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RESULTS OF EXPERIMENTAL IMPLEMENTATION OF THE MODEL OF PROFESSIONAL COMPETENCE FORMATION OF FUTURE DESIGNERS BY MEANS OF PAPER ENGINEERIN

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ABSTRACT

The article presents quantitative indicators and highlights qualitative changes in the formation of profession competence of future designers as a result of an experiment caused by: global activity in paper engineering a paper art; the state of research on the formation of professional competence of future designers, in particular, means of paper engineering and the content of paper engineering in design education. In particular, the rethoug content of paper engineering and paper art enabled students to acquire a new systemic vision, which had positive impact on the quality of discussion processes and cognitive activity. As a result of the mode implementation, students began to make more balanced decisions before creating paper structures, choosi manual or technological execution of parts of tasks, and performing preliminary design. Discussion of the wor increased the level of communication skills (communication, cooperation). Knowledge of the world's experience paper engineering and practical skills provided opportunities to form students' motivation and commitment educational and cognitive activities, to understand their own needs, to take risks in creative activities desp possible defeat and to publish their own new ideas. The experiment demonstrated the possibility of increasing t level of self-esteem and self-control of students' own achievements. Ability to form the qualities of independenc professional (creative) approach.

Keywords: Experiment, Future Designers, Professional Competence, Paper Engineering.

INTRODUCTION

Professional competence in the professional training of designers is a basic concept, and its formation is traditionally built around creative design. By designing graphic and object forms, future designers gradually acquire more pronounced signs of professional competence, which eventually turns into a respectable state of mastery (Chemerys et al, 2021).

The level of design work depends on their future, their further perception by society, their professional development and recognition. Having the appropriate professional competence allows them to hold a job or create their own (Chemerys et al, 2022). His existence depends on how well he is trained professionally. One of the areas of professional competence of a designer is working with paper. Paper is a basic material for both graphic and composite activities. It allows a future designer to generate ideas, demonstrate graphic skills, present works, do research on creating paper forms, and present their achievements (Брянцев, 2023).

ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

Modern scientific research demonstrates a wide range of studies on the formation of professional competence of designers. The issue of the positive impact on the formation of professional competence through the use of innovative technologies and modern technological changes is being actively studied. Most research is focused on the development of individual qualities and competencies of designers. Researchers are looking for and analyzing aspects of the development of design professionals in different approaches. They improve the content, forms, and methods of selecting the necessary means of forming professional competence. They define the criteria, indicators, and levels of formation of future design professionals.

However, the formation of professional competence through paper engineering is not sufficiently considered. In most cases, scientists see working with paper in the context of applied involvement in the formation of student qualities, as an intermediate position in the formation of individual competencies (Kovalchuk, 2023) or paper art within art (Özgüner, 2013). A meaningful understanding of the integrity of paper engineering and art as a single educational field is not yet well established.

ORGANIZATION, QUANTITATIVE AND QUALITATIVE RESULTS OF THE EXPERIMENT

The basic condition for the formation of professional competencies of future designers was determined by us as follows: rethinking the content of experience in paper engineering and paper art.

For the experimental work (during the academic years 2021-2024), we selected full-time bachelor's students of the Design Department of the Faculty of Social Pedagogy and Psychology of Zaporizhzhia National University; Design Department of the Faculty of Art and Design of the Khortytska National Educational and Rehabilitation Academy; Design Department of the Educational and Research Institute of Culture and Arts of Luhansk Taras Shevchenko National University; Design Department of the Private Higher Education Institution "Art Academy of Contemporary Art". When conducting the pedagogical experiment, we met the requirements of validity, reliability and reliability. In accordance with the requirements of validity, such factors of influence as the contingent of students, their level of training, the conditions of organization and conduct of the experiment in the control and experimental groups were the same. The only difference was the content of the training of future designers, which defines this experiment as a one-factor experiment. The requirement of reliability is ensured by the alignment of the basic conditions for conducting a pedagogical experiment in the real conditions of the educational process of higher education institutions.

