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COMPARATIVE PEDAGOGICAL ANALYSIS OF EDUCATIONAL PROGRAMS OF UNIVERSITIES IN UZBEKISTAN AND EUROPE

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Abstract:

The article examines the modernization of bachelor's programs in solar energy at Uzbek higher education institutions within the framework of the Erasmus+ DEBSEUz project (2023–2026). A comparative pedagogical analysis of curricula from Uzbek and European universities identified 12 key knowledge gaps. The existing curriculum was analyzed using Bloom's Taxonomy (revised version, 2001), revealing that 70–75% of the workload corresponds to lower cognitive levels (Remembering, Understanding, Applying), while higher levels (Analyzing, Evaluating, Creating) are insufficiently represented. The necessity of developing new modules based on a competency-oriented approach and strengthening higher cognitive activities to align education with international standards is substantiated

Keywords: solar energy, DEBSEUz project, Bloom's Taxonomy, educational modernization, renewable energy sources.

INTRODUCTION

In recent years, Uzbekistan's energy system has entered a phase of rapid development, becoming a key pillar of the country's economic potential and population welfare. The steady growth in electricity production volume, increasing participation of the private sector, and consistent expansion of the share of renewable sources have initiated a new technological stage in the energy sector. In the National Energy Development Program planned until 2035, priorities include forming infrastructure based on "green economy" principles, improving energy efficiency, and raising the share of renewable sources to more than 50% [1].

Such rapid changes are leading the energy system to a stage of introducing digital management, automated monitoring, energy storage, and grid integration technologies. This process requires engineering personnel not only to possess existing knowledge but also to master competencies such as spatial imagination, creative thinking, modeling, operation, and optimization.

Therefore, reviewing educational programs based on renewable energy sources in line with modern international standards, and modernizing them on the basis of a competency-based approach and integrated didactic model, is one of the most urgent scientific-pedagogical tasks of the present day.

In Uzbekistan's higher education system, in recent years, the process of modernizing engineering education based on principles of digital economy and sustainable development has been consistently established. Higher education institutions are actively involved in developing new curricula, subject modules, and programs based on a competency-oriented approach through international cooperation programs. In particular, within the framework of the European Union's Erasmus+ Capacity Building in Higher Education (CBHE) program, Uzbek universities are implementing a number of innovative projects in the fields of energy, engineering, ecology, and digital technologies.

Among these projects, the DEBSEUz (Development of the targeted Educational program for Bachelors in Solar Energy in Uzbekistan) project holds particular importance. This project is aimed at creating a bachelor's educational direction in solar energy in Uzbekistan's education system and modernizing it in accordance with international labor market requirements. The project is being implemented from 2023 to 2026 under Erasmus+ CBHE contract number 101128871, in collaboration with leading universities from Portugal, Italy, and Spain.

LITERATURE REVIEW

The scientific-methodological essence of the DEBSEUz project consists in fundamentally renewing the educational process in the field of renewable energy in Uzbekistan based on a competency-oriented approach. Within the project framework, new educational modules were developed for the direction "60711001 – Energy Devices Based on Renewable Energy Sources," including functional modeling methodology, a competency-based educational model, and modules aimed at developing spatial imagination and creative thinking.

Additionally, within the scope of the research, a comparative pedagogical analysis of bachelor's programs from Uzbek and European higher education institutions was conducted. As a result, the curricula of Tashkent State Technical University (TDTU), Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME), and Tashkent

International University of Chemistry (KIUT) were compared with the experiences of leading European universities — Technische Hochschule Ingolstadt (Germany), Kaunas University of Technology (Lithuania), Vilnius Gediminas Technical University (Lithuania), and Dublin City University (Ireland).

In this research, Bloom's Taxonomy was applied as a methodological criterion for analyzing subjects in solar energy education, assessing their cognitive coverage, and determining the scientific-pedagogical consistency of educational modules. The distribution of subjects across taxonomy levels allowed for identifying the extent to which students' thinking activity is activated in the process of forming engineering competencies.

Bloom's Taxonomy served not only for classifying educational objectives but also as an important tool in defining the scientific-methodological foundation of educational modules aimed at developing creative and analytical thinking in the direction of renewable energy sources.

METHODOLOGY

The results of the comparative analysis showed that in Uzbekistan's existing bachelor's programs in solar energy, there are 12 main knowledge gaps compared to international standards. This comparative-pedagogical analysis provided an opportunity to identify the methodological foundations and knowledge gaps necessary for aligning Uzbekistan's higher education system with international standards.

Within the scope of the research, Bloom's Taxonomy was used to determine the levels of cognitive complexity in the educational process and to assess the consistency between subjects. This taxonomy is a universal model that systematizes educational objectives according to the depth of knowledge acquisition and the level of its practical application. Originally developed in 1956 [2], the model was revised in 2001, introducing a system of active verbs that clearly express the processes of "thinking about knowledge and its practical application" [3].

The existing curriculum for the educational direction 60711001 – "Renewable Energy Sources (Solar Energy)" was analyzed based on the levels of Bloom's Taxonomy. This approach enables the identification of the cognitive complexity levels of subjects, evaluation of their mutual consistency, and analysis of the system of theoretical and practical competencies formed in students.

