conducted analyses show that these pedagogical mechanisms directly affect the conscious assimilation of knowledge, a critical approach to their own activities and personal development of students. Through reflection, students have the opportunity to deeply analyze their knowledge and skills, which increases their activity in the educational process.

Self-assessment plays an important role in the formation of responsibility, independence and self-management competencies in students. As the student learns to evaluate his/her own work, dependence on external evaluation decreases and internal motivation increases. This situation serves to form a culture of continuous development and self-improvement in the educational process.

Reflection is also an important methodological tool in the work of a teacher. The teacher's analysis of his/her own pedagogical experience, evaluation of the lesson process and drawing conclusions serve to improve the quality of education. The educational process organized on the basis of a reflective approach creates an atmosphere of effective cooperation and mutual trust between the teacher and the student.

In conclusion, reflection and self-assessment are an integral part of modern education, and it is necessary to systematically and purposefully introduce them into the educational process. These processes not only increase the quality and effectiveness of education, but also ensure the personal and professional development of students. Therefore, the development of reflective and evaluative activities should remain one of the priorities of modern educational policy and pedagogical practice.

References:

(1). Jo‘rayev R.X. Kompetensiyaviy yondashuv asosida ta’lim sifatini oshirish. Toshkent, “Fan va texnologiya”, 2018, 56–73-betlar.

(2). Xodjayev B.M. Zamonaviy pedagogik texnologiyalar va refleksiya. Toshkent, “Innovatsiya-Ziyo”, 2020, 64–81-betlar.

(3). Muslimov N.A. Ta’lim jarayonida reflektiv yondashuv asoslari. Toshkent, “O‘qituvchi”, 2015, 88–102-betlar.

(4). Schön, D.A. The Reflective Practitioner: How Professionals Think in Action. New York, Basic Books, 2023, p. 49–69.

(5). Black P., Wiliam D. Assessment and classroom learning. Assessment in Education: Principles, Policy & Practice. Vol. 5, № 1, 2018, p. 7–25.

(6). Zimmerman B.J. Becoming a self-regulated learner: An overview. Theory Into Practice. Vol. 41, № 2, 2022, p. 64–70.

Bannayev Qosimjon Qodirjonovich (Independent researcher at Namangan state technical university)

ENHANCING STUDENTS’ PROBLEM-SOLVING AND TECHNICAL THINKING THROUGH PROJECT-BASED LEARNING: A PEDAGOGICAL FRAMEWORK

Annotation. *Contemporary education increasingly prioritizes the development of technical thinking and complex problem-solving skills as essential competencies for participation in a technology-driven society. This study proposes a pedagogical framework grounded in Project-Based Learning (PBL) to cultivate these competencies. Drawing upon theories of cognitive science, computational literacy, and systems thinking, the framework explains how iterative and inquiry-based projects transform abstract knowledge into functional technical intuition. Technical thinking is conceptualized as a dual construct combining artifact-level understanding and systems-oriented reasoning. Complex problem-solving is analyzed through cognitive flexibility and metacognitive regulation. The findings emphasize that authentic, real-world projects and the failure-correction cycle inherent in PBL significantly contribute to durable cognitive restructuring. The study concludes that PBL, when systematically designed and evaluated, fosters transferable technical heuristics and innovation-oriented reasoning among learners.*

Keywords: *technical thinking, project-based learning, complex problem-solving, cognitive flexibility, experiential learning.*

Bannayev Qosimjon Qodirjonovich (Namangan davlat Texnika universiteti mustaqil tadqiqotchisi)

TALABALARNING MUAMMO YECHISH VA TEXNIK TAFAKKURINI LOYIHAGA ASOSLANGAN TA’LIM ORQALI RIVOJLANTIRISH: PEDAGOGIK MODEL

Annotatsiya. *Zamonaviy ta’lim texnologiyalarga tayangan jamiyatda samarali ishtirok etish uchun zarur bo‘lgan muhim kompetensiyalar sifatida texnik tafakkur va murakkab muammolarni hal qilish ko‘nikmalarini rivojlantirishga tobora ko‘proq ustuvor ahamiyat bermoqda. Ushbu tadqiqot mazkur kompetensiyalarni shakllantirishga qaratilgan Loyihaga asoslangan ta’lim (Project-Based Learning – PBL) ga tayanuvchi pedagogik modelni taklif etadi. Kognitiv fan, hisoblash savodxonligi va tizimli fikrlash nazariyalariga tayangan holda, model iterativ hamda izlanishga asoslangan loyihalar abstrakt bilimlarni funksional texnik intuitsiyaga qanday aylantirishini tushuntiradi. Texnik tafakkur artefakt darajasidagi tushuncha va*

