

RESEARCH ARTICLE

Problems of Ensuring Interdisciplinary Integration in The Development of Design Competence of Future Engineers

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Abstract

In this work, the problems of ensuring interdisciplinary integration in the development of design and engineering competence of future engineers are analyzed. In the context of the rapid development of modern equipment and technologies, the need for engineering personnel to possess knowledge and skills not only within the framework of individual disciplines, but also at the intersection of various disciplines is substantiated. The study examines the current state of interdisciplinary integration in the higher education system, the factors influencing its effectiveness, and the main problems encountered, including the lack of coherence of curricula, insufficient methodological support, and weak integration of practical classes.

KEY WORDS

Higher educational institution, engineer, essence of the concept of competence, competence, project design competence, knowledge, skills, abilities, personal qualities.

INTRODUCTION

In modern production conditions, an engineer is required not only of theoretical knowledge, but also of the ability to design and construct complex technical systems. Currently, a certain "gap" is observed between the fundamental knowledge and practical skills of graduates in higher technical education.

In prestigious higher educational institutions (HEIs) of the world, as one of the factors in the development of creative and communicative abilities of future engineers, the content and practical actions aimed at improving the quality and effectiveness of preparing students for professional activity in the field of professional activity are being deeply studied. At the same time, it is important to focus the content of education on creative thinking, the formation of practical skills, increasing the share of independent study hours, and improving methods and technologies aimed at practical training. Determining the importance of universities in the innovative development of regions is an important trend in the innovation policy of the EU countries. It should be noted that

at present, the problem of developing the integration of scientific achievements of science, higher educational institutions, and industrial enterprises remains one of the most pressing issues [1-3].

The purpose of the research is to develop an effective pedagogical model for the development of design and engineering competence in students and to assess its effectiveness. Design and engineering competence is a combination of the ability to creatively solve engineering problems, 3D modeling (CAD systems), and work with technical documentation [4,5].

METHODS

At the present stage of reforms being carried out in our republic to modernize the system of continuous education, significant work is being carried out to radically improve the quality of education, introduce advanced pedagogical and information technologies into the educational process, and

integrate the content of education [6-8].

The term "integration" has a long history in terms of content and essence. It was first introduced to science in the 18th century by the philosopher G. Spencer. Today, integration plays an important role in the socio-economic and production spheres of society, including in the field of education, from the micro-world to the macro-world. The possibility of solving important scientific problems through the practical implementation of developmental functions of integration has been proven in practice, and there is a great need for it [9-13].

In particular, O.Kh.Turakulov conducted systematic research in this area. In his research, the information resources of the information educational environment were studied in the following areas: textual materials; mathematical models; organizational structural forms and models; computer educational programs; multimedia educational materials related to a specific educational area; a set of practical programs; materials of traditional educational and methodological complexes related to the subject participating in the information educational environment; materials on choosing the optimal option for performing the functional task of the information educational environment; innovative components of the information educational environment; hardware and software complex reflecting the functional tasks of devices and stands intended for performing practical and laboratory classes [9].

A.I.Avazboev concludes that integration is "the process of uniting individual components into a whole, forming a new property." According to the author, integration should be interpreted as a process [7].

R.A. Mavlonova also interprets integration as a process and emphasizes that it manifests itself in two senses: 1. A system is a concept denoting the state of interdependence of individual differentiated parts and functions of an organism and the process leading to this state. 2. The process of convergence of sciences, carried out together with the processes of differentiation [11].

The study of the practical state of integrated learning in higher education shows that, despite the fact that a number of positive works have been carried out in this area (regarding the integration of the content of academic subjects), there are still a number of issues awaiting solutions. These are the following [12]:

- The concept of integrated education for higher educational institutions has not been developed;
- the integrated content of academic subjects and the methodology for its teaching have not been formed;
- methods of integrating the content of academic subjects have not been identified;
- No manuals have been prepared for teachers showing the integration of the content of academic subjects and its educational possibilities.

The application of the method of dialectical analysis in the process of cognition requires the movement of knowledge from simple to complex, from cause to effect, from accidental to necessary or vice versa. In a word, the highest point of analysis is the holistic object.

