IMPORTANCE OF DEVELOPING THE PROSPECTIVE COMPETENCES AMONG ENGINEERING STUDENTS

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Abstract - Training the engineering students to integrate in the labor market, nowadays, when, from one hand we are caught by the accelerating pace of change, and from other hand the technological innovations taking up more and more in our personal and professional life, indicates more prospective competencies, and the necessity to continue the educational reforms perceives increasingly.

Prospective competences represent the anticipation of the meaning and pace of changes, creation of a possible environment (planning, innovation), articulation of perennial values based on these transformations and, above all, the development of the human by cultivating his/her humanity, dignity and responsibility (directing the human to a planned future).

The necessity of developing prospective competences among the engineering students depends also on the way in which the graduate integrates into the labor market. The way he/she succeed to adjust to accelerated requirements of the changes, innovations, as well as to cause changes, innovations determine the quality of university education, as well as the educational policy of the Republic of Moldova.

The quality of university education, as well as the educational policy of the Republic of Moldova, is determined by the way it manages to adapt to the accelerated requirements of changes, innovations, but also to provoke changes.

Thus, the focus on university programs, curricula, on developing prospective competences, would emphasize the orientation of policy of university education to the needs of present as well as of the future.

Keywords - Competence, Objectives, Prospective competence

I. INTRODUCTION

Today, the accelerated pace of changes and the matters of the contemporary world cover a larger area, imposing new requirements in revising the educational policy both at the general and university levels. Thus, our research being realized within the scientific project „Programe Postdoctorat" as an output for the period 2021-2022, with the priority: Societal challenges, entitled: Conceptual and methodological foundations of the Prospective Education, emphasizes some problems of the system of higher education of the Republic of Moldova. From one hand, the reorganization of higher education system realizes, and it should be elaborated according to tendencies of development of society worldwide, and from the other hand, the lack of an appropriate funding for the increasement of national capacity of innovation, leads to differences between what the labor market demands and what the faculties are educating/training. We would like to notice that the accelerated rhythm of changes, informational tumult, lead to the fact that the student is put in the situation when what is learns today, tomorrow it could already be exceeded, irrelevant. At the same time, there is a rupture between scientific research and the disciplines taught in the institutions of higher education.

Thus, the novelty of our research refers to foundation of a new field of educational sciences – Prospective pedagogy, which highlights the necessity and importance of university programs/curricula to focus on prospective competence – determined as goal of the prospective education. This would emphasize the orientation of higher education policy towards the needs present as well as the future ones.

Currently, the higher education emphasizes the training of a competent specialist as personality quality. The researches from the given field show that the competence of the specialist is a mandatory condition of an efficient professional activity.

We consider that due to the technical-scientific development, the education as a priority field of the human development appears as an action of behavior guidance and as an intervention in the formation of personality, able to deal with solving the future problems, in the development of society. In contemporary society, there is a problem regarding the distance between the content of the education and the spirit of modern society. In this way, the focus of higher education system on developing prospective competences are represented by some imperatives: political, social-economic, psycho-social, pedagogic.

II. NECESSITY OF DEVELOPING PROSPECTIVE COMPETENCES WITHIN UNIVERSITY FRAMEWORK

Developing prospective competencies is determined by a series of imperatives.

1. Political. Adopting national documents related to orientation and training of the personality for future (strategic importance of the prospective education is based on the major objective of educational policy of the Republic of Moldova, namely connecting the quality and level of national education to European standards).

2. Social-economic. Prospective segregation on the labor market, the discrepancies between the necessary competencies and the professional training offered by university studies are, to a large extent, conditioned by the requirements of the society and the existing educational policy. These phenomena seriously affect the sustainable development of the country. As a strategy to overcome the mentioned situations, it is proposed to reorganize the educational process. This reorganization provides a new value organization of human needs through the value and significant hierarchy of skills that will contribute to achieving the educational ideal. Sustainable socio-economic development involves the process of taking maximum advantage of human potential.
3. Psycho-social. Global socio-economic transformations and accelerated changes at the national level are serious challenges for humanity. On the one hand, in society, there is a need for active involvement in political, socio-economic and cultural life, on the other hand, the accelerated pace of change, the problem of the contemporary world, generates situations of psychosocial discomfort for individuals. Preparing the personality to cope with the accelerated pace of change will help people overcome internal conflicts, will increase adaptability and develop creativity, innovation.
4. Pedagogic. The re-evaluation and adjustment of the educational process to the realities of life and to the contemporary development tendencies can be achieved more efficiently through prospective education, the process aiming at the formation of the prospective personality, the application of prospective competencies. To ensure the efficiency of prospective education, the process must be designed and carried out at a theoretical and practical level.

