International Journal of Engineering & Technology, 7 (4.8) (2018) 454-458

International Journal of Engineering & Technology

Website:www.sciencepubco.com/index.php/IJET

Research paper

Teaching the Engineering Graphics of the Applicants for Higher Education by Means of Computer Modeling as a Scientific and Pedagogical Problem

Vladislav Boyko[1], Irina Goliiad[2]*, Larysa Hrytsenko[3], Marina Korchemna[4]

[1]*Poltava National Technical Yuri Kondratyuk University, Ukraine*
[2]*National Pedagogical Dragomanov University, Ukraine*
[3]*Poltava V.G. Korolenko National Pedagogical University, Ukraine*
[4]*National Pedagogical Dragomanov University, Ukraine*
**Corresponding author E-mail: goliyad-ktnk@ukr.net*

Abstract

The article analyzes the state of graphic preparation of students of engineering specialties in accordance with the modern requirements regarding the professional activity of higher education graduates. The role of computer modeling as a means of training graduates of higher education in engineering graphics in pedagogical research from the didactic point of view is analyzed and substantiated.

Keywords: *engineering graphics, engineering and graphic preparation, computer modeling, applicants for higher education, engineering specialties, institutions of higher education.*

1. Introduction

The modern system of higher education in the context of a competent and personally oriented training paradigm should provide training for a specialist in engineering with the level of professional competence relevant to the needs of society and the development of creative abilities.

The engineer professional competence is largely determined by the feature of graphic training of students of engineering specialties, taking into account the close relationship graphic activities with the professional activities of a specialist engineering profile and the specificity of operating graphical forms of information.

The profession of engineer throughout the path of its development is accompanied by certain features at each of its stages. The modern stage is characterized by the strategy of automation of the workplace of the engineer-mechanic, which prompts the development and implementation of fundamentally new methods of work and the use of electronic tools and software in the narrow areas of professional activities. One of the most important functions of the activity is design, which provides for the form of technical design and competence design, which transforms the engineering idea into a package of documents – technical and graphic documentation. And all this accordingly actualizes a number of tasks of pedagogical science and practice in the field of graphic training of the applicants for higher education of engineering specialties.

Informatization of society in all spheres of activity makes significant changes in the graphic activity of the engineer in the work, as the development of new computer technologies leads to the transition to a qualitatively higher level of use of graphic tools and methods. Thus, socio-economic and technical factors of production development have a significant influence on the content, structure and organization of the process of forming graphic knowledge and skills of future specialists; they require timely adjustments that are adequate to the prospects for the development of modern information technology society, and graphic training of students of engineering specialties of institutions higher education. The theory and practice of training a future engineer proves the need to find new approaches and methods for their preparation. Unfortunately, the actual state of the process and the result of the training of engineers demonstrates the fact that the traditional model of formation of graphic knowledge and skills of future engineer profile specialists becomes a certain obstacle to the development of the system of training of a competent specialist. The professional preparation of which should include a high level of formed graphic knowledge and skills and, as a consequence, a high level of graphic culture of the future engineer.

2. Main body

Scientists and practitioners are convinced that engineering and graphic preparation forms the basis of the intellectual formation of the individual, contributes to the development of creative abilities, spatial imagination, figurative and technical thinking; forms the student's ability to design, construct and implement a technical design in the material. It is obvious that the integral part of the professional training of future engineers is the process of training engineering and graphic disciplines.

It is important to note that the problem of teaching engineering and graphic disciplines at various stages of pre-professional and professional training of youth has been widely researched by many local and foreign scholars.

The evidence of the real state of the graphic training of students of engineering specialties indicates that the level of graphic knowledge and skills of young specialists to the modern requirements regarding the practical activity of the engineer is inconsistent. Practical experience of the work with the students allows

Copyright © 2018 Authors. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

us to talk about the complexity of forming their ability to use graphic images for indirect recognition of reality, planning their actions, constructing the process of activities in images and reproducing in graphical form with the help of electronic graphic products. As a result, all this reduces the quality of students' training and future professional activity, makes it impossible to solve their creative technical tasks.

Naturally, more and more teachers of practitioners and scholars are joining to the solution of the current problem. For example, if we talk about the conceptual, content and technological aspects of improving the process of forming graphic knowledge, skills and abilities in schools, technical schools, colleges, then they are most closely researched by V. Vasenko, I. Vorontsova, H. Havryshchak, L. Hrytsenko, P. Dmytrenko, D. Kilderov, T. Olefirenko, V. Sydorenko, V. Chepok, Z. Shapoval and others.

