

CREATIVE METHODS AS AN OBLIGATORY COMPONENT OF THE TECHNICAL SPECIALISTS EDUCATION IN THE POST-INDUSTRIAL ERA

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Purpose: The article's objective is formalization of the model, the main stages and creative methods of training technical specialists, the definition of features and directions for further education development in the post-industrial era. The article is aimed at revealing the nature of creativity, highlighting the essence of the functions of methods of creative activity and their importance for students of technical specialties.

Design/methodology/approach: The work uses critical analysis of scientific and methodological sources, system and convergent analysis methods, generalization and systematization of practical experience. The method of convergent generalization made it possible to identify key indicators of the model of creative competencies. The conceptual model of creative competence was developed based on the results of cooperation on the frame of master's programs for the project managers training. For the practical part of research, a qualitative method was used (participant observation, individual interview, tests).

Findings: The need to train technical specialists in the methods of creative search using modern technologies, which allows to achieve the effects of the intellectual potential development for the individual, the state and society, is justified. An experiment on training project managers of two Ukrainian institutes in creative technologies proved the feasibility of implementing such training. Based on the calculation of the creative competencies' development of the first- and second-year study technical specialists, the need to add a mandatory creative component to educational programs has been determined.

Implications/Recommendations: To assess the quality of training, a methodology for assessing the level of competence has been applied. This made it possible to identify a low level of some competencies and, at the stage of improving the curriculum, plan the necessary corrective actions for the development of weak components of competencies. Since project-oriented learning is used, the model is similar to the model of the classical project life cycle and will be especially useful in the implementation of innovative projects in production. The article presents a framework for teaching students creative competence, which can be used by other educational institutions.

Originality/value: The review of literary sources proved that so far very little attention has been paid to the development of creative competencies in students of technical specialties, although these competencies will be the competitive advantage of a person in the competition with artificial intelligence. The model of creative competencies for the technical specialists training is presented, which is divided into four areas, which in turn are divided into four components. These areas relate to the sampling and systematization of knowledge; adaptation to user requirements; awareness and dissemination of hidden knowledge; transition to the active use of knowledge.

Keywords: creative competencies, learning models, post-industrial era.

Category of the paper: research article.

1. Introduction

The development of our society demonstrates that humanity clearly does not keep up with the changes taking place. Unexpected events of society exacerbate the situation very quickly and become the subject of analytical research when they need immediate solutions. Consequently, it is becoming increasingly clear that with the old models of thinking humanity cannot achieve sustainable development, which will provide conditions for the survival of future generations.

Since the beginning of the twenty-first century, there has been an intensive search for a new strategy for the survival of mankind in conditions of limited natural resources, the growth of the world's population and the aggravation of political, social and environmental problems. To meet the basic needs of mankind, not only a new wave of economic growth is needed, but also a deterioration in the natural conditions of human existence. For the safety of human existence as a biological species, not only economic growth, but also new products of innovative thinking are necessary. The problem of the future development of civilization in a changing reality has come to the forefront of scientific research and social consciousness. The development of the digital economy, based on the emergence and consumption of information, causes great socio-economic shifts, including in the field of labor relations, while changing the type and professional activity and nature of labor itself. Since not only simple physical labor, but also complex calculation algorithms machines perform faster and more efficiently than a person, they are increasingly displacing not only poorly qualified, but also sufficiently competent workers from the labor market. In the digital economy, the

nature of work is associated with the constant professional development of employees, their constant training and creative communication. The development of science and innovative technologies poses fundamentally new classes of cognitive problems for researchers, for the solution of which it is necessary to comprehend convergent and divergent technologies that bring together and interpenetrate into science, technology and man's life (Bushuyev et al., 2010; Rach, Medvedeva, 2015).

Modern education at the moment is the sphere in which the main task is to bring up a creative, capable of self-realization, and constantly learning person. From time to time, the situation of training specialists determines the presence of a contradiction in it: on the one hand, the training of a specialist is based on the acquisition of knowledge and skills in subjects within the framework of the "Educational Program", and on the other hand, the social situation requires that each person develop systemic thinking to solve complex problems. The solution to this contradiction is possible if, while maintaining the necessary content of the educational process forms, and methods of training specialists will contribute to the development of a creative and self-actualizing personality (Molokanova, 2007; Rybak, 2005).