From the perspective of these considerations, we must specify that the most important thing is that the educational beneficiaries should be aware of the necessity to develop prospective skills both for the university and for themselves, and namely: to be interested in high performance, to be concerned with professional training at a higher quality level, to be able to bring about change and to adapt to change.

III. PROFESSIONAL COMPETENCIES

Today, socio-economic realities impose a managerial approach to the goals in education which should be formulated not only in concrete and pragmatic terms, but especially from the perspective of the real training needs of the educated person and the social demands of the labor market. According to the theory of pedagogical aims, the elaboration of pedagogical goals must be correlated with the evolutionary tendencies of the society, ensuring the overcoming of the current state through adjustments of improvement, structuring, restructuring and reforms in the field of education [1].

When we refer to competences – we do not refer to experience, especially since "there can be no sign of equality between experience and education" [2], this is because any experience is a wrong path from an educational point of view, in situations where it has the effect of stopping or distorting the growth of future experience. It all depends on the quality of the experience. O. Ghibu has the same opinion, stating that one's own experience is not enough [2, p.98].

The process of developing competencies involves integration activities, so the professional competence can be developed due to the various integration situations that the learning situation provides.

3.1. Conceptual delimitations

Despite the fact that the implementation of teaching-learning-assessment methods aimed at training and developing competences lasts for over 25 years, the analysis of the specialized literature [3] leads to the conclusion that so far, in the field of educational sciences, there is no unanimous accepted definition for the term "competence". At the same time, the need to move from an education based on objectives (≈ what the student must learn) to one based on competencies (≈ what the student must be able to do) has led, volens-nolens, to the identification of explicit definitions, possibly formulated in a less academic style, which could, however, be used both in educational policy documents and normative-legal acts.

Transposing in a pedagogical context, the definition of competence formulated by the "Recommendation of the European Parliament and of the Council" of 23 April 2008 [4], mentioned as well in the Education Code of the Republic of Moldova [5], we can say that a competence represents the student's proven ability to select, combine and use appropriately, knowledge, skills, values and attitudes, in concrete situations, to accomplish efficiently and effectively, a learning task. I. Jinga and E. Istrate consider competence to be "the ability of a person to solve a problem, to make appropriate decisions, to fulfill a mission or to practice a profession in good conditions and with results recognized as good" [6].

The implementation in the practice of education of the construct "competencies" is conditioned by the need to overcome the contradiction between the content of the study disciplines and the future professional activity – engineer.

Thus, competence characterizes as a general ability manifesting and forming in professional activity, based on knowledge, values and allows the engineer to establish the link between knowledge and the concrete situation, to determine the system of actions for effective problem solving. Unlike knowledge and skills, which involve actions by analogy, according to

the model, competence requires experience of independent activity based on universal knowledge.
To be competent means to mobilize in a specific situation the acquired knowledge and experience.

3.2. Types of competences

When describing the "professional" component, in addition to qualification requirements, many scholars emphasize framework competencies, core competencies and special competencies, such as:

- general competencies, which are necessary in the social-productive activity of any contemporary specialist;
- basic competencies – the competencies in a certain professional field, the level of professional training of the graduate, which implies the possession of knowledge, skills, attitudes necessary for carrying out certain professional activities;
- special competencies – competencies in realizing a specific action, solving a specific problem or professional tasks.

