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THE IMPLEMENTATION OF STEAM EDUCATION IN ORGANIZING STUDENTS' PROJECT-BASED ACTIVITIES

Kusharbay Tashbayevich Suyarov¹,

Lola Muxiddinovna Sunnatova²

¹Chirchik State Pedagogical University, ²Samarkand State University, Uzbekistan

Abstract

The paper discusses the organization of project-based learning as a form of developing integrated STEAM education in higher pedagogical institutions.

Key words: STEM education, project work, laboratory work, general secondary education.

The gradual implementation of STEAM education into practice is addressed in a series of presidential decrees of the Republic of Uzbekistan, including: Decree No. PQ–5032 dated March 19, 2021, “On measures to improve the quality of education and develop scientific research in the field of physics”; Decree No. PQ–289 dated June 21, 2022, “On measures to further develop the activities of higher education institutions in improving the quality of pedagogical education”; and Decree No. PQ–3931 dated September 5, 2018, “On measures to introduce new principles of management in the public education system” [1–3]. The establishment of STEM laboratory complexes plays a crucial role in supporting the economic interests of our country in ensuring the implementation of these decrees.

In both developed and developing countries, interest in the integrated STEAM (Science, Technology, Engineering, Arts, Mathematics) education model is growing and becoming increasingly widespread. Although STEAM education is being widely promoted, there are various interpretations regarding its true essence. Recently, it has been observed that the information letters of scientific conferences held in our country include references to a special section dedicated to the STEAM education direction, where STEAM advocates are invited to participate with scientific articles. However, there is a significant lack of empirical research focused on exploring the skills, foundational knowledge, and experiences that teachers need



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to effectively implement integrated education. The results of the study indicate that science teachers lack sufficient pedagogical knowledge and competencies necessary for the effective implementation of STEAM education. This, in turn, creates challenges in the professional development of future specialists in relation to STEAM education within pedagogical higher education institutions [4].

Today, new knowledge is being generated within scientific and engineering communities, and this knowledge is being rapidly integrated into production. These advancements are, in fact, achieved through STEAM knowledge, which encompasses various intellectual fields such as science, mathematics, engineering, and others. Knowledge enriched and expanded through various disciplines fosters new intellectual integration, leading to the development of innovative inventions. For instance, the production of electric vehicles.

In the effective implementation of integrated STEAM education, three domains of knowledge are considered essential: content knowledge in science – This involves understanding the natural interconnections among disciplines and applying knowledge within authentic, real-world contexts, pedagogical knowledge – This encompasses the ability to explain various concepts clearly, recognize students' capabilities, and select the most effective instructional strategies, curricular knowledge – This refers to familiarity with educational materials that can be effectively utilized in classroom instruction.

In this article, we specifically examine how, in the teaching of physics, “Project” serve as a central focus where STEAM disciplines are integrated into a unified framework of action. The knowledge acquired in individual subject areas is applied to solving real-world problems within these projects. First and foremost, in order to implement a project, it is essential to clarify the practical basis and application context of the given problem. Additionally, the project must clearly define its objective, the function and application of the device developed within the project framework, its technical specifications, compliance with safety regulations, impact on the environment, and other relevant considerations.

The sequence outlined above is exemplified in Table 1, which presents the series of essential steps for students to successfully complete a STEAM project titled “Creating a set of laboratory experiments for studying alternating current laws.”



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Table 1

Topic	“Development of a Laboratory Work Set for Studying the Laws of Alternating Current”
Foundations for Project Implementation	1. Decree of the President of the Republic of Uzbekistan No. PQ–5032 dated March 19, 2021, “On Measures to Improve the Quality of Education in the Field of Physics and to Develop Scientific Research. 2. Decree No. PQ–289 dated June 21, 2022, “On Measures to Further Develop the Activities of Higher Education Institutions to Improve the Quality of Pedagogical Education.” 3. Decree of the President of the Republic of Uzbekistan No. PQ–3931 dated September 5, 2018, “On Measures to Introduce New Principles of Governance in the Public Education System.”
Project Idea	The purpose of this project is to enhance students’ practical understanding of the physical processes occurring in electrical circuits and the laws of alternating current within the study of electrodynamics. It aims to develop students’ skills and competencies in applying theoretical knowledge in practice, advance the use of experimental methods in physics education to a new level, and significantly improve the provision of laboratory equipment in physics classrooms. Due to these objectives, the developed apparatus can be used as a standalone autonomous device both in stationary and portable settings.
Objective	During the study of the electrodynamics section, students and learners are taught to apply their theoretical knowledge about electrical circuits, their types, the processes occurring within them, and the laws of alternating current in practical settings.
Tasks	Improving the quality of practical sessions for students and pupils by mobilizing and automating the process of conducting laboratory work in physics.
Field of Application	In conducting laboratory work in physics at both pedagogical higher education institutions and general secondary schools.
Technical Requirements	The use and maintenance of the laboratory work set for studying the laws of alternating current are carried out in accordance with the operation manual.
Safety and Environmental Impact	The design of the laboratory work set for studying the laws of alternating current must comply with technical safety requirements. Additionally, the laboratory work set for studying alternating current laws should have no adverse impact on the environment.

At Chirchik State Pedagogical University, within the Department of Physics and Astronomy Teaching Methods, a STEAM club has been established. Through this club, students specializing in physics are engaged in STEAM projects and are guided towards individualized learning. A set of physics laboratory experiments

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was developed for general secondary school students based on both internal and external resources. This laboratory set is compact, multifunctional, mobile, and user-friendly for students. It fully complies with laboratory safety requirements and features a modern, aesthetically pleasing design. Additionally, due to student involvement in the production process, the manufacturing cost of the product was significantly reduced. Table 2 presents samples of the prototypes developed as a result of the STEAM project.

Table 2

Samples of Laboratory Works		
1	Study of alternating current circuits	
2	Study of the transformer	
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Conclusion

General secondary education it is important to introduce laboratory and demonstrative-experimental work in accordance with the requirements of the time to the educational process in increasing the interest of pupils in Physical Science and the indicator of mastering science.



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