The article's objective is formalization of the model, the main stages and creative methods of training technical specialists, the definition of features and directions for further education development in the post-industrial era. The article is aimed at revealing the nature of creativity, highlighting the essence of the functions of methods of creative activity and their importance for students of technical specialties.

The article covers the methodology of the research, presents the main empirical findings, and outlines the implications for the economy and business. It also indicates further research directions in this area.

Main research problems: Do creative methods fulfill their role in the training of technical specialists in the post-industrial era?

What is the relationship between changes in the economy and business and changes in educational systems at the university level?

2. Unsolved aspects of the problem

In the second half of the twentieth century, the views of non-classical science have become more common, the object of study of which are complex systems dependent on human behavior. At the same time, the subject of management and the system of its values become the main subject of attention of researchers. At the same time, modern management abandons rigid hierarchical management structures and moves to dynamic project-oriented systems, which are enshrined in new standards for project management (A guide to the project management body of knowledge (PMBOK® guide, 2017; Individual Competence Baseline for Project,

Programme & Portfolio Management, 2015). This is supported by the recognition of the importance of human resource management not only in the European and American, but also in the Japanese system of knowledge on project management P2M (P2M: Management of projects and programs, 2009). Over time, the popularity of value-based management increases, which determines and structures a value-oriented approach in projects (Molokanova, 2015).

Manuel Castels, an authoritative social thinker and researcher of the modern world, one of the first paid attention to the phenomenon of growing convergence in modern society (Castels, Himanen, 2006). In the book "The Information Age: Economics, Society and Culture", he points to the existence of a complex interaction between technology and society. what affects the man's life. The meaning-forming factor of the new world, according to M. Castels, is a new technological paradigm built around information technology. It can be assumed that our future is connected with the interdisciplinary organization of science and cognitive technology (Run, 2008).

To meet this need, problem-based learning (PBL) was introduced as a method that promotes the development of critical thinking skills, the ability to solve complex problems. This may give technicians opportunities to find work in the future, as artificial intelligence cannot yet solve such problems on its own (Duch et al., 2001).

The methodology of knowledge management is becoming increasingly human-oriented, as the cause and factor of effective work in conditions of uncertainty. This opens a wide field for studying the personality of a modern technical specialist: his views, creative thinking, reactions to events occurring in life, that is, deeply individual factors (Wach, 2015; Nowiński et al., 2020).

Today, there is already a general understanding in the scientific community that curricula must be constantly updated in order to adapt to dynamic changes in the environment. Education should prepare the future specialist for such work, which does not exist and cannot yet be clearly defined, so it is not clear which skills should become the most important in the curricula. According to the authors, the development of personal qualities of students should be aimed primarily at forming a systematic understanding of the world construction and the need for constant development of the creative function.

In the history of knowledge, many attempts are known to reveal the nature, mechanisms and essence of the processes of creative activity. The majority of these attempts are characterized by a tendency to present the nature of creative search based on mechanical, biological, technocratic, psychological and similar views. In training specialists in technical specialties, teaching creative activity is practically absent in Ukraine, or is perceived with some skepticism. Such deformed ideas about the essence, tasks, and possibilities of innovative search methods have a very negative impact, both on the system of cognitive activity and on the processes of development of the intellectual potential of the individual, the state, and society.

The orientation of higher education to the formation of a holistic, creative, morally mature personality, as the highest value of society, is determined by one of the strategic directions of state policy in the field of higher education (On higher education: Law of Ukraine, 2014). In Ukrainian education, it is now more necessary than ever to find its way of reform to play the role of a locomotive in the society transformation (Zinkovsky, 2010).

3. The purpose of the work

The purpose of the work is the formalization of the model, the main stages and creative methods of training technical specialists, the definition of features and directions for the further development of education in the post-industrial era. To achieve the goal of the study, the following tasks were set:

1. To determine the features and main aspects of advanced education.
2. Analyze the relationship between the current and future model of the knowledge economy and changes in educational systems.
3. Conduct an experimental verification of the proposed approach, identify its logic, essence and basic rules.

4. Research Methodology

One of the most important factors that led to the transformations of the twentieth century was the creation of a new phenomenon of convergence of science, technology and society. The first attempts to comprehend this process were manifested in the concepts that arose with the assertion of the arrival of a fundamentally new type of society, which is so far called differently: information society, knowledge management society, post-industrial era, the era of digitalization, gig-era etc.

