Pedagogical Conditions for Formation of Design Competence of Qualified Workers with the Use of Information Technologies

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Summary
Modern production requires production staff who have design competence, experience and skills to work in various types of work integrated into professional activities. Possession of digital design methods significantly expands the opportunities for professional activities of qualified workers. The purpose of our study was to study the impact of pedagogical conditions on the formation of design competence of future qualified workers in a group work. We have identified a set of pedagogical conditions that promote the development of professionally oriented artistic and technical creativity of workers in the conditions of curricular and extracurricular activities, which include motivational-target, procedural-semantic, organizational-technological, and subject-oriented. It is shown that the formation of design competence is determined by motivational, informational-active and reflection criteria, which are aimed at motivational-value, cognitive, operational-active, creative, social and emotional components of this competence. The methodology of the research is highlighted, which includes the use of the following methods: determination of the personality's motivational sphere in order to identify strong and weak motives of students activity; multiple intelligence to identify students talents in the direction of practical intelligence, which is important for design competence; determining the level of creative activity to identify manifestations of students creative abilities; identifying the type of students innovative thinking in order to develop motivation for success; factor-criterion model, developed on the basis of a qualimetric approach, which is used to identify the level of design competence formation in accordance with its components. The results of the study showed that the creation of separate pedagogical conditions in the institution of vocational education and training (VET) had a positive impact on the development of design competence, which shows the potential of artistic and technical design in the development of professional creativity of future qualified workers taking into account the environmental approach.

Keywords:
design competence, artistic and technical design, information technologies, curricular and extracurricular activities, vocational education and training, qualified worker.

1. Introduction

The innovative model of state development is associated with the harmonization of relations between production, education and culture through the technical and technological culture of the population. Modern technologies have become the technical tools that stimulate creative activity and promote human self-expression. At the same time, changes in professional activity actualize the need for creative self-realization of professionals, when creativity is seen as a means of adaptation to the requirements of the labor market. Additional skills of specialists not only increase competitiveness, promote mobility, but also create a basis for expanding the profile of professional training.

The demand on the labour market for interdisciplinary competencies, focus on expanding the profile of training, integration of professions, the ability to make non-standard decisions draw attention to the opportunities of vocational education and training to promote the training of competitive future workers. The guarantee of their employment is the accumulated result of all types of training, focused on the professional sphere of activity.

Modern requirements for the results of workers professional training are described in the standards of professions on a competency basis. We analyzed the professions standards content of woodworking and machine-building profile, related to the transformation

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activity and with a pronounced aesthetic potential. In particular, the professions standards for woodworking profile - woodworking machine operator, carpenter, manufacturer of wood products, wood carver, carpenter, and for machine-building profile - blacksmith hand forging, blacksmith of artistic forging, electric welder, manufacturer of metal products. The analysis of the competencies content showed that in the transition to higher levels of qualification is actualizing the necessity for the employee to have design and technological competence, the ability to create a product from idea to manufacture in the material in compliance with quality requirements, including aesthetic. This indicates the attention to the project culture formation of future professionals, to design thinking mastering and the development of design competence. Accordingly, in this context, the issue of compliance with the continuity of technological training in general secondary and vocational education and training is relevant. In this regard, an important task for the and vocational education and training system is to take into account the previous experience of students and organize conditions for them to gain additional knowledge and skills focused on self-realization in design and creative activities and a new aspect of the profession. In the case of training future workers, additional skills are often associated with the realization of the artistic or technical aspect of their profession.

The theoretical basis of the study is the provision that artistic and technical design in vocational education and training is an important area of design development and creative potential of production staff, whose role is growing in the information society.

Scientifically based artistic and technical design at the basis of the environmental approach is considered as a necessary and sufficient component of future workers professional training, which lays the foundations of professional design education with different types of design in appropriate environments. Industrial design corresponds to technical professions.

The problem of rational and artistic knowledge unity, integration of technical and humanitarian knowledge, science and art, interaction of scientific concept and image has long been studied by scientists to study the mechanism of changing human perceptions in different ways, what you need to be able to do in the process of solving problems, and use the appropriate tools (Braund Martin & Reiss Michael, 2019). The ability of the future technical specialist to work with images is formed during the execution of graphic tasks and is tested by the manufacture of products. Active work with images develops his spatial thinking. The transition from graphic images to technical and artistic drawings involves the ability of the future specialist to work with information of an artistic nature, which requires visual-spatial thinking, on which design activities are based.

