JTET

http://penerbit.uthm.edu.my/ojs/index.php/jtet
ISSN 2229-8932 e-ISSN 2600-7932

Journal of Technical Education and Training

The Use of Modern Digital Technologies in the Design and Technology VET in Ukraine

Maryna V. Kolosnichenko[1], Olga V. Yezhova*[1], Kalina L. Pashkevich[1], Olena V. Kolosnichenko[1], Nataliia V. Ostapenko[1]

[1]Kyiv National University of Technologies and Design,
Nemyrovycha-Danchenka Street, 2, Kyiv, 01011, UKRAINE

*Corresponding Author

DOI: https://doi.org/10.30880/jtet. 2021.13.04.005
Received 06th April 2021; Accepted 11th October 2021; Available online 31st December 2021

Abstract: The objective of this paper is to substantiate the system of vocational education and training (VET) of fashion designers and technologists to perform computer modeling and design of the clothes. The use of the developed system of training specialists in fashion design, which provides for the use of CAD systems, contributes to the formation of readiness of future fashion designers to use specialized software in their professional activities. To increase the efficiency of VET, we used the following types of learning activities: development of creative collage, development of artistic sketches of clothes, design of templates for different sizes, use of programs for the 3D design of the clothes. A feature of this study is the selection of the software used in the design of the clothes, namely GraziaCAD and JULIVI CAD. The effectiveness of these types of tasks is confirmed by an experiment, in which 80 students from Kyiv National University of Technologies and Design took part (CG 44 students, EG 36 students). Comparing the results of incoming and outgoing control of the level of students' readiness, a decrease in the number of students with a low level of readiness for the use of ICT in the professional activities was noted: from 22.7 % to 11.4 % in CG and from 22.2 % to 5.6 % in EG. At the same time, the percentage of students with a high level of readiness increased in both groups: from 29.5 % to 38.6 % in CG and from 25.0 % to 66.7 % in EG. Also, it should be noted that the biggest changes in the number of students with a high level of knowledge took place in EG. This, with 95% reliability according to Pearson's criterion, means that the experimental educational program led to a significant increase in the level of readiness for the use of ICT in the EG, in comparison with the CG. This confirms the effectiveness of the proposed educational program. The results of the study confirm the effectiveness of the generally accepted international practice of using the digital design in VET in the field of fashion design and technologies.

Keywords: Design and technology VET, fashion designer, curricula, digital technologies, computer-aided design

1. Introduction

Nowadays, in the labour market, the enterprises of the fashion industry (garment factories, ateliers, design studios, etc.) want to offer jobs to universal specialists who have competencies in the design-projecting of garments of various assortment and purposes and have knowledge in the fields of design, construction, and clothing technology. Such a specialist must have integrated engineering training aimed at gaining knowledge and skills of developing sketches of models, considering the direction of fashion, and based on the principles of composition, design, and modelling of new models of clothes from different materials, development of technology of garments, etc.

Computer technologies are widely used in design-projecting and modern technological processes of design and production of clothes, which takes the professional activity of the fashion designer to a new, higher level of quality. Due to the widespread introduction of computer technologies in the garment industry, the functions of a modern

*Corresponding author: yezhova.ov@knutd.edu.ua

specialist in the field of modelling and designing of garments are changing; therefore, the mastering of the theoretical foundations and practical skills of computer design is a prerequisite for the training of highly qualified professionals. The problem of training specialists who are familiar with the methods of computer modelling of clothes has become equally important. As a result of the review of Taslibeyaz, Kursun, and Karaman (2020), it is recommended to have a learning activity focused on problem analysis and solving for effective computer education. In the review by Dobricki, Evi-Colombo, and Cattaneo (2020), the importance of researching the use of digital technologies in various types of vocational education and training is substantiated. For instance, a quasi-experimental study by Budi et al. (2021) conducted at Vocational High School in Bandung Raya, which found that Proteus simulation software had a significant impact on students' achievement.

The theoretical and methodological basis of teaching digital fashion design technologies has been studied by scientists. The purpose of the research Ryan (2020) is to study the integrated graduate internship program, which allows developing competencies in the field of digital fashion at the University for the Creative Arts (UK). Importantly, graduates of this program can enter the market with advanced specialization. The article by Kolosnichenko, Pashkevich, and Ostapenko (2015) considers the stages of formation and development of the speciality "Design", describes the experience of training specialists in computer design of the costume at the Kyiv National University of Technologies and Design. Important for this study is the description of the discipline "Computer design", which aims to study specialised software for drawing and decorating graphics, as well as the study of industrial software for digital fashion design.

