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Scientific and Theoretical Foundations of Modular Educational Technology and its Didactic Possibilities

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Abstract: The scientific and theoretical underpinnings, didactic and structural structure, and didactic capabilities of modular educational technology are examined in this article. It emphasizes that modular educational technology is founded on the ideas of a systematic approach, a competency-based approach, a constructive approach, and result-oriented education. Additionally, the content of the educational module, the basic structural model of modular education, and the mechanisms for the progressive structuring of the educational process are all supported by scientific evidence. It is found that modular educational technology provides substantial pedagogic capacities in terms of personalizing the learning process, helping students create autonomous learning activities, methodically arranging educational resources, and developing professional competencies.

Keywords: *Modular Educational Technology, Module, Pedagogical Technology, Systematic Approach, Competency-Based Approach, Constructive Approach, Result-Oriented Education, Didactic Opportunities, Educational Module, Individualization of the Educational Process, Independent Learning, Assessment Criteria, Pedagogical Model, Educational Process Design.*

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I. INTRODUCTION

One of the most successful pedagogical technologies for enhancing the educational process in the higher education system at the moment is modular educational technology. The creation of educational resources based on logically completed blocks, the division of the educational process into modules, and the development of students' independent learning activities are all made possible by modular educational technology. Modular educational technology is organized in terms of content based on modern approaches to pedagogy, psychology, and didactics, in particular, theories of practical activity-oriented education, individualization, differentiation of education, a systematic approach, and the gradual formation of learning skills. The methodical structuring of the educational process, the segmentation of instructional materials into logically finished sections, and the formation of certain goals, objectives, and other principles form the scientific and theoretical foundation of modular educational technology.

The scientific and theoretical basis of modular educational technology is the systematic organization of the educational process, the division of educational materials into logically completed parts, and the establishment of specific goals, objectives, and results for each module.

A module is a logically cohesive, linked collection of instructional resources in a certain subject where the technology of its mastering is integrated with the instructional content. Each module contains theoretical materials, practical assignments, individual work, and control in a given area and is designed to achieve a certain educational goal. According to this perspective, modular educational technology helps to improve the effectiveness of the educational process, foster students' independent learning activities, and personalize the learning process.

Today, one of the urgent pedagogical problems in the higher education system is the improvement of the educational process, the widespread introduction of a competency-based approach to education and the development of educational technologies for the effective organization of the educational process based on the module-credit system. In this regard, studying the scientific and theoretical foundations of modular educational technology, clarifying its didactic capabilities, and studying, analyzing and summarizing the approaches of various scientists in the

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field in their research work are of great methodological importance.

Modular educational technology is of particular importance due to its direct focus on designing the educational process, dividing the educational content of a particular subject into structural blocks, clearly defining educational goals and results, and increasing educational efficiency. The scientific approaches of foreign and domestic pedagogical scientists play an important role in the theoretical substantiation of this educational approach. Our research analyzes the scientific works of leading scientists who have contributed to the formation and development of modular educational technology with their approaches and scientific views. Their views on pedagogical technologies, educational process design, competency-based approach to education, and improvement of the educational process are summarized, and the theoretical and didactic foundations of modular education are highlighted.

II. LITERATURE REVIEW

N.A. Muslimov interprets modular educational technology in his research as a modern pedagogical technology, emphasizing it as an innovative approach aimed at organizing educational material in a particular subject on the basis of logically completed, goal-oriented didactic modules. According to the scientist, the module is not just educational material, but also a holistic systematized educational mechanism that integrates educational goals, content, educational activities and assessment criteria. N. Muslimov justifies the fact that the most important aspect of modular educational technology is a pedagogical technology that plays an important role in the development of students' independent learning activities. In the scientist's research theory, the educational process is directed towards the discovery and consolidation of new knowledge by students through their own independent activities, rather than the provision of ready-made knowledge by the teacher. At the same time, the scientist emphasizes that modular educational technology is a convenient methodological approach for implementing a competency-based approach.

O.K. Tolipov interprets modular education as a pedagogical technology aimed at designing the educational process on the basis of a scientific approach. The scientist defines it as “a module is a didactic unit that has a clear educational goal, is logically complete and provides for the independent mastery of the learner”. O. Tolipov distinguishes a number of didactic principles in organizing modular education. In particular, such principles as systematicity, consistency, gradualness, individualization and learner activity are among them. According to the scientist, a modular approach to education optimizes the educational process, and educational material is designed from a complex system into a simple, understandable, popular and technologically advanced form.

B.Kh. Khodjaev explains modular education as a pedagogical technology that is inextricably linked to the competency-based approach, and emphasizes that, in the scientist's opinion, a module is a logically completed part of the educational material in a particular subject, which serves to develop certain knowledge, skills and competencies in the student. The scientist justifies the integral relationship between the goal, content and result in modular education as the main aspects of educational effectiveness. In his research approach, the educational process is planned in advance and is result-oriented, and each module serves to develop a specific competency.

