



DOI: 10.15804/tner.2023.71.1.04

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## **Experimental Verification of the Effectiveness of the Pedagogical System of the Formation of Educational Environment in a Higher Educational Institution**

### **Abstract**

The study is related to the pedagogical experiment on the systemic controlled impact on the formation of educational environment in higher educational institutions. The article aims to verify the effectiveness of introducing the pedagogical system of educational environment formation in higher educational institutions on the example of an aviation educational institution. Evaluation of the effectiveness of the pedagogical system of educational environment formation is based on the monitoring analysis. Diagnostic techniques of the expert examination have been described. The statistical insignificance of discrepancies between the data of control and experimental samples has been proved. Significant changes in the educational environment formation levels in the control and experimental groups have been confirmed.

**Keywords:** *educational environment, pedagogical system, higher military educational institution, aviation-oriented.*

## **Introduction**

In a broad sense, the educational environment is a subsystem of the socio-cultural environment. The local environment of an educational institution is a specially organized pedagogical system of education and the personality development of students. The educational environment of higher educational institutions is the subject of the scientific research of many scientists (Huang, 2012; Masalimova, 2016).

According to the results of surveys of cadets and teachers, the educational environment of higher military educational institutions formed based on long-standing traditions is an obstacle to introducing educational innovations and inhibits the development of students' subjectness. In this regard, it is important to create at higher military educational institutions an educational environment conducive to achieving a balance between external goals of education (satisfaction of the government and society's demand for competent military specialists) and internal ones (meeting the hierarchy of personal needs).

## **Aim and Tasks**

The article aims to verify the effectiveness of introducing the pedagogical system of educational environment formation in higher military aviation-oriented education institutions.

## **Research Methods**

The scientific basis of the research is systemic, personality-social-activity, competence, acmeological and resource approaches, which postulate the principles of systemacy, a connection between theory and practice, natural and cultural correspondence, unity of external influences, and the inner world of a personality, individuality.

To achieve this goal, theoretical, empirical and statistical research methods were used. The theoretical ones include the study of scientific, philosophical, sociological, psychological and pedagogical literature to identify the state of development of the problem of the educational environment, retrospective and comparative analysis of different views on the research problem; synthesis to determine the criteria, indicators and levels of formation of the educational environment; methods of analogy, pedagogical modelling for the development of a pedagogical system of the formation of the educational environment; methods of generaliza-

tion, systematizing to formulate conclusions. Empirical methods are interviews, conversations, questionnaires, testing, pedagogical observation etc. The methods of mathematical statistics envisage the use of Student's t-test to determine the significance of discrepancies in the independent samples, Pearson's chi-squared test ( $\chi^2$ ) to prove the statistical significance of the experimental results.

Considering the socio-pedagogical essence of the educational environment, its examination was conducted both in the external and internal circuits. The external examination provided for its assessment by external stakeholders by such parameters as social integration, social productivity, and mobility. The internal examination was conducted with the participation of managers, research and teaching staff, course officers, cadets, their parents and others. Such parameters of the educational environment as strategy, saturation, assimilation, emotionality, dominance, harmony and stability were subjected to internal examination (Jasvin, 2001).

Taking into account the special features of the study, the following diagnostic tools were used:

- expert assessment of the quality of the educational environment;
- selective method;
- sociometry;
- conversations, questionnaires, and interviews with the staff and cadets to determine their understanding of the essence of the educational environment;
- a method of analyzing hierarchies to determine the level of significance of the educational environment for cadets;
- projective method "My vision of life in 5 (10) years";
- analysis of products of educational activity of cadets, civilian, and military students, military accounting documents, questionnaires, references, sergeant's books, psychological and pedagogical diaries, subunit commanders' testimonials, and medical and psychological assessment reports concerning a person's condition.
- study of the current orders from the administration, education curricula and syllabi, guidelines for evaluating educational results, and general and professional competencies of future aviation military specialists.

To obtain reliable results, the minimum number of experts must be at least:

$$N = \frac{t_a^2}{\varepsilon_1}, \quad (1)$$

where  $N$  is the minimum number of experts, is the indicator of the reliability of the obtained result for a given confidence probability, is the maximum allowable error given at the beginning of the survey, expressed as a fraction of the mean square deviation (Melash, 2020).

To assess the educational environment formation level in aviation-oriented higher military education institutions, criteria with the next indicators were determined, namely: personality, aviation-education-oriented, content-procedural, and productive.

The ego-integrative criterion was used to evaluate the generalized structure-and-content characteristic of the educational environment. For quantitative analysis of the obtained results, we used the technological map of educational environment examination (V. Jasvin), and with its help, identified indices Iint (interaction), Iman (participation in management), Idif (differentiation, and individual approach), Ivar (variability), Ia.sph (axiological sphere), Is.int (social integration).