The comparative analysis of Computer-aided design (CAD) systems used for training specialists in the fashion industry is provided in the study (Papachristou, Kyratsis, & Bilalis, 2019). The article by Papachristou, Kyratsis, and Bilalis (2019) presents the results of comparing licensed clothing CAD (Polypattern and Create) and open source software (Seamly2D and to Wild Ginger's Caveo V6). It is important for our study is a conclusion about the benefits of licensed software for training students in comparison with open-source software. The article by Blaga, Dan, and Penciuc (2019) reveals the possibilities of the Shape Sizer Program for designing and tailoring knitwear shapes for online or offline learning. So, the use of licensed CAD programs is recommended by scientists for online and offline training of future engineers and designers of various types of clothing.

The research of Manuela-Lacramioara, Emil-Constantin, Ionescu, Savin-Dorin, and Ionut (2018) is focused on the problem of e-training in the field of fashion design. The results of the development of a multimedia learning platform for studying fashion design are presented in the article (Qu, 2018). An interactive lesson on the study of the Gemini CAD System by the students of the master's program of the Faculty of Textiles, Leather, and Industrial Management is given in the article (Avădanei, Loghin, & Dulgheriu, 2015). Also interesting is the comparative analysis of the results of online and full-time groups that studied fashion design by Scarabottolo (2019), which revealed the high efficiency of online training in fashion design. A study by Wiana, Barliana, and Riyanto (2018) prove the effectiveness of the use of interactive multimedia applications based on motion graphics for the students who are studying digital fashion design. Thus, the researchers believe that online training in clothing design using specialized software is effective.

Relevant researches conducted by scientists are focused on the development of a theoretical basis for three-dimensional computer-aided design of the clothes: virtual mannequins with different postures (Yezhova & Pashkevich, 2021), 3D virtual fitting (Hwang Shin, & Lee, 2020), virtual try-on of the woman's dress (Agnė, Ancutienė, Pukienė, Lapkovska, & Dāboliņa, 2020), virtual stitching and try-on of the woman's dress (Zhu & Song, 2020), 3D printing of prototypes of the clothes with a multicoloured surface texture (Chan, Au, Ho, & Lam, 2020), and 3D printing of garments (Kang and Kim, 2019), personalization of clothing production based on 3D design and artificial intelligence technologies (Lee, 2021). The article by Smelik (2020) provides information on the design practice of Iris van Herpen's Fashion House, which widely uses 3D methods of designing and manufacturing fashion collections. The article by An and Park (2020) is devoted to the analysis of trends of fashion development considering digital technologies. Therefore the objective of this paper is to substantiate the educational program of engineering training of fashion designers and technologists to perform computer modelling and design of the clothes.

2. Methodology

This case study conducted a preliminary transformative experiment involving a limited number of participants to assess the effectiveness of methods of forming readiness to use modern digital technologies in professional activities.

2.1. The Methodology of Forming Readiness for The Use of ICT in The Professional Activities of Specialists of The Fashion Industry

The Faculty of Design in Kyiv National University of Technologies and Design (KNUTD) trains higher education specialists in the educational program 'Modelling, Design and Decoration of Light Industry Products'. Students enrolled in this educational program receive the profession of Modeler-Designer of Light Industry Products.

The discipline 'Computer-Aided Design of Products' (9.0 ECTS credits) is studied by the students of the 4th year after studying general technical disciplines, which provides a relationship with the previous educational course.. While studying the discipline 'Information Systems and Technologies' student studies the possibilities of computer programs

to solve various problems of professional activity. Thanks to the course 'Engineering and Computer Graphics' student studies methods of creation of graphic images by methods of descriptive geometry by means of modern computer programs. Indiscipline classes 'Art and Graphic Composition' student learns ways to use artistic and graphic means of composition in creating fashion drawings. As a result of studying the discipline 'Fundamentals of Applied Anthropology' student studies the methods of obtaining anthropometric characteristics of the human figure for clothing design. The main terms of the process of designing and making clothes the student learns in class with 'Fundamentals of Design and Manufacture of Clothes'. Students acquire knowledge and skills to develop designs of parts and patterns of clothing models of different assortment through the study of the discipline 'Design of Garments'. Through the study of discipline 'Technologies of Garments' student studies methods and technological processes of production of garments, substantiation of production decisions, in particular, on a choice of technology of garments and the equipment. Students study the characteristics of textile materials for clothing, their structure, properties and quality indicators in the course 'Materials Science'.