Most of the authors of these theories talk about the onset of the era of convergence, which introduces new "rules of the game" not only into the technological sphere, but also into the social, cultural, existential one. Although the term "era of convergence" does not appear in the theories of society, but the concept of convergence, convergence of technologies is present in a number of modern concepts. Science is already such forms of disciplinary integration of knowledge as interdisciplinarity, multidisciplinary, polydisciplinarity are known (Kryvoruchko et al., 2014).

Convergence in a broad sense is the interweaving, interaction and interpenetration of various spheres of society, as a result of which new synergistic effects arise, leading to rapid transformations of scientific, technical and social development of society. causing, ultimately, not only scientific and technological progress, but also the dangers and risks of the very existence of human civilization.

A special role in the implementation of convergence processes is played by creative search technologies. Today there is not a single developing industry without the use of innovative technologies (Telyuk, 2023). Methodologically, they became a common methodological basis for the search for innovative solutions. At present, information technologies have also appeared, uniting the existing highly specialized science and industry economy into a single picture of understanding the world.

A qualitative design was used in the study. The empirical data comes from the analysis of the curricula of two Ukrainian institutes training technical specialists in the development of creative competence. Our work uses the method and critical analysis of scientific and methodological sources, methods of system and convergent analysis, generalization and systematization of practical experience. The application of the creative model indicated the need to implement changes in educational programs shaping future managers in order to make them more easily adaptable to the labor market and to integrate the educational field with the business field.

5. Results and Discussion

Today, when Ukraine has already received the status of a candidate for accession to the EU and the country faces a hundred times more complex economic, political, social tasks, the question of improving the integral competence of future specialists is very acute. We have to consider a set of common strategic challenges related to innovation processes and quick response to the current state of the country.

Project management is a productive activity aimed at solving complex problems through the implementation of innovative projects. Project management is an ideal means of transforming the world by creating a project product (Doppelt, 2003). For the development of project education in Ukraine, the creativity of project managers is also very important, as it has not yet been integrated into the management methodology. Therefore, teachers and scientists face an important task of integrating into the methodology of technical specialists training numerous methods of creative search and means of organizing teamwork.

In the era of digitalization and the knowledge economy the transition of organizations to an innovative type of development becomes a matter of survival. The decisive role in this process belongs to the human resources of organizations, because the intellectual and creative abilities

of a person are the driving force behind the creation of new ideas that launch the innovation process.

Creativity is one of the most important conditions for success in creating innovative products and services. Without a powerful and continuous influx of fresh ideas, organizations lose their pace of development and position in the market. Creativity concerns any aspect of the organization's activities: company management, customer relationships, marketing, finance, human resource management. Non-standard approaches allow us to find ways of rational organization of work, original ideas give rise to bold plans, and readiness for innovative search turn the organization into a successfully developing creative unity.

In the context of the implementation of student-centered learning, almost all the leading universities and business schools in the world integrate a project-oriented approach into their curricula (Obradović et al., 2018). Why is this approach so important and widespread? As we know, a project is born out of an awareness of the existence of a problem, an environmental challenge or opportunities that suddenly appeared. Awareness of the problem and the formation of imagination about the product of the future project is a poorly structured creative process. Therefore, the first conceptual phase of the project has the greatest degree of uncertainty and requires creative abilities.

The conceptual (pre-investment) phase of the project can be either the initial stage of the project or act as an independent project. At the conceptual phase, a "linguistically designed" model of the future project is first built, and then well-known methods are applied to it to develop alternative versions of the project plan in accordance with existing standards (A guide to the project management..., 2017). The general task of the conceptual phase, in fact, can be divided into two sub-stages, which differ in management models.

The first stage is the formation of a common vision of the project product, and the second is the project analysis and selection of alternative ways to achieve the project result. Particular attention should be paid to the fact that the concept of the project should be formed by presenting the largest number of alternatives, so as not to disregard promising project options. After all, if a company chooses the wrong project, it cannot succeed in its development, even if it successfully achieves the goal of this project. The success of a wrong or poorly conceived project can only lead to the destruction of valuable corporate resources of companies.