For quantitative analysis of the obtained results, the study used the technological map of the educational environment, with which was compiled a table of values of the indices Iscien (scientific), Iac (aviation component), Iaeis (aviation education information space). The performance evaluation and rating of the academic teaching staff were used to implement diagnostic procedures according to the content-procedural criterion. Methodological support was examined based on the analysis of lesson review registers, records of conferences; materials of conferences on flight safety, annual conferences on flying procedures. Legal support was assessed by experts for compliance of educational activities with licensing and accreditation requirements. The state of material and technical support was determined by the results of the questioning of the cadets and academic teaching staff. To provide a quantitative evaluation of the formation of the educational environment according to the content-procedural criterion, we introduced the following indices: Imob (mobility of goals and education content), Iia (interactivity), Ispp (scientific and pedagogical potential), Imeth (methodological support), Imts (material and technical support) and determined the intervals of their values according to the educational environment formation levels.

The productivity of the educational environment can be assessed by both internal and external experts. The main indicator of the productive criterion of forming an educational environment is the development of future aviation military specialists' general (key) and professional competencies. The educational environment formation strategy is determined by goal-oriented guidelines, and the ability of the management to make strategic decisions related to the devel-

opment and provision of material resources for their higher military education institution.

To provide a quantitative evaluation of the formation of the educational environment according to the productive criterion, we introduced the indices Ipsd (professional self-determination), Icomp (formation of general and professional competence), Istrat (educational environment formation strategies), Isat (satisfaction with the educational environment) and determined the intervals of their values by the educational environment formation levels.

## **Data Collection and Analysis**

The experiment to verify the effectiveness of introducing the pedagogical system of educational environment formation was conducted in two stages: ascertaining and formative. Before the experiment, the participants were informed of the study's purpose and that the data collection results would be intended solely for academic purposes. The experimental group (EG) included staff and cadets of the flying and engineering and aviation faculties of the Ivan Kozhedub National Air Force University, Kharkiv (KhNUPS) 252 persons. The control group (CG) numbered 248 persons: representatives of the management, academic teaching staff, course officers, and university cadets, where the aviation component is weaker. Generalized (averaged) results of the ascertaining experiment are given in Table 1.

**Table 1.** Generalized results of the ascertaining experiment

Criteria	Educational environment formation levels							
	Innovative		Perfect stable		Has a tendency toward development		Initial	
	Absolute and relative (%) number of experts' answers							
	CG	EG	CG	EG	CG	EG	CG	EG
Personality-integrative	29 11,69	30 11,90	50 20,16	51 20,24	73 29,44	76 30,65	96 38,70	95 37,70
With aviation-oriented education	25 10,10	31 12,30	63 25,49	66 26,20	68 27,42	64 25,32	92 25,32	91 36,10
Content-procedural	34 13,70	35 13,90	51 20,56	57 22,62	94 39,52	90 35,71	69 26,2	70 25,4
Productive	29 11,70	27 13,90	61 24,59	65 25,79	93 37,50	96 38,10	71 28,60	69 25,40

Mean value	29	31	56	60	82	81	81	80
	11,69	12,30	22,58	23,81	33,47	32,14	32,70	31,70

The averaged data on the educational environment formation levels in aviation-oriented higher military education institutions according to expert assessments in the control and experimental groups (Table 2).

**Table 2.** Educational environment formation levels according to expert assessments in the experimental and control groups (averaged data)

Levels of formation	Samples		Deviation from mean		Deviation squares	
	CG	EG	$x_i - \bar{x}$	$y_i - \bar{y}$	$(x_i - \bar{x})^2$	$(y_i - \bar{y})^2$
Innovative	28	31	-34	-32	1156	1024
Perfect stable	56	60	-6	-3	36	9
Has a tendency to develop	83	81	21	18	441	324
Initial	81	80	19	17	361	289
Sums	248	252	0	0	1994	1646
Mean value	62	63	-	-	-	-

To confirm the homogeneity of EG and CG, we used Student's  $t$ -criterion for two independent samples. The formulas for calculating  $t$ -criterion for the two independent samples is as follows:

$$t_{emp} = \frac{|\bar{x} - \bar{y}|}{S_d}, \quad (2)$$

$$s_d = \sqrt{\frac{\sum_{i=1}^4 (x_i - \bar{x})^2}{n_1} + \frac{\sum_{i=1}^4 (y_i - \bar{y})^2}{n_2}}, \quad (3)$$

where  $t_{emp}$  is the empirical value of the Student's  $t$ -criterion,  $S_d$  is the corrected mean-square deviation,  $x_i, y_i$  are the current values of X, Y,  $\bar{x}, \bar{y}$  are the mean values of X, Y,  $n_1 = 252$  is the sample size of the experimental group,  $n_2 = 248$  – sample size of the control group (Bilyavets, 2019).