The realization of these competencies is ensured by the development of personal qualities such as: lasting memory, divergent flexible thinking, self-organization, emotional balance, flexibility of attention, observation, etc., which in accordance with the stable system of moral values ensures the formation of components necessary for training within any university specialty.
According to the recommendations of The Practical Guide for Curriculum Elaboration for Technical Vocational Education [7], in order to systematize the curriculum design process, curriculum developers will need to use the taxonomy of competencies:

- key competencies;
- professional competencies.

The key competences represent a multifunctional, transferable set of knowledge, skills and attitudes that all members of society need for professional fulfillment and development, social inclusion and finding a job.
In addition to key competencies, recognized as a behavioral integrative system, which facilitates human development as a personality and socio-professional integration, the technical vocational education has the mission to train and to develop professional competencies.
The professional training must offer the student the possibility to solve different situations in business and in life manifesting:

- social-professional competences (referring to the individual, subject of the activity and personality; social that determines his/her interaction with other people);
- general-professional competences (informational related to obtaining information and processing it; algorithmic, related to the ability to solve professional tasks, using adequate managerial knowledge). At the same time, the student must possess special professional- functional competencies, which ensure the concretization of the general-professional competencies within a specific field of work.

In the curriculum elaboration for technical vocational education the following categories of professional competencies will be used:

- general professional competencies;
- specific professional competencies.

General professional competencies are specific to a group of related professions/specialties within an occupational field, and the reporting of general competencies to a specific profession/specialty is done by formulating specific professional competencies. [7]
General competencies are professional behaviors that must be demonstrated in several professional activities. The system of general professional competencies ensures the success/ performance of the professional activity in all manifestation situations, influencing their quality through a systemic correlation. [7]
In essence, the quality of contemporary higher education approaches through the prism of the multidimensional systemic characteristic, in which the quality of the result, the quality of the specialist training is a basic component of this peculiarity.
At the same time, we must note that the competence-based approach in vocational training does not deny the value of the knowledge that the followers of the traditional approach emphasize. On the contrary, knowledge can have a different value, and increasing the value of knowledge does not always mean increasing the level of preparation of the student for professional activity.
Being an indispensable component of competencies, values and attitudes are as important as knowledge and skills. The Code of Education of the Republic of Moldova provides the following values for formation and development: general-human values; national values; cultural values; moral values, which allow the active participation of the person in the social and economic life [5].
The values and attitudes specific to the profession/specialty will be established based on the codes of ethics, the description of the qualifications, the wishes of the eventual employers, the requests formulated by the professional associations. According to the normative-legal framework in force, in a mandatory way, in the curriculum that is in process of elaboration, it is necessary to include the teaching-learning-evaluation activities that will contribute to the formation, development and consolidation of both general-human values and attitudes, as well as values specific to the profession/specialty.
In this sense, the quality of professional training, the formation of framework competencies is conditioned by the technologies used in university education. The organization of the interaction between the students of an institution or from different institutions depends on

the dominant values. Depending on the axis, the technologies can be oriented both towards the amplification of the efficiency of the students' results, and towards the creation of the conditions for satisfying the personal needs, the determination of their potential possibilities in specific activities.

The general qualities necessary for the training of a competent specialist are:

- flexibility, ability to modify the activity program in accordance with the requirements of the situation;
- abstraction, the ability to successfully generalize specific facts, to rely on images in the thought process;
- reflection, the ability to store information in long-term memory, each time updating it, meticulous thinking of their own actions [7].

The model of professional training focused on competencies involves the achievement of objectives related to the object of work, the achievement of specific functions, and the integrated interdisciplinary requirements at the level of the educational process outcome.

The formation of professional competencies requires the inclusion of the didactic activity of the students in the situations analogous to the professional activity, presented through different forms of quasi-professional activity.

The determination of the content in order to train the students for the professional activity must be done through the contextual prism, which supposes the reorganization of the professional activity on objective and social aspects. The model of the integral content of the professional activity included in the contextual training must present a system of professional problems, tasks and functions that are reflected in the integrity of the quasi-professional and instructive-professional tasks. Thus, it will be possible to initiate the engineering student in the real aspects of the professional activity, of its content, dynamics, forms of organization, norms and values.

