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DESIGN OF TAILOR-MADE TARGETED TRAINING PROGRAMS AT A TECHNICAL UNIVERSITY

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Keywords: tailor-made targeted training; additional professional programs; strategy; step-by-step methodology of tailor-made educational program design.

Abstract: The paper discusses the issues of using dynamic variability methods in design of additional professional programs (APPs) at a university that provides specialists' targeted training. The design process is presented as a sequence of actions for a step-by-step deep study of the situations and positions of all actors interested in the results. The purpose of the article is to offer specific recommendations on the theory and practice of designing the APP under continuous change and adjustment of industrial structure and objectives through the analysis of current industrial challenges and problems.

The authors found that the quality assurance of targeted training at university is achieved through the development of APP based on dividing the design process into certain stages, using a multilevel methodological design structure, applying the principle of dynamic design variability; using an iterative algorithm for the sequential involvement of experts and the Bayesian approach to reassess the results of the examination in order to develop a reasonable optimal solution.

Introduction

In recent years, social and economic changes have been observed more and more clearly in the country, which noticeably affects industrial and scientific spheres, as well as the education system. These changes cannot be ignored by

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organizations and enterprises. The state finances priority programs and projects for mass digitalization of all spheres of human activity. In industry, the transition to professional standards is being carried out, in the higher education system, there are processes of fragmentary renewal of state educational standards for training specialists, in universities, current curricula, work programs are constantly being revised, and additional educational programs are being developed in accordance with the needs of the regional economy. In a number of specialist training areas, targeted admission of students is organized both with the aim of increasing the prestige of certain industries (for example, for the military-industrial complex (**MIC**)) and providing qualified workers for regions with personnel shortage. Targeted training becomes the most important indicator of the idea (and program documents) of integrating science, education and industry.

The traditional education system, being focused on the individual (basic) competencies formation, is not able to meet the needs of modern society for targeted specialists. Thus, it is necessary to search for new forms and approaches to the organization of the educational process, to ensure the unity of the theoretical and methodological foundations for the design of various kinds of professional educational programs, and their integration. All this is reflected in the new educational standards, curricula and educational programs. The key role in the issues of targeted training is assigned to the creation of a regional system of professional training of such specialists, since the territorial conditionality of universities is focused on training specialists for regional enterprises. At the same time, a wider circle of various kinds of specialists are involved in the design processes of new educational programs, who need to be armed with the methodology of pedagogical design.

The Federal Law "On Education in the Russian Federation" of December 29, 2012 No. 273-FZ does not actually regulate the content of additional vocational education programs, therefore, many methodological aspects of their design in educational organizations are not normatively fixed, although the provisions give rise to a number of significant problems.

The organization of specialist targeted training at Tambov State Technical University (**TSTU**) dates back to 1993 and is focused on the comprehensive satisfaction of the requirements of all subjects interested in targeted training: students, their parents, the state, the customer enterprise and the university. Since 2014, the targeted program "Development of an integrated system for training highly qualified personnel to military-industrial organizations of the Russian Federation (The Program "New personnel for the military industry"), has developed into 18 specialized educational programs delivered by the university. At the same time, the university is a system-forming link of targeted training in the region [1].

The primary task in this case is the high-quality development of the targeted training. In the last decade, the radio-electronic enterprises in Tambov have been characterized by such transformations as re-equipment with modern apparatus and equipment, widespread digitalization of production processes, the use of new computer programs, new forms of organizational work, restructuring and reallocation of full-time employees and much more. In the opinion of the administration and employees, on the one hand, this has led to an increase in labor productivity, and on the other, to an increase in workload per one individual by 1.5-2 times (mainly due to the need to master new skills and competences).

In this article, based on the analysis of experimental study data of employees' working conditions of customer enterprises and the needs of young specialists, the causes of major professional challenges in the workplace, the need for the development of targeted training programs and their content are identified; possible methods of development and implementation of target programs are described, the author's approach to the design of variable educational programs of target professional orientation is proposed.

Materials and methods

The first problem in the development of APP is the problem of their content. As part of the APP design is targeted training of radio-electronic specialists in 2015 – 2019. We carried out an experimental study, in which employees of organizations of the defense-industrial complex of the city of Tambov took part. The first problem is the small proportion of young employees (21 % under the age of 35), which is not sufficient to transfer experience and knowledge from the older generation to the young workers (personnel reproduction). At the same time, some employees occupy engineering positions, without having higher education qualification. Another problem is the transition to professional standards that affects the issues of establishing the employee's compliance with the type of position held and a certain type of professional duties.