Using the data in Table 2, by formulas (2), (3) let us calculate the value  $S_d = \sqrt{\frac{1994}{248} + \frac{1646}{252}} = \sqrt{8,040 + 6,532} = \sqrt{14,572} = 3,817$ ,  $t_{emp} = \frac{1}{3,817} = 0,262$ .

The number of degrees of freedom  $k = n_1 + n_2 - 2 = 498$ .

We find the critical points (limits) of the criterion for the number of degrees of freedom  $k = 498$ . The left limit by the level of significance  $\alpha = 0.1$  on the critical value of the parameter  $t_{cr} = 1.64$ , the right limit on the significance level  $\alpha = 0.001$  by the critical value of the parameter  $t_{cr} = 3.29$ . The empirical value of the parameter  $t_{emp} = 0.262 < t_{cr} = 1.64$  by the significance level  $\alpha = 0.1$ , so we conclude that there are no significant differences between the experimental and control groups (Pugachev, 1984). Summarising, we conclude the expediency of introducing a pedagogical system of educational environment formation.

## **Discussion**

The rationale for the theoretical foundations of the educational environment formation in higher military educational institutions has been provided by scholars N. Zamotaieva, M. Neschadym, S. King (Zamotaieva, 2019; Neschadym, 2002; King, 2011). Researchers have determined the educational potential of the educational environment (Syed Mohamed, 2018). Some aspects of resource provision for the methodological and material-technical components of the educational environment have been studied (Danylko, 2021). Attempts have been made to address the information issues of organizing an electronic library as an innovative component of the educational environment (Aidong & Sreenivas, 2000). Some scholars see the complex structure of the educational environment of higher military educational institutions as associated with the process and outcome of the education and training of military professionals, whose professional activities bring a great deal of pressure to bear on their personal, intellectual, psychological, psychophysiological, physiological and physical qualities, are dangerous and take place in extreme conditions. Each and every resource of the educational environment is significant: material, financial, personal, technological, organizational, and reputational. By purposefully changing them, it is possible to indirectly impact all components of the educational process, including its subjects, providing a system of conditions for their personal, professional and cultural development (Bratko, 2020).

Despite many scientific works on structuring the educational environment, there is a lack of systematic research that would highlight the implementation of a pedagogical system as a methodological basis for an aviation-oriented higher military education institution. The specified pedagogical system consists of subsystems: a goal-strategic subsystem (goals and missions), a theoretical subsystem

(methodological, general scientific and specific-scientific basis), a content-component subsystem (structure), a technological subsystem (stages of formation), a performance and analysis subsystem (processing results and making adjustments) (Marchenko, 2020).

## Research Results

The introduction of a goal-strategic subsystem envisaged the propagation of the idea of the formation of an aviation-oriented educational environment in a multi-disciplinary higher military educational institution. For that purpose, work was organized to explain the pedagogical essence of the educational environment, its role in the professional training of competent military aviation specialists and the advantages of the environmental approach. In addition to activities aimed at contact with the audience, testing the study's results included content analysis of mini-papers and essays of cadets. The activity of initiative groups aimed at developing the creative abilities of teachers, course officers, sergeants, and cadets gained special importance.

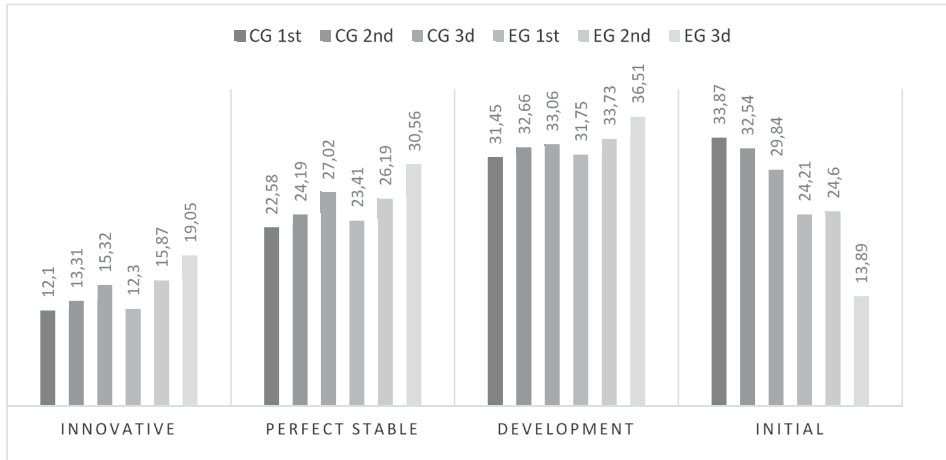
Diagnostic procedures for determining the educational environment formation levels according to specified criteria with indicators from the performance and analysis subsystem. Generalized experimental data are given in Table 3.

