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Preparation of Mechanics Educational Literature Based on A Professional Competence Approach: Problems and Solutions

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Abstract: In this article, intensive training in mastering the subject of mechanics to create optimal literature-the analysis of existing literature created in domestic and foreign higher educational institutions is studied and highlighted.

Keywords: Decree and regulation, methodology, technology, teaching methods, competence, students.

Introduction: In the context of our nation's efforts to secure a more prominent position within the global community, and particularly during these days when investments compatible with the requirements of a market economy are being attracted, the demand for competitive engineering personnel is significantly increasing as science, technology, and innovations develop at an accelerated pace.

In the "Concept for the Development of the Higher Education System of the Republic of Uzbekistan until 2030," approved by the Decree of the President of the Republic of Uzbekistan No. PF-5847 dated October 8, 2019, specific tasks were outlined. These include the introduction of digital technologies and modern teaching methods in higher education, broader engagement of youth in scientific activities, combating corruption, increasing the share of students in engineering and technical education, implementing the credit-module system, and enhancing the practical component of specialized subjects in curricula to improve practical skills.

In his Address to the Oliy Majlis on January 24, 2020, the President of the Republic of Uzbekistan, Sh. M. Mirziyoyev, proposed designating 2020 as the "Year of Science, Enlightenment, and Digital Economy Development." He emphasized the gradual increase in the coverage of school graduates by higher education, revisiting educational directions and subjects, reducing the number of non-specialized disciplines by half, transitioning the educational process in higher education to a credit-module system, introducing financial self-sufficiency in certain higher education institutions, fully digitalizing the education sector, and extensively applying public-private partnership mechanisms in education. These tasks were identified as pressing issues of the day.

The address also prioritized raising the population's educational level, which is considered a factor determining the nation's competitiveness. Consequently, the document also reflects elements of the challenge to establish a national education system that meets modern requirements and international standards.

Literature Review

All structures employed in engineering practices—buildings, structures, machinery, and mechanisms, including components such as beams, frames, and arches—are produced from structural materials (steel, cast iron, copper, wood, stone, bricks, glass, plastic, and various alloys), raw materials, products, or semi-finished goods. Naturally, the manufacturing processes involve various technical, mechanical, and chemical treatments, as well as specific processing methods unique to the technology.

A preliminary conclusion is that the disciplines of "Technical Mechanics" and "Strength of Materials," which hold leading positions in the training of engineering personnel, are interconnected with technical sciences in relevant fields [10].

The scientific aspect of engineering lies in scientifically substantiating the principles of efficient and cost-effective production processes that minimize the expenditure of time, labor, and energy resources in the use of material wealth in engineering practices.

The dynamic aspect of engineering includes activities such as the extraction of material resources, transportation, creation of products or structures and their components, processing, reprocessing, storage in warehouses, preservation, and technical control of production.

In engineering practices, concepts and terms such as "technological process," "technological map," and "technological procedures" are frequently used, highlighting their indispensable role.

The term "technological process" refers to a specific segment of continuous and interconnected processes in the form of actions performed directly at a workplace by a person or robotic equipment, brought to completion.

The totality of technological processes applied to products or structures and their components constitutes the technological process as a whole.

A technical document that describes the systematic and sequential order of technological processes performed during the production of certain products, structures, or their components, adhering to specific laws, is called a "technological map."

The "technological regime" refers to the strictly regulated and law-abiding procedures that govern the implementation of technological processes, defining the time and conditions required for these processes.

If the above concepts are applied to the educational process, it becomes possible to view the systematic (organized and interconnected) influence exerted by the educator on learners with the help of didactic tools as a social phenomenon without doubt. From this perspective, such a social phenomenon or process can rightfully and meaningfully be termed "pedagogical technology."

Main Purpose and Tasks:

Pedagogical technology is a systematic method for designing, implementing, and evaluating educational processes aimed at guaranteeing the assimilation of results through learner-centered, democratic, and replicable approaches.

