European International Journal of Pedagogics (ISSN: 2751-000X)

Received: 12 February 2026 | Accepted: 08 March 2026 | Published: 31 March 2026

DOI: 10.55640/eijp-06-03-40

RESEARCH ARTICLE

Pedagogical Modeling of An Environment Based on The Steam Approach in Inclusive Education (On the Example of The Inklusteam.Uz Platform)

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VOLUME: Vol.06 Issue03 2026

PAGE: 198-202

Abstract

This article addresses the development of digital-inclusive competence of future teachers in the higher pedagogical education system and the pedagogical modeling of an inclusive environment based on the STEAM (Science, Technology, Engineering, Art, Mathematics) approach. The polyfunctional model developed within the framework of the research and its practical implementation on the InkluSteam.uz platform are analyzed. Furthermore, a methodology is proposed for maintaining a personal map of academic and social development for students with special educational needs, adapting resources according to nosological needs, and establishing a minimum of interdisciplinary competencies using the physics course (2nd semester) as a case study.

KEYWORDS

Inclusive education, STEAM approach, pedagogical modeling, polyfunctional model, InkluSteam.uz, personal map, nosological adaptation, digital monitoring.

INTRODUCTION

In the current system of higher pedagogical education, the development of a future teacher's digital-inclusive competence is no longer limited to the mere skill of utilizing ready-made electronic resources. A modern teacher must be capable of diagnosing student needs, redesigning subject content within the STEAM framework, adapting virtual laboratories, and continuously modifying the learning environment based on formative assessment results. Regulatory and legal documents on inclusive education define key tasks for creating adapted environments for children with special educational needs, utilizing electronic resources, and aligning the educational process with individual capabilities. Consequently, this requires elevating the future teacher from the traditional status of a simple "subject teacher" to a broader professional position — advancing them to the level of a diagnostician, designer, methodical modifier, and monitoring educator.

Methodological Foundations and the Polyfunctional Model

The research analyzed the natural intersection points of inclusive pedagogy and STEAM education. While STEAM unfolds complex scientific concepts through real-world projects and engineering solutions, inclusive education requires organizing these activities in an accessible and personalized format for all learners. To this end, a non-linear, iterative polyfunctional model was developed within the framework of the study. Unlike traditional methodical preparation, this model shifts the focus from the question of "How will I teach the lesson?" to the crucial question of "How will the student participate in this environment, and what adaptation is required?" The structural blocks of the model and their practical implementation on the InkluSteam.uz platform are presented in Table1.

Blocks of the Polyfunctional Model and Their Practical Expression on the InkluSteam.uz Platform

Table 1

Model Block	Pedagogical Content	Practical Expression on the Platform	Developed Competence of the Student
Target-Normative Block	Defines training goals in accordance with inclusive education, digital transformation, and the STEAM approach.	Course, module, and lesson goals; learning outcomes; competence map.	Goal setting and outcome design.
Diagnostic-Adaptive Block	Identifies the psychophysiological, academic, and social needs of the learner.	Registration, profile, personal map, baseline test, teacher observations.	Diagnostic and adaptive decision-making.
Content STEAM Block	Links physics topics with science, technology, engineering, art, and mathematics components..	2nd-semester physics modules, theoretical text, visual explanations, micro-quizzes.	Interdisciplinary content construction.
Technological-Platform Block	Integrates software tools, virtual laboratory, material library, and AI assistant.	Virtual lab workspace, graphs, tables, calculations, AI assistant chat.	Subordinating a digital tool to a methodical goal.
Activity-Based Block	Transforms the student from a passive task executor into a subject of environment design	Assignments, projects, laboratory conclusions, tests, portfolio.	STEAM activity organization and management.

Monitoring-Reflective Block	Records results, time, attempts, errors, assistance, and reflective data.	Statistics page, monitoring panel, test results, teacher feedback	Evidence-based pedagogical analysis..
Outcome-Oriented Block	Determines the digital-inclusive, STEAM-design, collaborative, and reflective competencies of the student.	Competence map, portfolio, final test, laboratory reports.	Independent modeling of an inclusive STEAM environment..

