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RESEARCH ARTICLE

The Pedagogical and Methodological Necessity of Teaching Specialized Subjects in Developing the Professional Competence of Future Engineers

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Abstract

This article analyzes the pedagogical and methodological necessity of developing the professional competence of future engineers in the process of teaching specialized subjects. It highlights the issues of linking theoretical knowledge with practical professional tasks in engineering education, the purposeful use of digital tools, enriching independent learning with professional content, and directing assessment criteria toward competency-based outcomes.

KEYWORDS

Specialized subjects, future engineer, professional competence, engineering education, pedagogical and methodological necessity, digital learning environment, independent learning, competency-based assessment.

INTRODUCTION

Teaching specialized subjects plays an important pedagogical and methodological role in developing the professional competence of future engineers in modern higher engineering education. This is because, through specialized subjects, students begin to understand technical concepts, technological processes, field-specific principles, practical calculations, elements of design, and engineering problems directly related to their future professional activity. In this sense, specialized subjects are not limited to a set of courses in the curriculum; rather, they serve as a key pedagogical field that shapes the future engineer's professional thinking, practical preparedness, and attitude toward professional activity.

The pedagogical and methodological relevance of this issue is determined by the extent to which the content of specialized subjects is purposefully oriented toward developing professional competence. If the content of a subject is limited only to delivering theoretical information, completing practical exercises, and preparing for final assessment, students' technical knowledge may not be fully manifested in professional situations. Therefore, in teaching specialized subjects, the educational content, methods, assignments, and assessment criteria should be interpreted on the basis of a pedagogical and methodological approach aimed at developing professional competence.

In higher education, the training of engineering personnel is closely connected with technological modernization in production, the widespread use of digital tools, and the growing demand in the labor market for specialists oriented toward practical results. Therefore, the theoretical concepts mastered by students in specialized subjects should be linked with professional tasks, while practical assignments should be brought closer to the future professional activity of the prospective engineer.

LITERATURE REVIEW

The issue of developing the professional competence of future engineers in modern engineering education is not limited to the delivery of theoretical knowledge alone. Richard Felder and Rebecca Brent interpret students' active participation, problem-based and practice-oriented assignments, collaborative learning, and outcome-oriented educational activities as important factors in engineering education. The CDIO approach proposed by Edward Crawley, Johan Malmqvist, Soren Ostlund, Doris Brodeur, and Kristina Edstrom links engineering education with the stages of "conceiving — designing — implementing — operating" and substantiates the need to integrate theoretical knowledge in specialized subjects with real processes of professional activity.

In addition, Anette Kolmos's views on problem-based and project-based learning serve as an important methodological foundation for preparing future engineers to analyze professional situations, develop technical solutions, work collaboratively, and justify the obtained results. Neil Selwyn's ideas on the need to introduce digital technologies into the educational process in harmony with pedagogical goals expand the methodological possibilities of specialized subjects in a digital learning environment. G.F.Ismailova's approach to developing professional competence through independent learning, MOOCs, e-portfolios, and a distance communicative environment also demonstrates the need to enrich independent learning with professional content. Thus, the analysis of existing literature confirms that developing professional competence in the teaching of specialized subjects is a pedagogical and methodological process closely connected with educational content, practical assignments, digital tools, independent learning, and competency-based assessment criteria.

METHODOLOGY

The study used the methods of generalization, systematization, pedagogical observation, comparison, and logical analysis. Through these methods, the interrelationship between theoretical knowledge, practical assignments, digital tools, independent learning, and competency-based assessment in the teaching of specialized subjects was clarified. In addition, the pedagogical and methodological factors related to the development of the professional competence of future engineers were generalized.

RESULTS

American researchers in engineering pedagogy, Richard Martin Felder and Rebecca Brent, explain the effectiveness of the teaching process in engineering education in connection with students' active participation in learning. According to their approach, effective teaching in engineering education is characterized by the following:

firstly, ensuring students' active participation in the learning process;

secondly, linking theoretical knowledge with professional content through problem-based and practice-oriented tasks;

thirdly, organizing collaborative learning and teamwork;

fourthly, implementing learning assignments by orienting them toward a clear outcome [1,5].

This classification shows that the need to develop professional competence in teaching specialized subjects is not limited only to the content of the subject. It is also directly connected with the methodology of organizing learning activities, the content of assignments, and students' practical engagement.

