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THE ROLE OF EDUCATION POLICY IN VOCATIONAL TRAINING: INTEGRATING GENERAL AND SPECIALIZED LEARNING IN FIRE ENGINEERING

INTEGRAÇÃO DO TREINAMENTO TÉCNICO GERAL E ESPECIALIZADO NAS UNIVERSIDADES DE ENGENHARIA DE INCÊNDIO A

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ABSTRACT

Objective: To develop and implement a model that integrates general technical education with specialized training in fire engineering universities to enhance vocational education and prepare students for practical professional demands.

Methods: This study uses a combination of theoretical and empirical approaches, including pedagogical design, contextual learning, and professional orientation theories. It involves testing a four-stage educational model within the "Thermal Engineering" discipline, guiding students from basic learning activities to complex professional tasks.

Results: The implementation of the four-stage model demonstrated effectiveness in integrating general and specialized learning, facilitating students' transition from academic to professional environments. The model helped clarify the progression from learning basic concepts to applying knowledge in practical settings, enhancing both understanding and skill acquisition.

Conclusion: The study validates the necessity and effectiveness of integrating general technical and specialized training to prepare students adequately for professional demands in fire engineering. It also highlights the importance of creating educational environments that mimic real-world challenges.

Keywords: General technical education; Specialized training; Problem-based task; Continuity; Tradition, Intuitive activity approach.

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RESUMO

Objetivo: Desenvolver e implementar um modelo que integra a educação técnica geral com o treinamento especializado em universidades de engenharia de incêndio para aprimorar a educação vocacional e preparar os alunos para as demandas profissionais práticas.

Métodos: Este estudo utiliza uma combinação de abordagens teóricas e empíricas, incluindo design pedagógico, aprendizagem contextual e teorias de orientação profissional. Envolve o teste de um modelo educacional de quatro estágios dentro da disciplina "Engenharia Térmica", guiando os alunos desde atividades de aprendizagem básica até tarefas profissionais complexas.

Resultados: A implementação do modelo de quatro estágios demonstrou eficácia na integração do aprendizado geral e especializado, facilitando a transição dos alunos de ambientes acadêmicos para profissionais. O modelo ajudou a esclarecer a progressão desde o aprendizado de conceitos básicos até a aplicação de conhecimentos em contextos práticos, melhorando tanto a compreensão quanto a aquisição de habilidades.

Conclusão: O estudo valida a necessidade e eficácia da integração do ensino técnico geral e especializado para preparar adequadamente os alunos para as demandas profissionais em engenharia de incêndio. Também destaca a importância de criar ambientes educacionais que imitam desafios do mundo real.

Palavras-chave: Educação técnica geral; Treinamento especializado; Tarefa baseada em problemas; Continuidade; Tradição; Abordagem de atividade intuitiva.

1 INTRODUCTION

The structure of specialized technical education includes the knowledge, abilities, and skills mastered in general technical education, which reflect the interconnections of scientific and technical knowledge, techniques, and technologies in specific directions of science and technology. The interactive academic course of each general technical discipline has its fundamental core (FC) of natural science knowledge that is integrated into the FC of the specialized area of scientific knowledge (Babina, 2012; Medvedeva, 2020a; Medvedeva & Permyakov, 2018).

From this perspective, the objective and subjective models of vocational specialist training at a university need to interact in the context of successive detailization of educational objectives. The goal of this gradual identification of objectives is to understand the personal meaning of future professional activity (PA) in successive development of the types of activities: from learning activity (LA) to quasi-professional activity (QPA), from QPA to professional training activity (PTA), and on to PA.

A personal recognition of the goals and practical objectives of future PA provides for a

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personal transition of each learner from the theoretical stage of goal-setting to the practical stage of realizing the set goals.

The issue of integrating general technical and specialized training becomes a topical educational task that provides for the required level of professional training in technical universities. This integration becomes an invariant precondition of the quality of vocational education in engineering (depending on future PA).

The theoretical prerequisites for solving this urgent educational task include achievements in the theory of pedagogical design; theories of contextual learning (A.A. Verbitskii); theories of professional orientation (N.V. Kuzmina, V.A. Slastenin); scientific and practical studies on the relationship of theory and practice (A.P. Beliaeva, A.V. Barabanshchikov, V.A. Izvozchikov); studies on the pedagogical aspect of information culture (V.A. Izvozchikov, E.A. Tumaleva, M.P. Zolotukhin); studies on the need for creativity in students (A.I. Subetto, A.V. Dolmatov) (Bordovsky et al., 1995; Dolmatov, 1998; Verbitsky, 2017).