Different aspects of the problem of formation of graphic knowledge and skills of students in higher education institutions are presented in the scientific works of local scientists: didactic bases of optimization of graphing literacy process (A. Verkhola); individual work as a means of improving graphic preparation (V. Burynskyi, Ye. Vokh); formation of a spatial image on the basis of a graphic image (Y. Hushulei, I. Holiiad, M. Koziar, I. Lebedeva); methodology of using computer graphics tools (V. Bespalko, O. Hlazunova, O. Leibov, V. Makovetska, O. Sliepukhin, Yu. Feshuk, M. Yusupova) and others.

The analysis of the mentioned above works indicates that the problem of engineering-graphic preparation of the applicants for higher education is still considered in part and did not acquire a comprehensive and thorough study as an integral system. Unfortunately, it was not outlined in the dissertations and the development of a methodology of graphic training on the basis of new information technologies, which would be directed to the formation of professionally important types of graphic activities of the engineer.

As a result of scientific research, researchers found a number of contradictions between:

– a new competent competence of training paradigm and the lack of elaboration of theoretical and methodological foundations for engineering curriculum development for the applicants for higher education of engineering specialties;
– the high requirements of the modern labor market to the professional competence of engineers and the insufficient quality of the educational process of higher education in order to ensure the proper level of mastering of students' engineering-graphic knowledge and skills at the level of special competences;
– insufficient professional orientation of the graphic training of the future engineers and the actual demand for a system of professionally important types of graphics engineer activities;
– the dynamics of the essence of graphic activity in the conditions of the modern information society and the lack of information and methodological provision of the process of teaching engineering graphics on the basis of new information technologies;
– new knowledge about promising directions of engineering activity, development of a system of graphic images and traditional content of training in engineering graphics;
– the specificity of graphic representations and graphic activity as symbolic and uncertain categories of the forms of educational information of graphic disciplines, graphic activity of the student as a component of semiotic activity.

On the solution of these and other contradictions in the aspect of training the engineering graphics of future engineer-mechanics by means of computer simulation also directed our scientific interests. At the same time, we understand that a practical solution to the problem is possible with a proper theoretical substantiation of the methodical principles for organizing the training of engineering graphics in the educational process of the higher school. That's why we tried to investigate the positive results of the pedagogical theory and methodology of both local and foreign scientists.

We can assert that the problem of improving the process of engineering and graphic preparation of engineer-mechanics has received special attention since the first decade of the XXI century. It is connected with the development and growth of production output of machine-building production, the modernization of production equipment, the widespread computerization of production. Before the high school, appeared the task to organize the educational process in order to train highly skilled engineering personnel with advanced skills in the field of information technologies, readiness to master new equipment independently.

In this regard, in the pedagogical theory, the problem studied by us was studied by scientists in the first place in the context of the engineering training of mechanical engineers, the second – in the context of their engineering and graphic training, and in the third – in the context of didactic aspects of the organization of teaching the complex of engineering and graphic disciplines.

In the logic of our study was studied a significant part of the work devoted to the formation of professional competence of the future specialists (M. Holovan, E. Zeier, I. Zymnia, H. Klochkova, M. Lahunova, L. Salapak), in particular engineering and graphic competencies, design and development readiness (M. Betuhanova, P. Buianov, V. Vykhodets, S. Kovalenko, T. Olefirenko, T. Povaliaieva, A. Puzankova, T. Sylchenko and others). An important question for us is the content of the training of mechanical engineering specialists, namely the design of the structure and content of the educational standard, the professional field of the applicants for higher education in engineering specialties, through educational programs and student self-education (A. Asherov, V. Vanin, A. Hedzyk, Ye. Muratov, F. Yakubov and others). The analysis of the research works gives us the right to assert that the engineering-graphic training of mechanical engineers one way or another considered by scientists as a compulsory and important component of the training of students for professional activities, which has its own characteristics.

A more detailed analysis of the scientific work in terms of the structural components of the educational process regarding the engineering-graphic training of the applicants for higher education allows us to select the following.