Educational technology is applied to determine the scientific aspect of pedagogical technology, focusing on optimizing educational models by systematically creating, implementing, and analyzing the processes of education and upbringing, as well as acquiring knowledge and experiences. This involves considering human and technical resources and their dynamic interrelations.

In the system of continuous education, educational processes are viewed as social phenomena and are formed and improved based on didactic systems. Moreover, authoritarian (traditional lesson model) and learner-centered (non-traditional lesson model) technologies are applied in the teaching process.

A lesson embodies the primary form of the educational process, encapsulating tasks, content, methods, and techniques holistically. Under the direct guidance, instructions, or coordination of the teacher, lessons are conducted with a specific, guaranteed, and purposeful focus within a defined time frame, adhering to regulatory and legal requirements.

When the traditional lesson model is employed, the lesson's objectives are clearly defined; however, assignments or sets of assignments are generally presented in a model-based manner with predetermined algorithms. The activities of learners in acquiring knowledge are under pedagogical influence, making the educational process seem almost obligatory. In other words, the transmission of information is passive, limiting learners' ability to think critically and independently.

This model primarily utilizes methods such as lectures, question-and-answer sessions, and practical exercises. The lecture method, forming the basis of the approach, involves delivering large volumes of educational material in a monologic manner within a designated time. Additionally, the teacher is required to demonstrate professional skills in evaluating the situation correctly, acting as a scholar, educator, orator, and psychologist.

In learner-centered technologies, the student's personality is placed at the center of the pedagogical process, creating favorable conditions for their development and the realization of their natural abilities.

The author, while comparatively studying traditional and non-traditional lesson models, has clarified some key objectives of textbooks. These findings have been applied to the creation of textbooks in disciplines such as "Theoretical Mechanics," "Strength of Materials," and "Structural Mechanics," yielding significant conclusions (Figures 1-2-3).

By analyzing the literature, we firmly establish the undeniable truth that textbooks serve not only as a means of teaching but also as a tool that constantly directs and ensures the purposeful collaboration between teachers and learners in both processes.

Thus, traditional and non-traditional lesson models have been comparatively depicted, and their advantages and disadvantages scientifically substantiated.

When comparing these applications, it becomes evident that the role of the educator and the creator of modern textbooks is of paramount importance in both cases. For example, in authoritarian teaching technology, the educator at the center of the educational process emerges as the sole subject, leader, manager, and initiator.

Based on these conclusions, the author emphasizes that implementing the continuous system process within the framework of educational standards primarily depends on the activities of modern educators and the state of new-generation textbooks. This issue is highlighted as a fundamental problem that warrants more detailed scientific-pedagogical research.

Given the rapidly changing technical and technological landscape of the current era, aligned with the market economy, the educational process — encompassing both teaching and learning technologies — must adapt accordingly. It is self-evident that educational goals and objectives must evolve, update, and improve rather than remain static. Consequently, the new generation of literature must also develop in form and content, incorporating the achievements of innovative science and adapting to the principles of flexibility required by modern demands.

Additionally, the decree of the President of the Republic of Uzbekistan No. PQ-2099 dated April 20, 2017, "On Measures for Further Development of the Higher Education System," and the main goal of the ongoing reforms in the continuous education system underline the importance of training morally mature and highly qualified, competitive specialists in demand in real economic sectors and fields, capable of meeting international standards. This has been firmly established as one of the priority directions of state policy [2].

Particularly, in this regard, the role of the educator is crucial in improving technologies for creating new-generation technical textbooks as part of efforts to enhance the content, quality, and efficiency of education by introducing modern pedagogical technologies into the continuous education system.

To systematize and address the above-mentioned issues, we will first present several important conclusions and proposals regarding modern textbooks.

Scientific monitoring results on the creation and utilization of new-generation educational literature show that, firstly, there remain a number of unresolved issues in the ongoing scientific research in this area.