S.N. Kozlova's work confirms that the motives of PA are developed more intensively if the university educational process is designed as a gradual introduction to the profession (Kozlova, 1998).

The regulatory norms of gradual introduction to the subject field of future PA include the gnoseological principle of reflection, the methodological principle of continuity, and the methodological principle of systematicity.

According to the gnoseological principle of reflection, the content of educational and cognitive activity in the university educational process needs to be reflected in the content of future professional practice.

The methodological principle of continuity as a regulatory norm requires the continuity of students' activities in university vocational training.

The methodological principle of systematicity as a regulatory norm requires the creation of necessary didactic conditions for the personal discovery of the systematic nature of scientific and technical knowledge by the learner, which includes the core of natural science knowledge, basic knowledge of general technical disciplines, and specialized knowledge (a variation of the FC).

In the educational process of general technical disciplines, the future active subject of PA needs to personally master the experience of transformative activity as part of logically complete fragments of real types of tasks.

As argued by H. Spencer, "The great aim of education is not knowledge, but action"

(Frolov, 1991, p. 344).

Personally mastered knowledge represented by sign systems needs to become a means of regulation and a guiding foundation for the student's LA, QPA, PTA, and PA.

The continuity of the types of students' activities (LA→QPA→PTA→PA) by the didactic means of the general technical discipline is a prerequisite for:

fostering a culture of using the personally mastered triad of knowledge, skills, and abilities as a means of regulating competent practical actions,

personal understanding of the meaning of activity in mastering the subject and structure of future PA,

the quality of professional and technical training of a specialist.

The goal of the study is to explore and develop an effective model for integrating general technical and specialized training within fire engineering universities.

2 METHODS

Our 2023 research aimed to integrate general technical and specialized education in fire engineering universities, combining theoretical and empirical approaches. Theoretical foundations included pedagogical design theory, contextual learning, and professional orientation theories, supported by studies on the relationship between theory and practice and the pedagogical aspect of information culture. Research on fostering students' creativity contributed to the framework.

3 RESULTS AND DISCUSSION

Table 1 presents the main directions of professional training with the corresponding normatively specified types of PA mastered in the educational process in fire engineering universities.

Table 1. The main directions of professional training and corresponding types of PA

Direction of vocational training	Types of tasks as part of PA
specialty "Fire safety" (direction (profile) "Firefighting")	production technology, design and construction
specialty "Fire safety" (direction (profile) "State fire inspectorate")	production technology, design and construction
specialty "Technosphere safety" (direction (profile) "Fire safety")	production technology, service and maintenance
specialty "Forensic expertise" (direction (profile) "Engineering and technical expertise")	expert

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In fire engineering universities, the general technical discipline "Thermal engineering" is included in the educational programs in all areas of vocational training of specialists and undergraduates. Under the conditional numbers in Table 2, we present the normatively specified components of competencies to be formed in the study of the discipline.

Figure 1 depicts the essential connections of the normatively specified components of competencies with the subject matter of the training course of the discipline, which has its FC (Arkharov & Afanasyev, 2011; Koshmarov & Bashkirtsev, 1987; Lykov, 1967).

The distribution of knowledge and skills formed in the training course of the discipline (under the numbers adopted in Table 2) by the types of professional activities of training directions in fire engineering universities is presented in Figure 2.

Based on the example of analyzing the distribution of knowledge and skills formed in the discipline by the types of tasks as part of PA in the directions of professional training of fire engineering universities, we propose a model of the development of the main types of student activities based on their real continuity.