We analyzed the reasons for the slow development of new production orders. In most cases, an increase in the volume of special individual orders require certain support both at the documentary and technical levels, which is consistent with the data of foreign authors.

In addition, the following factors negatively affect the efficiency of radio-electronic enterprises:

– lack of proper staffing;

– imperfection of the wage system.

It should be mentioned that modern enterprise workers must have the skills of innovation. The experience of training young specialists and (their mentors) for such activities has been practiced in our university for a relatively long time [2]. The primary task was to identify the profile of a modern specialist. For this purpose, the effectiveness of operation of various departments and divisions was assessed; the features of professional activity and the types of tasks to be solved were investigated. As quantitative indicators of efficiency, we studied the cost of working time for various types of professional activity during one working week. The ultimate goal was to identify an additional group of specialized professional competencies to which targeted training should be oriented.

A survey of employees of enterprises and leading specialists revealed the most significant reasons affecting production efficiency (structured in Table 1).

The overwhelming majority of respondents – 95 % – were able to cope with the workload; at the same time, 65 % of them answered that the increased workload insignificantly reduced the quality of the work they perform, and only 35 % confidently answered that the workload did not affect the quality of the work performed.

Table 1

Reasons affecting productivity

Response options	% of respondents
Increased professional workload resulting from increased workflow	79
Increased volume of accompanying documentation in the manufacture of products	46
Insufficient number of specialists in departments	15
Irrational labor organization in departments and structural divisions	5

The next part of the study concerned the assessment of the actual expenditure of working time for types of professional activity in solving the main professional tasks (Table 2). In the future, this was the initial information to streamline and highlight the group of specialized professional competencies and their component structure.

Table 2

The cost of working time in solving of professional problems

Competency indicators	% of the working time costs
Research activities	
Work on the computer, documentation	40
Work with regulatory documentation, reference books and literature	30
Consultations and discussions with colleagues of complex issues	20
Work on the study of the colleagues' experience, the search for new creative solutions	5
Self-control and verification of work performed	5
Organizational and management activities	
Work on the computer and the preparation of reporting documentation	40
Discussion of current issues with colleagues at meetings, planning and distribution of tasks	40
Self-check of performed work	5
Verification and evaluation of work performed by colleagues	15
Design and technological activities	
Work on the computer for the projection and preparation of design and technological documentation	60
Work with normative and technical documentation, standards and professional literature	5
Consultations of employees from other departments	15
Self-control of performed work and submission of reporting documentation	5
Discussing with colleagues current issues and tasks, for work planning	5
Service and maintenance activities	
Visual and instrumental inspection of objects	20
Preparation of equipment and research of components and parts on a computer	20
Work with documentation	20
Preparation of systems and stands for equipment testing and adjustment	5
Equipment health research	25
Self-monitoring of performed work	5
Consultations of colleagues	5

Table 3

The competency model as a profile of a modern specialist subject to targeted training

Competency components		
Professional component		Industry-wide (universal and general professional competences)
Specialized professional competences	Professional competences from professional standards	
Research	Structural components of competencies	
Organization and management	– Motivational and valuable (professional motives and interest in the profession, willingness to work in the specialty, to professional development);	
Design and technology		
Service and maintenance	– Functional and creative (professional knowledge, skills; readiness to develop, replenish and improve them; ability to carry out professional activities);	
	– Reflexive-evaluative (the ability to make decisions independently and take responsibility; the ability to critically evaluate others; objective self-esteem);	
	– Communicative (sociability; ability to work in a team; knowledge of the ethics and conduct code norms in the team)	

The results of the study highlighted the most labor-intensive activities, including modeling, design and tuning of radio communication complexes, teamwork, implementation of research scientific and innovative projects.

Based on the research carried out, a competence model (a portrait of a modern specialist) was determined, presented in Table 3.

The basic skills of workers, demanded by modern production, are revealed: communicative interaction; exercise control and self-control of the work performed; ability to make non-standard decisions and creative approaches to solving professional problems

The implemented research methodology made it possible to identify, structure, substantiate the competencies that determine the content of the professional work of radio-electronic specialists, which should be targeted by the APP.

Research results

The specific difficulties of designing the APP are determined by the presence of specific factors, many of which are clearly not measurable, therefore they cannot be mathematically processed and thus provide the possibility of choosing an optimal APP. Regional factors also have a significantly impact. The development of such programs involves direct participation of almost all stakeholders who are interested in the results of their implementation - teachers, students and their parents, customers, industry, the government. Therefore, these programs solve not just problems of the economy, but also the didactics of higher education, as well as numerous organizational and educational problems, such as selecting forms of education, a specific place of study, a schedule of classes, administrative guidance of the educational process, etc. the conditions of variable educational programs [3], programs that

meet the objectives of national, regional and local socio-cultural characteristics and traditions, ensuring that the individual characteristics of students and their interests are taken into account.

