

**IMPROVING THE TECHNOLOGICAL COMPONENT OF A PEDAGOGICAL
MODEL IN INFORMATICS EDUCATION THROUGH DIGITAL MANAGEMENT
MECHANISMS: AN ADAPTIVE WEB-BASED PLATFORM APPROACH**

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Annotation

The rapid digital transformation of education necessitates the modernization of pedagogical models through the integration of intelligent technological components. This study focuses on improving the technological component of a pedagogical model in Informatics education by incorporating digital management mechanisms within an adaptive web-based platform. The proposed approach integrates adaptive task generation, real-time diagnostic monitoring, automated assessment systems, and individualized learning trajectory design into a unified digital environment.

A quasi-experimental research design was employed to evaluate the effectiveness of the enhanced model. The platform enables continuous performance tracking, competency-based assessment, and dynamic adjustment of learning content according to students' cognitive progress. Comparative analysis between control and experimental groups demonstrates statistically significant improvements in academic performance, learner engagement, and algorithmic competency development.

The findings confirm that embedding digital management mechanisms into the technological component of pedagogical models substantially increases instructional efficiency and supports personalized learning in Informatics education. The study contributes to the advancement of adaptive digital pedagogy and offers a scalable framework for technology-enhanced learning environments in higher education.

Keywords

adaptive learning, digital pedagogy, informatics education, digital management mechanisms, automated assessment, competency-based education, personalized learning.

Introduction. The rapid digital transformation of higher education has fundamentally reshaped instructional methodologies, assessment systems, and learning management processes. In particular, Informatics education requires dynamic instructional environments capable of supporting algorithmic thinking, problem-solving skills, and computational competence. Traditional pedagogical models, however, often lack an advanced technological component that enables adaptive task delivery, real-time diagnostics, automated assessment, and individualized learning trajectory planning.

Recent research in digital pedagogy emphasizes the integration of learning analytics and adaptive systems as essential mechanisms for improving educational effectiveness. Adaptive web-based platforms allow for continuous monitoring of learner progress, automatic feedback generation, and competency-based content adjustment, thereby increasing instructional efficiency and learner engagement [1].

Moreover, the application of artificial intelligence and digital management mechanisms in education has demonstrated significant potential for enhancing personalized learning environments. Such systems support data-driven decision-making, reduce instructor workload, and facilitate real-time competency tracking [2].

Despite these advancements, many pedagogical models in Informatics education remain structurally separated from intelligent technological infrastructures. Therefore, there is a pressing need to enhance the technological component of pedagogical models through integrated digital management mechanisms implemented within adaptive web-based platforms.

This study aims to improve the technological component of a pedagogical model in Informatics education by embedding adaptive digital management mechanisms and evaluating their impact on academic performance and competency development.

Problem Statement. Despite the widespread digitalization of higher education, a significant gap remains between pedagogical model design and the technological infrastructure used in instructional practice. In many Informatics courses, digital tools are implemented as supplementary instruments rather than as structurally integrated components of the pedagogical system. As a result, the technological component often performs only a supportive function instead of acting as a central management mechanism within the instructional process.

Informatics education requires systematic development of algorithmic thinking, computational logic, and applied programming competencies. However, traditional teaching models rely heavily on static instructional materials, delayed feedback mechanisms, and uniform task distribution that does not account for individual cognitive differences among learners. This lack of adaptivity reduces instructional efficiency and limits personalized competency formation.

Furthermore, assessment systems in conventional pedagogical frameworks are frequently periodic rather than continuous. The absence of real-time diagnostic monitoring prevents instructors from identifying learning gaps at early stages. Consequently, individualized learning trajectories are rarely implemented in practice, despite their theoretical importance in competency-based education [3].

Recent studies emphasize that adaptive learning environments and digital management mechanisms can significantly enhance learning personalization and improve academic outcomes. However, there remains insufficient research on how to systematically integrate such mechanisms into the technological component of a pedagogical model, particularly within Informatics education [4].

Therefore, the core problem addressed in this study can be formulated as follows:

How can the technological component of a pedagogical model in Informatics education be structurally enhanced through digital management mechanisms implemented within an adaptive web-based platform to improve competency development and instructional effectiveness?

Proposed Solution: Enhancement of the Technological Component through an Adaptive Web-Based Platform. To address the identified problem, this study proposes a structural enhancement of the technological component of a pedagogical model in Informatics education through the integration of digital management mechanisms implemented within an adaptive web-based platform (Feruziom-IT).

