Studying The Innovative Methods Of Specialists Training In Aerospace Complex

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Abstract: The aim of the study is to determine how susceptible to the use of information technologies the students of the departments of aerospace direction are. The novelty of the study is that such pieces of research are conducted for the first time among the future flight technicians, as the experts of the profession are increasingly responsible for the full functioning of the flight complex. The practical application of the research is that it not only allows the training plan adjusting, but also shows the feasibility of the development and dissemination of the gained experience to the rest of the aerospace training branches.

Index Terms: Development, Formation, Innovation, Learning, Structure, Technology, Training.

1. INTRODUCTION

Pedagogical features of the personal computer and information technologies allow the process efficiency improving of preparing engineers, introducing the fundamentally new educational tools into the learning process in the form of the professional and pedagogical software products. On professional software products, we are talking primarily about computer-aided design (CAD) systems, widely used in production. Making various kinds of products necessitates the use of effective forms of production organization, which in turn makes it possible to issue a wide range of quality products, rational use of equipment, production areas, rapid switching from production of one product to another without significant losses [1]. This requires improving the organization of production flows by means of ensuring the consistency between the level of technical equipment, expertise, capacity and organization form. The successful solution of the marked multi-purpose tasks of the production organization improvement is possible through the use of modern information technology, particularly computer-aided design systems [2]. The transition to automated calculation requires the use of innovative ways to prepare the product design information, to develop the computer calculation methodology for the basic construction points of parts and building the contours [3].

Therefore, the use of modern information technologies for design and modeling is becoming widespread. One of the most important tasks of engineers' training is the acquisition of proper knowledge and skills of using various computer software products by students in their future professional-pedagogical activity [4].

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2 LITERATURE REVIEW

2.1 General review

Modern philosophers, social scientists, culturologists, futurologists believe that humanity lives in an era of radical change of civilizations: the industrial civilization is replaced by a new "post-industrial", "information", "ecological", "noosphere", "nanotechnological" one and other. Formation of new world-view foundations, change of mindset, priorities and values predetermines the transition to a new phase of modern man's existence. In this regard, there emerge new requirements and trends in the development of modern professions. A necessary prerequisite for the active use of the newest technologies in the design of flight situations is to update the theoretical-methodological base of this process [5], focusing primarily on skills and competencies approach, which paves the way from the basic idea of models to the production work, i.e. the project implementation of in the material [6]. Such an approach requires the active development of modern scientific means of designing, formed at the junction of fundamental and applied sciences [7]. Now the automated production process, systems of machines and devices allow mechanizing and automating of the entire technological cycle of production [8]. After all, in the solution of creative tasks at designing, engineering development, technological calculations the active assistant of a specialist is means of IT [9]. Therefore, in today's conditions, when the newest IT dominate the production [10], there occurred the urgent need for highly qualified aerospace specialists with the pronounced creative personal potential, which level of professional skills depends on the vocational training of engineers [11].

Modern society requires highly skilled engineers, since they are training the country's working potential, on which the country's economic strength and the welfare of the nation depend [12]. Therefore, the preparation of the highly qualified engineering-pedagogical staff (in particular, in aerospace), capable of socio-professional and industrial-technological activities in the universities of different types, is a primary, priority direction of higher teacher's training education development. Engineer of modern vocational school is a teacher, who knows all the processes of production, wields the methodology of the vocational training organization of university students, is a creative personality, capable to reveal creativity and inner resources of each student, is a worthy representative of the national school [15]. Successful implementation of training of modern engineering-pedagogical personnel of high qualification depends crucially on the intensification of the process of learning the project designing disciplines based on pedagogical innovations and progressive educational methods, associated with the diverse use of IT capabilities of interactive computer graphics in the pedagogical process, which is realized by means of computer aided design (CAD) [17].

2.2 Components of e-learning resources

Thus, from the pedagogical point of view, e-learning resources can be defined as complex didactic system, implemented in an interactive informational educational environment [18], in the structure of which it is possible to distinguish two interlocking components [19]:

1) software – logically complete elements of an electronic resource, providing educational information, presence of feedback while interacting and possibility of automated control;
2) pedagogical – reflects the core competencies that are generated by the e-learning resource.