The discipline 'Computer-Aided Design of Products' is studied together with such disciplines. as 'Ergonomics', 'Comfort and Safety of Clothes', 'The Designing of Plastic Form of the Clothes', 'Artistic Design of Light Industry Products', etc. The purpose of the discipline 'Ergonomics, Comfort and Safety of Clothes' is mastering the skills of designing special and protective clothing taking into account aesthetic and ergonomic requirements. Methods of designing clothes and their decorative decoration by the modelling method students learn while studying the discipline 'Designing of Plastic Form of the Clothes'. Students study the features of the development of artistic systems of products of different assortment (knitted and corset products, leather and fur products, hats, etc.) in the discipline 'Artistic Design of Fashion Industry Products'. A fragment of a structural-logical scheme of training bachelors is presented in Figure 1.

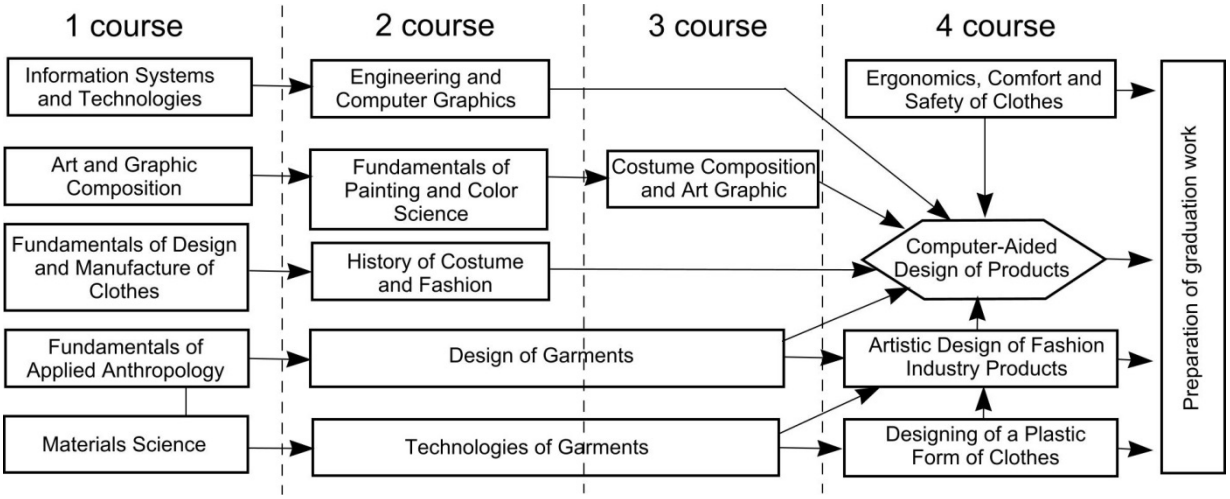


Fig. 1 - A fragment of a structural-logical scheme of training bachelors of the educational program 'Modelling, Design and Decoration of Light Industry Products'

To form the readiness of engineers in the fashion industry to perform professional tasks by means of ICT, a structural-logical scheme of educational components is developed, the fragment of which is shown in Figure 1. The bachelors' curriculum stipulates that student of specialty in 'Modelling, Design and Decoration of Light Industry Products' should study the discipline 'Computer-Aided Design of Products', which aims to consider a wide range of issues related to the modern process of fashion design and development of project documentation using computer-aided design (CAD) systems, as well as the formation of skills needed to solve problems of clothes designing in an automated mode.

The course of the discipline 'Computer-Aided Design of Products' is focused on studying specialized graphic programs for drawing and decoration of graphic images, as well as industrial software packages for computer design-projecting of the clothes. The program of the discipline consists of the following content modules: 1. Computer Graphics; 2. Computer Design-Projecting of the Clothes.

