

Pedagogical and Psychological Foundations of Preparing Future Teachers to Model A Steam-Based Environment in Inclusive Education

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Received: 18 March 2026; **Accepted:** 05 April 2026; **Published:** 30 April 2026

Abstract: This article examines the pedagogical and psychological foundations of preparing future teachers for modeling STEAM-based learning environments in inclusive education settings. The study highlights the integration of inclusive education, STEAM methodology, and digital technologies as essential components of modern teacher education. Particular attention is given to the role of the Universal Design for Learning (UDL) framework, the Technological Pedagogical Content Knowledge (TPACK) model, and digital competence in developing professional readiness among future educators. A structural-functional model for preparing future teachers to design inclusive STEAM environments is proposed. The findings indicate that the effective use of digital technologies enhances professional competencies and contributes to improving the quality of inclusive education.

Keywords: Inclusive education, STEAM approach, future teacher, educational environment modeling, digital technologies, digital competence, Universal Design for Learning (UDL), TPACK, pedagogical design, teacher professional development.

Introduction: Ensuring educational inclusion, implementing digital transformation, and widely integrating the STEAM approach have become among the priority directions of the global education system. Modern education systems require the creation of opportunities for all learners to receive quality education while taking into account their individual needs. Therefore, preparing future teachers to work effectively in an inclusive educational environment has become one of the urgent pedagogical challenges.

In inclusive education, the STEAM approach provides opportunities to develop students' interdisciplinary knowledge and to foster creativity, problem-solving abilities, and collaborative skills. In this process, digital technologies serve as an important tool for modeling educational environments, organizing individualized learning pathways, and improving the overall effectiveness of education.

LITERATURE REVIEW

The theory of inclusive education has been extensively discussed in conceptual frameworks developed by UNESCO, OECD, and other international organizations. The main objective of this approach is to ensure equal educational opportunities for all learners and to reduce barriers to participation in education. Florian and Black-Hawkins, in their theory of inclusive pedagogy, emphasize that the teacher's role is to create an open, flexible, and accessible learning environment for all students.

In Uzbekistan, the methodological aspects of subjects taught for training specialists in the field of pedagogical education at general educational institutions have been studied by several researchers. In particular, Q.T. Suyarov, Z. Sangirova, and N.R. G'aybullaev have contributed to methodological issues in pedagogical education; A. Avazboev, R. Isyanov, and R. Mavlonova

have investigated vocational guidance for students in practical training classes; A. Abduqodirov, U. Begimkulov, S. Bulatov, M. Mamarajabov, T. Shoymardonov, and G. Ergasheva have conducted research on the use of information and pedagogical technologies in the educational process; and N.N. Azizxo'jaeva, R.X. Jo'raev, J.G'. Yo'ldoshev, and N.A. Muslimov have studied the implementation of educational technologies based on instructional design in the teaching process.

Within the Commonwealth of Independent States (CIS), several scholars have investigated issues related to teaching natural science subjects and designing instructional activities. Significant contributions in this area have been made by B.P. Bepalko, V.M. Monakhov, M.V. Klarin, M.I. Makhmutov, V.A. Slastenin, V.S. Lerner, and F. Yanushkevich.

In addition, foreign researchers have extensively studied various aspects of implementing pedagogical technologies and improving teachers' methodological preparedness. In particular, issues related to the application of educational technologies have been examined by T. Sakamoto, B.S. Bloom, C.W. Cobb, P.H. Douglas, and G. Pimbley. Furthermore, different aspects of improving teachers' methodological training have been investigated by N. Chomsky, J. Jarmul, F. Carton, M. Grammont, P. Leon, A. Martinet, and other scholars.

The reviewed literature reveals a need to further improve the methodological aspects of designing instructional activities based on the STEAM approach in general education institutions. Moreover, it underscores the importance of investigating the design of Natural Sciences lessons, grounded in educational technologies and pedagogical principles, as a significant pedagogical issue within the context of general secondary education.

METHODOLOGY

The study employed systemic, competency-based, activity-based, and learner-centered approaches. In addition, methods such as scientific literature analysis, modeling, generalization, and comparative analysis were applied. The methodological framework of the research was based on the principles of inclusive pedagogy, the STEAM approach, Universal Design for Learning (UDL), the Technological Pedagogical Content Knowledge (TPACK) model, and digital competency theories

RESULTS

The findings indicate that the process of preparing future teachers to model a STEAM-based inclusive educational environment comprises the following structural components.

Component	Content	Indicators
Motivational	Positive attitudes toward inclusive education and the STEAM approach	Professional motivation and interest in innovative activities
Cognitive	Knowledge of inclusive education, STEAM, and digital technologies	Theoretical knowledge and understanding of regulatory documents
Operational-Activity	Skills in designing and modeling a STEAM-based educational environment	Lesson planning and educational environment development
Digital-Communicative	Effective use of digital tools	Ability to use Tinkercad, Scratch, Canva, and Google Classroom
Reflective-Evaluative	Analysis and improvement of one's own professional activities	Reflection and self-assessment

Table 1. Structural Components of Preparing Future Teachers for Modeling an Inclusive STEAM Educational Environment

According to the research findings, future teachers' readiness to model an inclusive STEAM educational environment is developed through the integration of these components. The proposed model represents a comprehensive pedagogical system for preparing future teachers to model a STEAM-based environment in inclusive education. The model consists of goal-oriented, content-based, organizational-technological, and outcome-evaluation blocks, which function in an interconnected and integrated manner.

DISCUSSION

The integration of pedagogical, psychological, and technological factors plays a crucial role in the process of modeling an inclusive STEAM educational environment. Digital tools expand opportunities to address learners' individual needs, visualize instructional materials, and adapt the teaching and learning process.

The application of the Universal Design for Learning (UDL) principles enables students to access and demonstrate knowledge through multiple forms of representation, engagement, and expression. In addition, the Technological Pedagogical Content Knowledge (TPACK) model facilitates the integration of future teachers' technological, pedagogical, and content-related competencies, thereby enhancing their professional preparedness for inclusive STEAM education.

CONCLUSION

Preparing future teachers to model a STEAM-based environment in inclusive education is considered one of the priority areas of modern teacher education.

The results of the study made it possible to draw the following conclusions:

1. An inclusive STEAM educational environment is formed through the integration of pedagogical, psychological, and technological components.
2. Digital technologies serve as an essential tool for modeling an inclusive educational environment.
3. The Universal Design for Learning (UDL) and Technological Pedagogical Content Knowledge (TPACK) approaches provide an effective methodological foundation for developing the professional competencies of future teachers.
4. The proposed structural-functional model

contributes to improving the effectiveness of preparing future teachers to model an inclusive STEAM educational environment.

Future research directions: Further studies may focus on integrating artificial intelligence, adaptive learning technologies, and data-driven educational analytics into the process of designing and implementing inclusive STEAM learning environments

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