Specifically, unlike the previous education system, today’s rapid advancement of science and the continuous updating of innovative scientific and technical information require that newly created educational literature must be fully oriented toward the development of the learner's personality. At the same time, considering the interchangeability of new technical-technological tools in modern production, there arises a need to update the content of education based on the principle of adaptability and to align pedagogical technologies used in continuous education with these production changes.

Indeed, while a textbook is primarily viewed as a material carrier of educational content, it also serves the function of organizing the educational process. In the higher education system, the issue of training specialists requires that knowledge is not transferred in a random and passive manner. More precisely, knowledge should be offered to learners, while the acquisition of knowledge should be achieved through the independent educational efforts of students, guided and coordinated by the educator, thus consciously influencing the capabilities and interests of learners.

Naturally, this approach ensures the alignment of professional motivations with educational (learning) motivations in career selection or mastery of a profession.

For example, processes such as constructing stress and strain diagrams for critical sections or conditions of structural parts, applying universal formulas not only for bending but also for other types of deformation, determining reaction forces at supports without forming equilibrium equations in statics, and verifying the strength and rigidity of beams, shafts, and rods should already be performed interactively using computers and mobile phones, rather than manually. However, new-generation textbooks and manuals still adhere to outdated approaches in this regard.

According to research findings, in most cases, the creation of subject textbooks is still based on outdated concepts and approaches, as substantiated scientifically. Additionally, it is concerning that many textbooks fail to meet modern practical demands and do not fully incorporate the shifts toward learner-centered and developmental education in their didactic structure.

In creating new-generation educational literature, it is essential to ensure that the texts in the textbooks effectively reflect interactive teaching strategies that enhance the pedagogical process's efficiency and outcomes. In this regard, the author has confirmed the necessity of applying methods such as "Brainstorming," "Case Study," "Modular Technology," "Learner-

Centered Technologies," "Concept Analysis," "Cluster Method," and "Crossword Method" in the preparation of textbooks for subjects like "Theoretical Mechanics," "Strength of Materials," and "Structural Mechanics" [8, 9].

At technical higher education institutions such as the Jizzakh Polytechnic Institute, Namangan Engineering and Construction Institute, Fergana Polytechnic Institute, and Samarkand State Architecture and Construction Institute, students are mastering educational materials with significantly reduced academic workloads compared to previous years. Furthermore, subjects like "Theoretical Mechanics" and "Strength of Materials," which are designed for students specializing in leading sectors such as machinery manufacturing, automotive engineering, metallurgy, transport, and construction, must also cater to independent researchers, doctoral students, industry engineers, and educators as natural users.

Taking these aspects into account, it is advisable to create modern educational literature that aligns with several directions, remains economically affordable, efficient, and universal. Such an approach would undoubtedly address the necessity of reducing or modifying content based on the corresponding curricula without compromising the quality or content of education. It may even require omitting certain paragraphs or chapters (modules).

Acknowledging the critical importance of new-generation educational literature in organizing and implementing the educational process in accordance with modern requirements, it is necessary, first, to effectively utilize traditional and non-traditional teaching models while creating the subject "Methods of Teaching Science" [71].