The management model of the first stage of the conceptual phase (pre-feasibility stage) can be attributed to the class of abstract models. Abstract modeling is often the only means of forming an idea of the product of a future project. Such models are sometimes called symbolic. The basis of this simulation is a set of symbols of individual concepts, taking into account which a symbolic description of the object is presented. This stage of forming a vision of the project requires the greatest degree of application of methods of creative search and system thinking. Until now, there is no clear formalized mechanism that allows the imagination of a specialist to form an image of the future product of the project. The search for means of intensifying innovation was carried out by many internationally recognized scientists, whose works are well

known in the global business environment. It is the achievements of these scientists that are now actively cited by Ukrainian researchers and studied in Ukrainian universities and business school. Modern education actively uses the thesis "Learning – by - doing". It is when we interact with information, try to recall it, reproduce it, we remember (Istévez-Ayres et al., 2015). Therefore, tests, practical tasks and business games are always present in training. One of the powerful interactive teaching methods is case solving. This is a method that trains the brain to find solutions in different situations (Kovalyova, Various, 2014). To intensify this process, various methods of activating creative activity are used, allowing to accelerate the process of creative transformation of the surrounding world. Some well-known methods and technologies of creative search are provided in Table 1. Each of these methods has its own history of development, scope, its advantages and disadvantages.

Table 1.
Methods and technologies of creative search

№	Method name	Authors	Features
1	The simplest methods		
1.1	Analogy method	Democritus	These are the first known methods
1.2	Dialogues to identify contradictions	Socrates	
1.3	Combining	Archimedes	
1.4	Splitting a problem into separate tasks	R. Descartes	
1.5	Formalization of operations on concepts	G. Leibniz	
1.6	Means of resolving contradictions (40 special and 3 universal)	G. Altshuller	
2	Associative methods		
2.1	Methods of control questions	A. Osborne, T. Eloart, D. Poya	Differ in the list of questions
2.2	Methods of morphological analysis	F. Zwicky	There are many modifications of these methods
2.3	Method of matrices of inventions	A. Mole	
2.4	Brainstorming method	A. Osborne	
2.5	Synectics method	W. Gordon,	
2.6	Focal object method	C. Wyting	
2.7	Associative chain method	Mr. Bush	
2.8	Lateral thinking method	E. De Bono	
3	System methods		
3.1	Method of orderly search for solutions	J.K. Jones	Methods of self-organization of thinking in solving complex problems
3.2	Fundamental design method	E. Metchet	
3.3	Cumulative strategy method	D. Page	
3.4	Algorithm for solving inventive problems	G. Altshuler	
3.5	Theory of solving inventive problems	G. Altshuler	
3.6	Functional-cost analysis	L. Miles	

Source: own study.

Employers are now increasingly concerned about the inadequacy of the knowledge acquired by students, since this knowledge changes every year and becomes outdated, sometimes before students can master it. They are much more concerned about the lack of specialists who are able to independently improve their knowledge and skills in various fields, because this is what they will have to do all their conscious lives.

According to such trends, the individual development of human potential is becoming increasingly important all over the world. Improving the quality of human capital, its creative abilities and focus on intellectual innovative work today are becoming a key factor in economic development.

To help students thrive in a rapidly changing world, Singapore's Ministry of Education has identified competencies that are becoming increasingly important in the XXI century (Framework for 21st century leaning, 2023). These competencies, presented in Figure 1, are the basis of the holistic education that schools provide to better prepare students for the future. It is assumed that teachers and students should work hand in hand to help develop 21st century competencies.

Within the framework of this study, we consider it appropriate to pay attention to another methodology that is successfully used by the world's leading companies and has proven its effectiveness in influencing the growth of both financial and non-financial parameters of business success – design management (The New Design Frontier..., 2023). This methodology can also be considered as a new direction or subsystem of management, formed at the intersection of the theoretical background and tools of different schools and concepts to help companies find and implement ideas for innovative development of their business.

