PROBLEM-BASED LEARNING AS AN INNOVATIVE TEACHING MODEL IN INFORMATICS EDUCATION FOR ACADEMIC LYCEUMS

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Abstract: *This article explores the integration of Problem-Based Learning (PBL) into Informatics education in academic lyceums. The study highlights how PBL enhances algorithmic reasoning, programming skills, digital literacy, and real-world technological problem-solving. Traditional instruction often limits student engagement because content is delivered as closed, pre-formulated knowledge. PBL introduces authentic problem situations that lead students to search, analyze, design, and justify solutions on their own. This article proposes a structured PBL model adapted to Informatics topics, identifies specific lyceum-level subjects that benefit from PBL, and presents problem scenarios that support inquiry-based learning. The discussion focuses on how PBL fosters curiosity, cognitive flexibility, teamwork, and practical competence. Recommendations for applying PBL sustainably in Informatics classrooms are provided.*

Keywords: *Problem-Based Learning, Informatics education, academic lyceum, computational thinking, programming skills, digital literacy, student engagement, inquiry-based learning, algorithmic reasoning, technology-enhanced instruction.*

INTRODUCTION

Informatics has evolved into a discipline that requires not only solid theoretical knowledge but also the ability to interpret data, design algorithms, work with complex digital systems, and solve open-ended technological problems. Academic lyceum students frequently experience difficulties when trying to apply abstract concepts—such as data structures, networks, or algorithmic complexity—to practical situations, largely because traditional teaching practices still emphasize explanation, note-taking, and memorization. Such approaches rarely create conditions in which learners are encouraged to experiment with code, test hypotheses, learn from failure, or collaborate in solving authentic technological challenges. As a result, many students can reproduce definitions and formulas but struggle to design solutions when confronted with real tasks that are messy, ambiguous, and multidisciplinary.

Problem-Based Learning (PBL) offers a powerful alternative methodology. Originally developed in medical education in the late 1960s, PBL was designed to help future doctors think like practitioners rather than passive recipients of information. Over time it has been successfully transferred to engineering, natural sciences, and other STEM fields. In PBL, learning begins with a carefully constructed, meaningful problem rather than with direct theoretical instruction. Students analyze the situation, identify what they already know and what they need to learn, search for information from multiple sources, propose and test solutions, and reflect on their decisions. Knowledge is not simply delivered; it is constructed through inquiry, argumentation, and experience. This process makes learning more active, situated, and personally relevant.

Informatics, as a discipline grounded in design, logical reasoning, simulation, and project-based work, is particularly suitable for PBL implementation. Realistic tasks such as diagnosing network failures, modeling school databases, or designing simple decision-support algorithms naturally demand investigation and problem-solving. When students confront such digital problems, their curiosity increases, they learn to navigate uncertainty, and they begin to see Informatics as a living, useful tool for understanding and shaping the world around them. At the same time, PBL supports both conceptual understanding—by requiring students to explain and justify their technical choices—and practical skill development, as they write code, build models, and test prototypes. This article therefore develops a model for integrating PBL into Informatics lessons at academic lyceums and argues that such a model can better prepare students for higher education and for participation in an increasingly digital society.

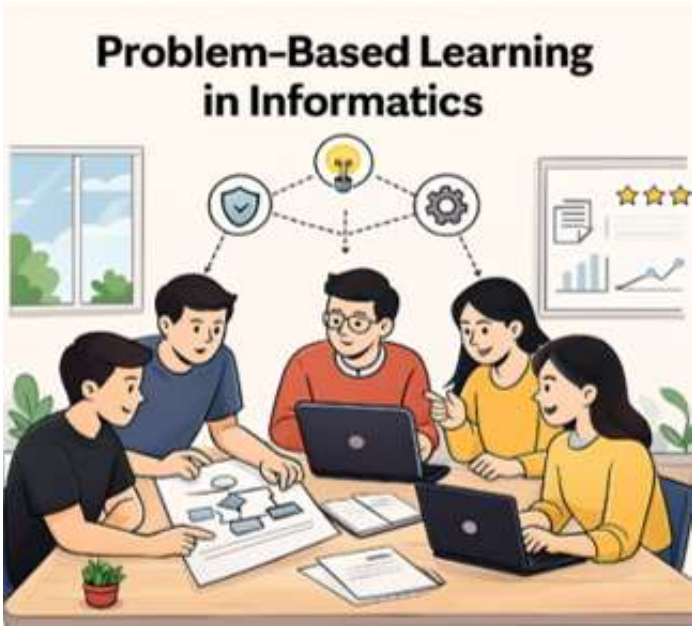
LITERATURE REVIEW

Research on Problem-Based Learning (PBL) consistently shows that students learn more deeply when they are required to explore, investigate, and construct knowledge rather than memorize fixed procedures. Scholars such as Barrows, Savery, and Hmelo-Silver describe PBL as a student-centered approach that develops analytical thinking, independent research, and collaborative problem-solving. In Informatics education, PBL has been shown to improve programming proficiency, debugging strategies, algorithmic reasoning, and system modeling by encouraging learners to work through meaningful digital scenarios instead of isolated theoretical exercises.

In Uzbekistan's academic lyceums, studies and teacher reports indicate that students often lose motivation when Informatics lessons rely solely on lectures or repetitive coding tasks. Because Informatics naturally involves identifying patterns, modeling systems, and solving complex technological problems, PBL offers a promising way to bridge the gap between theory and practice. When teaching is situated within real technological contexts that connect directly to students' digital lives, learners develop higher-order cognitive skills, stronger academic responsibility, and a more authentic understanding of how Informatics functions in real-world environments.

