INTEGRATIVE APPROACH TO THE FORMATION OF THE ERGONOMIC COMPETENCE OF FUTURE TECHNOLOGY TEACHERS

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Abstract: *Ergonomic competence of future technology teachers' competence in the structure of technology teacher training implies an assessment of the financial and ergonomic activities, assessment of labor results. The relevance of the study is determined by the fact that the components of the ergonomic competence of teachers are fully identified as transformations of the analogous competence of future teachers, as well as the opportunities of formation a separate ergonomic assessment by students of their ergonomic actions. The novelty of the research is determined by the fact that, for the first time in the literature, aspects of the formation of an assessment of ergonomic products at the stage of the development of professional competencies of future teachers were investigated. In particular, the authors showed that the use of the ergonomic aspects of the training of future teachers allows us to more predict the planned results of activities for the subsequent periods of professional activity. The practical application of the realizable technology is the formation of specialists' readiness for ergonomic factors of activity. The article presents a prognostic assessment and correlation factors.*

Keywords: competence; integration; teachers; profession; forecasting.

An important component of the ergonomic competence of future technology teachers is the possession of the methodic for raising children and adolescents in a general education school[1]. The methodic of a specific academic discipline is a branch of pedagogical science that explores the content of an academic subject and the nature of the educational process: it contributes to the achievement by those, who learn, of the necessary level of knowledge and skills; develops thinking, creates a worldview[2].

Scientists consider the methodic as a branch of pedagogical science that exploring the content of a school subject and the nature of the learning process, which contributes to students mastering a certain material, acquiring the necessary level of knowledge and skills, developing their thinking, shaping their worldview and educating the qualities of a citizen of their country. The methodic is a collection of methodical

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recommendation, tips and recipes, because it is dominated by the practical side of case[3].

So, the term "methodic" can be defined as a set of rules, principles, methods, means that allows carrying out the process of training and education within a certain pedagogical system[4]. The main functions of the methodic are: organizational, informational, integrational and controlling. Organizational – organizes the process of comprehension. Informational – provides for the transfer of information from a teacher to pupils (from professor to students) in the form of knowledge and skills. The integration function is aimed at achieving the integrity of the lesson, its effective connection with other objects, phenomena, species[5]. The controlling one reveals the level of mastering the content of the school subject, thereby monitoring the effectiveness of the educational process and the development of the culture of pupils (students).

Literature review

The method of education is defined as the process and the result of the interpretation of the main theoretical positions to specific pedagogical conditions[6]. The methodic implements the teaching, educational and developmental functions of education and occupies an intermediate position between science and art[7]. It finds its expression in concretization of the goals, tasks, content, methods, means of education and it is embodied in curricula, methodological recommendations, and vivid examples of the lively and creative process of interaction of the teacher and students in general[8]. The educational theory has a fundamental for the

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teaching methodic[9]. Theoretical propositions are at the same time the base and reference point, on the basis of which a specific educational methodology developed[10].

The experience, which gained by pedagogy, reflects two functions of education: classical, which provides for the formation of a culture of personality from the standpoint of spiritual and moral values and common humanistic convictions, and pragmatic, which satisfies the need in specialist[11]. Inclusiveness and multifunction are the features, that inherent to methodic of teaching[12]. So, the problem of forming the ergonomic competence of students has always been one of the central in any direction of pedagogical education, and methodological preparation is the basis of the practical professional activities of future technology teachers[13].

Levels of methodological competence are differently defined by scientists. Usually, there are six levels: knowledge, understanding, application in standard situations, analysis, synthesis, evaluation[14]. Or three levels distinguish, among which are: the transfer of solution options, of teaching methods to the conditions of a new pedagogical situation; finding new solutions; the creation of new solutions[15]. Considering the taxonomy

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of the research category, we distinguish three levels: basic, search, value-semantic[16].

The basic level provides for compliance by the student with the requirements, which are reflected in the methodic. At this level, students do not always substantiate their methodical actions[17]. They boil down to the transfer of solutions and teaching techniques to the conditions of a new pedagogical situation[18]. The search level involves foresight, analyzing and justifying methodical actions, identifying the positive and negative effects of using techniques to solve specific pedagogical situations and overcoming difficulties in the process of interpreting ergonomic factors or the preparation of their analysis[19]. At this level, a student with the help of a teacher finds new solutions, leads a partial search for expedient methods of achieving the set task. At the value-semantic level, the future teacher takes into account interdisciplinary communication, constructs various versions of methodical solutions[20]. At the same time, the search for the solution of tasks or problem situations becomes a source of enrichment of the student's subject experience, which is able to analyze and substantiate their methodological actions[21].