The complex of tasks, the methods of professional activity, including the situations of their social-psychological interaction, regulated by the normative-value system of the activity constitute the professional context of the training focused on competencies of the future specialist.

3.3. Determinants of engineering competencies

Engineering is currently facing many additional challenges. Attracting young people, to certain areas; establishing more effective interdisciplinary alliances with the natural and social sciences, as well as with the arts; focus on innovation; stimulating entrepreneurship and job creation; raising society's awareness in order to promote support for engineering, strengthening education – all are challenges that need to be taken into account in the training of skills among the engineering students.

Analyzing thoroughly these challenges we can also identify the opportunities, with a special focus on education, in the context of the global economy and sustainable development. A change is needed, because, sociologically, the phenomenon of professional mobility is registered, both in terms of the job and the competences of the profession itself. The development from the perspective of technologies confirms the transition to the approach of problems from a multidisciplinary and transdisciplinary perspective. Although it is neglected the fact that engineering solves problems, they are multidisciplinary.

The need to attract the younger generations to the technical professions (that of engineer) represents, first of all, a national problem of the EU member states, but also a problem of the European Union as a whole. Technology must be oriented in such a way as to respond to future problems. The environment is not the only area where technologies must – to a large extent – meet the challenges.

The competencies required in Europe or the Republic of Moldova in the field of science and technology will be able to be achieved by increasing the number of graduates, by their mobility, as well as by improving the quality of education. The structure, content and methods of engineering training must be "built" in such a way – in order to meet the requirements for each specialty, focused both on understanding the development of society and on its sustained future development. The superior quality of engineering education, as well as the competencies of engineers represent a competitive advantage, an advantage that should be further developed and favored.

3.4. Components of prospective competencies

In this order of ideas, we consider that regardless of the social context and the level of economic development, it is necessary to train personalities with prospective competencies. In order to train human resources for the future, several authors [8-11] have highlighted a number of objectives. In our research, we relied on the conception of researcher Vl. Guţu [12] to determine the objectives as inputs, and the competencies are considered as outputs.

It should be mentioned that, both at the level of pedagogical theory and practice, the educational sciences of the Republic of Moldova have already adopted a pedagogical language of competencies, including prognostic ones. In this sense, researchers Vl. Guţu, E. Muraru and O. Dandara [13] propose a series of prognostic competencies for initial professional training in university education.

In this order of ideas, we consider that regardless of the social context and the level of economic development, the formation of personalities with prospective skills, depends on the configuration of their objectives [14]. In order to prepare human resources for the future, several authors have stated a series of objectives. Moreover, the objectives

proposed by R. J. Dewey, Dottrens, Dm.Todoran, Torsten Husen, A. Tofler [8 -11, 16], are still valid today both individually and socially.

For the development of the conceptual framework, we propose the introduction as a necessary functional category of prospective competence in the following formula: prospective competence is a completed structure, generated by mobilizing a number of internal resources of the subject in a framework delimited by significant situations (pedagogically intentional or spontaneous, with a disciplinary or inter-transdisciplinary character) and which is manifested by anticipation, elaboration, as well as by attributions of meaning and direction of the action.

Approached from an educational perspective, prospective competence contributes to the formation/ development of the following specific competencies:

1. Anticipatory competence as a finality is a necessity of the contemporary personality to find specific and fast solutions in solving the multiple apparent problems in everyday life (anticipation of changes, risks and consequences). The deepening of the problem and the probability in the contemporary economic, social, political and cultural structure generates risks and a special receptivity towards the respective problems [17]. J. Botkin considers that the competence to anticipate includes the inherent responsibility in the influence and possible control of future events, therefore it can be considered one of the prospective competences [18].
2. Another prospective competence is the planning competence. Anticipatory planning involves the ability to develop prospective studies, forecasts, strategies and policies, plans, programs, projects in order to establish well-defined tasks for carrying out the proposed activities. Decision making, as one of the aspects of planning that has been determined by action, is important in today's society. In this sense, V. Cojocaru and M. Vladu [20] have conducted research which highlighted the importance of decision making in educational management.