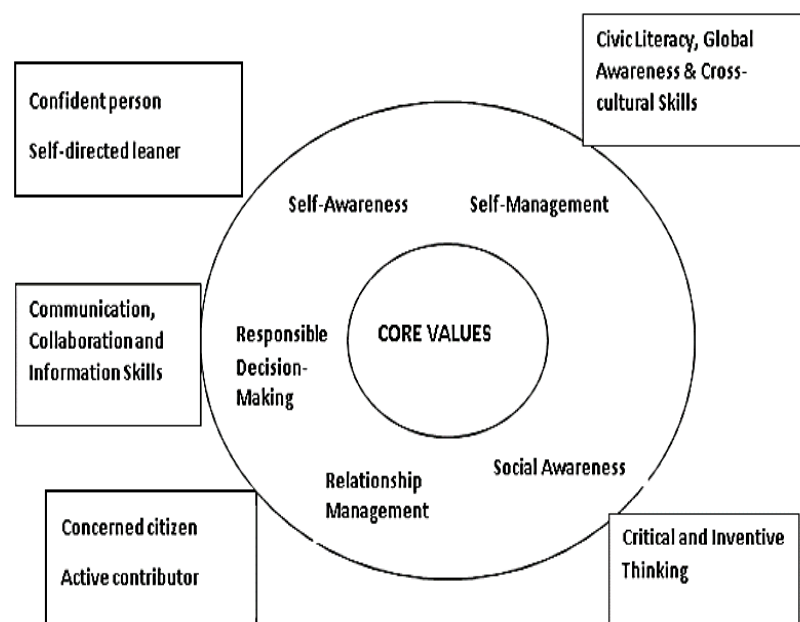


Figure 1. Framework for 21st century competence.

Source: Framework for 21st century leaning. Retrieved from: <http://www.p21.org/our-work/p21-framework>.

The term "design management" is practically not common in Ukraine, but the study of foreign sources allowed us to get acquainted with this methodology and divide the four stages of its development, from the board of corporate design to the board of design, as the basis for innovation (BS 7000-2:2008 «Design management systems - Part 2; BS 7000-3:2008 «Design management Systems — Part 3). Thus, design management is a constantly organized process

of creating or improving a product or service, which involves a deep understanding of the needs of stakeholders. The introduction of a customer-oriented approach to design thinking with a project management methodology creates a synergistic effect that ensures the satisfaction of the interests of all stakeholders' groups and the success of the organization in general.

Back in 1984, David Kolb first proposed a model according to which there are four phased of adults learning (Kolb, Fry, 1975). The principle of Kolb's theory is that the "direct and concrete experience" of an adult is the basis for "observation and reflection". These "observations and reflections" are transformed into "abstract concepts" that provide a new meaning of active actions that can be "actively tested", which in turn again gives new experiences, and then again in a circle (McCarthy, 2023).

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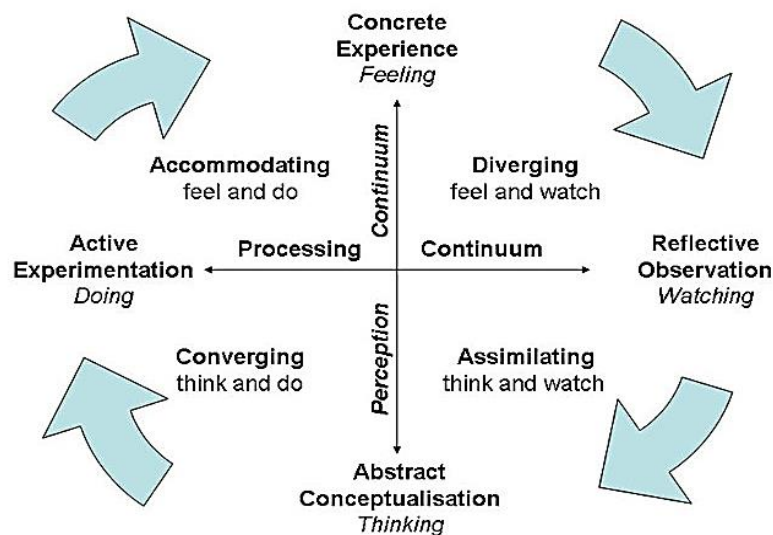


Figure 2. Model «step-by-step» for adult education.

Source: Kolb, Fry, 1975.

In the real practice of knowledge management, firms most often use a conceptual model with four areas of competence:

1. Externalization - sampling and systematization.
2. Internalization - adaptation to user requirements.
3. Socialization (intermediation) - the spread of hidden knowledge.
4. Cognition – transition to active use in in automatic mode.