tizimga yo'naltirilgan mulohazani birlashtiruvchi ikki tomonlama konstrukt sifatida talqin etiladi. Murakkab muammolarni hal qilish esa kognitiv moslashuvchanlik va metakognitiv boshqaruv orqali tahlil qilinadi. Natijalar PBL jarayoniga xos bo'lgan real hayotga yaqin, autentik loyihalar hamda "xato–tuzatish" sikli barqaror kognitiv qayta tuzilishga sezilarli hissa qo'shishini ko'rsatadi. Tadqiqot xulosasiga ko'ra, PBL tizimli ravishda loyihalashtirilib va baholanganida, o'quvchilarda ko'chma texnik evristikalar hamda innovatsion fikrlashni rivojlantiradi.

***Kalit so'zlar**: texnik tafakkur, loyihaga asoslangan ta'lim, murakkab muammolarni hal qilish, kognitiv moslashuvchanlik, tajribaviy o'rganish.*

Баннаев Косимжон Кодиржонович (независимый исследователь Наманганского государственного технического университета)

РАЗВИТИЕ НАВЫКОВ РЕШЕНИЯ ПРОБЛЕМ И ТЕХНИЧЕСКОГО МЫШЛЕНИЯ СТУДЕНТОВ ПОСРЕДСТВОМ ПРОЕКТНО-ОРИЕНТИРОВАННОГО ОБУЧЕНИЯ: ПЕДАГОГИЧЕСКАЯ МОДЕЛЬ

***Аннотация.** Современное образование всё больше уделяет приоритетное внимание развитию технического мышления и навыков решения сложных проблем как ключевых компетенций для эффективного участия в технологически ориентированном обществе. Данное исследование предлагает педагогическую модель, основанную на проектно-ориентированном обучении (Project-Based Learning – PBL), направленную на формирование указанных компетенций. Опираясь на теории когнитивной науки, вычислительной грамотности и системного мышления, модель объясняет, каким образом итеративные и исследовательские проекты преобразуют абстрактные знания в функциональную техническую интуицию. Техническое мышление рассматривается как двойственная конструкция, объединяющая понимание на уровне артефактов и системно-ориентированное рассуждение. Решение сложных проблем анализируется через призму когнитивной гибкости и метакогнитивной регуляции. Результаты подчёркивают, что аутентичные проекты, приближённые к реальным условиям, а также присущий PBL цикл «ошибка–коррекция» существенно способствуют устойчивой когнитивной перестройке. В заключении отмечается, что при системном проектировании и оценивании PBL способствует формированию переносимых технических эвристик и инновационно-ориентированного мышления у обучающихся.*

***Ключевые слова:** техническое мышление, проектно-ориентированное обучение, решение сложных проблем, когнитивная гибкость, опытное обучение.*

1. Introduction. The transformation of global education under the influence of Education 4.0 has shifted instructional priorities from memorization to analytical reasoning, computational literacy, and technological understanding. Modern learners must not only operate digital tools but also interpret, critique, and innovate within technologically complex environments. Traditional pedagogical models, which emphasize passive knowledge reception, have proven insufficient for cultivating these competencies.

Technical thinking has emerged as a central educational objective. While many students demonstrate operational familiarity with technology, they often lack the conceptual and systematic reasoning necessary for troubleshooting and innovation. This discrepancy calls for experiential, inquiry-driven methodologies. Project-Based Learning (PBL) provides a structured yet flexible environment in which learners actively design, test, and refine solutions to authentic problems.

The present study explores how PBL functions as a pedagogical mechanism for strengthening technical thinking and complex problem-solving. It synthesizes theoretical perspectives and pedagogical research to formulate a comprehensive instructional framework that emphasizes iterative learning, collaboration, and metacognitive reflection.

2. Methods. This study employs a theoretical-analytical and literature-based methodology rather than empirical experimentation. Peer-reviewed research in cognitive science, computational thinking, STEM pedagogy, and educational technology was systematically reviewed. Key constructs—technical thinking, complex problem-solving, and experiential learning–were deconstructed into cognitive and pedagogical components. A pedagogical framework was developed by integrating recurring principles identified across the reviewed literature, including authenticity, iteration, scaffolding, collaboration, and reflective practice.

This study employs a theoretical-analytical and literature-based methodology rather than empirical experimentation. The methodological approach includes:

2.1. Literature Synthesis. Peer-reviewed research in cognitive science, computational thinking, STEM pedagogy, and educational technology was systematically reviewed. Sources were selected based on relevance to technical literacy, design thinking, and project-based pedagogy.