Intervention for change involves, to some extent, planning for change (clear goals, realistic goals and realistic deadlines).

- to elaborate the solutions for crisis situations of tomorrow's education and society;
- decision making;
- transferring strategy into action (there are a multitude of strategies, but they are more theorized. Today strategy requires not only to act on a process, phenomenon, but itself to be action);
- behavior adaptation;
- competencies of inventing and innovating;
- elaborating public policies and strategies for sectoral, community, national development [14].

3. Competence in adaptability to change is characterized by rapid learning, this is due to the fact that one knows how to adapt. Trying new things and thus provoking the ability to solve problems in different circumstances.

   For example, adaptability – soft competence, requires a number of other soft skills in order to be successfully applied. One need to be able to learn quickly and put it into practice. In addition, one need to be able to remember what they has discovered so that they can identify trends and make decisions accordingly.
4. Decision-making is another competence necessary in present as well as in the future, where the most important stage of the decision-making process is the identification of alternatives. The forward-looking decision applies to the formulation of objectives, planning, scientific and technical research, innovation functions [19]. Meanwhile, prospective decisions are strategic.
5. Innovative competence. One of the objectives set to be achieved in the European Year of Creativity and Innovation was to develop creativity and innovative capacity followed by the creation of an innovation-friendly environment in a changing world [20].

In order to train/develop innovative competence K. P. Waychal drew attention to the fact that the functioning of innovation depends on processes, technology and individuals. While much work has been done in developing processes and technologies, less work has been done in developing individuals for innovation to work. Thus, P. Waychal proposes as competence units of innovative competence: visioning, skills to generate ideas, decision making, focus on tasks, etc. [21].

According to P. Waychal the two aspects of innovation – fresh thinking and value delivery – require student-centered learning. It is important that individuals be immersed in real-life situations to understand problems and generate various ideas [21].

It is important to mention that innovation is based on creative, repetitive thinking, involving a plan of change. Thus, the formation of prospective competence will facilitate the function of anticipation, planning, innovation and active involvement in social life. The capture and condensation of the general tendencies of the socio-economic evolution in the form of educational goals, constitutes only the theoretical context of the accomplishment of the instructive-formative approaches, being necessary the doubling of this framework with specific activities, corresponding to the effective endowment of the students with skills and competencies suggested through assumed didactic goals and objectives. Prospective competencies guide/direct us towards prospective personality formation.

6. Depending on scientific, technological innovations, etc., there is a need for another competence, namely information management. In fact, the information age is generally considered to comprise three major periods: the information society, the knowledge society and the

consciousness society. The knowledge society will lay the foundations for a future society [22].

It is identified by specialists in the field as a unit of competence of learning competence, which represents the identification, evaluation and appropriate use of the information we have at a given time to solve problems and make optimal decisions.

It includes the development of the following skills:

- identification of information;
- efficient exploitation of information:
- information evaluation and processing;
- efficient use of information. [23]

7. Directing competence is another prospective competence that can be achieved in several aspects, in terms of time – future, as well as in terms of essence – personality development. At the same time, any action of thought that is not oriented towards a destination, will have difficulties in crystallizing the effective strategic action. Therefore, it is important to determine the evolutions and development trends of the society/personality combined with the argumentation of the necessary actions to be performed.
8. With the accelerated pace of change, there is a need for another competence – time management. Rational time management as a neo-resource due to speed, causes accelerated wear and tear of knowledge, which justifies the need and training of the young generation for a series of tasks that they cannot accurately predict, but which influence their decisions over time. For efficient time management it is necessary to focus on objectives, but also on relationships, planning, spontaneity, prioritization or delegation, but also on work. In other words, it is very important to maintain a balance between all these elements for efficient time management – a perspective related to the success of personality formation/self-formation.

It is important to realize that the list of prospective competences can continue depending on the evolution of society, the accelerated pace of change, as well as the requirements of the labor market.

All these oriented us to the idea of broadening the horizon of the future specialist not only in their professional field, but also in any life situation. Thus, prospective education also develops specific skills, just as important, skills to learn how to learn, problem-solving skills, taking risks and responsibilities for a particular activity, adaptability, which essentially expresses the essence of foresight.