Thus, revealing the peculiarities of the theory and methodology of graphic preparation of students of engineering specialties in higher educational institutions, O. Dzhedzhula defines, as a goal of graphic preparation, the effective formation of graphic competence of an engineer, the development of his personality traits. The author is convinced that a modern specialist in the engineering profession must have a high level of professionalism and intelligence, creative abilities, professional mobility, communication skills, easily adapt to the world of information space, operate thoroughly with fundamental, general technical and special knowledge. The role of graphic preparation in the formation of certain qualities and competences O. Dzhedzhula substantiates the peculiarities of graphic information, the specificity of graphic activity, which allows to explore the objects of professional activity and technological processes, to disclose their essence, abstracting from the properties, accumulate, store and transmit information in graphical form about these objects, phenomena and processes [1].

Focus on the essence of the professional-graphic training of future professionals allows scientific works of M. Koziar, Ya. Matvisiv [2].

According to author's beliefs, professional and engineering-graphic training of the future specialists should be an integral system that has a personal, practical orientation in order to ensure the competitiveness of a specialist in the labor market in accordance with European standards, the effectiveness of its intellectual development, professional competence, creative potential, reflection of their own activities, ability to self-development on the basis of objective laws of society, nature, technics and technologies, taking into account the environmental and moral imperatives, awareness of the harmonization of the subject matter.

According to the scientist, the main components of the professional-graphic training system for the future specialists at institutions

of higher education are: a student (his needs, motives, interests); teacher (his guidance, coordinating, supervising activity); the purpose of professional-graphic training – the formation of graphic, design, technological and methodological competence of the future specialist and his personality traits.

It is definitely right, in our opinion, in the given logic of the research is the conclusion of M. Kozyar concerning the multicomponent graphic training of specialists in institutions of higher education. Each component occupies a certain place in its structure. In order for each of them to fulfill the expected tasks, it is necessary to provide links with the disciplines in the content of which there is a graphical component. Hence the need to find new technologies for the graphic training of the future professionals of engineering specialties [2].

To the role of innovation in the graphic training of the future specialists paid a lot of attention O. Dzhedzhula, M. Koziar, H. Raikovska ta M. Yusupova. Special attention is given to the development of information technologies and their implementation in the engineering-graphic training of mechanical engineers by scientists such as E. Krainova, O. Tarabrin, E. Rudenko.

The essence of such technologies in each particular case is conditioned by the introduction of innovative technologies in production and the need for adapting of the future specialists to the dynamics of working conditions. Y. Muratova, O. Popov in connection with the above-mentioned statement stress the importance of forming students of engineering specialties readiness for innovation and project activities and solving creative problems.

O. Tarabrin, studying the problem of training specialists in the engineering industry in the use of information technology in the use of design and development, distinguishes three stages of training: the formation of computer literacy, the formation of information literacy, the formation of information culture. Based on the principle of continuity of training, the scientist develops the substantive aspects, normative and teaching and methodological support of continuous design training of the future specialists in engineering specialties on the basis of SALS/IPI technologies. For their implementation, he substantiates the continuous computer support of the training process on the basis of the created scientific and virtual enterprise [4].

Considering the efficiency of the use of information technologies in the implementation of design and development by engineer-mechanics, scientists emphasize the essence and role of modern software tools. They provide an opportunity to simplify and improve the efficiency of the design process of machine-building products from preparing the drawings to the process of their testing by simulating the process of its exploitation. This confirms the special attention of the process of graphic and design engineering training of mechanical engineers by means of information technology designing in the process of training the relevant disciplines.

The substantive and technological aspects of the engineering and graphic training of the future specialists in the machine-building profile are substantiated in the works of O. Puzankova [5]. Proving the theoretical model of the pedagogical system of formation of professional engineering and graphic competencies of students, the researcher characterizes the process of formation through computer graphics training on the example of the specialties of the machine-building profile. As for our study, we are interested in the author's electronic teaching and learning program of the course of computer graphics, which includes: problem lectures, the method of using multimedia materials, interactive research activities of students, the implementation of creative projects, business games. An important didactic condition for the formation of students' engineering and graphic competences, the scientist considers the step-by-step process as a pedagogical technology, when each stage becomes preparatory to the following, usually more complex in form, content and method of conducting [5].

Familiarizing with the works of S. Fomenko, we noted the author's designed didactic system of design and geometric training of future specialists. The logic of building a system as a model of the learning process is based on the goals of both general didactic and specific subject levels, the structuring of the content of the training corresponding to them, the coordination of the forms, methods and means of learning with them, the development of criteria for quantitative and qualitative assessment of the level of knowledge acquired by students [6]. It is the consistency of the components of the educational and training components of the design and geometric training of future specialists in the machine-building profile, in our opinion, the starting mechanism for determining the place and role of studying each subject in general and the engineering and graphic content in particular, and the methods of its study.

