into educational environments. However, despite rapid technological development and increasing digital infrastructure, practical pedagogical methodologies for AI-supported differentiated Informatics education remain insufficiently explored. Therefore, this study proposes a competency-oriented Generative AI methodology for differentiated task creation in Informatics education.

III. METHODOLOGY

The proposed methodology is based on Generative AI, differentiated instruction, competency-based education, and adaptive learning principles. The framework was designed for secondary Informatics education through AI-assisted differentiated task generation according to students' competency levels. Unlike traditional instructional approaches, the system dynamically adapts learning tasks to students' cognitive readiness and practical performance.

The methodology integrates JSON-based lesson architecture, competency mapping, terminology dictionaries, theoretical questions, practical assignments, and AI-supported instructional rules into a unified adaptive learning environment. The system generates differentiated tasks for three learner categories: C-Level (beginner), B-Level (intermediate), and A-Level (advanced). Within the model, all students receive a common theoretical explanation, while practical and assessment activities are adapted according to competency levels. The methodology was experimentally

implemented on the aimetodika.uz platform using the topic “Security Protocols, Antivirus, and Firewall” for 9th-grade Informatics education.

3.1. Technological Lesson Map (45 Minutes)

The proposed technological lesson model is based on adaptive learning principles and AI-supported differentiated instruction. During the lesson, all students receive a common theoretical explanation from the teacher, while practical and assessment activities are automatically adapted according to A/B/C competency levels. The model integrates AI-generated tasks, adaptive assessment, personalized feedback, and competency-oriented learning pathways within the aimetodika.uz educational platform. Figure 1 illustrates the structure of the differentiated instructional workflow designed for learners with different competency levels.



Figure 1. AI-Based Differentiated Instruction Model for A/B/C Competency Levels

The technological workflow presented in Figure 1 demonstrates the integration of AI-supported differentiated instruction, adaptive assessment, and competency-oriented task distribution within a unified 45-minute Informatics lesson.

3.2. Differentiated Learning Structure

The differentiated structure of the proposed methodology is based on adaptive competency mapping and AI-supported task generation principles. According to diagnostic assessment results and students' practical performance indicators, the system automatically distributes learners into competency-oriented A, B, and C levels. Each level receives learning materials, practical activities, and assessment tasks adapted to students' cognitive readiness and competency requirements. This adaptive approach enables personalized learning pathways and supports competency-based Informatics education within the aimetodika.uz platform.

The differentiated competency structure of the proposed methodology is illustrated in Figure 2.