The role of specialized subjects in developing professional competence in engineering education is also widely recognized in international practice. In particular, the CDIO approach — Conceive, Design, Implement, Operate — developed by Edward Francis Crawley, Johan Malmqvist, Soren Ostlund, Doris Brodeur, and Kristina Edstrom, explains engineering education in relation to the processes of "conceiving — designing — implementing — operating" [2,4].

This approach also reflects the main stages of engineering activity. In this regard:

conceiving means identifying an engineering problem, determining needs, and developing an initial conceptual view of a technical solution;

designing means systematizing the selected idea on the basis of drawings, calculations, models, and technical requirements;

implementing means practically carrying out the developed project or technical solution, testing it, and verifying the results;

operating means applying, monitoring, and improving a finished product, technological process, or engineering system in real conditions.

From this perspective, this approach helps to connect

theoretical knowledge with the stages of practical engineering activity in the teaching of specialized subjects. At the same time, it also substantiates the need to introduce students to the logical stages of professional processes and to link theoretical knowledge with project-based and practical activity in the teaching of specialized subjects.

The development of professional competence in teaching specialized subjects is also connected with the nature of learning assignments. If assignments are mainly focused on answering theoretical questions, applying ready-made formulas, or finding solutions based on a fixed algorithm, students' independent engineering thinking may not be fully demonstrated. In assignments aimed at professional competence, students analyze the situation, identify the necessary information, take technical limitations into account, justify the solution, and draw conclusions regarding the result. This requires increasing the share of problem-based, project-based, analytical, and practice-oriented assignments in specialized subjects.

Danish scholar Anette Kolmos substantiates that problem-based and project-based learning in engineering education has a direct impact on students' professional development. Her approach can be explained as follows:

firstly, students are directed toward independently understanding a real or simulated problem;

secondly, project assignments develop the ability to create technical solutions;

thirdly, teamwork develops skills in decision-making, task distribution, and defending results;

fourthly, the learning process strengthens students' ability to analyze professional situations and justify their own solutions [3,9–12].

This view shows that in the process of teaching specialized subjects, learning assignments should be brought closer to professional problems, while students should master knowledge through independent inquiry and practical justification.

At this point, it should be particularly noted that the professionally oriented nature of specialized subjects is manifested in their technical content, practical essence, and direct connection with future engineering activity. However, this feature does not produce a pedagogical outcome by itself. It requires purposeful methodological organization by the teacher. In particular, subject topics should be linked with professional tasks, practical classes should be brought closer to engineering problems, laboratory work should be directed toward analytical conclusions, and independent learning should be connected with searching for technical information and justifying professional decisions.

In Uzbekistan's current educational policy, special attention is also paid to the quality of education, qualification requirements, curricula, and the effectiveness of educational content. In particular, the Law "On Education" stipulates that the quality of education is monitored by determining its compliance with state educational standards, state educational requirements, and curricula [4]. This normative approach demonstrates the need to pedagogically and methodologically substantiate the relationship between educational content, qualification requirements, and professional outcomes in the teaching of specialized subjects.

In the context of a digital learning environment, the content of teaching specialized subjects is enriched with new methodological requirements. Presenting engineering knowledge through digital models, simulating technological processes, conducting experiments through virtual laboratories, completing project assignments on electronic platforms, and analyzing results in digital form expand the content of the educational process. Under such conditions, digital tools should not serve only as visual materials; rather, they should be connected with learning tasks aimed at developing students' professional competence.

International studies on digital education also emphasize that the use of technology affects educational outcomes only when it is aligned with pedagogical goals. In this regard, Australian scholar Neil Selwyn, professor at Monash University, substantiates the need to analyze the introduction of digital technologies into education within a broader socio-pedagogical context. His approach can be classified as follows:

digital technologies introduced into the educational process should be evaluated in terms of how well they serve pedagogical goals;

the use of technologies should be assessed in real conditions related to the activities of students, teachers, and educational institutions;

the effectiveness of digital tools in education depends on their integration with existing infrastructure, institutional capacity, and methodological preparedness;

digital technologies should be regarded not merely as tools for transmitting information, but as pedagogical factors that serve to organize, monitor, and analyze learning activities and to develop professional competence [5,3].

From this perspective, when digital tools are integrated with the content of specialized subjects, students' active participation, teachers' methodological guidance, and assessment criteria, they contribute to the development of the professional competence of future engineers.