Design activities are aimed at creating material and spiritual objects, expanding the space of thinking, increasing the possibilities of using tools for creativity, which gives grounds to introduce design into the system of continuing education. Expansion of the training profile, the need for deep modern knowledge and complex skills create the preconditions for the introduction of design education in the system of and vocational education and training.

In Ukraine, the training of a designer-performer is carried out at the level of a junior specialist in colleges and higher vocational schools, and in vocational education they are trained in the working profession "manufacturer of art products" with an indication of the type of material. Annual monitoring of graduates employment is carried out by the educatioal institutions and state institutions themselves, which determine the expediency of training workers in a particular profession. Analysis of long-term statistical information on employment of graduates who have obtained a separate technical, artistic specialty and integrated profession, shows that it is advisable for working professions that have a strong aesthetic aspect, to prepare future workers in integrated professions, such as "carpenter, art manufacturer trees". This makes it possible to form project-creative competence through the curriculum. In the case of non-integrated professions, opportunities for extracurricular activities of students are used.

At the present stage in Ukraine, the development of vocational and technical design education is limited by professional standards and most of all it involves those students who acquire artistic professions, in particular, service professions - tailors, hairdressers, jewelers. Since the goals of the study of design differ at different levels of education, in vocational education for technical professions, the socio-cultural problems of design education are solved by artistic and technical design.

2. Analysis of recent research and publications

The authors Kuzminskyi, A. I., Kuchai O. V., Bida, O. A. in their article have determined the content basis of specialist in computer science vocational training which was grounded on the functional approach in the research process. In particular, the content of relevant curricula and programs has been analyzed. The curricula of Poland and Ukraine provide a set of disciplines that ensure the formation of the professional competence of a specialist in computer science. Based on the state standard of a specialist in computer science, we have identified the following teacher of informatics competences: information system, operative-informatics, computer networks, competence in the field of programming [10].

Scientists Kuchai, O., Yakovenko, S., Zorochkina, T., Okolnycha, T., Demchenko, I., Kuchai, T. considers the training of specialists in education in the conditions of distance learning. It is lights up the advantages of distance learning and determined the characteristic features of

distance learning of students training in the implementation of these technologies in the educational process [7; 8; 9].

In the conditions of the accelerated technologies development, the possession of information technologies becomes a necessary condition of expert's self-realization in creative professional activity [2; 15; 16].

The use of information technologies in the educational process is carried out in the following areas: empowerment of traditional tools in narrow subjects; performance of interdisciplinary tasks, but within the framework of traditional means (constructing, modeling, research, designing); as non-traditional teaching aids (complexes of computer educational programs, software, textbooks-navigators on the computer environment). An integrated approach is used in artistic and technical design, as all these areas are important. The systematic research conducted by scientists on the formation of design competence in technical professions has shown the importance of applying the STEM and STEAM approaches, which integrates engineering and artistic creativity [15; 16].

Computer software allows you to create a virtual information model of any design object, implement dynamic visibility and influence the perception of spatial images, understand the relationships of structural elements, creating schemes and models. Therefore, training of future workers is impossible without mastering the basic programs (Corel Draw, SketchUp, Adobe PhotoShop, AvtoCAD, 3ds MAX).

The result of mastering by technical professions future workers of artistic and technical design is the formation of design competence, which provides worker's contextual understanding of the professional field development through the experience of creative activity in which subject and artistic images interact. At the same time, it develops creative, critical, design thinking, promotes the adaptation of graduates to change and increases mobility in the labour market.

According to our scientific concept, artistic and technical design is a necessary and sufficient component of the methodological system of professional design education, which should contain types of design that correspond to professional environments in the field of activity (human-technique, human-nature, human-artistic images, human-sign systems, human-man). The content of design type is developed considering the standards of working professions and socio-cultural objectives of this level of design education. The introduction of vocational and technical design education takes place in stages, involving various forms and levels of training: the first stage - group artistic and technical creativity with an emphasis on the professional sphere; the second stage - design education in appropriate professional environments (industrial design for technical professions, landscape design for human-nature professions, costume design for service professions, etc.); the third stage is the introduction of professional STEAM education.