Project-oriented learning is a learning process that provides opportunities to combine all four components of D. Kolb's model. Throughout the project life cycle, the project manager changes from an idea generator to a simple administrator, from a significant guiding analytical role to a position dedicated to practical stakeholder integration. Thus, project-oriented learning

is a tool for uncovering natural talents and providing students with opportunities for their development through planning skills and experience in applying basic - system competencies. In this way, project management can be useful in providing talented learners with an understanding of their capabilities and creating a supportive environment that enables them to learn, maintain, and create innovation.

The approach to achieving a particular goal depends on the situation. Initial search guidelines are elements of sampling and system analysis of information used to build a solution. This practice is based on the fact that, first of all, we need to study the already available solutions, and then create an image of the best solution. This can be defined as technological and functional architecture. When there are many uncertainties and a changing context, it is often impossible to specify goals and requirements for the result. Therefore, various agile approaches are used, which are, in fact, a guiding algorithm, with how the problem is gradually solved (Bushuyev et al., 2020; Agile Practice Guide: Paperback, 2017).

Based on the principle of decomposition for the proposed model, key indicators for each component of creative competence were developed. The conceptual model of creative competence was developed based on the results of cooperation on the frame of master's programs for the project managers training at the Dnipro Regional Institute of Public Administration and the National Metallurgical Academy of Ukraine (Dnipro, Ukraine). There were two groups of students from these institutes which during this program were evaluated on four components of the creative competencies model. After assessing the level of creative competencies of first-year students, competencies were determined where the level of assimilation is quite low. Therefore, educational programs were developed with the addition of subjects to develop relevant creative competencies. After improving educational programs in the following year, the same assessment was conducted for second-year students. The results of the assessment of the creative competencies level for the first and second-year students are provided in Table 2.

Table 2.

Results of the assessment of the creative competencies level for the first and second-year students

Assessment of the competencies after the first-year students		Assessment of the competencies after the second-year students	
Competencies	Assessment level	Competencies	Assessment level
Externalization			
Knowledge acquisition Creativity and innovation	8	Knowledge acquisition Creativity and innovation	8
Product modeling	5	Product modeling	7
Vision of the future	5	Vision of the future	8
	3		5
Internalization			
Strategy of behaviour	6	Strategy of behaviour	9
Culture and values	4	Culture and values	8
Planning	5	Planning	8
Risks management	3	Risks management	7

Cont. table 2.

Intermediation			
Empathy	3	Empathy	6
Impact	4	Impact	8
Teamwork	3	Teamwork	7
Leadership	4	Leadership	7
Cognition			
Result orientation	4	Result orientation	7
Initiative	4	Initiative	7
Flexibility	4	Flexibility	8
Self-realization	2	Self-realization	9

Source: own study.

Comparison of the results of assessments of the assimilation of creative competencies by students of the first and second year of study is provided in Figure 3. Analysis of the data obtained suggests that after completing the training of the second year, there was an effort to develop the creative abilities of students. Even taking into account that any diagnostic method has a degree of error, the study showed that on the basis of the individual's desire for creativity, it is possible to create effective tools for training technical specialists.

Let's pay a little attention to the competencies for the master's educational program "Design Management of Innovations", which is implemented in the Ukrainian State University of Science and Technology (Dnipro, Ukraine).