Table 2. Knowledge and skills formed in the discipline "Thermal engineering"

1	The ability to use methods of calculating thermal resistances in practical calculations using the example of series and parallel inclusion and to analyze the factors affecting the thermophysical processes to the greatest and least extent
2	Knowledge of how to perform calculations using spreadsheets, data sorting tools, and graphic information presentation
3	Knowledge of the main advantages and disadvantages of numerical modeling of thermal processes for the analytical and in-situ variants of problem-solving, methods of calculations, basic assumptions, and limitations
4	The ability to use the finite difference method as an example of solving heat conduction problems, use analytical solutions, and determine the limits of applicability of thermal models
5	Knowledge of the principles of thermodynamic transformation of thermal and mechanical energy and the factors determining the efficiency of these processes and physical differences of the main methods of heat transfer in closed spaces, technological equipment, and open spaces
6	Knowledge of the thermophysical principles of operation of technical tools for analyzing the fire situation using remote detection devices, performing fire extinguishing, and calculating safe distances from the source of the fire
7	The ability to substantiate the use of design solutions and means of protection against thermal impact based on the principles of absorption and reflection of thermal radiation and assess the pressure and temperature of gas mixtures in hermetically sealed containers
8	Knowledge of the physical principles underlying the regulations for determining temperature, heat fluxes, and other thermophysical parameters and ensuring the safety of technological processes and the procedure for assessing the fire resistance of enclosing structures and transformable fire barriers
9	The ability to evaluate the parameters of the state of thermodynamic systems and gas mixtures under the conditions of thermal influence and the efficiency of conversion of heat energy into other types and analyze the contribution of different types of heat exchange depending on the specifics of the task addressed and fire conditions

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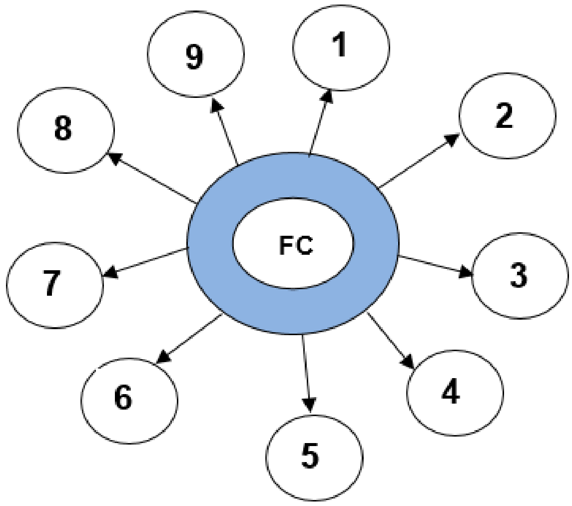

Figure 1. Content relationships between the normatively defined competence components and the subject matter in the curriculum of the discipline "Thermal engineering"