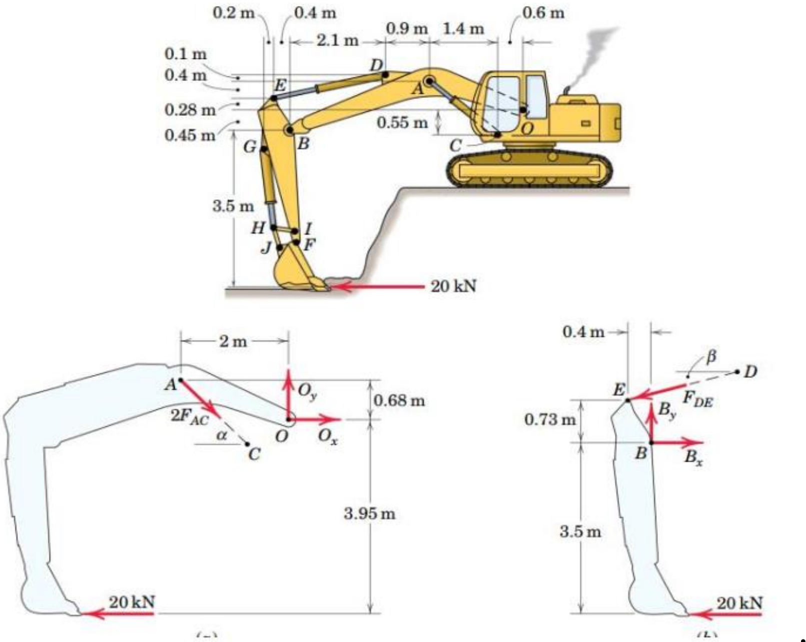
From this perspective, the relevance and practicality of this dissertation become evident, particularly in its role in addressing economic and political issues.

Secondly, given the rapid development of science and the dynamic growth and frequent updates of innovative scientific and technical information, along with the improvement of engineering structures, technological processes, and the increasing automation levels of management systems, it is clear that relying solely on authoritarian teaching methods is no longer viable in teaching subjects like "Strength of Materials" and "Theoretical Mechanics."

At this juncture, we encounter two primary aspects that need to be addressed.

Firstly, in learner-centered teaching technology, although significant professional requirements are placed on the educator, such as possessing deep critical thinking, scientific and creative approaches to the process, and didactic experience, it is evident to all that the role of the educator-scholar seems "not sufficiently noticeable" in cases where the educational material is new and considerably complex.

Secondly, in non-traditional education, while the role of the learner is of utmost importance, it is also natural that, in many cases, they lack sufficient experience in their chosen field, have limited understanding of ways to solve problematic issues, are not yet experienced enough in independent activity, and, most importantly, require practical, methodological, didactic, and scientific support. (See Figure 1).



Picture 1

These analytical considerations once again emphasize the importance of learner-centered (non-traditional) teaching technologies in improving the methods for creating new-generation educational literature. The essence of learner-centered (non-traditional) teaching technologies is primarily based on modeling, collaborative activity, and research-oriented learning models, where the learner is placed at the center of the pedagogical process. These methods create favorable conditions for the learner's development and realization of their natural potential. Therefore, it is advisable to rely on these models when improving technologies for creating new-generation textbooks.

Modeling refers to a method where real-life events, phenomena, and processes are simplified, compactly represented, and depicted in a way that is more accessible and practical for educational use. These models are created in educational laboratories, where learners actively participate and engage in these processes. Typically, a modeled lesson or educational process involves stages such as setting educational goals, preparing for the process, conducting exercises (or games), and analytically reviewing the results.

It is worth noting that in the calculation-design processes of structures, it is often difficult to simultaneously account for all the characteristics of real objects. Hence, while studying the subject "Strength of Materials" and deriving its solutions and conclusions, reliance on models of deformable solid bodies is essential. Although modeling processes are somewhat conditional, they are not arbitrary; rather, they follow specific laws and are grounded in scientific principles. In other words, the material of the object is assumed to be homogeneous, isotropic, and continuous, with stress and deformation considered linearly related, and the subject is studied based on these assumptions.

The collaborative activity model involves learners engaging in independent group work to receive education and training. The essence of collaborative learning lies in transitioning from a "teacher-learner" dialogue to a tripartite interaction involving "teacher-group-learner" relationships. This approach fosters communication within the group, encourages teamwork, strengthens interdependent relationships, instills a sense of responsibility, and enhances motivation.