Our position is confirmed by the results of Y. Krainova research on the issue of preparing the specialists in engineering specialties and forming their informational competence. We agree with the author that such training should be carried out continuously. The proposed model of training offered by the author, which includes the designing of goals, the selection of training content, control and diagnostic technologies is based on a competent approach and the principles of uncertainty and systemicity. This model contributes to the introduction of a cross-cutting program of studying disciplines, consisting of three stages of mastering information technologies throughout the entire study [3].

The analysis of the above-mentioned works of domestic and foreign scientists on the problem under investigation shows that the training of engineering graphics of the future engineers mechanics by means of computer simulation is specifically targeted and specifically not reflected. However, its certain aspects are somehow presented by scientists from different positions:

– professional training of the future specialists in the engineering industry;
– engineering and graphic training of future specialists (different profiles) in the institutions of higher education;
– the use of information technologies in the process of continuous training of engineers;
– formation of graphic activity of students of higher technical educational institutions by means of computer technologies, etc.

All this gave us an opportunity to make sure that the problem of mastering the students' engineering graphics is not only actualized by scientists, but is reflected from the didactic point of view: regarding the modernization of content both in the structure of vocational training (a set of educational subjects) and in the context of a separate educational subject; motivating and activating the educational activity of students in the educational process; organizational and pedagogical conditions of training; learning outcomes, etc. However, we can trace the generalization of the approach to solve the problems of the research problem we are investigating and the need for a specific methodological and technological justification.

According to the aim we have studied in detail the work of such scientists as V. Hyloi, M. Pryns, Y. Hardan, V. Mykhailenko, F. Hnyp, B. Polozov, Y. Эndzhel, S. Rotkov, I. Kotov, Yu. Kotov, D. Raian, H. Ryzhov, S. Frolov, V. Yakunin and others. They paid a great deal of attention to the development and implementation of engineering and computer graphics into educational process. An interesting fact for us was the identification of geometric training by scientists. At the same time, we noticed that when developing theoretical and methodological foundations, establishing the relationship of individual elements and structural components, justification of the principles of selection and structuring of the content of graphic disciplines research by scientists can be divided as follows:

– researches in which the traditional descriptive geometry is based;
– researches that recognize the descriptive geometry, but a greater priority is given to the study of computer graphics. Moreover, both disciplines are considered as independent;
– researches in which scientists propose to abandon the descriptive geometry and solve engineering graphics problems using computer graphics. Thus, they cast doubt on the theoretical foundations of geometric modeling, that is, the study of visual-figurative language;

– researches studies in which geometrical training as a single integral course based on the ideology of three-dimensional geometric modeling is substantiated.

At the same time, with all possible differences in defending their scientific positions, all authors put forward one unchanged condition for structuring the content of engineering graphics training. Its essence lies in the fact that for today in the training of engineers-mechanics there is a need to form the content of training in accordance with the specifics of professional activities.

Taking into account the tendency of introducing a competent approach in the system of vocational education, we can assert with certainty that the specificity of such activity forms the requirements for the final result of training and, in our opinion, orientates the organization of the learning process itself on the basis of the introduction of innovative technologies [8; 9]. For example, S. Hinne as the final result of computer graphic study distinguishes the formation of basic analytical skills. The scientist, explaining the essence and content of the analytical skills of future mechanics engineers, characterizes them as the ability to analyze scientific and technical and normative-technological documentation, technological parameters and the state of production equipment, experience and results of their activities.

In the perspective of our scientific interests attracts the substantiation and didactic support of the investigated process of organizational and pedagogical conditions. To them the researcher includes: orientation of the components of the educational process to mastering the basic analytical skills; active inclusion of students in this process; enriching the experience of analytical activity of the future mechanic-engineers. To the method of realization of justified conditions, the author offers specific tasks of analytical character, reflecting one or another professional function of the future engineer-mechanic; the organization of independent experiments with elements of analysis when performing laboratory and practical work; conducting lectures with elements of problem dialogue; independent work of students for the preparation of reports, abstracts, projects of graphic documentation of analytical search [12].