According to the requirements of the program profile, students must know: basic concepts of computer graphics; principles of work in programs of vector and raster graphics; capabilities and functions of graphic programs used to create the images of art objects; sequence and stages of construction of drawings of new models of the clothes in an automated mode; modern technologies of the 3D design of the clothes; be able to: develop sketches of models of the clothes using the graphic editors; perform artistic decoration of products' images, visualize color, drawing and texture of the material; make drawings of clothes designs of different assortment and purpose using CAD; carry out gradation of patterns and form a complete set of patterns of the clothes, prepare the design documentation for clothes in CAD

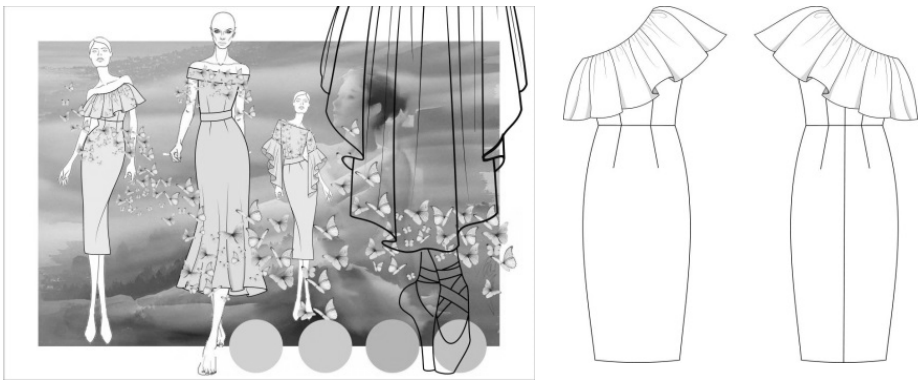
programs; have skills to: develop and process images of the clothes, collages, sketches of models of clothes using the computer graphics programs; make drawings of details of shoulder and waist clothes of various assortment and purpose, model products and their elements, make patterns and prepare design documentation for new models using modern computer technologies; be able to demonstrate the ability to: develop the image of the clothes, creative collage, sketches of the fashion collection using modern design programs; develop the sets of patterns of the clothes of various assortment and purpose, and prepare design documentation for clothes in CAD programs. While studying, students perform the following learning activities:

- develop sketches of models of the clothes using a graphic editor;
- develop technical drawings in vector graphics programs;
- develop collages in raster graphics programs;
- make drawings of details of a basic design of a garment in the automated mode;
- develop model designs of the clothes of various compositional and constructive decisions;
- design the primary patterns of details of garments;
- design the final patterns of garments;
- prepare the models of design documentation for clothes in CAD programs;
- visualize the models of clothes in the 3D design programs.

In the 8th semester, students are expected to prepare a term paper on 'Development of a Collection of Models of Clothing in an Automated Mode'. Students work in the industrial CAD programs for clothes and develop the models of clothes on their own, starting from the development of the sketch in computer programs to the manufacture of models of clothes or its mannequin. This component of the educational process, when the student is faced with the need to solve a specific production task, encourages them to learn the program faster and to master various CAD tools.

Examples of students' work are shown in Figure 2 and Figure 3. Figure 2 shows an example of 3D visualization of a model of clothes, made using JULIVI CAD. The example of the work of the student from EG, performed in JULIVI CAD, is presented in Figure 3, in particular: creative collage, sketch, drawing, and modelling of a dress of complex cut.