The ascertaining stage of the pedagogical experiment (2021-2022) was conducted to theoretically analyze the state of the problem of forming professional competence in future designers by means of paper engineering and determine its criteria and levels.

At the first stage - the statement (2021-2022 academic years) - on the basis of the created theoretical and empirical base: the problem, topic, purpose, objectives, object, subject, hypothesis of the study are formulated; the methodological support of the study and its methods are substantiated; the relevance and essence of the formation of professional competence of future designers by means of paper engineering are revealed; a model of formation of professional competence of future designers is developed; the content, methods, means and forms of formation of professional competence of future designers are developed (Брянцев, 2024a).

At the formative stage of the pedagogical experiment, the following tasks were solved: the formation of professional competence in future designers by introducing certain pedagogical conditions in the experimental group; determining the level of professional competence in future designers in the control and experimental groups by means of paper engineering in accordance with certain criteria and levels. At this stage of the pedagogical experiment, students of the control group were trained according to the traditional methodology, while students of the experimental group were trained according to the methodology developed by us, which involved the implementation of certain pedagogical conditions for the formation of professional competence in future designers by means of paper engineering.

Each criterion was responsible for studying the state of formation of certain indicators of professional competence. In particular, the professional content criterion involved knowledge of theoretical information that is the basis of paper science. The operational and technological criteria includes the activity component: technical skills and mastery of basic manipulations, techniques, practical skills of working with various tools, software and technologies; ability to work with different types of paper. The personal psychological criterion was responsible for communicative qualities: development of communicative and organizational behavior, interpersonal communication; student's ability to take risks with new materials and approaches; motivation. The reflective and evaluative criteria included questions about: the level of self-esteem and self-control; the ability to perform paper engineering tasks independently, without help; the ability to combine different thoughts, feelings and facts; to show conceptual solutions and originality in creating paper products; the ability to generate new and original ideas and new innovative approaches (Брянцев, 2024b).

To conduct the experiment, a number of methods were chosen to obtain quantitative and qualitative results of the experiment and determine the levels of professional competence of future designers (reproductive, productive and professional (creative)).

Determination of the formation of professional competence of designers according to the professional content criterion is carried out by means of test control. Determining the formation of future designers' professional competence according to the operational and technological criterion, a statistical verification of quantitative indicators was carried out by evaluating the results of the tasks. The tasks had a three-level complexity and an iterative approach to their implementation. The determination of the personal and psychological criterion of the formation of the professional competence of future designers was carried out by questioning students using: methods for assessing communicative and organizational tendencies by V. Sinyavsky and B. Fedorishyn (Кокун, 2011); methods of diagnosing the degree of risk readiness by Schubert (Кокун, 2011); methods of motivation for professional activity by K. Zamfir in the modification of A. Rean (Кокун, 2011). The reflexive-evaluative krerion was determined by questionnaires, the following methods were used: the method of determining the level of self-esteem by G. Kazantseva (Дмитрієва & Гаврилова, 2002); the method "My self-educational activity" (Мартинюк, 2020); the method of determining the level of formation of general creative abilities of the individual (Дмитрієва & Гаврилова, 2002).

At the formative stage of the experiment, students of the control group were trained according to the traditional methodology, while students of the experimental group were trained according to the model. The level of formation of future designers' professional competence by means of paper engineering in the control and experimental groups was determined according to the defined criterion and levels.

The qualitative changes were as follows: the new content of paper engineering and paper art gave students a better understanding of world heritage, which had a positive impact on the quality of discussion processes, cognitive activity, and motivation in general. The level of professional use of terminology has increased, the ability to distinguish between the principles by which artistic artifacts were created has improved, and the design concepts of paper engineering have become better understood.