Sh.S. Sharipov interprets modular education as an effective pedagogical technology aimed at developing competencies in the vocational education system. According to the scientist, a module is a didactic unit that gradually develops students' readiness for professional activity[2]. In the scientist's scientific approaches, the qualities and pedagogical possibilities of individuality and practical orientation of education are revealed as the main possibilities of modular education. That is, each module connects theoretical knowledge with practical activity and serves to develop students' professional competence.

N.N. Azizkhodjaeva defines modular education as a pedagogical technology that allows for the individualization of the educational process and the organization of a differentiated approach. According to the scientist, the modular educational process creates the opportunity to take into account the individual level of mastery and abilities of each student. The scientist recognizes modular education as a technology that is adaptable to the educational environment, in which students independently assess their knowledge, control the level of mastery and, if necessary, refer to additional educational materials.

B. Ziyamuhammedov explains modular educational technology as a systematic approach aimed at pre-designing the educational process on a scientific basis. According to the scientist, the educational process should be organized based on the interdependence of the main goal, content, methods and assessment system from pre-design. In his pedagogical research, the scientist pays special attention to the principle of effectiveness in designing educational activities, emphasizing the need for each lesson or training session to be strictly defined with clear educational goals and expected results. He justifies the need for a step-by-step organization of the educational process, the systematic formation of educational material in a particular subject based on logically completed didactic units, and the need to specify assessment criteria in advance. Such an approach in education is considered important in ensuring the systematization and continuity of the educational process, increasing its effectiveness and activating students' learning activities.

J. Sweller puts forward scientific ideas that it is necessary to design the educational process taking into account human memory and cognitive capabilities. According to the scientist, when subjects are divided into small, logically complete blocks (modules), the efficiency and quality of students' mastery of the subject increases. This idea of the scientist is one of the main scientific foundations of modular education. In the science of mechanics, the

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gradual division of formulas, laws and problems into modules without excessive cognitive load directly corresponds to Sweller's theory.

K.A. Smith, as a scientist who widely introduced interactive methods into the practice of engineering education, applied methods for designing the educational process based on organizing the educational process on the basis of problem situations, small groups and interactive activities. In this regard, the scientist's research work reflected the effective results of ensuring the collaborative learning of students by considering each module as a problem block in modular education. In the subject of our research work, Mechanics, this approach means consolidating knowledge through practical problems.

M. Prince emphasizes that modular education requires pedagogical design based on enriching the content of a particular subject with problem situations, cases, and practical tasks. This makes laboratory work and tasks from Mechanics the main components of the educational module.

R. Felder is one of the scientists who developed a person-centered and outcome-based learning model in engineering education, and the scientist emphasizes the need to take into account the different styles of educators in teaching. In particular, in modular education, this approach allows you to organize each module in different didactic forms (visual, practical, analytical). In the teaching of mechanics, this implies a combination of teaching methods such as graphics, formulas, and experiments.

The analysis of the scientific research works of the above-mentioned scientists shows that today the theoretical foundations of modular educational technology are sufficiently scientifically and methodologically based. In particular, the problems of the inextricable connection of modular education with the competency-based approach, the division of educational materials into logically complete parts, the orientation of the educational process to the result based on a clearly defined goal, and the development of independent educational activities of students are scientifically based. On the basis of modular education, significant scientific results have been achieved in the areas of individualization of the educational process, the use of a differentiated approach, the systematic design of the educational process and the definition of assessment criteria. In addition, the need to divide educational materials into small, logically complete blocks, the use of interactive teaching methods, the organization of the educational process based on problem situations, and the need to take into account the individual learning characteristics of students have been substantiated in the analyzed scientific studies. It is justified that these approaches serve to increase the effectiveness of education in higher educational institutions, develop students' independent thinking skills, and develop professional competencies. At the same time, the analysis of our scientific research shows that the issue of adapting modular educational technology to the teaching process of exact sciences, in particular mechanics, has not yet been sufficiently studied as an object of research. In particular, the development of a didactic model of teaching mechanics based on a modular approach, improving the content of modules, dividing theoretical and practical training into modules, and developing criteria for assessing educational effectiveness remain one of the urgent problems. During our research, the following problems were identified in improving the methodology of teaching mechanics based on a modular approach:

The implementation of research on improving the methodology of teaching mechanics based on a modular approach has not been sufficiently studied;

- The lack of scientifically and methodologically based mechanisms for teaching theoretical and practical training in mechanics by dividing them into modules;
- The lack of a fully studied competency-based approach and its pedagogical capabilities in modular teaching of mechanics;
- The lack of development of improved content of criteria for assessing the effectiveness of modular teaching of mechanics;
- The lack of sufficient research in pedagogical research on the issues of combining modern pedagogical technologies and a modular approach in teaching mechanics.