2.2. Conceptual Analysis. Key constructs–technical thinking, complex problem-solving, and experiential learning–were deconstructed into cognitive and pedagogical components. Comparative conceptual mapping was used to align theoretical models with PBL practices.

2.3. Framework Construction. A pedagogical framework was developed by integrating recurring principles identified across the reviewed literature, including authenticity, iteration, scaffolding, collaboration, and reflective practice.

This qualitative methodological design allows for theoretical generalization rather than statistical inference, focusing on explanatory depth and pedagogical applicability.

3. Results. Analysis indicates that technical thinking consists of two interconnected dimensions:

Artifact-Centric Reasoning – understanding the functional logic of individual components, such as code segments or mechanical elements.

Systems-Oriented Reasoning – perceiving interdependencies among components and managing trade-offs within complex systems.

These dimensions collectively enable learners to move beyond surface interaction with tools toward structural and systemic comprehension.

3.2. Cognitive Dimensions of Complex Problem-Solving

Complex problem-solving is characterized by:

Cognitive Flexibility – the ability to shift strategies when initial attempts fail.

Metacognitive Regulation – ongoing self-monitoring and evaluation of one's reasoning processes.

Students engaged in structured project environments demonstrate higher resilience, adaptability, and reflective awareness compared to those in purely lecture-based settings.

3.3. Structural Potential of Project-Based Learning PBL environments support experiential growth through:

Iterative Prototyping – encouraging cycles of testing and refinement.

Authenticity – embedding real-world relevance to increase motivation and cognitive engagement.

Collaborative Cognition – distributing thinking processes across peers and tools.

Transferability – enabling learners to apply acquired heuristics to novel contexts.

The "failure-correction loop" was identified as the most influential mechanism driving conceptual restructuring and durable skill acquisition.

3.4. Implementation Constraints. Challenges include limited instructional time, insufficient resources, and rigid curricular standards. Effective implementation requires institutional support, modular curriculum design, and competency-based assessment systems.

4. Discussion. The findings reinforce the premise that technical thinking is not an innate ability but a cultivated cognitive capacity. PBL serves as a mediating structure that transforms abstract knowledge into applied understanding by situating learners in authentic problem contexts. The dual nature of technical thinking aligns closely with systems theory and design thinking frameworks, highlighting the importance of integrative reasoning.

The interplay between cognitive flexibility and metacognitive regulation underscores the need for reflective scaffolding in project environments. Without guided reflection, learners risk engaging in unproductive trial-and-error cycles. Therefore, teacher facilitation remains essential even in student-centered models.

Furthermore, authenticity enhances intrinsic motivation and promotes deeper engagement, while collaboration mirrors real-world technical practices. However, the scalability of PBL depends on systemic educational reforms, including revised assessment models and teacher professional development.

Overall, PBL demonstrates strong theoretical validity as a framework for cultivating analytical reasoning, creativity, and adaptive problem-solving in technical education.

5. Conclusion. Project-Based Learning represents a transformative pedagogical approach for developing technical thinking and complex problem-solving skills. Through iterative inquiry, authentic engagement, and reflective collaboration, learners acquire transferable cognitive heuristics that extend beyond disciplinary boundaries. Strategic curricular restructuring and competency-oriented evaluation can mitigate implementation barriers. Prioritizing cognitive processes over product outcomes prepares students to navigate technological uncertainty with resilience and systematic reasoning.

References:

(1). Kafai Y., Proctor C. (2022). A revaluation of computational thinking in K-12 education: Moving toward computational literacies. Educational Researcher. https://journals.sagepub.com/doi/abs/10.3102/ 0013189 X2 1105 7904

(2). Gerlich M (2025). AI tools in society: Impacts on cognitive offloading and the future of critical thinking. Societies. https://www.mdpi.com/2075-4698/15/1/6?ref=newcanaanunplugged.org

(3). Janoušková S., Rathouská…, (2023). The scientific thinking and reasoning framework and its appli-cability to manufacturing and services firms in natural sciences. https://www.tandfonline.com/doi/abs/10.1080 /02635143.2021.1928048

(4). Yue M., Jong M., Dai Y., Lau W… (2025). Students as AI literate designers: a pedagogical framework for learning and teaching AI literacy in elementary education. https://www.tandfonline.com/doi/abs/10.1080/ 15391523.2025.2449942

(5). Mouza C., Yang H., Pan Y., Ozden. (2017). Resetting educational technology coursework for preservice teachers: A computational thinking approach to the development of technological pedagogical content …. https://ajet.org.au/index.php/AJET/article/view/3521