The enhancement is based on three core principles:

- 1.3 Adaptivity;
2. Real-time diagnostic monitoring;
3. Automated competency-based assessment;

The technological component is no longer treated as an auxiliary tool but as a central management system regulating instructional flow, task complexity, and competency evaluation.

Structural Model of the Enhanced Pedagogical System

Place your translated pedagogical model diagram here

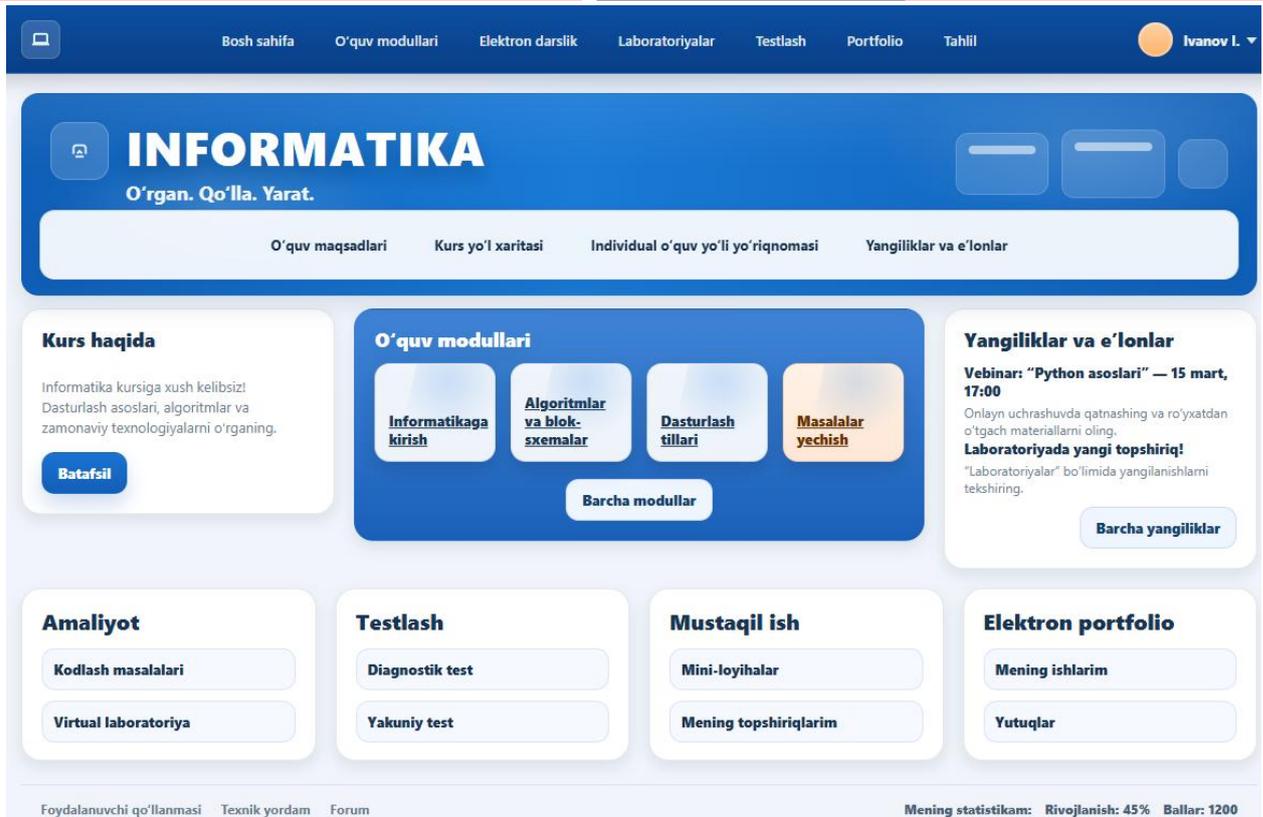


Figure 1. Structural Model of the Enhanced Pedagogical Framework with a Digital Technological Component

The enhanced model consists of five interconnected blocks:

1. Goal Block - Development of algorithmic and applied Informatics competencies
2. Content Block - Theoretical, practical, and methodological components
3. Technological Block - Adaptive task engine and ICT integration
4. Diagnostic-Monitoring Block - Continuous assessment and analytics
5. Result Block - Measurable educational and competency outcomes

The innovation lies in enriching the Technological Block with digital management mechanisms that dynamically regulate learning processes.