The above problems indicate the need to conduct scientific research on improving the methodology of teaching mechanics based on modular educational technology and determine the relevance of this research work.

III. METHODOLOGY

Although some research has been done on the introduction of modular educational technology into the practice of teaching mechanics in higher education institutions, it is clear from the analysis of research works corresponding to the aforementioned research object that more work needs to be done to strengthen its theoretical and scientific underpinnings, create a methodology for module design, and fully reveal the didactic possibilities of the modular approach in the educational process using the example of mechanics. In this sense, determining the theoretical and scientific underpinnings as well as the didactic potential of modular educational technology is a crucial scientific undertaking.

Modular educational technology, as a modern pedagogical technology, is based on the organization of the educational process on the basis of logically completed, goal-oriented and interconnected didactic modules. Such a technological approach to education makes it possible to design the educational process as a system with a structure aimed at the gradual mastery of all components of educational activity, namely, the goal, content, method, means and result. The scientific and theoretical basis of modular education is the mechanism of a systematic approach in a step-by-step and block-based form. In accordance with this mechanism, the educational process is considered as a holistic complex consisting of interconnected modules. Each module is an independent, functional unit of this complex serving a common goal. The interconnectedness between the modules

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ensures the sequence and consistency of the educational content, which leads to the structural organization of educational material in a particular subject.

One of the important scientific foundations of modular education technology is the pedagogical process organized on the basis of the principle of result orientation. According to this principle, the educational process is designed primarily on the basis of a clearly defined educational goal and a mechanism implemented to achieve this goal. Each module is coordinated with specific learning objectives, competencies that the student must master, and assessed results. In modular education, the main criterion is not the learning process, but the final result of education and its quality and efficiency indicators. Modular education is based on cognitive pedagogical and psychological approaches. In particular, attention is paid to increasing the cognitive knowledge of students by dividing the educational material into micro and macro and logically completed blocks. This is important for the gradual mastering of complex subjects of science, the rejection of redundant information, and the retention of acquired knowledge in long-term memory. Another important theoretical and methodological aspect of modular education is the possibility of focusing on a competency-based approach. In accordance with this educational approach, the educational process in a particular subject is aimed not only at developing theoretical knowledge, but also at the integrated development of knowledge, skills, competencies and practical experience in students. Each module is presented as a holistic didactic mechanism serving to form a specific competency.

The constructivist approach also plays an important role in modular educational technology. In this technology, the student is considered not as a passive subject receiving ready-made knowledge, but as an active object independently acquiring knowledge. Therefore, in the modular educational process, processes such as problem situations, independent tasks, research-oriented activities, and reflexive analysis are of paramount importance. Modular education is also based on the principles of individualization and differentiation. These principles provide the opportunity to receive education taking into account the quality of mastery, level of knowledge, and individual abilities of each student. The student will be able to independently determine his educational trajectory, use additional educational materials on the subject, and constantly monitor his knowledge. Today, the didactic capabilities of modular educational technology are wide, and they are of great importance in the effective organization of the educational process.

➢ *In Particular:*

- The possibility of structurally organizing the content of the subject into blocks is created;
- The independent learning activity of students is developed;
- The accuracy and transparency of the assessment process is ensured;
- The possibility of individualizing the educational process increases;
- The level of practical orientation in teaching subjects increases;
- Integration with digital educational technologies is ensured.

Modular educational technology serves to strengthen educational cooperation between the teacher and the student. While the teacher acts as a manager and guide of the educational process, the student appears as a subject independently acquiring his knowledge. This ensures that the educational process is based on subject-subject relations.

Modular educational technology has an advantage in terms of pedagogical possibilities among modern pedagogical technologies due to its systematicity, variability and focus on a competency-based approach. This educational technology allows you to organize the educational process as a holistic didactic system, ensuring the quality of education based on the logical division of educational material into complete modules. Below is the general structure of modular educational technology (see Figure 1.).