The highest level of dialectical analysis arises as a result of synthesis. In essence, the task of synthesis consists of integration (generalization, unification, rounding), aimed at restoring the unity, internal connections, and relationships of the multifaceted aspects (aspects) of the studied object. In this way, one gains knowledge (images) about the change and development of the object.

Analysis and synthesis always require each other and are carried out in continuity, consistency, and interconnection. Their unity leads to a higher level of cognition. In the process of cognition, analysis is always the basis of synthesis.

The following methods were used in the research process:

- Project-based learning: Students were given problem tasks based on real production tasks.
- Integrated learning: Modules have been created that ensure the interconnection of the disciplines "Machine Parts," "Engineering Graphics," and "Material Resistance."
- Experimental group: The study involved 120 engineering students (60 control and 60 experimental groups).
- Mathematical statistics: Student's t-test was used to calculate the results.

RESULTS

In higher educational institutions, the disciplines of the standard curriculum are of great importance for the purposeful training of specialists for their activities. The content of the subjects in the curriculum and the educational process prepare

the ground for the student to acquire the knowledge, skills, and abilities necessary for professional activity in their chosen specialty.

The curriculum, along with the development of students' research, organizational, and managerial qualities in the teaching of compulsory, additional, and elective subjects, provides for the provision of design, engineering, operational, and service services through the integration of production enterprises and higher educational institutions, as well as the comprehensive formation of production training.

The content of this block of disciplines should be oriented towards the profession that students acquire, expand their scientific worldview, and the specialty should be taken into account when teaching the philosophical foundations of understanding the world. The content of compulsory subjects in the technical field should differ from the content of subjects taught in other specialties.

For the organization of the process of developing design and engineering competencies of future engineers, we identified the following principles.

1. The principle of integrity, aimed at the active creative

development of students in relation to professional activity based on modern educational technologies, as a necessary condition for the professional development of future engineers.

2. The principle of consistency, ensuring the holistic organization of the process of developing design and engineering competencies of future engineers based on all its components: goals, content, methods and forms of organizing various types of activities.

3. The principle of a systematic approach to the model, which allows for the use of integrated web technologies in the educational process, the scientific development and theoretical justification of new technologies.

4. The principle of a competency-based approach to education, which allows taking into account the interests and needs of the individual when choosing their orientation, personal characteristics, means and methods of education.

As a result of the conducted pedagogical experimental work, it was established that the design skills of students in the experimental group increased significantly. The following table shows the levels of competence:

Indicators (Levels)	Control group (Before/After)	Experimental group (Before/After)
High (Creative)	12% / 15%	14% of 38%
Middle (Independent)	45% / 48%	42% / 52%
Low (Reproductive)	43% / 37%	44% / 10%

The results showed that in the experimental group, a high level of competence increased by 24%. Students made fewer errors when designing complex parts in AutoCAD and SolidWorks.

DISCUSSION

In order to raise the integration processes between science, education, production, and research to a higher qualitative level during the current implementation of the Law "On Education" in Uzbekistan, we consider it necessary to conduct the following scientific research:

1. Creation of technological, humanitarian, and pedagogical technologies for use in the educational process in educational institutions of the Academy of Sciences and research institutes;
2. Creation of opportunities for students and masters of higher

educational institutions to open small enterprises, ensuring the organic and continuous connection of production technologies with pedagogical technologies;

3. Providing principles that connect and harmonize pedagogical technologies and production technologies. Integration processes between educational, research, and production enterprises will yield positive results if they are carried out based on the following principles:

The principle of professional flexibility: In this case, the goal of fostering the ability of future engineers to master new technological equipment and the need for continuous improvement of their knowledge and skills will be a priority. Accordingly, it is required to include in the content of education a certain set of theoretical knowledge, a high level of formation of skills and abilities, and the study of operational skills and abilities. Professional adaptability covers not only

clarifying the interrelationship between the priorities of state educational policy and the dynamics of improving the quality of training future engineers; revealing the directions, stages of implementation, pedagogical possibilities of intersectoral integration as an innovative process that allows for a synergistic effect in the training of future engineers at the present stage of society's development; studying the interaction of educational and production enterprises, the continuity and unity of their activities, the directions, features, conditions, content and structure, problems, needs and opportunities as an important component of intersectoral integration.

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