The research-oriented learning model aims to develop learners who can think independently, make decisive decisions when necessary, and purposefully acquire specific knowledge. This approach is particularly beneficial for learners participating in various academic Olympiads, competitions, and practical-scientific research activities. Typically, this method involves stages such as identifying the problem, seeking solutions, proposing initial hypotheses or innovative ideas, adopting scientific (theoretical and experimental), creative, and didactic approaches to the research process, gathering information about problems and their solutions, substantiating and generalizing this information from a scientific-methodological perspective, synthesizing the validity of initial hypotheses and ideas, and, finally, arriving at definitive conclusions regarding the solutions to the problems.

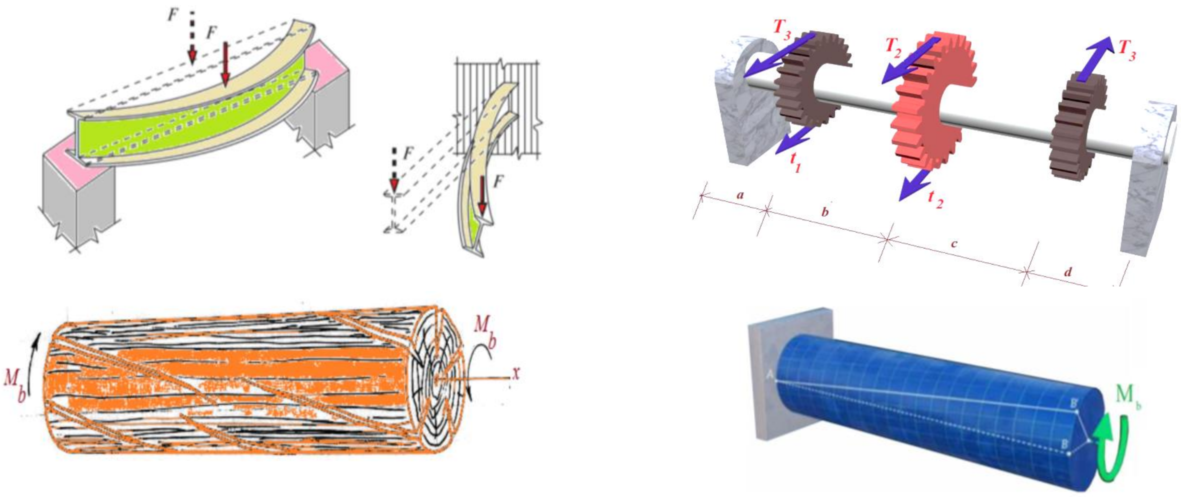
It is self-evident that the development of practical skills requires learners, first and foremost, to purposefully process their existing knowledge, then to develop skills and abilities through systematic repetition resembling a "technological process," and ultimately to acquire competence—more specifically, high-quality competence—as demanded.

In practice, it is no secret that most existing educational materials allocate little space to practical texts, focus less on them in terms of volume, or primarily present educational content in a theoretical style.

When creating new-generation textbooks, it is crucial to strictly adhere to the requirements of didactics and modern teaching technologies, significantly increasing the volume and substance of practical texts.

The diagrams, graphs, epures, tables, structural frameworks, illustrations, plans, and maps presented in textbooks are referred to as visual materials, which are essential for studying and assimilating educational information.

At various stages of events and processes, quantitative and qualitative indicators are often expressed through diagrams, graphs, epures, and tables; spatial changes in the environment through maps, structural frameworks, and graphs; time-related changes in phenomena or events through chronological tables and graphs; and the cause-and-effect relationships through structural frameworks, plans, and tables. Additionally, changes in engineering structures or other research objects, as well as the consequences of physical, chemical, mechanical, or technological processes, and even processes occurring in living organisms, should ideally be expressed in the form of illustrations, photographs, photomicrographs, diagrams, and graphs (see Figure 2).



Picture 2

Modeling changes occurring in nature and society, along with representing the results of mathematical and statistical analyses in the form of comparative diagrams, graphs, and tables, is also appropriate.