The article presents the study results of the first stage of the artistic and technical design introduction in the system of vocational education and training.

The aim of the article is to study changes in the development of design competence of technical professions future workers and analyze the impact of pedagogical conditions on this process.

3. Research methods

To identify common problems and differences in the organization of artistic, technical and artistic-technical creativity by students of different levels, a critical analysis of scientific and methodological literature was carried out. The study of laws and regulations on education and professional activities was carried out to identify the requirements for the level of future workers creative development and identify leading scientific approaches to the organization of creative activities.

The educational model of artistic and technical design for vocational education and training includes the following components: scope of activity and object of work, which allows to identify the basis for the integration of technical and artistic creativity for technical, artistic and integrated professions; invariant content, which provides theoretical training (technologies in the field, industry materials science, drawings, etc.) and industrial training; leading discipline, on the basis of which artistic and technical design is realized; variable content, which determines the module through which future skilled workers are involved in the study of artistic and technical design ("Artistic and technical design in the profession" and "Design in the field"); content orientation, which takes into account the profile of the profession (technical, artistic or integrated); the content of extracurricular work aimed at artistic and technical design in the profession or design in a professional environment.

In the context of the design competence formation, depending on the object of work for different profiles of professions, different disciplines become leading: for technical professions - technology, for artistic professions - art. Only integrated professions, where the first level is technical and the second artistic, are objectively aimed at studying design in the industry. In the absence of a separate discipline for the study of design, this function is taken over by extracurricular activities and the potential of professional disciplines, which is realized in the work of clubs.

On the basis of substantiated theoretical and methodical bases of vocational education and training and out-of-school education modeling of art-technical designing was carried out, pedagogical conditions of its development in

curricular-extracurricular work are defined and criteria and indicators for diagnostics of formation level of design competence of future qualified workers are developed.

The development process model of the artistic and technical design of future qualified workers in the conditions of class-group work reflects the step-by-step process of students design competence formation in the club on the basis of invariant content of technical disciplines and variable content of group work. It includes diagnostic-motivational, information-content, organizational-environmental and reflection-evaluation stages. Let's briefly consider the essence of these stages.

At the diagnostic and motivational stage, the motive for choosing a club by a future employee is determined, and input data are accumulated to track the development of design competence; at the information and content stage the development, improvement and correction of the content is carried out taking into account the competence and personality-oriented approaches; at the organizational and environmental stage provides interpersonal interaction of students with the teacher in a professional environment, which gives a developmental effect; at the reflection and evaluation stage there is an assessment of changes in the development of design competence of future skilled workers.

The design competence has a multilevel structure and integrates different competencies of lower levels, important in design activities, so the important task was to identify for each of its components appropriate indicators that determine its formation. The objectivity of the assessment was ensured by a factor-criterion model developed based on a qualimetric approach [6; 18].

Formation was assessed considering the obtained expert scores and the weight of each component and indicator. The factors are the components of competence, and the individual criteria of the model - the selected indicators. Positive changes in the results between the initial and final measurement of the formation indicate the development of a component of competence.

Competence has a hierarchical structure in which the first level factors are the components of design competence, which give an intermediate result, at the second level - integrated components according to the criterion that has its components (information and activity criterion - cognitive, operational - activity and creative; reflective - social and emotional). At the third level we get a parameter - design competence, which is an integrative formation of three criteria - motivational, information-activity and reflection. The following formulas were used for calculations:

$$Pgen = P1 + P2 + P3 \quad (1)$$

where:

Pgen – design competence (a parameter that is a factor of the third level),

P1 – motivational criterion (second level factor),

P2 - information and activity criterion (second level factor),

P3 – reflection criterion (second level factor).

$$Pi = MP1 \times \Sigma (m1K1 + m2K2 +... + mtKt) \quad (2)$$

where:

Pi - factor by serial number,

MPi – the weight of the factor in fractions of a unit,

K1, K2, K3, ... Kt – criteria (indicators) by which the factor is determined.