As a result of the formation of the operational and technological (activity) criterion, technical skills and mastery of basic manipulations have improved. Students began to take a more balanced approach to the choice of a particular manipulation and their combination in techniques when creating paper structures. Working with tools, software and hardware provided opportunities to make decisions about the choice of manual or technological execution of parts of the tasks. During the review of the works, students began to better understand the technological principles involved. They began to show better abilities to combine their own manipulations and technologies. The level of preliminary design sketching has increased (see Fig. 1).

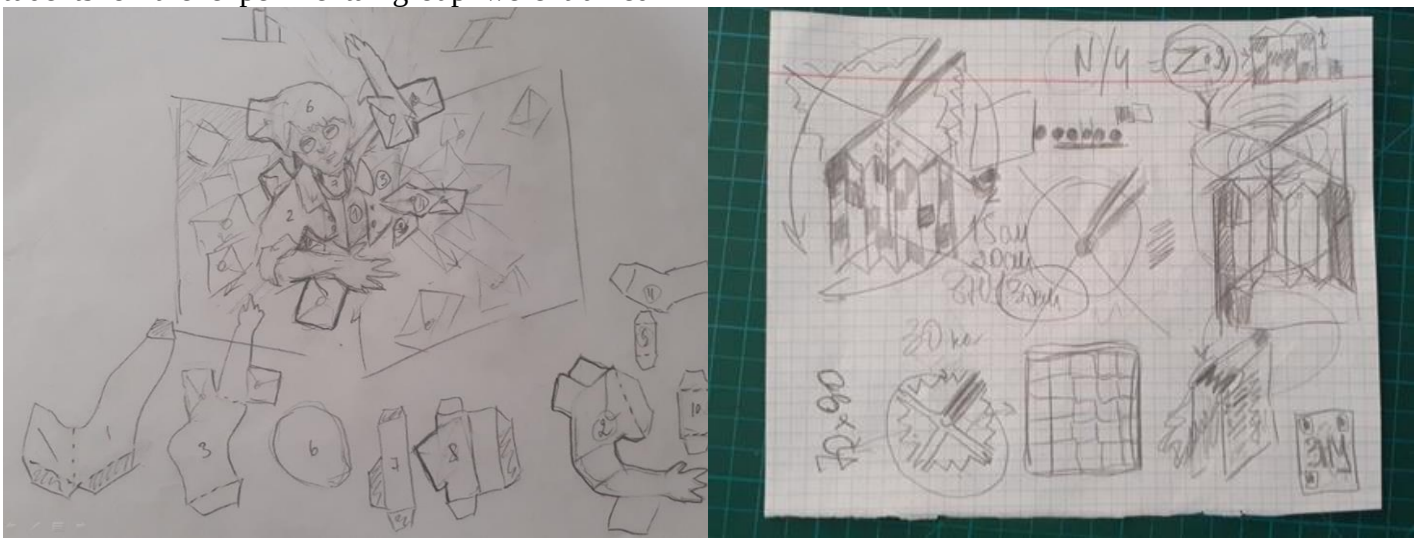

Fig 1. Design sketches

This had a positive impact on the subsequent reproduction of instructional graphics when describing folds, bends, and model assembly sequences (see Fig. 2).

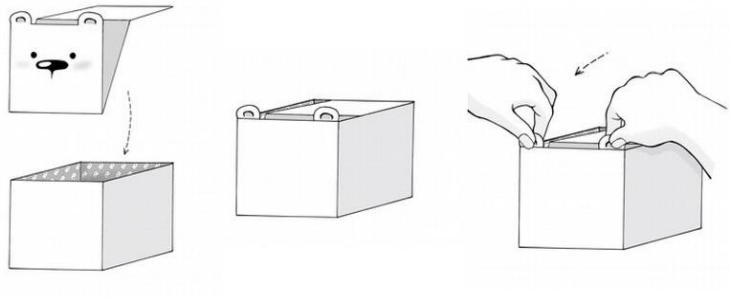

Fig. 2. Introductory graphic

The ability to accurately and neatly perform complex folds, breaks and joints in paper to ensure high quality and aesthetic appearance of a paper product has been demonstrated. Understanding of the use of different materials, the ability to work with different types of paper to create a variety of paper products has improved (see Fig. 3).