Fig. 2 - 3D virtual dress made using JULIVI CAD



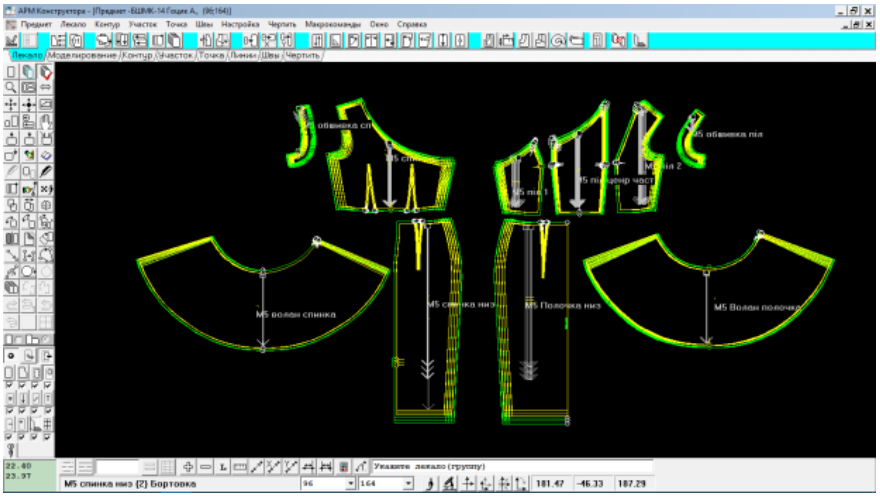


Fig. 3 - The development of the collection of models of clothes in JULIVI CAD (student's work)

2.2. The Methodology of the Experiment

To confirm the effectiveness of the system of the formation of professional ICT competence of specialists in the garment industry, an educational pedagogical experiment was conducted during 2017 – 2020. The experiment lasted 4 years, during which the full cycle of bachelor's degree training according to the educational program described in this study was carried out. During the first year of 2017, the theoretical and ascertaining stage of the experiment took place. The research methodology was developed, the members of the experimental group and the control group were determined. Students studied the course 'Information Systems and Technologies' and received final marks in this subject. Based on the estimates obtained, the levels of students' readiness for the use of information and communication technologies in the professional activities were stated. During the formative stage of the experiment, students from the EG and CG of 2-4 years in 2018-2019 were taught according to the structural-logical scheme (Fig. 1). The difference was in the learning activities that the EC students performed in the 'Computer-Aided Design of Products' course. At the analytical and evaluation stage in 2020, the graduation works of bachelors are completed and appreciated, which made it possible to determine the levels of readiness of bachelors to use ICT in professional activities.

To participate in the experiment, two groups of students-bachelors from KNUTD were formed, who attended the educational program 'Modelling, Design, and Decoration of Light Industry Products'. All the participants were 18 – 26 years old and participated in the experiment voluntarily. Ethical norms with respect to the participants of the experiment were observed. At the beginning of the experiment, the control group (CG) consisted of 47 students aged 18-25, including 43 women and 4 men. These students studied according to the traditional system and performed the following types of educational projects using digital technologies: development of technical drawing of the model, creation of the drawing of a basic design of details of the clothes, modelling of details of the clothes, designing of the patterns for basic size and preparation of the models of design documentation, assessment of the quality of obtained drawings and patterns of details of the clothes.

The experimental group (EG) at the beginning of the experiment consisted of 38 students aged 18-26, including 35 women and 3 men. These students studied according to the experimental system and performed, in addition to the traditional stages of developing new models of clothes that is the professional competence of a fashion designer (i.e. creation of the drawing of a basic design of details of the clothes, modelling of details of the clothes and preparation of the models of design documentation, assessment of the quality of obtained drawings and patterns of details of the clothes), the following types of educational projects: development of creative collage, development of sketches of models of the clothes, design the patterns for different sizes, use of 3D programs for modelling of the clothes.

The software GraziaCAD and JULIVI CAD were used in the experiment; CG used only 2D modules of such programs, while EG used both 2D and 3D modules. Students of the control group paid more attention to the completion of technological tasks of developing new models of clothes: the rules for linear technical drawing, designing of patterns, and preparation of design documentation. The training program for students of the experimental group was aimed at developing creativity and an open mind by activating creative imagination while performing tasks on the creation of the collages, creative sketches of models of the clothes using different colour combinations, textures that imitate different types of textiles, and so on. An important condition for obtaining reliable experiment data and their validity was the same learning conditions for both groups, except for the studied factor. The same for both groups were: the level of basic training, duration of the training, pedagogical collectives, premises, and facilities of the education institution. The compliance with the requirements ensured the objectivity and validity of the experiment.

The level of basic training in information and communication technologies was determined based on the final control in the discipline 'Information Systems and Technologies', studied by the students of the 1st year. The evaluation was performed using a 100-point scale. The following levels of students' readiness for the use of information and communication technologies in the professional activities were stated: low (60.-..73 points), medium (74…89 points), and high (90…100 points). The level is determined based on the results of practical tasks in the classroom (up to 50 points), tasks for independent work at home (up to 10 points), and final testing (up to 40 points).