Based on the comparison of the results before and after the formative experiment in the control and experimental groups, the tendency of changes in the levels of design competence in the group members is revealed.

The implementation of motivational-target, procedural-substantive, organizational-technological and subjective-oriented pedagogical conditions in the educational process of professional training affects the formation of the components of future qualified workers design competence.

Various methods, techniques and methods were used to identify the formation level of the design competence components. We will give their brief description.

For the motivational-value component, the method of determining the structure of the motivational sphere of personality was used with the help of the questionnaire of V. Gorbachevsky [13]. The use of this technique makes it possible to identify the supporting motives that are the internal mechanism of the formation of the claims of the individual. The method proposes 15 motives, which are divided into three groups according to the impact on humans: the first group - motives as driving forces in the activity; the second group - motives as necessary conditions of activity; the third group - the motives of the subject's understanding of the causal factors of their own activities. According to the methodology, we identified the 5 most and 5 least developed motives in the motivational sphere of students. Working with the first motives promotes the development of student's creativity, and with the second - orients the teacher and student to the reasons that inhibit the development of his creative abilities.

The formation of the cognitive component of competence was determined by means of a control check of educational achievements in the performance of professional nature tasks of different levels of complexity: direct main production tasks performed by workers of transformational professions; tasks for the development of tools (for the analysis or transformation of the subject, subject management); tasks of analysis and synthesis for restoration, creation, reproduction, and preservation. Gradually, these tasks were supplemented by tasks for the transformation of products depending on the design, functional and ergonomic requirements, to work with the aesthetic properties of materials, to create an artistic image of the product. Tasks were assessed on a 10-point school.

A factor-criterion model for evaluating the experience of creative activity, artistic-aesthetic and technical-

technological culture, tastes, skills and abilities was used to determine the operational and activity component of design competence. The experience of creative activity was determined by three criteria, each of which has its own weight: the availability of basic knowledge and skills in artistic and technical creativity; compliance with the requirements for the work (completeness, accuracy); independence, originality, the presence of elements of novelty in accordance with known decisions in the field of professional activity. Technical and technological culture was determined by the following criteria: technical and technological knowledge, skills, qualities; technological worldview; technical and technological thinking; technological ethics; technical and technological aesthetics [14]. To determine the artistic and aesthetic culture of future professionals, the following criteria were identified: aesthetic consciousness, aesthetic worldview, artistic and aesthetic taste, artistic education, artistic and aesthetic values, and artistic and aesthetic abilities [1]. According to the total sum of factors, taking into account the importance of each, the levels of formation of the operational component of design competence were determined [6; 18].

To assess the creative component of competence, methods were used to determine multiple intelligence (H. Gardner's improved method), E. Johnson's creativity, the type of innovative thinking according to M. Kirton, and the products of creativity were studied. Let's briefly consider these techniques.

The study used an improved method of determining the multiple intelligence of H. Gardner, which allows to determine the system of abilities-competencies that correspond to the profiles of talent and have a hierarchical structure: the academic profile integrates linguistic, logical-mathematical, and musical intelligence; practical profile - naturalistic, body-kinestatic and spatial intelligence; social (aesthetic) profile - intrapersonal, interpersonal and suprapersonal intelligence. Based on the analysis of generalized results, a map of intellectual talent of students in three profiles is built. The dynamics of change was determined at the beginning and end of the formative stage of the study [17].

In pedagogical research, the method of determining the creativity of E. Johnson allows direct assessment to assess the creative manifestations of students' abilities. To this end, use eight characteristics of creative thinking and behavior, which are evaluated by the teacher. Its advantage is that the evaluation can be both one-off or in several stages. Evaluation by this method was conducted by us at the beginning and end of the formative stage of the study [4].

According to the method of "Kirton's Indicator" the type of innovative thinking in students was studied on the scale "adapters-innovators", which is divided into six categories depending on the degree of manifestation within these two poles. The expediency of using this technique is based on the position that no matter what category you belong to, you can improve the type of thinking through self-reflection and motivation to succeed [12].