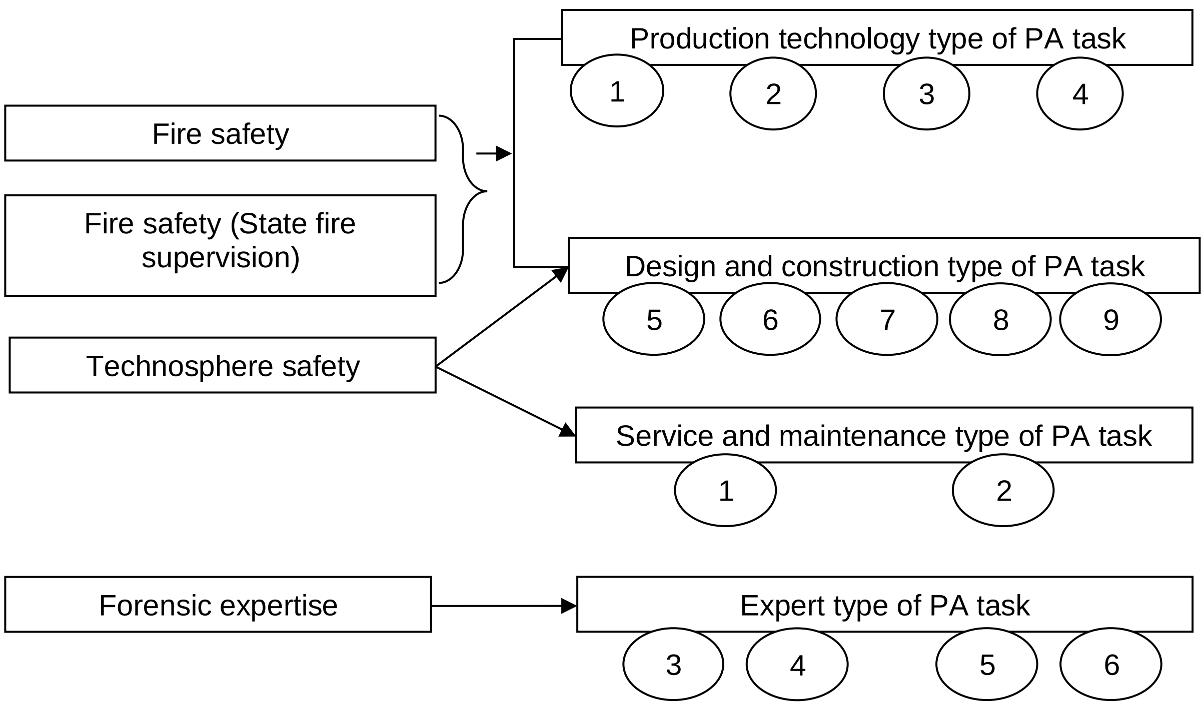

Figure 2. Distribution of knowledge and skills formed in the discipline "Thermal engineering" by the types of professional activities of training directions in fire engineering universities

The convergence of the structure of training with the structure of future PA is achieved in the course of three interconnected stages, which **successively substitute the subjects of activity** and **transform the form** of individual problem-based knowledge.

The first (preparatory) stage involves preparation for solving contextual tasks. Students engage in LA to master the conceptual apparatus and FC of the discipline. To practice the practical skill of solving problem-based tasks, students complete **individual problem-based <u>thematic</u> assignments**, acquire the skills of working with reference

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literature, and master specially developed educational and methodological virtual training complexes (Medvedeva, 2020b; Shadrikov, 1996).

At the second stage **(contextual modeling)** the subject of LA is **substituted by the subject of QPA**. The problem situation of a training task is **replaced by a situation approximated to the professional**, asking to solve an individual **contextual task**, the subject of which is a logically completed fragment of a professional (real) task (Medvedeva & Romanov, 2022).

Table 3 presents a list of contextual tasks for practicing the skills and abilities of PA in the areas of training offered by fire engineering universities.

All contextual tasks are software products of our development. Certificates of state registration of software products have been obtained (Kuzmin et al., 2023; Medvedeva et al., 2022; Romanov et al., 2020, 2021, 2023; Romanov & Kuzmin, 2019a, 2019b; Romanov & Permyakov, 2022; Volkov et al., 2023).

In the process of developing **the stage of contextual modeling of QPA** in the subject field of the discipline, the system of principles of contextual modeling, presented in Table 4, was established as **the regulative norms of teaching and LA**.

Table 3. Contextual tasks by professional training areas

Direction of vocational training	**Specific tasks to practice professional skills and abilities**
Fire safety	1. Choosing the material and thickness of the protective coating for a fire barrier under the conditions of a prolonged fire 2. Determining the thickness of the protective layer of reinforcements in a reinforced concrete wall 3. Determining safe distances for fires with liquid hydrocarbon spills 4. Thermal calculations for the structural elements of a fireproof curtain under the conditions of prolonged fire
Technosphere safety	1. Calculating the time of formation of an explosive mixture 2. Determining the temperature field of a slab in a room fire 3. Calculating local temperatures of the room environment in a fire 4. Successive parameterization in solving the problems of design solutions optimization
Forensic expertise	1. Gas leaks 2. Structural calculations for heat exchangers 3. Determining the minimum distance between different objects 4. Determining the thickness of the protective layer of reinforcements in a reinforced concrete pillar

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Table 4. The system of principles of contextual modeling in the discipline "Thermal engineering"

Regulatory norms (principles) of modeling QPA	
Real problem-based nature	Each topic of the training course and the study objects in the development of real professional problems are determined by the future
Unity of basic and variable components	Analysis of the structure of systemic scientific and technical knowledge and the models of future PA
Complementarity	The model of PA becomes cohesive if the modeled fragments of PA complement each other
Interdisciplinary interaction	Interaction with the teachers of specialized and general technical disciplines whose pedagogical field models QPA
Uncertainty	Prohibits the **simultaneous** consolidation of decision-making algorithms and the algorithms of practical actions by the subjects of QPA in the framework of contextual modeling
Modern information support for QPA	Ensuring feedback in a human-machine system and developing the skills of information inquiry, search, and critical analysis
Business communication	The requirement of constructive rather than formal role interaction between the teacher and students in a situation approximated to the professional context
Professional ethics of an engineer	Honesty, responsibility, respect for the rights and dignity of others, and tolerance
Developing the personality of a modern engineer	Require directing pedagogical influences towards the development of metacognitive experience (self-control, autonomy, self-organization, reflection, comprehension of previously acquired experience, self-assessment of actions)

Contextual problem-solving is carried out in a human-machine (ergatic) system, in which the student's natural intelligence plays the leading role, and the teacher's functions include information support, counseling, and operational assistance in dead-end problem situations in solving contextual problems.