Fig. 3. Students' works

As part of the personal and psychological criterion, students demonstrated improved communication skills. Discussion of work improved the level of communication and cooperation. Students began to communicate better, using basic concepts, expressing their own opinions, presenting their achievements, ideas, paper products in both written and visual form, and improved their ability to work in a team and cooperate with clients and colleagues (see Fig. 4).

Fig. 4. Results of the communication indicator

The students showed a willingness to take risks with new materials and approaches, despite possible failure, and to publicize their new ideas (see Fig. 5).

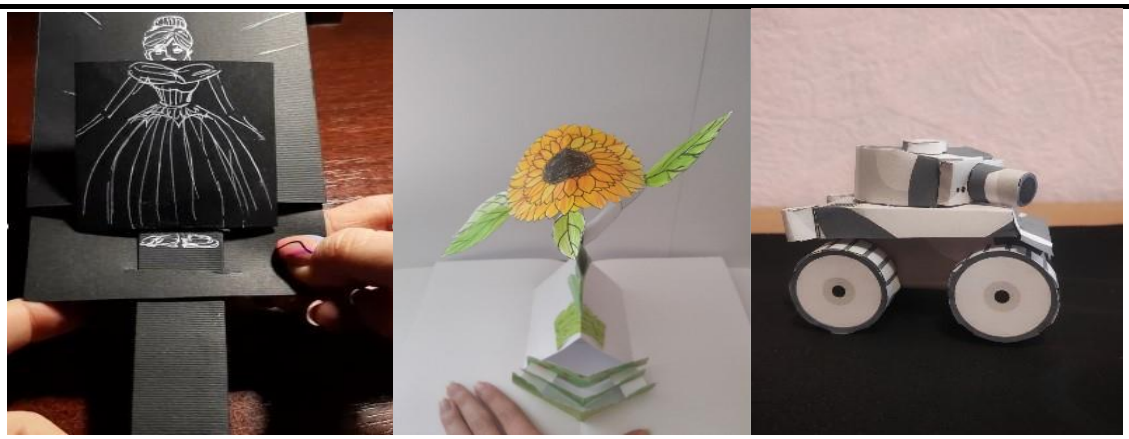

Fig. 5. Results of the material risk appetite indicator

Along with the acquired knowledge of the world experience of paper engineering and practical skills in the use of manipulations and techniques, they provided opportunities to form the motivation and purposefulness of students to engage in educational and cognitive activities, to understand their own needs.

According to the results of the test of the formation of the reflective and evaluative criterion, the level of self-esteem and self-control of their own achievements has increased. Students began to better understand the difference between the working and final concepts. The students had the opportunity not only to choose the appropriate level (reproductive, productive, professional (creative)) of the task, but also to perform tasks from simple to complex. This made it possible to see their own shortcomings, make decisions to eliminate them, improve their professional level at their own discretion, and, accordingly, build self-confidence. The presence of three levels made it possible to develop the independence to perform paper engineering tasks without help and guidance, using their own knowledge and skills (see Fig. 6).

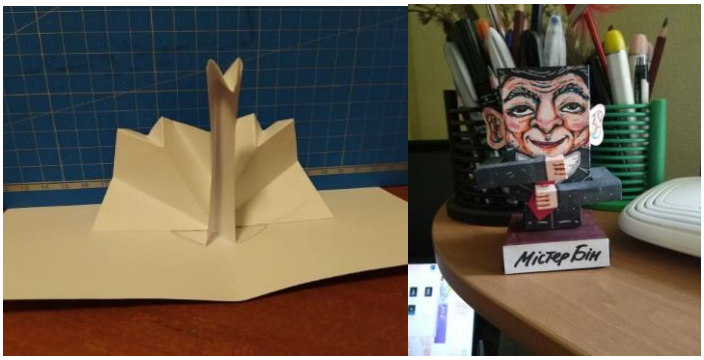

Fig. 6. Results of the reproductive and productive levels

Such indicators as resistance to isolation, the ability to avoid haste, and satisfaction with a quick decision and result have been improved (see Fig. 7).