The evaluation of creative products was based on such factors as artistic design, technological performance, and the ability to publicly present their work. Criteria were developed for each factor, in particular: artistic design - completeness of image disclosure through design and creative design, perfection of design, artistic and aesthetic level of execution; technological execution - quality and accuracy of processing, conformity of manufacturing technology to properties of material, rational use of processing methods; presentation of work - relevance and practical significance, the ability to reconcile the verbal and visual content of the product, the culture of speech. A factor-criterion model was used to generalize the assessment for creative activity.

The social component of students' design competence reflects their activity in such areas as cultural, educational and social. For each of these areas, important indicators were identified: the cultural area concerned the general culture and the culture of work in the workplace during classes; educational - the ability to cooperate and politeness; social - participation in exhibitions, competitions, collective projects. The formation of the social component during the year involved the production of individual and collective projects, which were exhibited at exhibitions reviewing the creative achievements of students of the educational institution. In particular, these are exhibitions after passing large topics on professional and practical training, semi-annual and annual exhibitions-reports. Product evaluation was carried out in a differentiated - current model, layout, tool, device, finished product - according to the criteria of evaluation of creative products. Existing models and models were the result of collective projects. The generalized factor was determined by the factor-criterion model.

D. Lyusin's method, as well as methods of observation and self-assessment were used to determine the emotional component of design competence. D. Lyusin's method of determining emotional competence is aimed at determining the state of emotional intelligence by the components of its structure, the picture of which sets the direction of personal change. In the structure of emotional intelligence there are intra-personal and interpersonal intellects, the interaction between which provides an understanding of their own and others' emotions. In creative activity, the ability to control one's emotions and expression is important [11], which is very important for young people.

At the ascertaining stage the ways and ways of involving future workers in professional creativity in the educational process were investigated. We analyzed curricula, programs, educational and methodical literature of professional technical and artistic disciplines, industrial training, curricula of extracurricular education in order to identify opportunities for training future qualified workers in the

basics of creative, design and technological and artistic and design activities. In particular, there was a tendency to converge technical and artistic-technical creativity, which orients teachers to supplement the knowledge and skills of students in art and project activities.

To participate in the experiment, vocational education institutions were determined by the way professions are oriented towards artistic and technical creativity. We have taken into account those institutions that train specialists in the production of art products made of wood or metal and related technical professions, or where there are art and technical clubs.

The formation of design competence in future qualified workers in classroom and extracurricular activities was studied in four stages during 2014-2019, which ensured the reliability of its results: search (2014); ascertaining (2015); formative (2016-2018); generalized (2019).

In total, 450 students of vocational and technical education institutions of Volyn, Ivano-Frankivsk, Lviv and Rivne regions took part in the experiment. At the ascertaining stage, based on a questionnaire of 250 students, the potentials of different groups of abilities were assessed and the expediency of involving future workers of technical professions in mastering their artistic aspect was established. The formative stage of the experiment was attended by 200 students who acquired technical professions and were engaged in clubs of professionally oriented creativity. The clubs functioned on the basis of the following institutions of professional (vocational) education: Higher Vocational School № 21 (Ivano-Frankivsk), Higher Vocational School № 22 (Rivne region, Sarny), Art Vocational and Technical School named after Y. Stanko (Ivano-Frankove, Yavoriv district, Lviv region), Higher Vocational School № 8 (Stryy, Lviv region), Interregional Higher Vocational School of Railway Transport (Lviv), Higher Vocational School № 29 (Lviv), Lviv Higher Vocational Art School, Lutsk Higher Vocational School of Construction and Architecture (Volyn Region).

The selection to participate in the experiment was natural, as the participants were students who, with their consent, chose the profile of the circle, and were also interested in participating in the experiment. Their consent to participate in the experiment with awareness of its purpose was one of the motivating factors. Accordingly, all ethical rights of participants are respected. The experiment was approved by the decision of the Academic Council of the Lviv Scientific and Practical Center of the Institute of Vocational Education of the National Academy of Pedagogical Sciences of Ukraine (protocol № 5 of 20.05.2015). Students studied in various professions of technical profile and integrated professions, where the second was the profession of art, in particular, carpentry, wood art manufacturer, blacksmith hand forging, welder, electric welder, metal art manufacturer, locksmith-repairman. They have been involved in clubs for two years, starting with the first year. Given the specifics of these professions, only young people aged 16-18 were involved in the clubs. The formative experiment was conducted in eight clubs of professionally oriented artistic and technical design. Classes were held within the curriculum, without disrupting the educational process.