At the third stage (course design), the subject of QPA is ***replaced by the subject of PTA*** (LA→QPA→PTA), and ***the contextual task is transformed into the form of a course project*** – a certification test for the main training program, which is the final (research) stage of the discipline. In course design, **the subjects of contextual tasks are replaced by the subjects of engineering tasks** that require mastery of special calculation methods and qualified application of normative documents and special technical literature.

The educational process in technical universities in all areas of training is completed with thesis defense, in which the personal readiness of the graduate to solve professional problems is manifested.

From these positions, it is necessary to realize the fourth (final) stage, at which students working on their thesis design realize the successive final transition from PTA to PA (LA→QPA→PTA→PA).

At the fourth stage (thesis design) **the subject of PTA is replaced by the subject of PA**. At the stage of the thesis project, each student who carried out scientific research as part of the course project gets the opportunity to expand and deepen the subject of scientific

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research and obtain practically significant research findings relating to the subject of their future PA.

These interrelated stages of transition from educational to PA based on the **transformation of the form** of educational tasks become the stages of introduction to the profession in the subject field of the general technical discipline.

From stage to stage, each student gradually forms an image of their future profession as a result of personal interiorization of the system of gradually expanding knowledge about the profession, its meaning, and significance for human life and society, which gives an emotional experience of its correspondence to personal attitudes and needs.

From this standpoint, the following aspects become extremely important at each stage of introduction to the profession:

the student's ***position,*** which is formed by pedagogical means and can be assessed based on the student's engagement in the learning process and their attitudes to the results,

the principle of unity of the personal and activity as a system-forming factor in the upbringing and training.

In this context, the psychological condition for the organization of gradual introduction to the profession is the formation of a system of basic motives of PA: professional, cognitive-professional, managerial, and research (Medvedeva, 2020b; Shadrikov, 1996).

The professional motive as a systemic formation includes the need to acquire a profession as a social necessity; personally significant desire to become a professional; positive attitude to the profession; readiness to perform professional functions and carry out conscious regulation of activity.

The cognitive-professional motive stimulates interest in professional knowledge. ***The managerial motive*** arises as a consequence of mastering the role functions in situations approximated to professional in designing course and thesis works.

To conclude the results of the study conducted at the St. Petersburg University of the State Fire Service of the Ministry of Emergency Situations of the Russian Federation, we should highlight that our search for a solution to the topical issue of integrating general technical and specialized training in technical universities relied on the study of historical traditions of the Russian classical engineering school created by M.V. Lomonosov (Bilyarsky, 1865).

The need to integrate general technical and specialized education in technical universities reflects the need to revive the traditions of the intuitive activity approach to technical vocational education, which served as a foundation for the Russian classical

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engineering school.

According to the intuitive activity approach, students were gradually introduced to professional engineering activity. At the first stage, students mastered natural science (fundamental) knowledge. At the second stage, students mastered the skills and abilities to use knowledge for regulating independent practical actions in logically completed fragments of engineering activity. At the final stage, students acquired the ability to develop the mastered fragment of engineering practice and transform it innovatively.

At the core of this approach was a deep conviction of the founders of the Russian engineering school that the content of education not only determines the success of self-realization in the profession but also "corrects the damaged morals" of society and "purifies the mind" of man.

4 CONCLUSIONS

In the framework of the integrative training course of the general technical discipline "Thermal engineering" in fire engineering universities, the developed didactic means and tools allow for a gradual introduction into the subject field of future PA through a conversion of the structure of learning with that of future PA.

The didactic means of the discipline ensuring the succession of students' activities (LA→QPA→PTA→PA) in the subject field are practice-oriented problem-based assignments, whose form is successively transformed (training problem-based tasks, contextual tasks, course projects, thesis projects).

In the implementation of the four interrelated stages, the succession of the subjects of activity and a transformation of the form of individual problem-based tasks occur simultaneously.

The problem of integrating general technical and specialized training into the study of the discipline is addressed in an informational educational environment of our development, which offers the conditions necessary to solve real professional tasks and conduct research.

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