When creating educational materials and incorporating them into teaching, visual materials must meet the following strict requirements:

Objectivity and Accuracy:

All visual materials must be based on principles of objective reality, authenticity, fairness, and transparency. Additionally, they should reflect changes in events, phenomena, and processes occurring in human society and nature, grounded in laws, principles, and rules, and should be implemented in practice. Otherwise, the integrity of the educational information content will be compromised.

Support for Content Enhancement:

Visual materials should complement, enrich, and make the text content clearer and easier to understand.

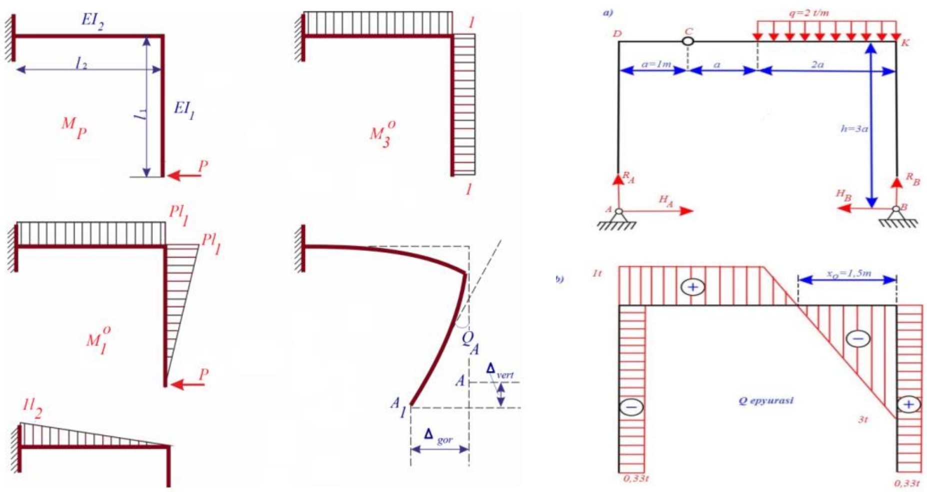
Accessibility for All Learners:

They must be expressed in a clear, precise, and easily understandable manner for learners of various levels.

Alignment with Research and Aesthetic Standards:

Visual materials should correspond to the analysis of research results, have a high level of aesthetic quality and clarity, and avoid “excessive” or conflicting information that could distract from the text's content. Finally, they should not obstruct the layout or readability of the text.

In creating educational literature for subjects like "Strength of Materials," "Theoretical Mechanics," and "Structural Mechanics," it is essential to cover processes such as stress and deformation in beams, shafts, and frames; internal forces and displacement or deformation laws; kinematic and dynamic parameters of absolutely rigid bodies; the internal structure and properties of construction materials; and the structure and working principles of construction machinery and equipment. These should be illustrated with appropriate visual materials, such as diagrams, epures, tables, graphs, schematics, images, and photographs, while adhering to didactic requirements and aligning them with the text content (see Figure 3).



Picture 3

CONCLUSIONS

The above ideas and considerations can serve as a foundation for the following key conclusions aimed at improving technologies for creating new-generation educational materials for technical education fields and their practical application:

Modernizing Traditional Models:

Based on the characteristics of specific chapters (modules) or topics, it is necessary to rely on traditional lesson models while modernizing them. This includes organizing the educational process rationally and striving to enhance the effectiveness of didactic and technical tools used in education.

Integration of Traditional and Non-Traditional Models:

Particularly for topics such as those in the "Strength of Materials" textbook, which deal with research on structural components and broader explanations of the physical, mechanical, and technological aspects of certain phenomena and processes, there is a need to focus on deriving computational formulas and addressing complex problems that most learners cannot independently solve. In such cases, it is advisable to form and apply textbook materials based on the principle of integrating traditional and non-traditional teaching models.

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