In the writings of O. Popov [7], we drew attention to the methodology of organizing the active participation of students in the Olympiad direction in the preparation of future engineers of the machine-building industry for creative activity. We were interested in the effective possibilities of Olympiads in the study of engineering graphics. For this purpose, we launched the All-Ukrainian Olympiad on Graphic Design by Victor Sydorenko at the National Pedagogical University named after M.P. Dragomanov.

As such an organization of the educational process substantially activates the educational and cognitive activity of students, it provides an opportunity to develop cognitive motivation, using collective forms of work and transform learning into self-education, then the obvious is the effectiveness of the learning process in general and engineering graphics in particular. Naturally, the result of the pedagogical experiment has shown the deepening of students' knowledge of the disciplines, their effectiveness, development of creative thinking, educational and professional interests. Taking into account the significance of the organization of the competitive learning style, we asked the question of ensuring a harmonious relationship between the quantity and quality of the ready-to-learn competitions.

Maximum active participation of students in the educational innovation-project activity, taking into account the constantly changing tasks of engineering design, from our point of view, offers E. Muratova. The scientist proves the effectiveness of the developed methodology for organizing coursework and diploma design: the division of the project implementation process into stages, the definition of goals for each stage. Expanding the range of information technologies use as the means of supporting educational and cognitive activity of students in the design process [4].

The methodical system of studying engineering and graphic disciplines of applicants of higher education in high school conditions is quite thoroughly presented in the dissertation of I. Nischak [5]. The basis of the concept of a methodical system of teaching engineering and graphic disciplines the author put a number of key ideas:

– rethinking the role and importance of graphic information as a universal language of communication in the scientific and technical field and increasing the professional-applied orientation of learning outcomes;
– the priority of engineering and graphic knowledge as a fundamental in the development of general technical and special components of the professional training of the future specialist;
– expansion of the subject area of professionally oriented engineering and graphic disciplines;
– orientation of the process of teaching engineering and graphic disciplines to the systemic development of fundamental knowledge and professionally meaningful skills, taking into account the degree of expansion of cognitive capabilities of higher education applicants;
– clear continuity and consistency of engineering-graphic training in higher education institutions;
– widespread use of means of modern information technologies training at all stages of engineering and graphic preparation;
– a shift in the emphasis on engineering and graphic preparation for the development of figurative and technical thinking, cognitive activity, creative abilities and other personality traits necessary for the successful professional activity of a future specialist in the conditions of information and technology.

The didactic background of the proposed methodological system is considered by the scientist to be a system of principles for organizing the process of studying engineering and graphic disciplines. The latter include: general pedagogical principles (humanization, continuity of education, democratization, integrity, individualization, activization of education, etc.), didactic principles (scientific, systematic, systematic and consistent, visibility, accessibility and strength, strength of knowledge acquisition, etc.). and specific principles (the fundamental of engineering and graphic knowledge, the structuring of the goals of engineering and graphic preparation, the systematic training of engineering and graphic disciplines, the informatization of the process of engineering and graphic training etc.).

It attracts the author's position that the implementation of the concept of the methodical system of teaching engineering and graphic disciplines, although it provides the training of the future teacher, but to perform the functions of various professions in the system of technological education and design and development activities. It is not only about the position of the teacher, but also the head of the school design bureau, the head of the subject and technical circles of different directions, the teacher of pedagogical institutions of higher education of different levels of accreditation, a scientist-researcher in the field of pedagogical and vocational education, etc.

The researcher has proved that the level of engineering and graphic training of higher education graduates will increase significantly if in the structure of higher education the model of the methodical system of training of engineering and graphic disciplines is realized, which is based on the principles of creative personality development, takes into account the global informatization of society and relies on the system-holistic, active, personally oriented, competence, synergetic, integration and informational and technological approaches to the design of the educational process.

An important conclusion for us was the confirmation of hypothetical provisions [5], the essence of which was that the teaching of engineering and graphic subjects of higher education graduates would be effective if:

– to create conditions for their awareness of the importance of graphic means of presenting information in the context of world trends in the modernization and technology of society and the need to master them by younger generations;
– selection and structuring of the contents of the training of engineering and graphic disciplines will be based on the principles of integration of graphic and technological and technological knowledge, will take into account the logical continuity of training

courses and the interconnection of relationships between them, will have personally oriented and creative nature;
– realization of engineering and graphic training of higher education graduates will be carried out in the conditions of the methodical system of teaching as a mechanism for organizing an effective subject-graphic environment aimed at developing creative skills and abilities, the development of professional self-awareness, the provision of subject-subject pedagogical interaction.