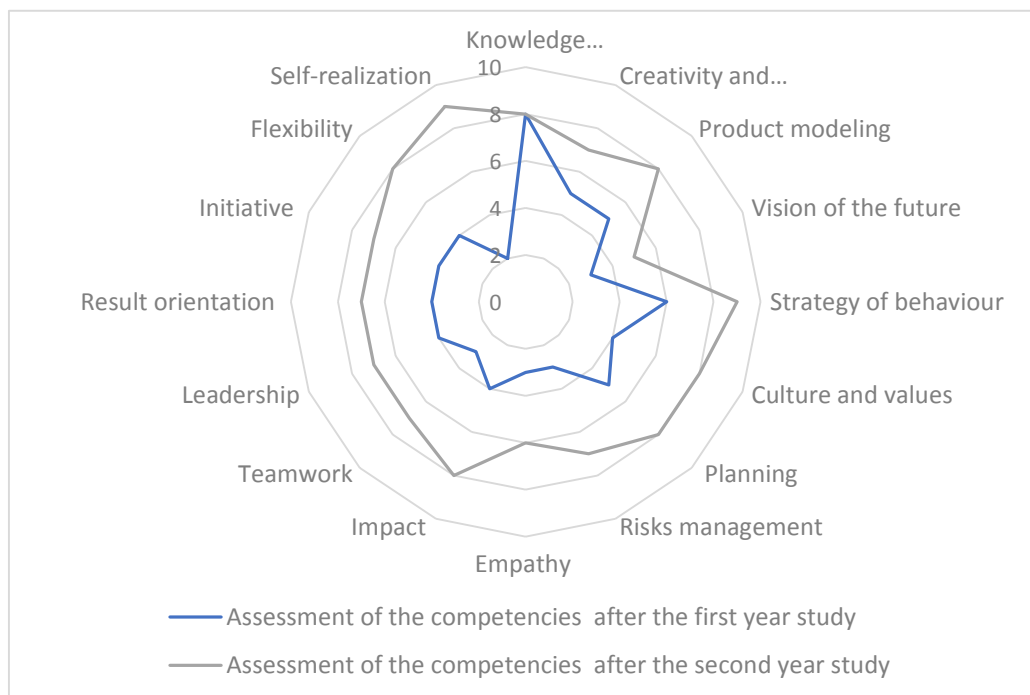


Figure 3. Comparison of the assessment of the level of creative competencies of the first and second year of study.

Source: own elaboration.

There are four groups of competencies that an ideal knowledge management manager should have. It should perfectly perform four different functions, first proposed by I. Adizes (2008). (P – manufacturer, A – analyst, E – entrepreneur, I – integrator). PAEI functions differ in their ability to be productive or efficient and in their focus on short-term or long-term goals. These functions correspond to the four phases of the project life cycle, where at each stage one of the four functions manifests itself more strongly than the others. Each of these stages for the case of project management requires the following steps:

1. In order to more fully use all the advantages of intelligent technologies, it is necessary to clearly present the main goal of the project on the basis of preliminary analysis. At this stage, the creative abilities of the listener (function E – entrepreneur) are most pronounced.
2. At the planning stage, there is a transition from the idea of the project to the real product. The essence of planning is to determine how to achieve goals by forming a set of works to be implemented. At this stage, the analytical skills of the listener (function A – analyst) are most important.
3. The third phase of the project, the most time-consuming. Management at the implementation phase is based on monitoring all project subsystems. Here it is especially important to show the ability to perform the amount of planned work in accordance with the project plan. At this stage, the manufacturer's abilities (function P – manufacturer) are most pronounced.
4. The last phase is the project life cycle closure. The purpose of this phase of the project is to verify and disseminate information about the compliance of the finished product with the expectations of customers. At this stage, the abilities of the integrator (function I – integrator) are most demanded.

Thus, during the training, students must demonstrate the skills of modern management thinking and systemic knowledge in the field of project management, the ability to professional project activities, which involves understanding their own potential in the form of project implementation.

6. Conclusions

In the context of the accelerating development of information technologies in modern education, there is a fundamental change in the goals and objectives of education. Engineering students are increasingly required to be creative in their ability to prepare for international careers, research, and global problem-solving.

Education for the Future plays an important role in supporting the local and above local economies, thanks to which the labor market is entered by highly qualified workers with competencies responding to the real needs of business.

The article presents an example of teaching students creative technologies in two educational institutions, and the presented results may not necessarily have an identical effect if they are implemented in another institution. To confirm the effectiveness of the proposed training model, it is necessary to conduct additional research in other similar institutes.

In the work on the proposed model of creative competencies for the training of technical specialists, which includes four blocks of competencies. These blocks relate to the sampling and systematization of knowledge; adaptation to user requirements; awareness and dissemination of hidden knowledge; transition to the active use of knowledge in practical activities. In addition, every block, in turn, allocated with its own set of competencies. To assess the quality of training, a methodology for assessing the level of competencies was applied. This made it possible to identify a low level of some competencies among technical specialists and, at the stage of improving the curriculum, plan the necessary corrective actions for the development of weak program components. Since project-oriented learning is used, the model of creative competencies is similar to the model of the classical project life cycle. Teaching creative technologies according to the proposed model should become a starting point for further in-depth research in the field of technical education.

As directions for future research, the following issues should be highlighted:

- the development of individual blocks of creative competencies with the help of modern information technologies for project management;
- the creation of effective models and tools for assessing creative competencies for each subject area separately.

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