Considering the fact that it takes a lot of time to conduct pedagogical professional experiments in order to verify the validity of the ideas and proposals put forward, it is most realistic to make operational decisions on the content, structure, conditions for the APP design aimed at the timely implementation of innovative projects on the basis of expert assessments of various options by specialists, using methods of scientific planning and methods of statistical processing of the results. The experience of our work allows us to assert that ideology can be considered a "strategist" in real life.

The term "strategy" in our study means primarily the choice of the methodological foundations for the APP design, ensuring the achievement of the required quality of targeted training of specialists, taking into account the socio-economic situation and psychological characteristics of both students and customers.

Taking into account the dynamically changing nature of professional tasks reflected in specific target results [4], the most expedient was the use of the idea of stage-by-stage design as the first strategy [5], in accordance with which the holistic process of designing the APP for targeted training is divided into a set several stages, at each of which the entire set of actions is subjected to an evaluative analysis, given the emerging new conditions and available solutions, and each step is based on an assessment of possible consequences and possible subjective counteractions. At the same time, the main design tasks, from a methodological point of view, are the following sequence of actions: motivation (disclosure of the relevance of the project), concept formation (solving existing problems of socio-economic development), direct creation of a project, its implementation (execution), verification of the adequacy of the solution of the assigned tasks, assessment of effectiveness [6]. The results of solving each of the listed tasks necessarily predetermine the implementation of the subsequent ones, which thus ensures the implementation of the principle of the continuity of the design process.

As a result of the analysis of pre-project studies, we have chosen the a three-level design methodology, implemented in four stages and based on methodological approaches and methods as a second strategy (Table 4).

At each of the identified main stages, it is possible to perform smaller ones corresponding to the structure of the tasks being solved.

It is assumed that APPs are aimed at the formation of specialized professional competencies (**SPCs**) (see Table 3), ensuring the implementation of specific professional tasks for the targeted training of specialists, so that a competence model of a specialist that satisfies the modern profile is created.

Given the significant financial costs of training engineering personnel (extra-budgetary training costs at least 90 000 rubles / year), it is not advisable to make a mistake with the formation of professional competencies, a quality guarantee for targeted training of engineering personnel is required. This makes it possible to offer the third strategy – the implementation of actions to improve the scientific and methodological apparatus through the selection of the optimal combination of methods at each stage of the APP design and informed decision-making at each methodological level of design.

Table 4

Strategized methodology for APP stage design

Methodological Levels of APP Stage Design				
Levels	Target	Functional technological	Assessment	
Theoretical and methodological approaches	Competency, system, process, praxeological	Integrative-modular, systemic, environmental, personality-oriented	Qualimetric, synergetic, process	Synergetic, qualimetric, cybernetic
Methods	Timing the complexity of production activities	Method of expert assessments (phased re-evaluation of the results according to the Bayes formula)	Qualimetricm ethod	Expertjudgment, questioning
Stages	**1. Stage** Identification or clarification of the competencies composition	**2. Stage** Identification or clarification of the competencies composition	**3. Stage** Development of criteria and indicators for assessing competencies	**4. Stage** Assessment of the degree of predisposition to the type of professional activity
Result	Competency model	Organization of technology target training	Evaluation matrix	Certificate of readiness (disposition)

The three-level design methodology used has characteristics inherent to each level:

– the target level provides for the selection of didactic mechanisms for identifying and clarifying the composition of SPCs;

– functional and technological level contains didactic mechanisms and methods for choosing the technology (methodology) of professional training, ensuring the readiness of students to meet the requirements of target training;

– the assessment level provides for the solution of two tasks: the development of criteria and indicators for the SPC assessment and evaluation of students' professional predisposition to the type of professional activity, their orientation to a specific type of activity (specific type of industry).

The selection of the optimal combination of methods used at each stage of the APP design for targeted training (see Table 4) makes it possible to make the sequence of actions for the design reasonable and ensuring the formation of the required portrait of a modern specialist in the radio-electronic profile.

The fourth strategy is the use of the principle of dynamic variability in the design, which consists in the fact that several alternative options are formulated, which are subjected to careful examination. As a result, the best option is determined, or everything is rejected in order to formulate new ones. The main criterion for the priority of options is the assessment of the probability of the proposed options according to Bayes' formula and the reassessment of the hypotheses put forward [5]. Thus, a reasonable choice of the most effective teaching technology (method of program implementation) is provided in the

context of dynamically changing requirements for the level of professional competencies of graduates [3].