Contemporary research in education emphasizes that every teacher's primary responsibility is to equip learners with high-quality, modern knowledge and competencies. To achieve this, various instructional methodologies have been developed, including digital pedagogy, which supports the use of diverse online platforms and interactive tools in the learning process. Recent Uzbek studies also explore innovative approaches to teaching: for example, some authors propose adapting instructional materials to students' intellectual abilities [1], while others highlight the importance of using specialized terminological dictionaries in education [2]. Another strand of research presents modern methods for teaching Informatics and describes their structure, principles, and technological advantages in detail [3]. In the field of Uzbek natural language processing (NLP), several publications address educational applications such as automated text analysis, reading support, and adaptive learning technologies [5]–[8]. In addition, studies on international teaching practices show how foreign pedagogical approaches can enrich local reforms and support more effective ICT-based instruction in Informatics and related subjects [9]–[13]. Overall, the literature demonstrates a clear trend: modern Informatics education increasingly demands pedagogical models that promote autonomy, inquiry, and real-world technological engagement, and PBL emerges as one of the most promising frameworks within this context.

METHODOLOGY



This study uses a conceptual-descriptive methodology to outline a PBL model specifically adapted for Informatics. The method includes examining the lyceum curriculum, identifying topics that benefit from inquiry-based approaches, and formulating problem situations that encourage technological reasoning and experimentation. Observations from PBL-inspired Informatics lessons inform our understanding of student behavior and achievement.

The PBL process begins with presenting a realistic problem situation and encouraging students to analyze what they know, what they assume, and what they need to learn. In Informatics, these stages often involve interpreting a scenario, testing code snippets, researching concepts, simulating digital systems, or designing small prototypes. Students then develop and present their solutions, reflect on their reasoning, and compare multiple approaches. This iterative cycle helps learners internalize Informatics concepts while developing autonomy and resilience.

Informatics Topics Suitable for PBL: The following core areas of Informatics are particularly suitable for integrating Problem-Based Learning. These domains naturally require inquiry, exploration, experimentation, and solution design, making them ideal environments for PBL-based instruction.

- Algorithms and Programming: This area supports PBL through tasks that involve analyzing and solving algorithmic problems such as searching, sorting, and optimization. Students design decision-making algorithms, test different approaches, and refine code as they investigate real scenarios. Debugging and iterative improvement become meaningful when learners must justify their choices and evaluate the efficiency of their solutions.
- Data Management and Databases: PBL in this domain allows students to model real datasets—for example, academic records, attendance systems, or digital resource inventories. They learn to structure data meaningfully, formulate queries, and interpret results to support decisions. Through investigation and hands-on data exploration, students gain a deeper understanding of information organization and analysis.
- Computer Networks and Cybersecurity: In this topic, PBL tasks may involve designing or improving a functional campus network, identifying sources of connectivity problems, or proposing security measures. Students explore vulnerabilities, examine safe user behavior, and evaluate basic cybersecurity protocols. Such activities require authentic inquiry into how digital systems operate and how they can be protected.
- Digital Systems and Logic: Problem-based activities in this area encourage learners to build simplified digital circuit models and apply logical reasoning to automate small processes. By experimenting with circuit behavior and logical conditions, students develop an understanding of how digital systems function at a foundational level and how logic is used to design reliable computational mechanisms.

Each of these domains provides meaningful opportunities for students to ask questions, explore technological systems, analyze information, and construct practical solutions—core principles at the heart of Problem-Based Learning.

RESULTS

Observations from Informatics lessons influenced by PBL reveal several significant outcomes. Students showed increased persistence when working on real problems because each task had a meaningful purpose connected to lyceum life. Their algorithmic reasoning improved as they learned to decompose complex issues into manageable components. Programming proficiency strengthened due to repeated cycles of testing, debugging, and refining their code. Database modeling, network design, and cybersecurity tasks became more intuitive because students explored them through hands-on inquiry rather than pre-formulated explanations. Collaboration also intensified: students took responsibility for specific roles such as coder, researcher, designer, or presenter, which enhanced communication and leadership. Overall, their motivation, confidence, and creativity increased noticeably.

DISCUSSION

PBL naturally complements Informatics because both emphasize inquiry, iteration, and problem-solving. Integrating PBL into lyceum classrooms helps transform theoretical lessons into meaningful digital experiences that reflect the technological demands of modern society. Students become more independent, reflective, and capable of dealing with ambiguity—essential skills for advanced STEM learning. Despite these benefits, PBL requires well-prepared teachers, flexible lesson planning, and assessment tools that recognize reasoning, collaboration, and creativity. Some students may initially struggle with open-ended problems, but with appropriate scaffolding, they gradually adapt to inquiry-based learning. The long-term advantages of PBL, however, clearly outweigh the challenges, making it a strategic pedagogical approach for modern Informatics education.

CONCLUSION

Problem-Based Learning offers a compelling model for enhancing Informatics education in academic lyceums. By shifting the instructional focus from memorization to investigation, PBL strengthens computational thinking, deepens conceptual understanding, and builds essential digital competencies. Students learn to collaborate, to articulate ideas clearly, and to design technological solutions with relevance to their immediate environment.

The sustainable adoption of PBL requires investing in teacher training, curricular adaptation, and resource development. Once integrated systematically, PBL transforms Informatics lessons into environments where students not only learn technology but also learn to think like technologists.

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