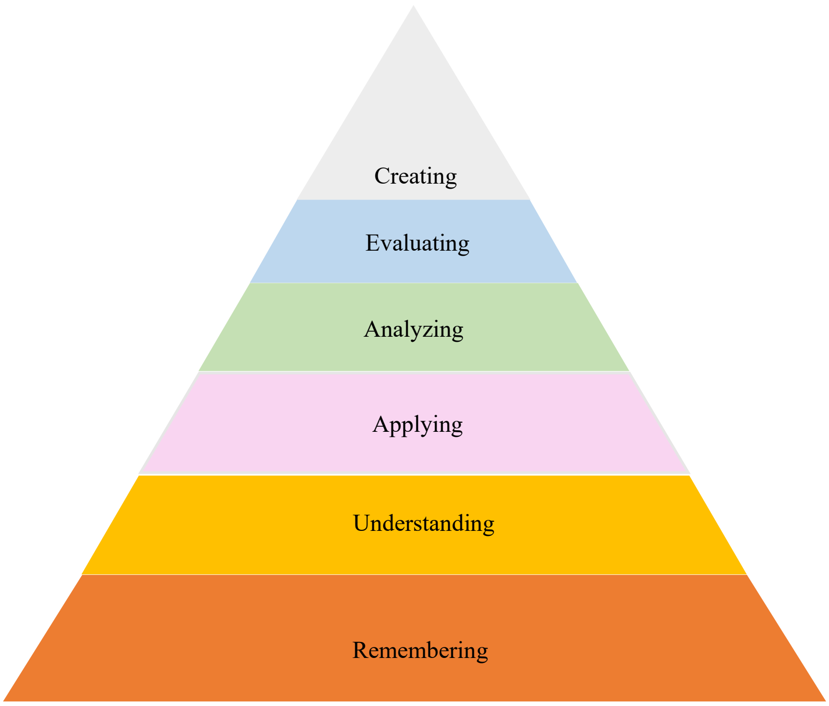

Figure 1. The six levels of increasing cognitive complexity according to Bloom's Taxonomy

ANALYSIS AND RESULTS

The identified knowledge gaps include the following areas:

- technological measurements and instruments in the grid;
- electrotechnical materials and elements;
- electrotechnical devices;
- fundamentals of solar energy;
- optical and physical properties of semiconductor materials;
- design of energy devices and stations based on renewable energy sources;
- hybrid solar power plants;
- systems for electricity generation, transmission, and distribution;
- solar thermal devices and systems;
- production technology of solar cells, photovoltaic panels, and their components;
- energy storage methods and devices;

- technologies for creating new technical developments based on renewable sources.

Table 1 presents the distribution of subjects in the existing curriculum according to the levels of Bloom's Taxonomy.

Table 1
Analysis of the Existing Curriculum Based on Bloom's Taxonomy

№	Level	Cognitive Objective	Subjects	Type of Cognitive Activity
1	Remembering	Recalling facts, laws, terms	Higher Mathematics 1–3, Physics 1–2, Chemistry, History, Religious Studies, Foreign Language	Knowing and reproducing fundamental physics, chemistry, and humanities knowledge
2	Understanding	Comprehending interrelationships, explaining phenomena	Hydraulics, Theoretical Mechanics, Theoretical Electrical Engineering, Uzbek (Russian) Language, Engineering Ethics	Understanding physical processes and professional terminology
3	Applying	Applying knowledge in engineering problems	Engineering Graphics, Energy Management, Electrical Machines	Skills in calculations, schematics, and practical parameter application
4	Analyzing	Breaking down systems into elements, identifying relationships	Hydrodynamics, Heat Engineering, Power Supply	Skills in analyzing and diagnosing engineering processes
5	Evaluating	Making decisions, assessing efficiency	Ecology, Philosophy	Assessing the sustainability and social significance of engineering solutions
6	Creating	Designing new solutions	Design, Final State Attestation	Developing and defending an engineering project in renewable energy sources

The analysis results indicate that the main part of the curriculum is oriented toward the "Remembering," "Understanding," and "Applying" levels, which account for 70–75% of the total workload. At the same time, subjects and types of educational activities related to higher-level cognitive processes — "Analyzing," "Evaluating," and "Creating" — are included only to a limited extent.

This analysis shows that the existing curriculum relies on a reproductive teaching model. In it, tasks focused on reproducing knowledge predominate, while elements of project-based and design activities that require creative thinking are not sufficiently integrated.

CONCLUSION AND SUGGESTIONS

If these areas are not introduced as in-depth modules in the education system, graduates will not fully develop skills in the integration of energy systems, digital modeling, and optimization. Therefore, eliminating these knowledge gaps will enable the alignment of Uzbekistan's education system with international engineering education standards (ABET, EUR-ACE) and meet the technical competency requirements of the local labor market.

Additionally, it is necessary to update the taxonomic structure of the educational content. Systematized indicators based on Bloom's Taxonomy will shape an educational process aimed at developing higher-level cognitive competencies in students, such as applying knowledge, analyzing, evaluating, and synthesizing new solutions.

When updating the curriculum structure, it is essential to include higher cognitive levels—analyzing, evaluating, and creating activities—as mandatory components. This will establish a methodological foundation for developing students' spatial imagination, technical thinking, and creative potential during the teaching process. As a result, although graduates may be theoretically prepared, their level of independent activity in solving practical engineering problems, developing innovative technological solutions, or designing new systems will increase.

LIST OF USED LITERATURE

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