The principle of dynamic variability (the corresponding stratagem) was used by us to substantiate the choice of concentrated teaching as the main form of targeted training of students in the APP [5].

Each of the alternative options usually has both advantages and disadvantages. The university is faced with the task of choosing an option that will allow, with the highest probability, to solve the problem of forming the competencies required by the educational standard and additional agreement. To reduce the likelihood of errors in the prompt decision-making of the indicated problems, as a separate fifth strategy, we single out the methodology for choosing a priority option (forms of learning, technology / teaching methods) and building a decision-making algorithm, using an iterative algorithm for sequential involvement of experts and a Bayesian approach for re-evaluating the examination results [2].

The ability to outline the most effective pedagogical trajectories consists in the application of the Foresight methodology, which consists in generalizing the disparately existing expert positions (including by "pushing" experts against each other) [4]. Considering that each expert is not absolutely confident in making a decision, we can only talk about the probability of making an informed decision, which can be independently assessed, i.e. the priority place of the project and the confidence level of the decision made can be indicated. An expert assessment can be carried out simultaneously by several experts, and the results then undergo statistical processing. In our practice, it turned out to be a more acceptable option of consistently attracting experts, when their number can be optimized. The algorithm for choosing a priority option among the selected ones was discussed in detail in [5], using a specific example. It confirms our main idea that the process of the APP design should be considered as a sequence of strategies that ensure optimal quality achievement of the set goal.

Thus, the process of the APP design presented in the article includes a sequence of the following strategic actions: selecting design stages, using at each stage a three-level methodology (goal-technology-assessment), improving the methodology based on dynamic variability methods and choosing the best option using probabilistic mathematical methods.

The initial information for the content of the programs is the demands of the economy, production and the real conditions for their implementation at a particular enterprise, with regard to trainees' interests. In terms of the ideas presented, about 20 educational modules have been developed, approved by the academic community (within the framework of the implementation of the targeted program "New Defense Industry Personnel") and are being implemented at the university, including "Development of intelligent means and radio communication systems", "Design of intelligent electronic warfare systems", "Design and operation of modern mechatronic systems at defense industry enterprises", etc.

The accomplishment of targeted training, as well as the achievement of the planned educational outcomes, is assessed annually by the criteria for a comprehensive assessment of the quality of university training.

Discussion and conclusions

Summarizing the above, it can be noted that the process of the APP design is a creative process, embedding professional and pedagogical actions to form new, experimentally identified competencies into the current structure of state educational programs. Most rationally, such work should be carried out in stages, relying on the identified stratagems as tools to ensure the required level of quality in the design of the APP for targeted training. This paper completes a whole cycle of studies conducted by the authors [2, 4, 5], being its logical continuation on the APP design, which allows us to conclude that modern educational programs should meet the needs of a dynamically developing society, in which more and more attention is focused on targeted training of specialists, embodying the idea of integrating science, education and industry. The practical significance of the study lies in the possibility of using this methodology for the APP design for targeted training of specialists for high-tech military industries, faced with ongoing update of their work. The proposed recommendations for organizing the design of educational programs in technical universities in Russia will contribute to the formation of educational competencies among the teaching staff and production competencies among students. The results of this study can be used by education specialists and industrial workers. Further development of the conducted research can be the development of a system for automated selection of the APP content (from universal blocks) based on the analysis of the requirements of the customer enterprise.

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Проектирование вариативных программ целевой подготовки в техническом вузе

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Ключевые слова: целевое обучение; дополнительные профессиональные программы; стратегия; пошаговая методика построения вариативных образовательных программ.

Аннотация: Рассмотрены вопросы использования методов динамической вариативности при разработке дополнительных профессиональных программ (ДОП) в вузе, обеспечивающим целевую подготовку специалистов. Процесс проектирования представлен как последовательность действий для пошагового глубокого изучения ситуаций и позиций всех субъектов, заинтересованных в результатах. На основе анализа проблем современного производства предложены конкретные рекомендации по теории и практике проектирования ДОП в условиях постоянного изменения производственных задач. Выявлено, что обеспечение качества целевого обучения в университете достигается за счет разработки ДОП, основанной на разделении процесса проектирования на определенные этапы; использования многоуровневой методологической структуры проектирования; принципа динамической вариативности конструкции; итерационного алгоритма для последовательного привлечения экспертов и байесовского подхода для переоценки результатов экспертизы с целью разработки оптимального решения.