Materials and methods

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The establishing experiment in the study was carried out in stages and solved the following tasks:

– to develop a criterion apparatus of research, taking into account the component structure of the ergonomic competence of future technology teachers;

– select diagnostic methods and interpret the data obtained during the application of various diagnostic procedures;

– taking into account the results of pedagogical observation, according to the established criteria and their diagnostic indicators, to find out the state of formation of the ergonomic competence of future technology teachers.

The establishing experiment involved preliminary exploratory work in order to determine the development of the adaptive abilities of freshmen; development of diagnostic methods; performing basic establishing procedures; processing the data obtained and determining quantitative indicators of the levels of development of the ergonomic competence of future teachers of technology.

To implement the main goal of the establishing experiment, namely, to determine the state of development of the ergonomic competence of future teachers of technology in accordance with a specific component structure, criteria for the development of the phenomenon under study were established and scientifically substantiated.

The main criteria for the level of ergonomic competence of future teachers of technology are defined: motivational-targeted, information-methodical, operational-modeling, systemic-active. The motivational-target criterion is based on the value attitude of the future teacher to mastering the methodical techniques and methods of teaching-pedagogical activity, finding ways to solve specific pedagogical problems arising in the practice of the modern teacher, and how he solves it. It is aimed at identifying among students the level of motivation for professional development based on the perception and assessment of the pedagogical situation as a multidimensional, constantly innovative pedagogical reality and a priority of the goals of developing the personality of students. Motivational-target criterion was determined by indicators such as:

– presence of motivation to work, understanding the value of knowledge and skills;

– level of understanding of the purpose of work in the context of multidimensionality of tasks arising in the process of learning activities;

– degree of desire to navigate the flow of information, independently structure and assign new knowledge.

The informative-methodical criterion is based on the identification of a set of methodical knowledge necessary for the qualitative performance of educational and methodical activities. This criterion is revealed by the following indicators:

– the degree of development of cognitive independence and ability to manage their own intellectual activities;

– ability to synthesize knowledge and use them both in the process of self-learning, and in solving methodical problems arising in practical activities;

– the degree of flexibility of thinking, the ability to move from one solution to another, to find the appropriate answer;

– the ability to overcome the inertia of thinking.

Operational-modeling criterion accumulates the skills of the future teacher, which are related to diagnosing the conditions of the learning process, predicting difficulties and achievements, developing on this basis a specific action plan, choosing forms and means of presenting information, a self-assessment. This criterion is characterized by such indicators as:

– the degree of speed of thinking, the ability to see new connections, non-standard associations;

– ability to plan, evaluate the results of their own educational activities;

– the degree of critical thinking, the ability to objective value judgments, the ability to find the causes of their mistakes and failures.

The system-activity criterion is determined by the degree of proficiency in the method of influencing students, adjusting their activities at all its stages, based on the goals and degree of successful passing of the educational process. This criterion is determined by such indicators:

– degree of readiness for independence in the process of solving problems;

– the ability to see and pose problems; go beyond the scope of assigned tasks;

– aspiration to creative achievements, self-realization during training.

In the ascertaining experiment, we introduced a three-point scale for evaluating the results of questionnaires, surveys, interviews, students' fulfillment of educational-creative tasks, test and examinational requirements, and the like.

The ascertaining experiment various research methods were included: pedagogical observation, conversations with students, a questionnaire, a survey, an analysis of the results of performing special tasks, pedagogical documentation. The process of diagnosing the level of development of the ergonomic competence of future specialists was accompanied by observation of the conduct of teaching practice and occupation. During the experienced-experimental work, we relied on the features of the organization and conduct of pedagogical research, disclosed in the work on identifying the level of ergonomic competence of students in the process of learning in higher education institution, particularly on the third course.