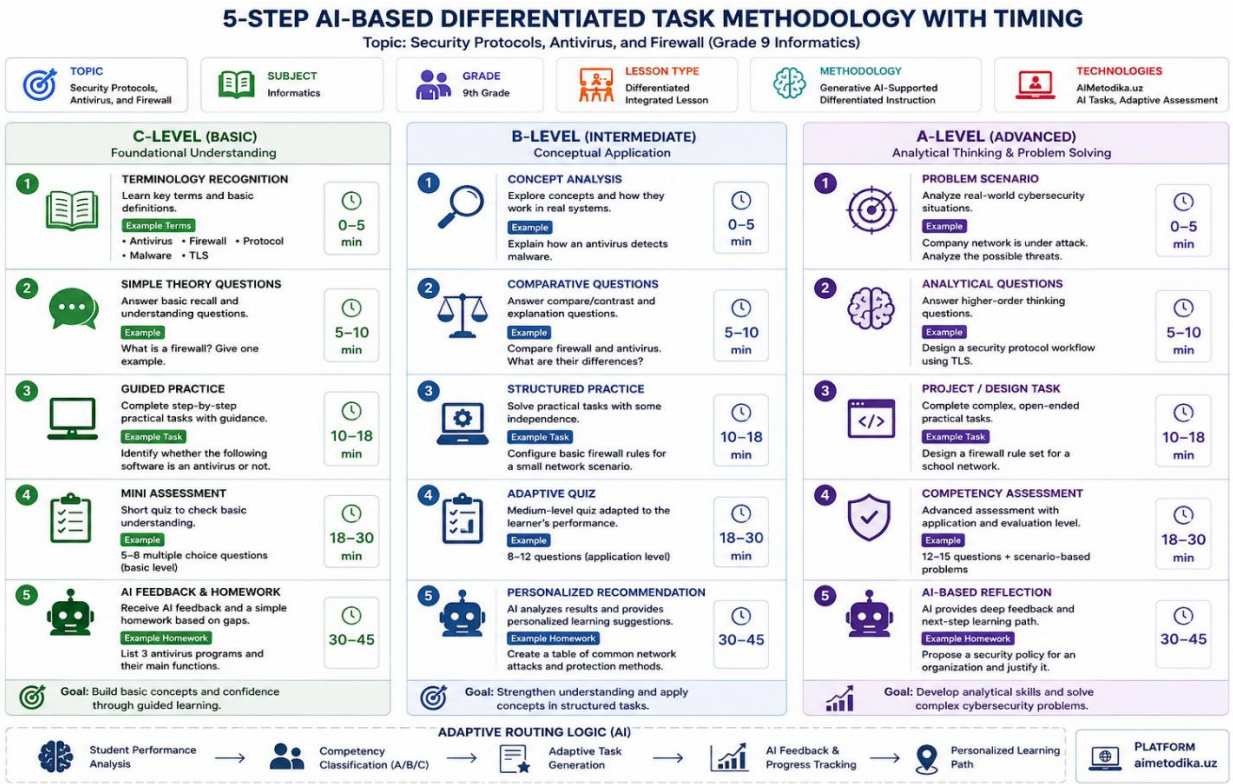


Figure 2. AI-Based Differentiated Learning Framework for a 45-Minute Informatics Lesson

At the C-Level, beginner learners focus on fundamental cybersecurity concepts, including HTTPS, antivirus systems, firewall definitions, and recognition of suspicious files or phishing links through simple terminology-based activities.

The B-Level is designed for intermediate learners and includes analytical tasks related to authentication and authorization processes, protocol and port identification, antivirus heuristic analysis, and interpretation of cybersecurity rules.

At the A-Level, advanced learners perform higher-order practical activities such as firewall rule design, incident-response planning, TLS workflow analysis, and cybersecurity architecture modeling.

3.3. Adaptive Assessment and Personalized Homework

The proposed methodology includes AI-supported adaptive assessment and personalized homework generation. During the assessment stage, the system analyzes students' errors according to competency levels and automatically recommends individualized tasks. Beginner learners receive additional terminology-based exercises, while advanced learners complete higher-order analytical activities. This adaptive mechanism supports differentiated instruction, competency-based assessment, and personalized learning in secondary Informatics education.

IV. RESULTS AND DISCUSSION

The implementation of the proposed Generative AI-based differentiated instruction methodology demonstrated significant pedagogical advantages in Informatics education. The aimetodika.uz platform enabled adaptive task generation, competency-based assessment, AI-generated feedback, and personalized homework assignment for A-, B-, and C-level learners. Figures 1 and 2 illustrate the differentiated workflow and adaptive lesson structure developed for the methodology. The

framework integrated AI-generated terminology dictionaries, differentiated theoretical questions, practical assignments, tests, and independent learning activities within a unified instructional process. NLP-based text complexity analysis using ASL, SD, PLS, and AWL indicators enabled automatic adaptation of educational materials according to students' cognitive readiness and competency levels.The reliability of the proposed framework was validated through **5-fold cross-validation**, achieving an overall classification accuracy of 0.894 and a macro-average **F1-score of 0.883 ± 0.006**. Experimental results additionally demonstrated a 14% improvement in learning effectiveness compared to the control group, confirming the effectiveness of AI-supported differentiated instruction in secondary Informatics education.

V. CONCLUSION

In conclusion, this study proposed a Generative AI-based differentiated instruction methodology for Informatics education using adaptive learning principles, competency mapping, and AI-supported task generation. The framework integrated JSON-based lesson architecture, differentiated A/B/C learning levels, adaptive assessment, and personalized homework mechanisms within the aimetodika.uz educational platform. The experimental implementation demonstrated that the proposed methodology supports differentiated instruction, improves learner engagement, and enhances competency-oriented educational processes in secondary Informatics education. The findings indicate that Generative AI technologies can effectively support adaptive learning, intelligent educational content generation, and competency-based assessment when combined with pedagogically structured instructional design.

The study also confirmed the importance of teacher supervision and methodological control in ensuring the quality and reliability of AI-generated educational materials. Future research may focus on real-time learning analytics,

multimodal AI integration, automated competency tracking, and large-scale implementation of adaptive AI-supported educational systems.

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