Having as an orientation point the theory and methodology of the curriculum, the specific goals of prospective education (PE) have been proposed, the contents and learning activities form the curricular frame of reference of the PE.

The specific content of the PE corresponds to the specific objectives engaged in the training-development activity of prospective personality skills, reflecting two defining coordinates, which aim at relating man to society (educating specialists for the future according to labor market demand) and self (educating the person in order to solve the problems depending on the causal factors, determining the change, minimizing the risks of the action).

IV. DEVELOPING THE PROSPECTIVE COMPETENCIES AMONG ENGINEERING STUDENTS

Although, in the basic research the experimental intervention aimed at training students that was done through the curriculum of Prospective Education (according to the disciplinary approach), and through the curriculum of Professional Ethics (according to the infusion approach). In this paper we will present only those results that refer to the formation of prospective competencies through infusion within the discipline Professional ethics.

The experiment focuses on: anticipating the problems and trends of the development of prospective education; risk forecasting, analysis and minimization; elaboration of the personal and professional development plan; training prospective competencies among engineering students.

In this sense, the most important strategies to motivate students in favor of the prospective topic were:

- at professional level – vocational training to meet the current and future requirements of the labor market and society, prospective education having the role of responding to changes in the labor market;
- at personal level – understanding the mechanisms for developing the skills to identify alternatives in problematic situations, anticipating the consequences of personal actions, risk assessment and management.

Determining the level of prospective competencies formation among engineering students was made after the infusion approach.

- According to the infusion approach. By applying the test Assessing the level of training of prospective competencies in Professional Ethics, we focused only on identifying three major prospective competencies. Comparatively analyzing the data obtained at the pre-test and post-test stage for students from IT and MI specialties, we elaborated table nr.1.

Professional ethics	Informational Technologies (pretest)			Management of Information (pretest)			Informational Technologies (posttest)			Management of Information (posttest)		
Level of formation	I	II	III	I	II	III	I	II	III	I	II	III
Anticipation	64%	36%	0%	48%	35%	0%	71%	42%	3%	76%	59%	4%
Planning	50%	40,5%	9,5%	35%	52%	11%	79%	49%	18%	57%	62%	23%
Directing	86%	14%	0%	85%	15%	0%	89%	26%	3%	91%	28%	3%

Table 1. Level of forming prospective competencies at the discipline Professional Ethics

From the presented Table, we can observe the changes that occurred in the development of the anticipatory competence, the planning competence and the directional competence at level I, II and III. Significant results are attested at level III for students in the MI specialty: anticipation competence is determined by an increase from 0% to 4%, targeting competence from 0 to 3% and planning competence from 11% to 23%. Small differences are also observed in the IT specialty. Students have the ability to plan change actions, but face difficulties in anticipating the consequences of actions, directing them.

V. CONCLUSION

The fact that universities train specialists in solving various problems of our society, and also the focus of the higher education system on the formation of prospective skills are representative of certain imperatives: political, socio-economic, psycho-social, pedagogical.

But, we believe that regardless of the social context and the level of economic development, it is necessary to focus engineering programs on training personalities with prospective competencies, thus preparing engineering students not only to adapt to the accelerated pace of change, but to create a favorable future through planning and innovation.

The experiment showed that the implementation of the prospective dimension in education is an important step in the formation of prospective competencies.

Prospective pedagogy as a field of Educational Sciences, emphasizes and brings to the fore the need and possibility to take control of formative concerns, in a global and value-oriented manner, building change and the future through the activity of design, implementation, conscious pursuit and evaluation of transformations, at different levels and degrees, as a vector of development.

The presence of only the planning competence in the university curriculum highlights the need to focus on the design and training of prospective skills.

We specify the idea that the finality of the formation of prospective competencies is not achieved only within the university, but occurs throughout life. Based on this premise, we find that the formation of prospective competencies is a long process of actions, which lasts over time and can be assessed over the years, depending on the success of the graduate's integration into the workforce, their ability to adapt to change and to face social challenges.

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