Fig. 7. Results of the indicator of haste and satisfaction with a quick result

Rethinking the created paper artifacts helped to better understand the result, combine different thoughts, feelings and facts, features of structures and mechanisms when creating functional and detailed paper products. Understand the design features of the parts and their graphic design (see Fig. 8).

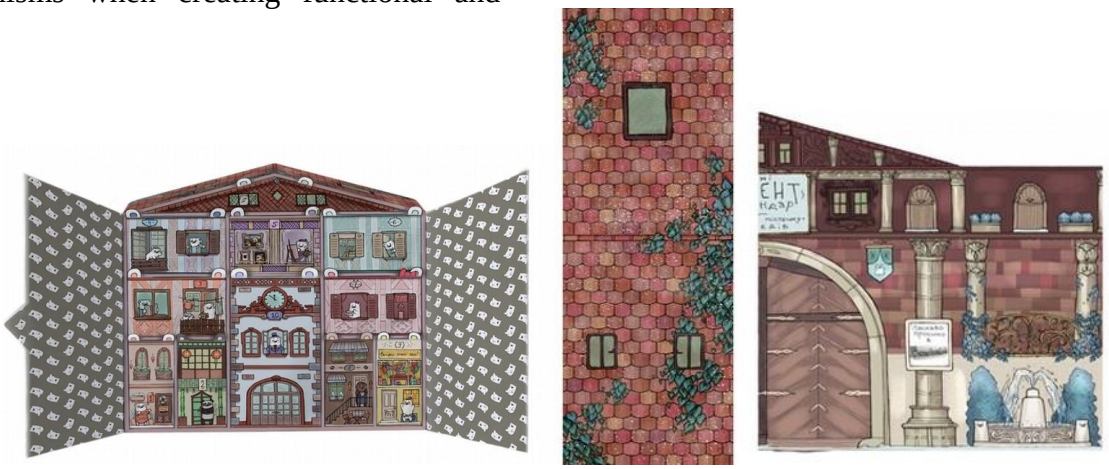

Fig. 8. Results of the self-development and synthesis indicator

During the experiment on the formation of designers' professional competence by means of paper engineering, the qualities of the students' creative approach and creativity were positively affected. Students began to demonstrate interesting solutions with a kind of originality (see Fig. 9).

Fig. 9. Results of the creativity indicator

The students' attitude towards creating paper products using special printing methods, such as embossing, varnishing, foiling, and texturing, has changed significantly. Students began to better understand the possibilities of their use (see Fig. 10).

Fig. 10. The result of using cutting and varnishing

The ability to generate new and original ideas and new innovative approaches, the ability to look at problems from non-standard perspectives and develop innovative design solutions has improved. Improved ability to mentally construct more conceptual solutions.

The content of paper engineering is reflected in the interdisciplinary connections of other educational components such as "Design of volumetric and moving books", "Packaging design", "Art objects" and others that involve working with paper in the development of theoretical material.

Thus, in the course of the educational component "Design of Volumetric and Moving Books", students began to consider the issue of volumetric book illustration in more depth. Considering each of the basic elements of three-dimensional illustration, students form their own catalog of basic elements, collecting and, based on the results of processing, creating a project for two scans. This finalizes their in-depth knowledge of the design of three-dimensional and moving books in paper engineering (see Fig. 11).

Fig. 11. Results of paper engineering in the educational component «Design of volumetric and moving books»

Paper engineering issues are also considered in the design features of paper packaging and packaging design. Students consider the technical aspects and assembly schemes of packaging, which brings them closer to the most correct technological understanding of both the shape and graphic design of packaging (see Fig. 11).