2.3 Groups of e-learning resources and their didactic tasks

Currently, in the pedagogical practice the following groups of e-learning resources are applied [20, 21]:

1. Electronic educational and methodical editions for the support and development of the educational process, represented by the electronic manuals, scanned electronic copies of the original paper, which provide a systematic material of a specific discipline. In their structure one can include: electronic lecture notes, electronic textbooks, implemented in the hypertext environment, virtual laboratory workshops (simulation and modeling environments of the processes and phenomena), attestation systems (tests, control works), additional information and reference materials, electronic teaching materials, etc.

2. Electronic information and reference resources (virtual encyclopedias, dictionaries, e-libraries, network directories, reference and search engines, databases) that are intended for the self-educational and individual scientific and research activity.

3. Network e-resources:

- of general cultural nature (virtual museums, exhibitions, art galleries, tours, online newspapers and magazines);
- of educational purpose (educational web sites, databases, e-libraries, resources of search engines, educational portals, thematic forums, teleconferences, etc.).
- training environments for the independent design of e-learning resources (generic constructors of presentation slides, visualization systems for multidimensional objects, shell and templates to develop testing systems, etc.).

4. Simulation environments (keyboard training simulator, Internet guides, etc.).

5. Demo e-resources, which provide the illustrative representation of the course material, visualizing the studied phenomena, processes and relationships between the objects.

6. Educational-gaming software tools for the training situations “playing” (for example, with the aim of formation of skills to take the optimal solution or develop the optimal action strategy).

7. Educational and technological software tools that are intended to be used by the teacher in the course of professional activities to meet the challenges of planning, management and registration of the effectiveness of the educational process.

Thus, the didactic tasks, which are solved in each of these groups of e-learning resources, are diverse and specific, so there is a need for their integrated application with the aim of system usage at the different stages of the vocational training of future engineers. Such approach predetermines the creation of electronic teaching materials of the discipline “Flight situation designing”, which is an important component of the didactic information-technological complex of the vocational training of future engineers.

Analysis of the scientific literature indicates that the problem of the integrated application of electronic educational resources as pedagogical tools is reduced to one of the aspects:

1) combining multiple electronic resources for general use for the purpose of obtaining new pedagogical opportunities;
2) the combined use of various electronic resources to get results that are unavailable when their usage is scattered;
3) complementary use of electronic resources in order to optimize the learning process;
4) the use of various electronic resources combined with the traditional teaching methods in accordance with the objectives of the vocational training of specialists.

3 MATERIALS AND METHODS

Bearing in mind the objectives of the study, you need to understand the pedagogical experiment as a system of cognitive operations related to the study of factors and conditions, facts, phenomena and processes in a specially crafted informational educational environment for identifying the properties, relations, patterns of the vocational training of future engineers by means of IT. The pedagogical experiment is characterized by the following features:

- special introduction of fundamentally important developments into the educational process in accordance with the objectives of the study;
- organization of the teaching process that enables to trace the connection between the phenomena without breaking its integrity;
- deep qualitative analysis and precise quantitative measurement of the individual components, imposed (modified) in the pedagogical process, and the results of the entire process.

The scientific and educational literature analysis allowed the allocation of the general principles for the experimental work organization, regardless of its content:

1) the pilot study should be conducted in conformity with the established objectives;
2) the experiment should have a variable character, which makes conclusions demonstrative;
3) the neutralization of the independent variables is mandatory, so that they do not affect the dependent

variables;

4) the experiment should be based on an objective basis, that is, on the scientific approach observance;
5) in the experiment all the factors of influence on a student should be taken into account (efforts, time, acquired experience, the qualitative changes in the structure of personality, etc.);
6) the collective or group character of the training activity, allowing the deeper exploring of conditions, causes, factors, that contribute to the change in the pedagogical process.