In the process of determining the content of questionnaires and conversations, we held to the position that the questions should reveal all aspects of the development of the ergonomic competence of future technology teachers. On this occasion, the task of the experimental work was to determine the level of formation of ergonomic competence by the motivational-target criterion.

In the course of conversations, the teachers-methodologists determined the level of development of the ergonomic competence of future technology teachers according to the motivational-target criterion. All teachers paid attention to the fact that students should not only have training, but also be competent in applying various teaching methods, be able to analyze and select information, own various ways of presenting it, and be ready for self-improvement and further education. However, students consider these questions as secondary and give considerable preference to mastering the reproductive complex of knowledge and skills.

Results and discussion

Since the ergonomic competence of future teachers of technology is in relation to its professional-pedagogical competence in the dialectic of the share and the whole, we specify the content of the individual components of competence in the context of ergonomic activity.

Analysis of qualitative and quantitative results, as well as the results of surveys, interviews, pedagogical observation and questioning to identify the level of development of ergonomic competence of students according to the motivational-target criterion showed that the majority of students demonstrated an average level of development of ergonomic competence according to the specified criterion. In order to find out whether students show a desire to acquire ergonomic competence, it was suggested to

answer the question: "What would you like to achieve during your studies at a higher educational institution?".

Analysis of the survey results showed that 13.0% of students are trying to master ergonomic competence. Some students are able to list didactic methods, but do not know how to use them; students are not oriented in questions aimed at explaining the psychological and pedagogical mechanisms of pupils' mastering ergonomic information; they are not able to use educational information rationally. At the same time, 33.7% of students wanted to increase their intellectual and cultural level; 20.5% – to acquire knowledge in the field of ergonomic s; to get a diploma of higher education – 13.3%.

According to students' opinion, the objectives of training are to develop skills, expand the amount of knowledge in the field of ergonomic s. Some students set themselves up to achievement by self-determined goal (some set a goal to study excellently, some read individual ergonomic works, others decided to participate in the university's creative life, etc.). The results of diagnostics of the development of ergonomic competence of students in the process of learning by the motivational-target criteria are presented in Table 1.

An analysis of the results obtained allows us to state that the majority are studying with interest and are satisfied with their own choice of specialty, and as a result, they retain a fairly high internal motivation to learn. In general, the average level of motivational-targeted direction of students in the learning process was identified.

This fact contradicts the current situation in education, in particular in the process of preparing future technology teachers: the need for a qualitatively different teacher training, which allows combining the fundamental professional basic knowledge with innovative thinking and a practice-oriented approach to solving specific pedagogical problems, the need to form personality, able to live in terms of turnover, ambiguity in the assessment of aesthetic and cultural values. In this regard, we came to the conclusion that it is important for future technology teachers to create the idea about the need to master ergonomic competence in the learning process.

Table 1: Diagnostics of the development of the ergonomic competence of future teachers of technology on the motivational-target criterion

Indicators	Levels		
	Value-semantic	Prospecting	Basic

	N.	%	N.	%	N.	%
The degree of stability of positive motivation to ergonomic work, understanding the value of ergonomic knowledge and skills	25	11.0	139	61.0	64	28.0
The level of understanding of the goal of ergonomic work in the context of multidimensionality of tasks arising in the process of activity	45	19.7	142	62.3	41	18.0
The degree of desire for independence in finding solutions to methodological problems, structuring and acquiring new knowledge	20	8.8	95	41.7	113	49.5
Average in %	13.2		54.8		32.0	

The basic foundation of methodical-practical training is the independent acquisition of fundamental theoretical and historical knowledge, as well as the methods and forms of their transfer. That is what made us pay attention to the degree of development of ergonomic competence according to the informative-methodological criterion. The work on the study of the level of development according to the informative-methodological criterion is aimed at identifying information retrieval skills, working with literature, identifying the main idea, its construction, as well as the skills to apply theoretical knowledge in practical activities, to choose the most rational method for solving the task.

The results of the assessment of ergonomic competence according to the information and methodological criterion (observations in the process of pedagogical practice, interviews and conversations) prove that only 11% of students consciously put into practice various teaching methods, construct teaching material, manage the methods of presenting the educational information. The result of the observation is evidenced by the fact that there are a certain number of students who do not pay attention to the assimilation of information by the students. Their attention is paid to the reproduction of studied.