Fig. 11. Results of paper engineering in the educational component «Design of volumetric and moving books»

The acquired knowledge and skills in paper engineering were demonstrated by the applicants as their personal professional direction during the qualification works. At the beginning of the experiment, the percentage of choosing paper engineering-related areas, based on the results of choosing the topics of qualification works, was 2-3 applicants per group.

According to the results of diagnosing the dynamics of changes in the level of professional competence of future designers formed by means of paper engineering, a study was carried out using mathematical statistics methods (Pearson's criterion χ^2).

The main hypothesis H_0 was put forward: The effectiveness of the implementation of the developed model of the formation of future designers' professional competence by means of paper engineering in the control and experimental groups by each criterion has no differences.

And the alternative H_1: The effectiveness of the implementation of the developed model of future designers' professional competence formation by means of paper engineering in the control and experimental groups by each criterion has significant differences.

To draw a conclusion about which of the hypotheses (main or alternative) should be accepted, we used criterion χ^2, a statistical criterion (Pearson's criterion) that is suitable for analyzing data measured on an ordinal scale.

Based on the data on the results of observations (indicators of the experimental and control groups), the empirical value of the criterion χ^2_{emp} was calculated, which was compared with the known (specified in the table of critical values χ^2_{kr}) reference number, the critical value χ^2_{kr} of the criterion with a given probability of error (level of significance).

In our study, we chose an error probability level of 0.05, i.e., a 5% possibility of error is allowed, or in other words, the result is 95% reliable. The critical value of the statistical criterion χ^2_{kr} for 3 levels of gradation (L=3) according to the table of criteria is 5.99 (χ^2_{kr} =5.99).

The empirical value of χ^2 criterion is calculated by the formula:

$$\chi^2_{\text{емп}}=\text{N}\cdot M\sum_{i=1}^{L}\frac{\left(\frac{n_i}{N}-\frac{m_i}{M}\right)^2}{n_i+\text{m}_i}$$

where: N is the total number of students in the experimental group; M – the total number of students in the control group; n_i – the number of students in the experimental group with the appropriate grade level; m_i - the number of students in the control group with the appropriate level of grading; L - number of grading levels.

Based on the results of comparing the critical and empirical values of criterion χ^2, the following conclusions are made:

– if the empirical value of criterion χ^2_{emp} obtained by the researcher is less than or equal to the critical χ^2_{kr}, the null hypothesis is accepted, i.e., with a probability of 95%, the qualitative characteristics of students of the experimental and control groups coincide;

– if the empirical value of the criterion χ^2 is greater than the critical χ^2_{kr}, then the null hypothesis is rejected an the alternative hypothesis is accepted; the qualitative characteristics of students in the experimental and control groups are considered different with a 95% probability.

The statistical processing confirmed the indicators of the level of formation of future designers' professional competence by means of paper engineering according to the four criterions (criterion of professional content, operational and technological criterion, personal and psychological criterion, reflective and evaluative criterion) and was carried out by calculating the obtained statistics using the Pearson method.

Comparative data of the levels of formation of future designers' professional competence by means of paper engineering of students of the control and experimental groups are presented in the table 1.

Table 1. The results of the pedagogical experiment on the dynamics of the formation of professional competence among students of the control and experimental groups according to the specified criteria

The level of formation	Confirmatory experiment				Formative experiment				Dynamics		$\chi2$ Pearson's criterion $\chi2_{kr}$ =5,99	
	Control group		Experimental group		Control group		Experimental group		Control group	Experi-mental group	Control group	Experimen-tal group
	Persons	%	Persons	%	Persons	%	Persons	%				
The level of formation of professional competence according to the professional and content criterion												
Reproductive	6	7,41%	21	12,96 %	4	4,94%	7	4,32%	- 2,47%	- 8,64%	$\chi2_{emp}$=2,72 $\chi2_{emp}<\chi2_{kr}$ H_0	$\chi2_{emp}$= 6,03 $\chi2_{emp}>\chi2_{kr}$ H_1
Productive	58	71,60 %	117	72,22 %	56	69,14 %	87	53,70 %	- 2,47%	- 18,52 %		
Professional (creative)	17	20,99 %	24	14,81 %	21	25,93 %	68	93,15 %	4,94%	78,34 %		
The level of formation of professional competence according to the operational and technological criterion												