**Table 3.** Generalized results of the pedagogical experiment to form the educational environment in an aviation-oriented higher military education institution

Level of formation of educational environment	Experts' answers					
	At the beginning of the experiment		During the experiment		At the end of the experiment	
	CG	EG	CG	EG	CG	EG
Innovative	29 11,69%	31 12,30%	31 12,50%	38 15,08%	35 14,11%	43 17,06%
Perfect stable	56 22,58%	60 23,81%	59 23,79%	72 28,57%	63 25,40%	76 30,16%
Has a tendency to develop	80 32,26%	81 32,14%	82 33,06%	93 36,91%	86 34,68%	97 38,49%
Initial	83 33,47%	80 31,75%	76 30,65%	49 19,44%	64 25,81%	36 14,29%

The dynamics of the educational environment formation levels is illustrated in the diagrams shown in Fig. 1.





**Figure 1.** The dynamics of the educational environment formation levels at the beginning (1st snapshot), during (2nd snapshot) and at the end (3rd snapshot) of the experiment

As shown by the data, according to all the specified criteria, the experimental groups show more significant positive changes in the educational environment formation levels than the control groups. Since the samples of the experimental and control groups are random and independent, the members of each sample are also independent of each other. The study used Pearson's chi-squared test ( $\chi^2$ ) to verify the hypotheses. The properties of the educational environment were measured on the ordinal scale, which has four levels: innovative, perfect stable, tends to develop, initial.

The value of the experimental statistics is calculated by the formula:

$$T_{emp} = \frac{1}{N_1 N_2} \sum_{i=1}^4 \frac{(N_1 Q_{2i} - N_{1i})^2}{Q_{1i} + Q_{2i}}, \quad (4)$$

where  $N_1$  is the number of experts' answers of the experimental group;

$N_2$  is the number of experts' answers of the control group;

$Q_1$  and  $Q_2$  are the number of experts' answers of the experimental and control groups, corresponding to a certain educational environment formation level (for the initial level  $i = 1$ , for the level that tends to develop,  $i = 2$ , for the perfect stable level  $i = 3$ , for the innovative level  $i = 4$ ) at the beginning and end of the formative experiment.

For the level of significance  $\alpha = 0.05$  and the number of degrees of freedom  $\nu = c-1 = 3$  the critical value of the statistics  $T_{cr} = 7,82$ . According to the rule of decision-making by the criterion of consent, if calculated by the formula (4) the value of  $T_{exp} > T_{cr}$  ( $8,441 > 7,82$ ), it is hypothesized that the differences in the distribution of experts' answers according to the levels of formation of the educational environment at the beginning and end of the formative experiment are statistically significant with a probability of  $p = 0,95$ .

Statistical processing of the experimental data confirmed the positive dynamics of the educational environment formation levels in both experimental and control groups. The statistical significance of the obtained results was confirmed by Pearson's chi-squared test ( $\chi^2$ ), according to which the differences in the distributions of the educational environment formation levels in the experimental and control groups are significant. Based on the value of statistics ( $T_{exp} = 12,004$ ), the most significant changes took place according to the productive criterion, which indicates an improvement in the quality of professional training of military aviation specialists due to the introduction of a pedagogical system of educational environment formation. Significant changes were observed according to the personality-integrative criterion, as evidenced by the high value of  $T_{exp} = 10,434$ . It can be explained by the purposeful efforts of the management, course officers, academic teaching staff and cadets to attain a well-balanced use of educational resources. Statistically significant positive shifts were also observed according to the criteria of aviation orientation of education criterion and content-procedural criterion due to the aviation-focused integration of courses of instruction, professional context and flight atmosphere. The analysis of the expert assessments of the educational environment formation levels in the control groups also showed positive shifts, but they turned out to be less significant.

## **Conclusions**

Therefore, the introduction of the pedagogical system had a positive effect on the state of the educational environment in aviation-oriented higher military education institutions, which manifested itself in the systemic perception of pedagogical reality by all subjects of the educational process, organization of an educational and information space common for all faculties based on the aviation orientation of the program-methodological and educational-basic components of the educational environment.

Evaluation of the effectiveness of the developed pedagogical system of educational environment formation was based on analysing the monitoring results. The analysis of educational environment formation dynamics in the experimental and control groups revealed during the formative stage of the experiment confirms substantial, statistically significant changes in all the criteria.

The study does not cover all aspects of the problem. In theoretical terms, deeper studies of adaptive mechanisms of a personality under the conditions of educational environment transformations based on the introduction of information and communication technologies, distance and blended learning are promising. In practical terms, research concerning the enrichment of the diagnostic toolkit for studying the effects of the environment is of interest.

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