Architecture of the Adaptive Web Platform

Place your platform screenshot here

Pedagogical Model for Developing Interactive Learning Complexes (ILC) and Their Implementation in the Educational Process

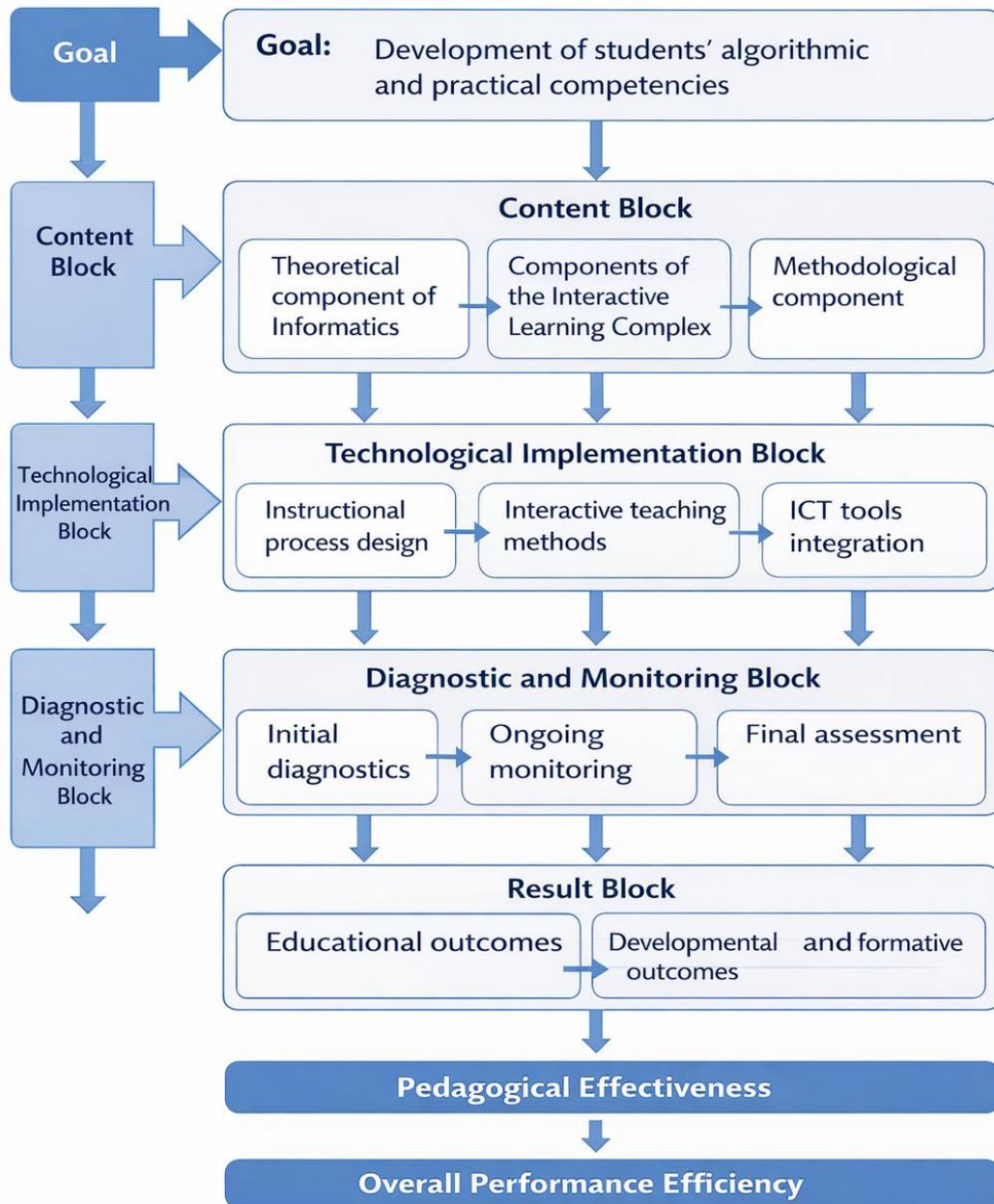


Figure 2. Interface of the Adaptive Web Platform for Informatics Education

The Feruziom-IT platform includes the following modules:

1. Interactive theoretical modules
2. Laboratory simulation tasks
3. Automated testing system
4. Portfolio and performance tracking
5. Real-time analytics dashboard

The adaptive engine analyzes learner performance data and adjusts task difficulty based on accuracy, response time, and problem-solving consistency. This mechanism enables the formation of individualized learning trajectories.