Reproductive	13	16,05 %	16	9,88%	11	13,58 %	5	3,09%	-2,47%	-6,79%	$\chi2_{emp}$=3,72 $\chi2_{emp}<\chi2_{kr}$ H_0	$\chi2_{emp}$= 20,08 $\chi2_{emp}>\chi2_{kr}$ H_1
Productive	63	77,78 %	126	77,78 %	59	72,84 %	98	60,49 %	-4,94%	-17,28 %		
Professional (creative)	5	6,17%	20	12,35 %	11	13,58 %	59	36,42 %	7,41%	24,07 %		
The level of formation of professional competence according to the personal and psychological criterion												
Reproductive	9	11,11 %	21	12,96 %	8	9,88%	10	6,17%	-1,23%	-6,79%	$\chi2_{emp}$=0,52 $\chi2_{emp}<\chi2_{kr}$ H_0	$\chi2_{emp}$= 6,15 $\chi2_{emp}>\chi2_{kr}$ H_1
Productive	62	76,54 %	117	72,22 %	60	74,07 %	103	63,58 %	-2,47%	-8,64%		
Professional (creative)	10	12,35 %	24	14,81 %	13	16,05 %	49	30,25 %	3,70%	15,43 %		
The level of formation of professional competence according to the reflective and evaluative criterion												
Reproductive	9	11,11 %	25	15,43 %	6	7,41%	4	2,47%	-3,70%	-12,96 %	$\chi2_{emp}$=1,18 $\chi2_{emp}<\chi2_{kr}$ H_0	$\chi2_{emp}$= 10,03 $\chi2_{emp}>\chi2_{kr}$ H_1
Productive	61	75,31 %	120	74,07 %	61	75,31 %	102	62,96 %	0,00%	-11,11 %		
Professional (creative)	11	13,58 %	17	10,49 %	14	17,28 %	56	34,57 %	3,70%	24,07 %		

The analysis of the measurement results using descriptive statistics for each of the criteria showed positive changes in the experimental group. The statistical significance of the difference between the indicators of the control and experimental groups was determined using Pearson's statistical criterion. The results of the analysis of experimental data confirmed a statistically significant difference (at the level of significance of 0.05) in the indicators of the criteria for the formation of professional competence of the control and experimental groups. The dynamics of changes in the level of professional competence of future designers, which was formed by means of paper engineering, is shown in the form of a diagram (Fig. 12.).

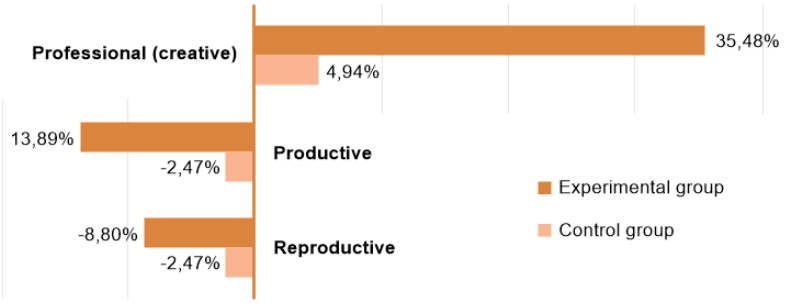

Fig. 12. The dynamics of changes in the level of professional competence of future designers, which was formed by means of paper engineering

The reliability of the differences in the characteristics of the experimental and control groups after the experiment is 95%, i.e. it can be concluded that the application of the proposed pedagogical influence aimed at forming the professional competence of future designers leads to statistically significant differences in the results at the level of 95% according to Pearson's criterion. That is, the analysis of the research results indicates positive changes in the formation of professional competence in students of the experimental group, and according to the results of statistical testing of the effectiveness of the implementation of the developed model of forming the professional competence of future designers by means of paper engineering, an alternative hypothesis H_1 is accepted: The effectiveness of the implementation of the developed model of forming

the professional competence of future designers by means of paper engineering in the control and experimental groups by each criterion has significant differences.