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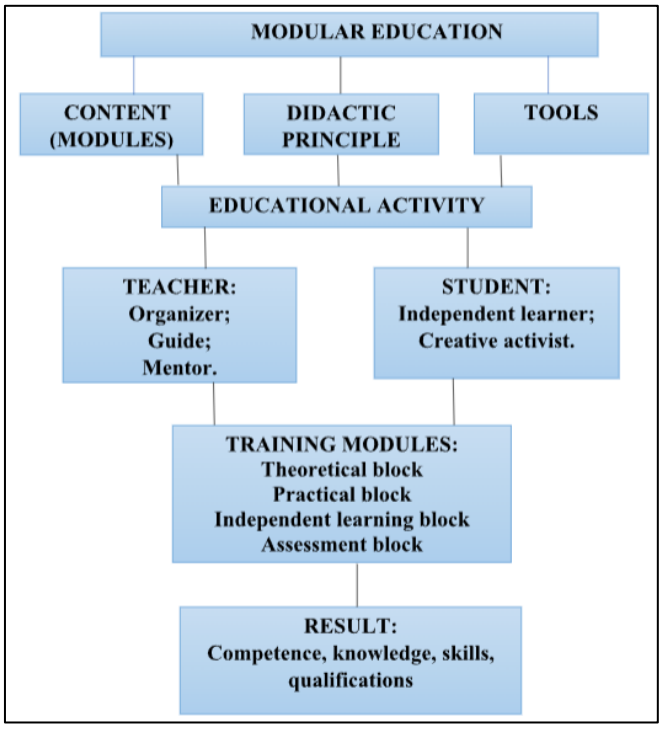

Fig 1. Structure of Modular Education

The module, as the main unit of this modular educational technology, represents the educational process as a logically complete and didactically integrated whole. Each module, including its purpose, content, types of activities, as well as control and evaluation components, serves to organize students' independent learning activities. The methodological structure of the module ensures the gradual mastery of the educational material of a particular subject and integrates theoretical knowledge with practical activities. At the same time, the presence of elements of independent work, analysis and reflection in the module allows the student to form the competence of independent thinking and self-development. These aspects are important factors that increase the pedagogical effectiveness of modular educational technology. The methodological structure of the module is presented in the figure below (Figure 2).

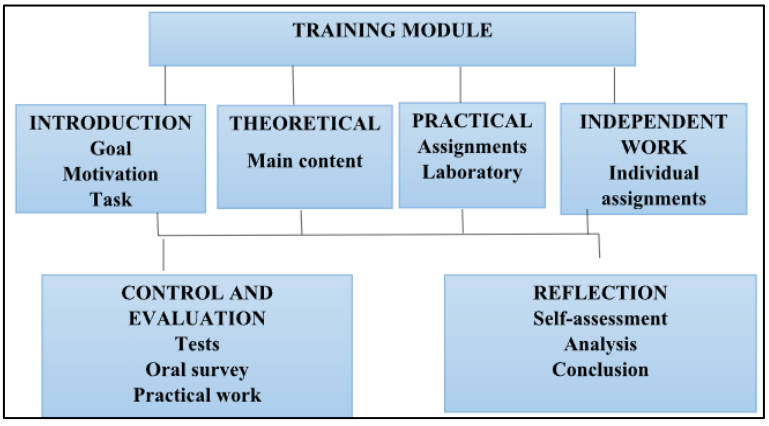

Fig 2. Structure of the Training Module Content

In modular educational technology, the educational process is organized into strict stages, each stage of which serves to gradually develop the student's knowledge, skills and competencies. This process begins with a diagnostic analysis of the quality of education and ends with the stages of goal setting, mastering educational material, organizing independent educational activities, and monitoring and reflection. The consistent and coherent implementation of these stages in the educational process in a particular subject increases the effectiveness of the educational process and allows the student to form an individual educational trajectory. Therefore, the modular educational process, unlike traditional approaches to education, is systematic, step-by-step and result-oriented (see Figure 3).

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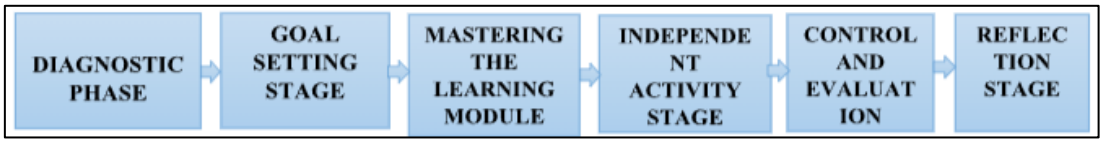

Fig 3. Stages of Organizing a Modular Educational Process

IV. CONCLUSION

Because of its methodical, adaptable, and goal-oriented nature, modular educational technology is crucial to contemporary pedagogical techniques. By structuring the learning process according to logically completed modules, this technology offers the chance for consistent and efficient mastering of instructional content. The concepts of a methodical approach, a competency-based approach, a constructive approach, and result-oriented education provide the theoretical and scientific underpinnings of modular educational technology.

Nonetheless, an examination of educational practices reveals certain issues with the use of modular educational technology. The need for more scientific research in this area is particularly highlighted by the inadequate development of the methodology for creating educational modules, the ambiguity of evaluation criteria based on modules, and the absence of a single methodological foundation for the application of modular education across disciplines. Thus, among the most pertinent areas of contemporary pedagogical research are a thorough examination of the theoretical and scientific underpinnings of modular educational technology, an extension of its didactic capabilities, and the creation of mechanisms for its successful integration into the educational process.

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