After the experiment, the level of readiness for the use of information and communication technologies in professional activities was determined based on the analysis of bachelors' theses, in particular, a section on digital technologies of design. The assessment was carried out by an examination committee consisting of 5 experts, including 2 doctors of sciences, 2 candidates of sciences and 1 practising specialist in the field of technology and clothing design with higher education and 15 years of experience in the field of clothing production. To assess the level of readiness, a 100-point scale was used. When determining the level of readiness, the quality and complexity of the bachelors' theses were taken into account, namely: the complexity of the created clothing models, the number and complexity of the computer programs used for the design, the quality of the finished project of the clothing collection models. The performance of the student at the defence of the thesis was also taken into account. A low level of readiness (60…73 points) was demonstrated by the students, whose models of the clothes were created using a single computer program, simple in design, close in design to the basic structures, with a minimum number of structural and decorative elements, divisions, and decorations. A medium level of readiness (74…89 points) was demonstrated by the students who created the models of clothes of the original cut, with a moderate amount of structural and decorative elements and decoration by means of ICT, using a wide range of tools of two computer programs or software modules. A high level of readiness (90…100 points) was demonstrated by the students who created models of clothes of complex cut, collections of products of different assortment with various finishes by means of ICT, using a wide range of tools of three computer programs or software modules.

When performing statistical analysis of the results of the educational experiment, two types of tasks were solved. The informative description of results of measurements of students' readiness for the use of innovative technologies in future professional activity was carried out by means of descriptive statistics. The homogeneity of the corresponding characteristics of the control and experimental groups before the experiment, as well as the difference of the corresponding characteristics of the control and experimental groups after the experiment, were investigated by the methods of inductive statistics by calculating the Pearson's criterion χ^2 for a reliability level of 95%. The data of this study are limited to a single university.

3. Results

Due to good reasons (birth of a child), 3 female students from the EG and 2 students from the CG took an academic break and stopped participating in the experiment. In this regard, the calculated data are presented for the students who took part in the experiment from start to finish, namely 44 participants from the EG and 36 participants from the CG. Due to the small number of male participants (4 in the EG and 3 in the CG), the statistics were not calculated separately for the male and female gender. All students from CG and EG have mastered professionally oriented software but demonstrated different levels of readiness to perform professional tasks by means of ICT. A comparison of the results of students' readiness before and after the pedagogical experiment is presented in Table 1.

Comparing the results of incoming and outgoing control of the level of students' readiness, we note a decrease in the number of students with a low level of readiness for the use of ICT in professional activities: from 22.7 % to 11.4 % in CG and from 22.2 % to 5.6 % in EG. At the same time, the percentage of students with a high level of readiness increases in both groups: from 29.5 % to 38.6 % in CG and from 25.0 % to 66.7 % in EG. Also, it should be noted that the biggest changes in the number of students with a high level of knowledge take place in EG.

Table 1 - The results of measuring the level of readiness for the use of information and communication technologies in the professional activities

Level	Before the experiment				After the experiment			
	CG		*EG*		*CG*		*EG*	
	stud.	*%*	*stud.*	*%*	*stud.*	*%*	*stud.*	*%*
Low	10	22.7	8	22.2	5	11.4	2	5.6
Medium	21	47.7	19	52.8	22	50.0	10	27.8
High	13	29.5	9	25.0	17	38.6	24	66.7
Total	44	100	36	100	44	100	36	100
χ^2_{emp}	0.25				6.24			

To identify similarities or differences between the experimental and control groups in knowledge, we formulated and tested the following statistical hypotheses:

I. a null hypothesis of no differences between EG and CG levels of students' readiness for the use of information and communication technologies in the professional activities;
II. an alternative hypothesis of the significance of differences between EG and CG levels of students' readiness for the use of information and communication technologies in the professional activities.

The calculated empirical Pirson's indicator χ^2_{emp} was compared with the tabular value for L-1=2: $\chi^2_{0.05}$= 5.99. Before the experiment χ^2_{emp} =0.25 $\leq\chi^2_{0.05}$, which allows us to conclude that as to the level of readiness, the characteristics of CG and EG comply with the level of significance $\alpha = 0.05$.