(6). Avsec S., Jamšek J. (2018). A path model of factors affecting secondary school students' technological literacy. https://link.springer.com/article/10.1007/s10798-016-9382-z

(7). Palop B., Díaz I., & Rodriguez-Muniz…, (2025). Redefining computational thinking: A holistic framework and its implications for K-12 education. https://link.springer.com/article/10.1007/s10639-024-13297-4

(8). Badarnah L. (2025). Holistic Education for a Resilient Future: An Integrated Biomimetic Approach for Architectural Pedagogy. Biomimetics. https://www.mdpi.com/2313-7673/10/6/369

(9). Csapó B., Funke J. (2017). The development and assessment of problem solving in 21st-century schools. publicatio.bibl.u-szeged.hu. https://publicatio.bibl.u-szeged.hu/11202/1/2017_Csapo_Funke_Nature OfProblem Solving_01.pdf

(10). Ramírez-Montoya, M., Castillo-Martínez…, I… (2022). Complex thinking in the framework of education 4.0 and open innovation–a systematic literature review. https://www.mdpi.com/2199-8531/8/1/4

Khamdamova Shokhista Yusup kizi (Termez State University, independent researcher;
E-mail: khamdamova.sh@gmail.com)

CO-TEACHING AS A TOOL FOR FOSTERING COGNITIVE AND ANALYTICAL THINKING IN ENGLISH CLASSES AT PRESIDENTIAL SCHOOLS

Annotation. *This article explores the role of co-teaching as an effective instructional approach for fostering cognitive and analytical thinking skills in English language classes at Presidential Schools. Given the emphasis on critical thinking and high-level cognitive skills in modern education, Presidential Schools aim to implement innovative pedagogical practices that support learners' intellectual development. The study examines how collaborative teaching models such as team teaching, parallel teaching, and complementary instruction contribute to students' ability to analyze information, evaluate ideas, and apply language skills in complex contexts.*

Keywords: *co-teaching, cognitive thinking, analytical thinking, English language teaching, Presidential Schools, collaborative instruction, critical thinking.*

PREZIDENT MAKTABLARIDA INGLIZ TILI DARSLARIDA KOGNITIV-ANALITIK FIKRLASHGA YO'NALTIRISHDA HAMKORLIKDA O'QITISH (CO-TEACHING)NING O'RNI

Annotatsiya. *Ushbu maqolada Prezident maktablarida ingliz tili darslarida kognitiv va analitik fikrlash qobiliyatlarini rivojlantirishda hamkorlikda o'qitishning (co-teaching) samarali pedagogik yondashuv sifatidagi roli tahlil qilinadi. Zamonaviy ta'lim tizimlarida tanqidiy fikrlash va yuqori darajadagi kognitiv ko'nikmalarga e'tibor qaratilgan bo'lib, Prezident maktablari o'quvchilarning intellektual rivojlanishini qo'llab-quvvatlaydigan innovatsion pedagogik amaliyotlarni joriy etishga intiladi. Ushbu tadqiqot, jamoaviy dars berish, parallel dars berish va komplementar ta'lim kabi hamkorlikka asoslangan dars usullari talabalarning ma'lumotlarni tahlil qilish, g'oyalarni baholash va til ko'nikmalarini murakkab kontekstlarda qo'llash qobiliyatini rivojlantirish natijalarini ko'rsatadi.*

Kalit so'zlar: *co-teaching, kognitiv fikrlash, analitik fikrlash, ingliz tili ta'limi, Prezident maktablari, hamkorlikka asoslangan ta'lim, tanqidiy fikrlash.*

СОВМЕСТНОЕ ПРЕПОДАВАНИЕ (CO-TEACHING) КАК ИНСТРУМЕНТ РАЗВИТИЯ КОГНИТИВНОГО И АНАЛИТИЧЕСКОГО МЫШЛЕНИЯ НА УРОКАХ АНГЛИЙСКОГО ЯЗЫКА В ПРЕЗИДЕНТСКИХ ШКОЛАХ

Аннотация. *В данной статье рассматривается роль совместного преподавания (co-teaching) как эффективного подхода к обучению, направленного на развитие когнитивного и аналитического мышления на уроках английского языка в Президентских школах. С учетом акцента на критическое мышление и высокий уровень когнитивных навыков в современном образовании, Президентские школы стремятся внедрять инновационные педагогические практики, способствующие интеллектуальному развитию учащихся. Исследование анализирует, каким образом модели совместного преподавания, такие как командное преподавание, параллельное преподавание и компле-*