The control group included 100 students from the following institutions: Higher Vocational School № 22 (Rivne region, Sarny), Higher Vocational School № 8 (Stryy, Lviv Region), Higher Vocational School № 29 (Lviv) and Lutsk Higher Vocational School of Construction and Architecture (Volyn region). At the same time, the experimental group included 100 students who studied at the Higher Vocational School "21 (Ivano-Frankivsk), Art Vocational School named after Y. Stanko" (Ivano-Frankove, Yavoriv district, Lviv region).), Interregional Higher Vocational School of Railway Transport (Lviv), Lviv Higher Vocational Art School.

Under the conditions of the experiment in the control groups, training was conducted without changes, according to the programs that were drawn up by the leaders of the groups themselves. Each leader developed a program based on their own vision of the place of artistic and technical design in the profession. Mostly in these programs more attention was paid to technical creativity. The formative influence on the design competence of students of experimental groups was carried out by the content of group work, methods of teaching artistic and technical design in the circle and the implementation of pedagogical conditions. To exert a formative influence on students of experimental groups, a complex was developed, which included a manual, a course program on the basics of organizing creative activities of students of vocational (vocational and technical) education for teachers, a circle "Artistic and technical design in the profession", a collection of best design products made by students based on the results of annual festivals of creativity and exhibition-reports organized by the Lviv State House of Technology. We will give a brief description of this complex.

The manual "Methodological principles of implementing modern approaches to the work of groups" aimed to guide teachers to organize research and design work of students in circles of technical and artistic creativity, considering the competence and personality-oriented approaches. It reveals the features of the methodology of teaching in a circle, methods of forming the competencies of circle members, the theme of creative work that can be done considering the profession. It is supplemented by a description of the techniques used to determine the formation of the components of design competence, discussed above.

The course on the basics of organizing the creative activity of students of vocational education aimed to acquaint teachers with important issues of creative activity and its organization in all forms available in the institution

where future qualified workers are trained. An important component of this course was the topic of organizational foundations of technical and artistic creativity, which was accumulated content, which later formed the basis of the content of the program circle "Artistic and technical design in the profession." The student group program was designed for two years and consisted of five modules. During the first year, students took two modules: the first module was to get acquainted with creativity as an important component of human activity in general and the specialist in particular; the second module was devoted to design in professional activities. Much attention was paid to the formation of the foundations of technical-technological, artistic-graphic and artistic-design culture in students, as well as solving professional problems. In the second year of study, students studied two modules related to the artistic and technical patterns of development of industry objects and the basics of education. The focus was on the type of design that suited the professional environment. Given the fact that the circle was engaged in students of transformational professions, the leading was the industrial design. The fifth module included the production and presentation of the project. In each project the creative use of the acquired knowledge and the formed abilities of pupils in a circle was analyzed.

In the third year in the lessons of professional disciplines begins work on the final qualifying work, which gives the opportunity to use the knowledge and skills acquired in the clircle and show design competence. Almost all the works of students who studied in integrated professions have a design component. Here is an example of one of the best works of students performed in a circle.

To identify the dynamics of changes in the development of design competence, the results of the formation of its components at the beginning and end of the formative stage were compared. The difference between the empirical distributions of the EG and CG groups was checked using the Pearson agreement criterion $\chi 2$. As part of the experiment, future workers worked in the club for two years, so the formation of their design competence took place in stages. At the beginning of the first year, the diagnosis of the entry level of the formation of design competence was carried out according to the criteria defined for further monitoring of its changes. The calculation of the Pearson agreement criterion $\chi 2$ showed the homogeneity of the EG and CG groups that participated in the experiment.