CONCLUSION

The revealed dynamics allows us to assert that the implementation of the model contributed to the improvement of the level of professional competence of the participants of the experiment. It should be noted that the diagnosis of the level of professional competence of future designers was successful due to the rethinking of the educational content of paper engineering and paper art. The model of forming the professional competence of future designers by means of paper engineering provided favorable conditions for the acquisition of knowledge and practical experience by future specialists, influenced their motivation and the formation of reflective and personal qualities, contributed to the improvement of professional (creative) abilities, the ability to evaluate their own achievements using instrumental, software and technological means.

Thus, the effectiveness of the developed model of forming the professional competence of future designers by means of paper engineering in higher education institutions has been experimentally proved, which is reflected in the increase in the number of students whose level of professional competence is characterized as professional (creative) and the decrease in the number of students whose professional competence demonstrates productive and reproductive levels.

The obtained results of the experimental work give grounds to assert that the purpose of the study has been achieved, the tasks have been completed.

REFERENCES

1. Chemerys, H., Ponomarenko, O., Kardashov, V., & Briantsev O. (2022). STEAM project based learning for future designers. *AIP Conference Proceedings,* 2453, 030026. DOI: 10.1063/5.0094432.
2. Chemerys, H. Yu., Briantsev, O. A., Briantseva, H. V., & Vynogradova, A. S. (2021). Combined Capabilities of AR Technology and POP-UP Constructions for Designing Books for Children. *Yearbook of Moving Image Studies*, 182-206.
3. Özgüner, E. (2013). Locating Paper Art Within The Art of Today [Thesis, Izmir University of Economics]. URL: https://gcris.ieu.edu.tr/bitstream/20.500.14365/753/1/753.pdf
4. Kovalchuk, T. P., Bogaychuk, L. R., & Oros, I. V. (2023). Development of creative thinking of students: paper plastics in modern design. *Scientific Bulletin of South Ukrainian National Pedagogical University named after K. D. Ushynsky*, 2 (143), 19-25.
5. Брянцев, О. А. (2024a) Сутність і структура професійної компетентності майбутніх дизайнерів з паперової інженерії. *Актуальні питання гуманітарних наук: міжвузівський збірник наукових праць молодих вчених Дрогобицького державного педагогічного університету імені Івана Франка.* Дрогобич: Видавничий дім «Гельветика», 74. (2024, *In press*).
6. Брянцев, О. А. (2024b). Критерії і показники сформованості професійної компетентності майбутніх дизайнерів засобами паперової інженерії. *Педагогіка формування творчої особистості у вищій і загальноосвітній школах: зб. наук. пр*. Запоріжжя: КПУ, 92. (2024, *In press*).
7. Брянцев, О. А. (2023). Дизайнер паперу, професія у паперовому мистецтві. *Дизайн, візуальне мистецтво та творчість: сучасні тенденції та технології: матеріали II міжнародної науково-практичної конференції,* 1, 34-37. DOI : 10.5281/zenodo.10360291.
8. Дмитрієва, С. М., & Гаврилова, Н. В. (2002). Методи дослідження творчих здібностей школярів: посібник-практикум. Житомир.
9. Кокун, О. М. (2011). Збірник методик для діагностики психологічної готовності військовослужбовців військової служби за контрактом до діяльності у складі миротворчих підрозділів : Методичний посібник. Київ : НДЦ ГП ЗСУ. URL: https://core.ac.uk/download/pdf/32309843.pdf
10. Мартинюк, І. (2020). Методика дослідження готовності студентської молоді до самоосвітньої діяльності. *Psychological Journal*, 6, 9, 58-67. DOI : 10.31108/1.2020.6.9.5