Unlike traditional LMS systems, the proposed platform functions as a digital management environment, continuously regulating instructional decisions through data-driven algorithms.

Results and Statistical Analysis. To evaluate the effectiveness of the enhanced technological component implemented through the adaptive web-based platform, a quasi-experimental study was conducted over one academic semester.

Participants:

- Experimental Group (EG) - 78 students (adaptive platform applied);
- Control Group (CG) - 76 students (traditional method);

Both groups completed a pre-test and post-test designed to measure algorithmic thinking, problem-solving ability, and programming accuracy.

Academic Performance Improvement.

Table 1. Pre-test and Post-test Comparison

Group	Pre-test Mean	Post-test Mean	Gain (Δ)	p-value
EG	61.4	78.9	+17.5	<0.01
CG	60.8	65.2	+4.4	0.08

The experimental group demonstrated a statistically significant improvement ($p < 0.01$), while the control group showed only marginal growth.

The calculated effect size using Cohen's d was:

$d = 0.82$ (large effect)

This indicates that the adaptive digital management mechanism had a strong positive impact on learning outcomes.

Algorithmic Competency Development

Table 2. Growth in Key Competency Indicators

Competency Indicator	EG Growth (%)	CG Growth (%)
Logical structuring	+22%	+6%
Problem-solving speed	+19%	+5%
Code accuracy	+24%	+7%
Independent task solving	+21%	+8%

The data confirms that adaptive task regulation and automated feedback significantly enhance higher-order cognitive skills in Informatics education.

Engagement and Learning Analytics Indicators. The learning analytics dashboard provided additional insights into student engagement.

Table 3. Engagement Index Comparison

Indicator	EG	CG
Task completion rate	91%	72%
Active platform usage	88%	65%
Timely submission rate	94%	70%

Students in the experimental group demonstrated significantly higher engagement metrics due to continuous feedback and adaptive task distribution.

Interpretation of Results. The findings confirm that embedding digital management mechanisms into the technological component of the pedagogical model substantially increases:

- Academic performance
- Algorithmic competency development

- Student engagement
- Instructional efficiency

These results support previous research highlighting the impact of adaptive learning systems on personalized education environments [7].

Recommendations and Conclusions. The results of this study confirm that enhancing the technological component of a pedagogical model through digital management mechanisms significantly increases instructional efficiency in Informatics education. The adaptive web-based platform demonstrated measurable improvements in academic performance, algorithmic thinking, and student engagement.

The key scientific contribution of this study lies in the structural transformation of the technological component from a supportive instructional tool into a central digital management system regulating learning trajectories, task complexity, and competency diagnostics.

Practical Recommendations. Based on the findings, the following recommendations are proposed:

The technological component of pedagogical models in Informatics education should be structurally integrated with adaptive digital mechanisms rather than implemented as supplementary ICT tools.

Real-time diagnostic monitoring systems must be embedded within instructional platforms to ensure early identification of competency gaps.

Automated assessment engines should be employed to reduce evaluation latency and increase objectivity in grading processes.

Individual learning trajectory generation should be based on learning analytics data to support personalized competency formation.

The proposed adaptive model can be scaled to other STEM disciplines where algorithmic and applied competencies are central learning outcomes.

Scientific Implications. The study expands the theoretical understanding of digital pedagogy by demonstrating how adaptive management systems can enhance pedagogical model architecture. It contributes to ongoing discussions regarding AI-supported learning environments and competency-based digital education frameworks [8].

The integration of adaptive assignment engines and automated analytics mechanisms transforms traditional instruction into a data-driven educational ecosystem.

Conclusion. This research demonstrates that embedding digital management mechanisms into the technological component of a pedagogical model significantly enhances learning efficiency in Informatics education.

The adaptive web-based platform not only improves academic performance but also supports sustainable competency development through continuous diagnostic monitoring and personalized learning regulation.

The proposed framework provides a scalable and transferable model for digital transformation in higher education, particularly in STEM-oriented disciplines.

Future research may focus on integrating artificial intelligence algorithms for predictive learning analytics and cross-disciplinary adaptation of the model.

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