When comparing the indicators of CG and EG after the experiment, the empirical value χ^2_{emp} =6.24 is obtained, which exceeds the tabular value $\chi^2_{0.05}$= 5.99. Thus, the level of readiness of students from CG and EG after the experiment differs with a 95 % reliability. Therefore, the input (before the experiment) state of the cognitive component of CG and EG is similar, and the final (after the experiment) state is different. Taking this, we conclude that the effect of changes in the level of students' knowledge is due to the application of the proposed model of training specialists in fashion design.

4. Discussion and Conclusion

The results of calculating the average score for groups of students before and after the experiment are shown in the table. 2.

Table 2 - The results of calculating the level of readiness for the use of information and communication technologies in professional activities

	Before the experiment		**After the experiment**	
	CG	***EG***	***CG***	***EG***
Score	81,95	81,39	84,82	89,56
Standard deviation	3,00	3,30	3,15	4,12

As you can see from Table 2, before the experiment, the average score in the EG and CG was approximately the same. After training according to the standard program, the average score of the CG increased by 2.86 points (from 81.95 to 84.82), and after training according to the experimental program, the average score of the EG increased by 8.17 points (from 81.39 to 89.56). Therefore, the input (before the experiment) state of the readiness for the use of information and communication technologies of CG and EG is similar, and the final (after the experiment) state is different. Taking this, we conclude that the effect of changes in the level of students' knowledge is due to the application of the proposed model of training specialists in fashion design. For the most part, the results of the study confirm the effectiveness of the generally accepted international practise of using digital design in training specialists in the field of fashion design and technologies. In this regard, it was decided to further train future clothing designers at Kyiv National University of Technologies and Design using the proposed educational program. A feature of this study is the selection of the software used in the design of the clothes, namely GraziaCAD and JULIVI CAD. The conclusions of Papachristou, Kyratsis, and Bilalis (2019) on the effectiveness of using licensed software in training future clothing designers have been confirmed.

Moreover, it was found that the competencies acquired by the students did not depend on the chosen computer program but depended on the types of completed projects since modern CADs and graphic editors have almost the same range of options for design-projecting of the clothes. The expansion of the range of tasks performed during the training and familiarization with modern programs for the 3D design of the clothes contributed to raising the level of preparation of students, developed creativity and innovation in solving professional tasks, and affected the speed of tasks' completion.

The experience in training engineers in the fashion industry allows us to conclude that the readiness for the use of modern professional software is a necessary condition for the employment of future professionals. The use of the system of training specialists in fashion design, developed in KNUTD, which provides for the use of CAD systems, contributes to the formation of readiness of future fashion designers to use specialized software in their professional activities.

To increase the efficiency of training, it is effective to use the following types of learning activities: development of creative collage, development of sketches of clothes, design of templates for different sizes, use of programs for the 3D design of the clothes. The effectiveness of these types of tasks is confirmed by the experiment, in which 80 students from KNUTD took part (CG – 44 students, EG – 36 students). Comparing the results of incoming and outgoing control of the level of students' readiness, a decrease in the number of students with a low level of readiness for the use of ICT in professional activities was noted: from 22.7 % to 11.4 % in CG and from 22.2 % to 5.6 % in EG. At the same time,

the percentage of students with a high level of readiness increased in both groups: from 29.5 % to 38.6 % in CG and from 25.0 % to 66.7 % in EG. Also, it should be noted that the biggest changes in the number of students with a high level of knowledge take place in EG. According to Pearson's criterion (χ^2_{emp} =0.25), the compliance of CG and EG with the level of significance $\alpha = 0.05$ was determined, and after the experiment (χ^2_{emp} =6.24) the difference between CG and EG with 95 % reliability was stated. This study finding in line with previous studies (Kang and Kim, 2019; An and Park; 2020; Agnė, Ancutienė, Pukienė, Lapkovska, & Dāboliņa, 2020; Chan, Au, Ho, & Lam, 2020; Hwang Shin, & Lee, 2020; Zhu & Song, 2020; Lee, 2021; Yezhova & Pashkevich, 2021). In conclusion, the training of specialists with the use of specialized CAD systems for design-projecting of the clothes makes it possible to provide the necessary competencies for further effective work of graduates at garment enterprises.

Acknowledgement
The author would like to thank all researchers who were involved in this study.

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