Another important aspect of developing professional competence in teaching specialized subjects is enriching students' independent learning with professional content. In G.F.Ismailova's research, the development of students' professional competence through independent learning is examined in relation to an interdisciplinary integrative approach, MOOCs — massive open online courses, e-portfolios, and a distance communicative environment [6]. This approach indicates the need to organize independent learning as a methodological process aimed at developing professional competence.

The pedagogical and methodological relevance of developing professional competence is also closely related to the content of assessment. In specialized subjects, assessing students' level of mastery should not be limited to knowing the topic or completing a ready-made assignment. It should also cover such indicators as understanding a technical situation, choosing a solution, justifying the selected solution, using digital tools, analyzing the result, and demonstrating professional responsibility. Thus, the assessment process should reflect the components of professional competence, show the connection between theoretical knowledge and practical action, and serve to identify the dynamics of students' professional development.

Based on the above analysis, the main pedagogical and methodological factors determining the need to develop the professional competence of future engineers in the teaching of specialized subjects can be summarized as follows.

Pedagogical and Methodological Factors Determining the Need to Develop Professional Competence in Teaching Specialized Subjects

Pedagogical and Methodological Factors	Content	Importance in Developing Professional Competence
Professionally oriented educational content	Linking the topics of specialized subjects with real engineering tasks	Strengthens students' readiness to apply technical knowledge in professional situations
Problem-based and project-based assignments	Guiding students to analyze technical situations, search for solutions, and justify decisions	Develops independent thinking, engineering reasoning, and practical decision-making skills
Interdisciplinary integration	Ensuring the interconnection between fundamental, general professional, and specialized subjects	Facilitates the transformation of knowledge into a unified professional outcome
Purposeful use of digital tools	Using electronic platforms, simulation tools, virtual laboratories, and digital modeling	Helps in the visual, interactive, and analytical mastery of technical processes
Professional content of independent learning	Linking independent assignments with technical problems, digital inquiry, and practical conclusions	Strengthens students' self-development and professional inquiry skills
Competency-based assessment	Assessing, along with knowledge, practical action, technical decision-making, the use of digital tools, and responsibility	Makes it possible to identify the content-related, activity-based, and personal aspects of professional competence

Thus, the development of professional competence in teaching specialized subjects is not limited merely to enriching educational content. This process is shaped on the basis of interconnected pedagogical and methodological factors, such as professionally oriented assignments, interdisciplinary integration, the purposeful use of digital tools, linking independent learning with professional content, and developing competency-based assessment criteria.

CONCLUSION AND RECOMMENDATIONS

From this perspective, the development of professional competence in teaching specialized subjects is justified as a pedagogical and methodological necessity by the following factors:

— the practical and technological nature of engineering activity and the need to link educational content with professional tasks;

— the integration of digital tools into the learning process and the need to direct them toward the development of professional competence;

— the need to enrich independent learning with professional content and support students' individual learning activities;

— the requirement to develop technological thinking and orient assessment criteria toward competency-based outcomes.

These factors show that the issue of developing professional competence in teaching specialized subjects emerges as a complex pedagogical and methodological problem that requires the integration of theoretical knowledge, practical activity, digital tools, and assessment criteria.

REFERENCES

1. Richard Martin Felder, Rebecca Brent. Teaching and Learning STEM: A Practical Guide. Jossey-Bass, 2016, p. 5.
2. Edward Francis Crawley, Johan Malmqvist, Soren Ostlund, Doris Brodeur, and Kristina Edstrom. Rethinking Engineering Education: The CDIO Approach. Springer, 2014, p. 4.
3. Anette Kolmos. The Aalborg PBL Model: Progress, Diversity and Challenges. Aalborg University Press, 2004, pp. 9–12.
4. Law of the Republic of Uzbekistan "On Education" No. LRU-637. September 23, 2020. Article 43. Source: https://lex.uz/docs/-5013007
5. Neil Selwyn. Education and Technology: Key Issues and Debates. Bloomsbury Academic, 2016, p. 3.
6. Ismailova G.F. Methodology for Developing Professional Competence in Students through Independent Learning. Abstract of the Dissertation for the Degree of Doctor of Philosophy (PhD) in Pedagogical Sciences, Bukhara State University, Bukhara, 2025.