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OPPORTUNITIES FOR DEVELOPING STUDENTS’ TECHNICAL CREATIVITY THROUGH PROJECT-BASED LEARNING TECHNOLOGY

Abstract. This thesis highlights the pedagogical opportunities, methodological stages, and practical effectiveness of developing students’ technical creativity through project-based learning technology. Technical creativity is analyzed as an important professional competence that integrates students’ technical and technological knowledge, constructive thinking, design skills, prototyping ability, and reflective assessment activities. Project-based learning technology is substantiated as an integrative pedagogical mechanism that connects the stages of problem identification, technical idea design, development of constructive solutions, modeling, prototyping, testing, and evaluation of results.

Keywords: technical creativity, project-based learning, technological education, constructive thinking, prototyping, innovative design, creativity, reflection, professional competence.

Introduction.

The rapid development of technical and technological innovation processes in the world is setting new tasks for the higher education system in training a new generation of specialists. Today, students are required not only to master ready-made knowledge, but also to independently analyze existing technical problems, approach them creatively, develop constructive solutions, and create practical products. The dissertation abstract also emphasizes that, in the context of deepening technical and technological innovation processes, the need to prepare students for professional activity through the development of their technical creativity is increasing. At the same time, in the current traditional educational process, students in some cases remain limited to mastering theoretical information, while their active involvement in independently solving real technical problems, designing, modeling, testing, and defending results is not sufficiently systematized. This creates the need for the purposeful and step-by-step use of project-based learning technology in developing students’ technical creativity.

The purpose of this thesis is to scientifically substantiate the pedagogical opportunities, methodological stages, and effectiveness factors of developing students’ technical creativity through project-based learning technology.

Technical creativity is an integrative activity of a student aimed at creating a new idea, construction, model, product, or technological solution using existing technical and technological knowledge. It combines knowledge, skills, practical actions, creative thinking, independent decision-making, and the ability to evaluate the results of one’s own activity. In the dissertation abstract, technical creativity is interpreted as a complex pedagogical and psychological process related to students’ acquisition of technical and technological knowledge, analysis of problematic

situations, generation of original ideas, development of constructive solutions, creation of innovative projects, and reflective evaluation of the results of their own activity. Project-based learning technology is an effective pedagogical mechanism that directs this process toward practice. In this technology, the student studies a problem, collects information, develops a technical idea, creates a model or prototype, analyzes the result, and justifies the proposed solution. In this process, the teacher does not act as a mere transmitter of ready-made knowledge, but as a consultant, guide, facilitator, and expert.

It is advisable to implement the development of technical creativity through project-based learning technology in the following methodological stages: The first stage is problem identification and motivation formation. At this stage, students are presented with a technical problem related to real life, production, technological processes, or the everyday environment. For example, tasks such as developing a model of an energy-saving device, improving a simple mechanism, creating an element of robotics, or redesigning a folk craft product based on modern design principles increase students’ creative interest.

The second stage is information search and analysis. The student studies theoretical information, existing technical solutions, material properties, types of constructions, and technological opportunities related to the selected problem. In this process, the cognitive-motivational component develops; that is, the student consciously masters technical knowledge and connects it with a practical task.

The third stage is the development of a technical idea and constructive solution. At this stage, students propose several solution options and compare them from technical, economic, aesthetic, and practical perspectives. As a result, the most appropriate constructive solution is selected. This process develops students’ non-standard thinking, technical imagination, creative approach, and innovative decision-making skills.

The fourth stage is modeling and prototyping. The most important aspect of project-based learning is that the student transforms a theoretical idea into a practical product. In this process, a mock-up, model, drawing, 3D project, robotic device, or functional prototype may be prepared. The dissertation abstract states that tests, practical assignments, project products such as models or prototypes, presentation-defense results, reflection sheets, and expert assessment can be used as diagnostic tools.

The fifth stage is testing, assessment, and improvement. The created model or prototype is tested, and its effectiveness, durability, ease of use, and practical significance are evaluated. Shortcomings are identified, and ways to eliminate them are determined. This process develops the creative-reflective component of technical creativity.

The sixth stage is presentation and defense. Students defend their project before an audience, justify their technical solution, answer questions, and accept critical feedback. This stage develops communication, teamwork, critical thinking, and the ability to defend one’s idea on a scientific basis. The scientific and methodological significance of project-based learning technology lies in the fact that it develops students’ technical creativity not as a separate skill, but

in the unity of cognitive-motivational, creative-reflective, and activity-based components. This technology moves students away from merely imitating a ready-made model and directs them toward independent inquiry, constructive analysis, the development of technical solutions, and the creation of innovative products. Integrating project-based learning with such subjects as “Technical Creativity and Construction”, “Fundamentals of Robotics”, “Technical Mechanics” and “Folk Crafts and Artistic Design” increases the effectiveness of developing technical creativity. For example, within the subject “Technical Creativity and Construction,” students develop practical projects based on the structure of constructions, material properties, modeling, and prototyping. In the subject “Fundamentals of Robotics,” they propose innovative solutions to complex technical problems by programming technical systems and using sensors and control mechanisms.

The scientific novelty of this thesis lies in the interpretation of project-based learning technology not as a set of simple practical tasks, but as an integrative pedagogical mechanism operating on the basis of the chain “problem idea project prototype testing reflection improvement” in developing students’ technical creativity. This mechanism serves to comprehensively develop students’ competencies in applying technical knowledge in practice, constructive thinking, developing innovative solutions, and evaluating the results of their own activity. The experimental results presented in the dissertation abstract also confirm the effectiveness of methodological approaches aimed at developing technical creativity. The study involved a total of 447 students from Fergana State University, Namangan State University, and Kokand State University, who were divided into experimental and control groups. At the end of the experiment, the cognitive-motivational indicator in the experimental group reached 81 percent, the creative-reflective indicator reached 72 percent, and the activity-based indicator reached 58 percent. These results show that the integration of project-based, problem-based, and practical-creative learning elements is effective in developing students’ technical creativity. For the effective application of project-based learning technology, the following pedagogical conditions are important: creating a problem-based educational environment; providing students with independent choice and creative freedom; using laboratory and workshop facilities; applying digital modeling and simulation programs; organizing teamwork; assessing results based on criteria; and developing an analytical and constructive attitude toward students’ mistakes. The dissertation abstract also emphasizes that a problem-based learning environment, a free creative atmosphere, a mentoring system, material and technical support, and stimulating assessment mechanisms are necessary for the development of technical creativity.

In conclusion, project-based learning technology is an effective pedagogical tool for developing students’ technical creativity. It directs students to independently analyze problems, justify technical ideas, develop constructive solutions, create prototypes, test them, and reflectively evaluate the results.

Through this technology, students’ technical knowledge and practical skills are integrated, while their creative thinking, teamwork, innovative approach, and independent decision-making

abilities are developed. Project-based learning transforms the student from a passive recipient of knowledge into an active creator, researcher, and developer of technical solutions. Therefore, the systematic implementation of project-based learning technology in technological education is of great scientific and methodological importance in developing students’ technical creativity, improving their professional competence, and training competitive specialists ready for innovative activity.

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