After that, pedagogical conditions for teaching professionally oriented artistic and technical design in a circle were created and implemented: motivational-target - the formation of students' motivational and value attitude to professional and artistic-technical creativity, the need for continuous improvement of skills, self-learning and self-development; procedural and semantic - purposeful integration of knowledge, skills and abilities in artistic and technical creativity in the conditions of curricular and extracurricular activities, development of the content of professionally oriented artistic and technical design and methods of its teaching, active acquisition of creative experience by students; organizational and technological - selection of forms, methods and technologies of training for self-realization in artistic and technical design; subject-oriented - providing personal meaning to be creative, professional, personal, artistic, aesthetic and cultural development of students. The previously developed content of professionally oriented artistic and technical design was improved and adjusted in accordance with the wishes, inclinations and needs of the group members, which made it possible to move to the formative influences, which were carried out in accordance with the developed methodology. The content of artistic and technical design was mastered by future workers in a circle with an emphasis on the profession throughout the period of professional training. Gradually, during classes, skills were formed that combine the typical skills of technical creativity in the context of the profession. At the same time, they were complemented by skills related to art and design activities. During the training in the circle, methods and technologies were used that promote the search, creative, reflective activities of future qualified workers. Particular attention was paid to those methods and technologies that, through the mechanisms of personal motivation, intensified the processes of independence, self-reflection, self-improvement, self-management, and self-realization. These include a group of methods of pedagogical coaching: the method of projects, the method of specific situations, the method of creating cognitive discussion and the method of emotional stimulation.

At the end of the second year of study in the experimental and control groups, the diagnosis of the initial level of formation of design competence was carried out according to the criteria, which made it possible to quantify the effectiveness of formative influences in the experimental groups.

4. Research results

After completion of the formative stage of the experiment, the following results were obtained (table 1).

Table 1: The results of the design competence formation of future qualified workers

Criteria	Groups	Formative stage start (%)			Formative stage end (%)		
		Low level	Medium level	High level	Low level	Medium level	High level
Motivational	CG	12,0	50,0	38,0	8,0	51,0	41,0
	EG	14,0	47,0	39,0	4,0	35,0	61,0
Informational and active	CG	50,0	46,0	4,0	31,0	59,7	9,3
	EG	48,3	46,0	5,7	19,0	59,7	21,3

Reflective	CG	34,0	61,5	4,5	23,0	66,0	11,0
	EG	34,5	60,5	5,0	13,5	64,5	22,0
Design competence	CG	32,0	52,5	15,5	20, 7	58,9	20,4
	EG	32,3	51,1	16,6	12,17	51,73	36,1

The calculation of the Pearson agreement criterion $\chi 2$ showed the heterogeneity of the EG and CG groups, which indicates higher learning outcomes in the experimental groups. Comparison of the dynamics of changes in the control groups, which occurred naturally, and in the experimental groups due to the created conditions allowed us to conclude about the effectiveness and efficiency of the impact of our identified pedagogical conditions (Fig. 1).

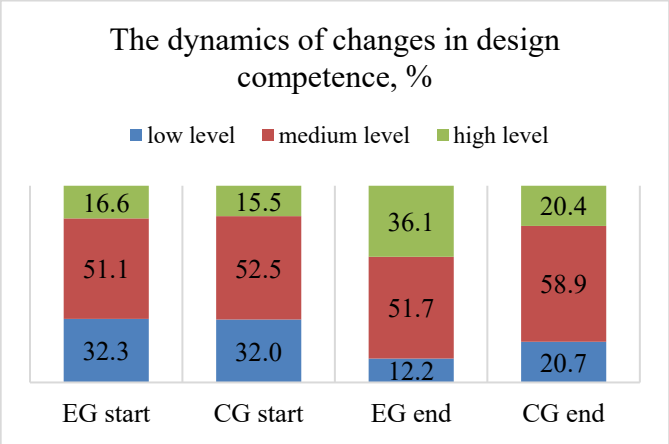

Fig. 1 The dynamics of changes in design competence levels of students of control and experimental groups based on the results of the formative experiment

Sourse: Author's own conception

As can be seen from Fig. 1, positive changes occurred in both groups, but with different effectiveness. The number of students at low, medium and high levels, which were determined by the results of the input diagnosis of design competence, in the process of implementing the pedagogical conditions changed at the end of training. The decrease in the number of low-level students due to the transition to the middle level and the increase in the number of high-level students in general indicate positive changes. We found a gap in the number of students in the experimental and control groups by levels, in particular, at a low level the gap is 8.5%, at a high level - 15.7% in favor of experimental groups. This conclusion was confirmed by the calculation of Pearson's agreement criterion: $\chi^2_{0,05} = 5.9915 < 7.04 < \chi^2_{0,01} = 9.2103$, which suggests that there are differences between groups caused by formative factors and created pedagogical conditions.