4 RESULTS AND DISCUSSION

The main factor that affects the reliability of the experiment results is the possible difference between the level of the vocational training of the students from the experimental (EG) and control (CG) groups at the beginning of the formative phase of the pedagogical experiment. At this stage the input diagnostics of the level of EG and CG students' training was conducted for the discipline "Flight situation designing". The students were offered to perform the tests of 4 difficulty levels and solve the professionally oriented tasks on the technology of designing the flight situations.Analysis of the input diagnostics results (see table 1) showed mainly a low level of the vocational training of students from the control (46.53%) and experimental (47.95%) groups in the discipline "Flight situation designing". An average level of the vocational training was observed in 29.17% of CG students and in 26.71% of EG students respectively. A sufficient level of the vocational training was owned by 15.28% of CG students and 17.12% of EG students. The smallest number of students was characterized by a high level of the vocational training in the discipline "Flight situation designing" (9.03% in CG and 8.22% in EG).

TABLE 1

INDICATORS OF THE LEVEL OF THE VOCATIONAL TRAINING OF CG AND EG STUDENTS AT THE BEGINNING THE PEDAGOGICAL EXPERIMENT

Level of students' vocational training	Number of students		Indicator in % from the number of students	
	CG	EG	CG	EG
Low	67	70	46.53	47.95
Average	42	39	29.17	26.71
Sufficient	22	25	15.28	17.12
High	13	12	9.03	8.22

Since the average absolute value of the difference between the levels of the vocational training of the students from the control and experimental groups (1.63%) at the beginning of the pedagogical experiment does not exceed 2% (table 2), it can be argued about the homogeneity of the sample of CG and EG students and predict the obtaining of reliable experimental data.

TABLE 2

DIFFERENCES BETWEEN THE LEVELS OF THE VOCATIONAL TRAINING OF CG AND EG STUDENTS AT THE BEGINNING THE PEDAGOGICAL EXPERIMENT

Level of students' vocational training	Number of students		Indicator in % from the number of students
	CG	EG	
Low	46.53	47.95	1,42
Average	29.17	26.71	-2,45
Sufficient	15.28	17.12	1,85
High	9.03	8.22	-0,81
Absolute average value:			1.63

Analysis of the experimental data concluded that the level of students' preparation on the design technology of flight situations is mostly low and medium, which we believe is due to the low level of their training from the school course, the low level of choice of technological profile with variable modules. A slightly higher level of preparation was observed in the students, who previously attended technical schools and colleges of light industry, vocational training institutions, where they got the qualification of a worker or specialist on a particular field of specialization. However, the percentage of such students was insignificant (11.6%), so the overall level of students' preparation in the design and technology of flight situations remains low. Thus, the results of the ascertaining phase of the pedagogical experiment showed the insufficient basic training of students in the designing of flight situations, which in its turn complicates the further successful study of professional disciplines at the university and, as a result, the inability to effectively solve the fully professional-pedagogical tasks in the process of future working activity at the university. In view of the above mentioned the problem of improvement of the training of future flight technicians became urgent, in particular through the active use of IT tools. Thus, there is a need of comprehension of the new pedagogical possibilities of modern IT and the terms of their combination with the traditional teaching methods to enhance the effectiveness of the training of future flight technicians. At the exploration phase of the pedagogical experiment the testing of a structural-functional model of the vocational training of future flight technicians was carried out by means of IT and, accordingly, the adjustment of the method of teaching the professional disciplines to students, in particular. Also, this phase of the experiment was aimed at creating, evaluating and verifying the effectiveness of the work of the electronic teaching material on the discipline "Flight situation designing", and the development and testing of the author's training course "CAD of the flight systems". The formative phase of the scientific pedagogical experiment involved the concluding diagnostics of the educational achievements of CG and EG students, setting and comparison of the obtained results in order to verify the effectiveness and expediency of the scientific-methodical tools of the vocational training of future flight technicians by means of IT. In order to clarify the dynamics of changes in the quality of CG and EG students' vocational training, the results of the formative phase of the pedagogical experiment (the concluding diagnostics) were compared with the results of the ascertaining experiment (the input diagnostics). The statistical data analysis shows the increase in the level of students' vocational training of both control and experimental groups during the scientific research work (tables 3-4).