As can be seen from the table, each block of the polyfunctional model is linked to a specific practical mechanism on the platform. This connection does not leave the model at the level of theoretical description, but rather brings it into the real digital activity of the future teacher. For instance, the diagnostic-adaptive block is implemented through profiles and personal maps, the content block through physics modules, and the monitoring-reflective block through statistics pages, test results, and laboratory reports. On this basis, the future teacher makes their pedagogical decisions relying on the evidence gathered on the platform, rather than on guesswork or general experience.

Personal Map of Academic and Social Development

The central tool of the polyfunctional model is the personal map of academic and social development. It helps to view the student not through the lens of a disability or difficulty, but through their development opportunities and growth dynamics. The map integrates two main directions:

1. Academic direction: applying formulas, altering experiment parameters, reading graphs, and test results.

2. Social direction: assuming roles within a group, requesting assistance, and contributing to the collaborative product.

On the InkluSteam.uz platform, when a student completes a virtual laboratory or requests an explanation from the AI assistant, all digital footprints are automatically enriched within the personal map.

Nosological Adaptation and the Minimum of Competencies

In an inclusive STEAM environment, adapting resources to the sensory and cognitive needs of students constitutes a critical stage. The concept of a "minimum of competencies" does not imply a simplification of the science content; rather, it refers to identifying the core of essential knowledge within the scope of the student's actual capabilities. Using the physics component of the "General Chemistry and Physics" course for the 2nd semester (topics 16–30: mechanics, oscillations, hydrostatics, electricity, optics, and atomic-nuclear physics) as a case study, directions for nosological adaptation have been developed.

Adaptive Resources and Minimum Competencies by Nosological Needs

Student Need	Appropriate Resource	Form of Application on the Platform	Minimum of Competencies	Pedagogical Precautionary Measure

Visual Difficulty	High contrast, audio description, large font, tactile model.	Enlarging graphs and diagrams, audio explanation scenarios via the AI assistant.	Explaining the cause-and-effect relationships of a physical phenomenon verbally or through a model.	Avoiding differentiation by color only; introducing alternative symbols.
Hearing Difficulty	Subtitles, infographics, written instructions, visual signals.	Written algorithms, laboratory steps, and graphic instructions on the lesson page..	Performing the experiment sequence in a written or visual format.	Not relying exclusively on oral explanations.
Musculoskeletal Limitation	Keyboard control, large buttons, step-by-step menu.	Simplified input of laboratory parameters, retry button.	Independently changing virtual experiment parameters and providing a conclusion.	Reducing speed and time pressure.
Attention and Cognitive Difficulties	Micro-steps, short text, prompts, low-distraction design.	Micro-quizzes, one task per screen, progress indicators.	Isolating the core concept within a topic and demonstrating it in a simple experiment.	Avoiding unnecessary animations and multi-element interfaces.

Autism Spectrum or Sensory Sensitivity	Stable interface, predefined algorithm, mute option, elective activity.	Topic sequence, predictable steps, calm colors..	Executing explicit steps during the experiment process and recording the result.	Restricting sharp sounds, flashing, and unexpected warnings.

Integrating physics concepts in a manner of professional and methodical significance for future biology teachers (for instance, linking capillarity with the rise of water in plants, and optics with visual physiology and microscopy) further enhances the interdisciplinary essence of STEAM.

Individual Monitoring and the Redesign Cycle

Individual monitoring makes the pedagogical process visible through digital footprints (the time a student spends on the platform, the number of attempts, the speed of error correction, and queries to the AI). Monitoring is not a control tool, but rather a mechanism that drives the adaptation of the learning environment.

The actual practical mechanism identified in the research consists of the following continuous cycle:

Diagnostics->Personal Map-> Adaptive Minimum ->Virtual Lab and Lesson-> Platform Monitoring ->Redesign Decision

This cycle shifts the future teacher from a "design a lesson once and keep it unchanged" approach to a culture of "continuous improvement and modification of the learning environment."

CONCLUSION

The polyfunctional model for preparing future teachers to model an inclusive STEAM environment elevates the digitalization of education to a new level. Using the example of the InkluSteam.uz platform, it has been demonstrated that digital technologies are not merely a repository of resources, but a powerful tool for constructing evidence-based, individualized learning trajectories. The proposed nosological adaptation scenarios and the personal map system directly contribute to developing the differential and inclusive mindset of future educators.

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