5. Discussion of results

The study for the first time substantiated the theoretical and methodological principles of artistic and technical design in the training of future qualified workers in the technical profile in institutions of vocational education. They reveal a conceptual idea, which is that scientifically sound artistic and technical design optimizes training and production processes and reorients future workers to the complementarity of production, information and design technologies. Accordingly, the complementarity of lessons in technical disciplines and industrial training in artistic and technical design allows to identify the design and creative potential of future qualified workers and use it to form their design competence.

The method of forming the design competence of future qualified workers in curricular and extracurricular activities, taking into account the professional environment: the content of artistic and aesthetic direction, important for the study of design in the field, which was included in the content of the circle. In the semantic part of the methodology, attention is paid to the trends of changes in production technologies (focus on waste-free production, new opportunities in the design and shaping of products, the use of software). This content is adapted to the training opportunities of future qualified workers. Implementation of the technique involves the use of a set of methods inherent in artistic and technical design (artistic design, analog modeling, technological formation, iterations, brainstorming, associative, etc.), tools (didactic, media libraries of creative works, field objects, museum exhibits, software means, etc.), organizational forms (exhibition, festival of creativity, creative report, preparation for the competition of professional skills).

The pedagogical conditions for the development of artistic and technical design in the professional training of future qualified workers, which contribute to the formation and development of design competence in them, are determined. The creation of these conditions makes it possible to transfer the integration of technical and artistic creativity into a new quality - artistic and technical design, where the leading technology is the technology of shaping production facilities.

The expediency of forming design competence in future workers corresponds to the modern understanding of the quality of human capital, when the labour market increasingly values the flexibility of the specialist, creativity, assimilation of relevant information and mobility. We agree that design as a quality of thinking is an important value for all levels of education because it contributes to the formation of a special type of thinking and type of culture, resulting in a person's ability to plan and design. In this aspect, it is important that in general secondary school during the transition from class to class, students can immerse themselves more deeply in project culture, and in

vocational education and training - to delve into and master the professional project culture, taking into account the professional environment.

The formation of design competence in future qualified workers in practice requires consideration of the principles of continuity, complementarity, and perspective, which allows to further develop creativity, improve design thinking and culture, but focusing on the need for additional competencies and prospects in professional activities. Therefore, when teaching the profession of future workers, attention is paid to the possibility of integration of professions, creating conditions for additional education, which would consider the abilities and would contribute to the formation of knowledge, skills and abilities necessary for creative potential. In this context, design education ensures the integrity of technical and artistic methods of activity and contributes to the competence development of the personality of future workers.

In modern economic circumstances, the mechanism of stability of many enterprises is the integration of working professions, which involves the possession of specialists with relevant competencies and expands the boundaries of the professional field. Implementation of the basic provisions of the concepts of technological education, artistic and technical design, STEM and STEAM pedagogical technologies highlight the need for the formation of design competence of future qualified workers with a focus on the professional environment.

Conclusions

We consider the design competence of workers as an important component of professional competence, which is related to their practical intelligence and ability to be creative in a professional environment. It is due to the use in modern enterprises of design technology aimed at the appropriate type of design. For workers in technical professions, it is advisable to get acquainted with the technology of industrial design, which can be best done for professions such as "man-technique-image". Mastering the technology of industrial design through artistic and technical design in a circle aligns the internal information environment of the worker's personality with the needs of production and the social requirements of creative self-realization.

Our research has shown that the creation of pedagogical conditions and the provision of competency, integrative activities and cultural scientific approaches to artistic and technical design in the process of training has had a positive impact on the formation of future workers' design competence. This confirms our assumption about the possibilities of artistic and technical design to reveal the creative potential of future workers and direct it to the professional sphere.

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