TABLE 3

COMPARATIVE INDICATORS OF THE LEVEL OF THE VOCATIONAL TRAINING OF CG STUDENTS AT THE BEGINNING AND THE END OF THE PEDAGOGICAL EXPERIMENT

Level of	Number of students	Indicator in % from the	Dynamics

students' vocational training			number of students		of changes, %
	At the beginning of the experiment	At the end of the experiment	At the beginning of the experiment	At the end of the experiment	
Low	67	45	46.53	31.25	–15.28
Average	42	52	29.17	36.11	+6.94
Sufficient	22	28	15.28	19.44	+4.17
High	13	19	9.03	13.19	+4.17

TABLE 4

COMPARATIVE INDICATORS OF THE LEVEL OF THE VOCATIONAL TRAINING OF EG STUDENTS AT THE BEGINNING AND THE END OF THE PEDAGOGICAL EXPERIMENT

Level of students' vocational training	Number of students		Indicator in % from the number of students		Dynamics of changes, %
	At the beginning of the experiment	At the end of the experiment	At the beginning of the experiment	At the end of the experiment	
Low	70	17	47.95	11.64	–36.30
Average	39	62	26.71	42.47	+15.75
Sufficient	25	41	17.12	28.08	+10.96
High	12	26	8.22	17.81	+9.59

The results of the formative phase of the experiment (the concluding diagnostics of CG and EG students) are presented in table 5.

TABLE 5

SUMMARIZED INDICATORS OF THE LEVEL OF THE VOCATIONAL TRAINING IN DESIGNING THE FLIGHT SITUATIONS OF CG AND EG AT THE END OF THE EXPERIMENT

Level of students' vocational training	Number of students		Indicator in % from the number of students	
	CG	EG	CG	EG
Low	45	17	31.25	11.64
Average	52	62	36.11	42.47
Sufficient	28	41	19.44	28.08
High	19	26	13.19	17.81

Comparative dynamics of changes of the level of CG and EG students' vocational training in designing the flight situations during the experimental work is presented in table 6.

TABLE 6

COMPARISON OF THE DYNAMICS OF CHANGES OF THE LEVEL OF CG AND EG STUDENTS' VOCATIONAL TRAINING IN DESIGNING THE FLIGHT SITUATIONS

Level of students' vocational training	Dynamics of changes, in %		
	CG	EG	Absolute comparative measure
Low	–15.28	–36.30	21.02
Average	+6.94	+15.75	8.81
Sufficient	+4.17	+10.96	6.79
High	+4.17	+9.59	5.42
Absolute average value:	7.64	18.15	10.51

The experimental data analysis, mentioned in table 6, shows that at the time of the concluding diagnostics in EG students the high dynamics of growth of the level of students' vocational training in designing the flight situations was observed (18.15%), compared with CG students (7.64%). In this case, the absolute comparative measure of the dynamic changes was 10.51%. It is seen logical, that the level of CG students' vocational training was naturally enhanced as a result of the study of special disciplines in aerospace (primarily the entire course "Flight situation designing") according to the traditional training technique. Instead, the higher indicators of the level of EG students' training in designing the flight situations are also caused by the purposeful use of the modern IT tools in the educational process (in particular the electronic teaching materials and CAD "Flight") and the introduction of the author's course "CAD of the flight situations". The obtained experimental data needed further statistical processing in order to establish the veracity of the study results. According to the results in table 6 the largest positive changes in the quality of students' vocational training in designing the flight situations are fixed at the low level (15.28% – for CG students and 36.30% – for EG students). As to it the assumption can be made (null hypothesis – H_0) that the probabilities to obtain a low level of CG and EG students' vocational training are equal and do not depend on the teaching methods, and the difference in the diagnostics indicators is caused by random factors (H_0: x1=x2). In contrast to null hypothesis an alternative one (H_a) was formulated, under which a smaller number of students with the low level of the vocational training in designing the flight situations in EG is not caused by random factors and is the result of the purposeful and systematic use of IT tools in the educational process (H_a: x1≠x2). To verify the reliability of the obtained results of the research and to confirm (refute) the suggested hypotheses (null and alternative) the t-test of Student's normal distribution was used. Significance of the diagnostics results of CG and EG students with the low level of the vocational training were verified by the method of comparison of the average values of the samples. At that the average number of scores for the entire category of CG and EG students with the low level of the vocational training was calculated by the formulae:

$$\overline{x}_1 = \frac{1}{n_1}\sum_{i=1}^{n_1} x_{1i} = \frac{3821}{45} = 84.91 \quad (1)$$

$$\overline{x}_2 = \frac{1}{n_2}\sum_{i=1}^{n_2} x_{2i} = \frac{1617}{17} = 95.12 \quad (2)$$

where x_{1i} and x_{2i} – the number of scores for the diagnostics of i-th student with the low level of the vocational training in CG and EG respectively; n1 and n_2 –the number of students with the low level of the vocational training in CG and EG respectively.

The difference between the average values of two samples was calculated by the formula:

$$\Delta = \overline{x}_2 - \overline{x}_1 = 95.12 - 84.91 = 10.21 \quad (3)$$

Sums of the squares of deviations for both samples are:

$$W_1 = \sum_{i=1}^{n_1} (x_{1i} - \overline{x}_1)^2 = 5477.64 \quad (4)$$

$$W_2 = \sum_{i=1}^{n_2} (x_{2i} - \overline{x}_2)^2 = 5477.64 \quad (5)$$

The joint dispersion of two samples was calculated by the formula:

$$\sigma_0^2 = \frac{\sum_{i=1}^{n_1} (x_{1i} - \overline{x}_1)^2 - \sum_{i=1}^{n_2} (x_{2i} - \overline{x}_2)^2}{(n_1 - 1) + (n_2 - 1)} =$$

$$= \frac{w_1 + w_2}{(n_1 - 1) + (n_2 - 1)} = \frac{5477.64 + 1071.76}{(45 - 1) + (17 - 1)} = 109.16 \quad (6)$$

Average error of the difference of the average values of two samples was as follows:

$$\overline{m_{1-2}} = \sqrt{\sigma_0^2 \frac{n_1 + n_2}{n_1 n_2}} = \sqrt{109.16 \frac{45 + 17}{45 \times 17}} = 2.974 \quad (7)$$

Accordingly, the rated t-test of Student's normal distribution was calculated by the formula:

$$t_p = \frac{(\overline{x}_2 - \overline{x}_1)}{\overline{\overline{m_{1-2}}}} = \frac{\Delta}{\overline{\overline{m_{1-2}}}} = \frac{10.21}{2.974} = 3.4315 \quad (8)$$

For each of two samples the number of degrees of variation freedom was:

$$v_1 = n_1 - 1 = 45 - 1 = 44 \quad (9)$$

$$v_2 = n_2 - 1 = 17 - 1 = 16 \quad (10)$$

$$v_{1-2} = (n_1 - 1) + (n_2 - 1) = 44 + 16 = 60 \quad (11)$$

For the research a significance level α = 0.05 was adopted, which suggests a possible 5% margin of error, valid for educational research. At that the authenticity of the received data will be 95%.

5 CONCLUSIONS

The work demonstrates the possibility to improve the quality of future specialists' training in aerospace complex, taking into account the informatization processes of manufacture and the learning process. In the presented article the authors show how to generate the opportunity to gradually develop the student's perception of new learning technologies and structuring of the training levels. Thus, at a significance level α = 0.05 and 60 degrees of variation freedom the critical value of Student's t-test in accordance with the table value is 2.0003. So, the calculated value of Student's t-test is more table (tp= 3.4315 > t=0.05 = 2.0003), and the null hypothesis about the random nature of the difference of the average values of two samples is denied. Accordingly, the alternative hypothesis is accepted and the assumption is proved, that fewer students with the low level of the vocational training in designing the flight situations in the experimental group were not a random phenomenon, but the result of the purposeful use of modern IT tools in the educational process.

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