

Improving The Methodology Of Technical Thinking Competence Development In Teacher Education Based On Steam Technologies

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Abstract: This article analyzes the improvement of the methodology for developing technical thinking competence in teacher education based on STEAM technologies. The study proposes mechanisms of STEAM project design, digital modelling, engineering design, interdisciplinary integration, and reflective assessment aimed at increasing the effectiveness of professional pedagogical training.

Keywords: STEAM technologies, teacher education, technical thinking competence, methodology improvement, engineering design, digital modelling, interdisciplinary learning, project-based learning, assessment, innovation.

Introduction: STEAM technologies have become a strategic direction for modern teacher education because they combine scientific inquiry, technological application, engineering design, artistic creativity, and mathematical reasoning. For future teachers, this integration is important not only as content but also as a methodological model for organising innovative learning.

Technical thinking competence develops effectively when students are placed in situations requiring interdisciplinary reasoning and practical design. STEAM technologies provide exactly such situations: students identify a problem, analyse scientific principles, perform calculations, create a design, use digital tools, build a model, test it, and present the result.

Despite the popularity of STEAM, its implementation in teacher education often remains superficial. Sometimes STEAM is understood as the simple combination of several subjects rather than as an integrated design methodology. Therefore, improving the methodology of technical thinking development based on STEAM technologies is a relevant pedagogical task.

The purpose of the article is to substantiate ways of

improving the methodology of technical thinking competence development in teacher education based on STEAM technologies. The objectives are to analyse the didactic potential of STEAM, define methodological stages, propose assessment indicators, and formulate recommendations for implementation.

Literature Review And Methods

STEAM education emerged as an integrative approach that expands STEM by including creativity, design, and human-centred thinking. Yakman describes STEAM as a framework that connects disciplines through purposeful integration [1, 18-20]. For teacher education, this means that technical thinking should be developed in connection with creativity and pedagogy.

Bybee argues that STEM education should prepare learners to apply knowledge to real-world problems [2, 25-27]. This principle supports the use of authentic design challenges in future teacher training. Such tasks make technical concepts meaningful and professionally applicable.

Honey, Pearson, and Schweingruber emphasise that integrated STEM should include design, problem solving, disciplinary knowledge, and application [3, 51-

54]. These elements correspond to the core operations of technical thinking: analysis, modelling, construction, testing, and improvement.

Digital technologies strengthen STEAM methodology by enabling simulation, visualisation, and iterative testing. UNESCO's ICT competence framework underlines the role of digital tools in transforming teaching and learning [4, 16-18]. Therefore, STEAM-based technical thinking development should include digital modelling as a central methodological element.

The article was prepared within a theoretical and methodological research design. The study applied system analysis, comparative pedagogical analysis, conceptual modelling, synthesis of international literature, and pedagogical generalisation. System analysis made it possible to consider technical thinking competence as an integral formation that includes cognitive, operational, creative, communicative, and reflective components. Comparative analysis was used to examine the didactic potential of innovative methods in contrast with predominantly reproductive teaching formats. Conceptual modelling enabled the development of a methodological sequence that can be

implemented in teacher education programmes.

Results And Discussion

The improvement of methodology should begin with the selection of authentic STEAM problems. A problem should be interdisciplinary, technically meaningful, feasible for students, and pedagogically valuable. For example, future teachers may design an energy-saving model, a smart classroom prototype, a simple robotics task, or a digital simulation explaining a technological process.

The second stage is interdisciplinary analysis. Students identify what knowledge from science, technology, engineering, arts, and mathematics is necessary for solving the problem. This stage prevents superficial integration and teaches students to see how different types of knowledge interact in a technical task.

The third stage is engineering design. Students formulate requirements, create sketches or digital models, select materials and tools, and predict expected outcomes. Engineering design is the core of STEAM-based technical thinking because it transforms theoretical knowledge into a structured solution.

Component	Didactic focus	Expected outcome
Authentic STEAM problem	Real technical challenge with interdisciplinary content	Motivation and problem awareness
Interdisciplinary analysis	Identification of scientific, mathematical and design resources	Integrated technical reasoning
Engineering design	Requirements, sketches, digital models and prototypes	Constructive and creative competence
Reflective assessment	Evaluation of product, process and pedagogical use	Professional readiness and improvement

The fourth stage is digital modelling and prototype testing. Digital tools allow students to test ideas before physical implementation, compare alternatives, and visualise complex processes. Prototype testing develops evidence-based decision-making and helps students understand that technical solutions require revision.

The fifth stage is pedagogical presentation and reflective assessment. Since the participants are future teachers, they should explain how their STEAM product can be used in a lesson, what learning outcomes it supports, and how pupils' activity can be organised. This stage links technical thinking with professional

pedagogical competence.

Conclusion

The methodology of technical thinking competence development in teacher education can be significantly improved through STEAM technologies. The key condition is to move from declarative interdisciplinarity to authentic design-based and digitally supported learning activities.

The proposed methodology includes authentic problem selection, interdisciplinary analysis, engineering design, digital modelling, prototype testing, pedagogical presentation, and reflective assessment. Its

implementation can strengthen future teachers' technical reasoning, creativity, digital competence, and ability to organise innovation-oriented learning.

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