3. Conclusions

An important conclusion for us was the confirmation of hypothetical provisions [5], the essence of which was that the teaching of engineering and graphic subjects of higher education graduates would be effective if:
– to create conditions for their awareness of the importance of graphic means of presenting information in the context of world trends in the modernization and technology of society and the need to master them by younger generations;
– selection and structuring of the contents of the training of engineering and graphic disciplines will be based on the principles of integration of graphic and technological and technological knowledge, will take into account the logical continuity of training courses and the interconnection of relationships between them, will have personally oriented and creative nature;
– realization of engineering and graphic training of higher education graduates will be carried out in the conditions of the methodical system of teaching as a mechanism for organizing an effective subject-graphic environment aimed at developing creative skills and abilities, the development of professional self-awareness, the provision of subject-subject pedagogical interaction.

References

[1] Dzhedzhula OM, Systema hrafichnoi pidhotovky studentiv inzhenernykh spetsialnostei vyshchykh navchalnykh zakladiv, Vinnytsia: VDAU, (2007), p. 246.
[2] Khutorskoy AV, Klyuchevyye kompetentsii kak komponent lichnostno oriyentirovannogo obrazovaniya, *Narodnoye obrazovaniye*, № 2. (2003), pp: 58–64.
[3] Koziar MM, Formuvannia hrafichnoi diialnosti studentiv vyshchykh tekhnichnykh navchalnykh zakladiv osvity zasobamy kompiuternykh tekhnolohii : monohrafiia, Rivne : NUVHP, (2009), p. 280.
[4] Kraynova EA, Professional'naya podgotovka buduschih inzhenerov-mehanikov v oblasti informacionnyh tehnologiy: avtoref. dis….kand. ped. nauk: 13.00.08, Nizhniy Novgorod, (2007), p. 24.
[5] Muratova. EI, Podgotovka spetsialistov mashinostroitelnogo profilya k innovatsionno-proyektnoy deyatelnosti v usloviyakh vysshey shkoly: diss…. kand. ped. nauk: 13.00.08, Tambov, (2002), p. 247.
[6] Nishchak ID, Metodichna sistema navchannya inzhenerno-grafichnikh distsiplin maybutnikh uchiteliv tekhnologiy. – Rukopis. Disertatsiya na zdobuttya naukovogo stupenya doktora pedagogichnikh nauk za spetsialnistyu 13.00.02 – teoriya ta metodika navchannya (tekhnichni distsiplini), Natsionalniy pedagogichniy universitet imeni M. P. Dragomanova, Kiïv, (2016).
[7] Popova OP, Rozvitok tvorchogo potentsialu maybutnogo inzhenera v protsesi profesiynoï pidgotovki u vishchomu tekhnichnomu navchalnomu zakladi : avtoref. dis. ... kand. ped. nauk : 13.00.04, Zaporizhzhya, (2006), p. 20.
[8] Puzankova AB, Formirovanie professional'nyh inzhenerno-graficheskih kompetenciy studentov v processe ih obucheniya komp'yuternoy grafike: na primere special'nostey mashinostroitel'nogo profilya: avtoref. dis…. kand. ped. Nauk: 13.00.08, Samara, (2012), p. 23.
[9] Stolbovaya. ID, Adaptivnoye upravleniye kachestvom predmetnoy podgotovki v tekhnicheskom vuze na osnove kompetentnostnogo podkhoda (na primere graficheskoy podgotovki studentov : dis. … kand. ped. nauk : 05.13.10, M., (2012), p. 399.
[10] Stolbovaya ID, Vyyavleniye sostava aktualnykh kompetentsiy graficheskoy podgotovki, *Problemy kachestva graficheskoy podgotovki*, № 4, (2010), pp: 12–19.
[11] Tarabrin OA, Kompleksnoe ispol'zovanie informacionnyh i kommunikacionnyh tehnologiy v processe nepreryvnoy podgotovki inzhenernyh i upravlencheskih kadrov: na primere podgotovki specialistov dlya otrasley mashinostroeniya: avtoref. dis….dokt. ped. nauk:13.00.02, M., (2006), p. 45.
[12] Fomenko SI, Didakticheskie osnovy povysheniya effektivnosti podgotovki inzhenerov-konstruktorov sel'skohozyaystvennogo mashinostroeniya: avtoref. dis. ... kand. ped. nauk: 13.00.01, Rostov-na-Donu, (1991), p. 17.