After analyzing the results of the questioning, survey, interviews and pedagogical observation, we performed mathematical data processing and obtained such a percentage ratio of the results on identifying the development levels of students' ergonomic competence in the learning process with information-methodological criterion (the results are presented in Table 2).

Table 2: Diagnostics of the development of the ergonomic competence of future teachers of technology according to the informative-methodological criterion

Indicators	Levels					
	Basic		Prospecting		Value-semantic	
	N	%	N	%	N	%
The degree of development of cognitive independence and ability to manage their own intellectual activities	39	17.1	133	58.3	56	24.6
The level of development of the ability to synthesize the knowledge and use them, both in the process of self-education, and in solving methodic problems in the process of practical activity	25	11.0	116	50.9	87	38.1
The degree of flexibility of thinking, the ability to move from one way of solving problems to another, to find the most original and productive answer, the ability to overcome the inertia of thinking	48	21.1	137	60.1	43	18.8
Average in %	16.2		56.6		27.2	

Table 3: Diagnostics of the development of the ergonomic competence of future teachers of technology according to the operating-modeling criterion

Indicators	Levels					
	Basic		Prospecting		Value-semantic	
	N	%	N	%	N	%
The degree of thinking rapidity, the development of the ability to see new connections, non-standard associations	33	14.5	124	54.4	71	31.1
The level of development of skills to plan their own educational activities	12	5.3	98	43.0	118	51.7
The level of development of skills to evaluate the results of methodical activities and to find the reasons for their successful discoveries, as well as errors and failures	29	12.7	121	53.1	78	34.2
Average in %	11.0		50.0		39.0	

After analyzing the results of the questioning, survey, pedagogical observation, individual interviews, assignments, we carried out

mathematical data processing and determined the following levels of ergonomic competence development among students according to the operating-modeling criterion (Table 3).

Generalized results of diagnostics of the development of ergonomic competence by system-activity criterion, in particular, the questionnaire survey, pedagogical observation, self-assessments and the expert assessments of performing the creative tasks by students, allowed to determine the following levels of development of the studied phenomenon in the learning process (the results are presented in Table 4).

The overall quantitative results of the establishing stage of the study showed the advantage of middle and low levels of student development in universities. The results are presented in table 5 and in Figure 1.

Table 4: Diagnostics of the development of the ergonomic competence of future teachers of technology on a system-activity criterion

Indicators	Levels					
	Basic		Prospecting		Value-semantic	
	N	%	N	%	N	%
The degree of readiness to independence in the process of solving problems	19	8.3	96	42.1	113	49.6
The degree of development of the ability to identify problems, going beyond the assigned tasks	8	3.5	95	41.7	125	54.8
Striving for creative achievements, self-realization during training	21	9.2	120	52.6	87	38.2
Average in %	7.0		45.6		47.4	

Table 5: Levels of development of ergonomic competence of future technology teachers

Criteria	Levels					
	Basic		Prospecting		Value-semantic	
	N	%	N	%	N	%
Motivational-targeted	30	13.2	125	54.8	73	32.0
Information-methodical	37	16.2	129	56.6	62	27.2
Operational-modeling	25	11.0	114	50.0	89	39.0
Systemic-active	16	7.0	104	45.6	108	47.4
Average	11.8		51.8		36.4	

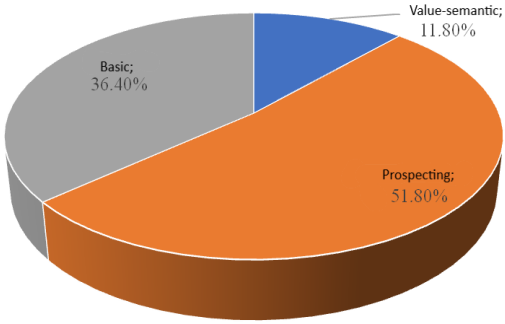


Figure 1: Levels of development of the ergonomic competence of future technology teachers

The generalization of the results of the diagnostic experiment proves that the indicators of the system-activity criterion are more developed. Somewhat lower are the results of the evaluation of the development according to the operating-modeling criterion.

Significantly lower are the manifestations of indicators of motivational-target and informational-methodological criteria. Students experience particular difficulties in the implementation of a component of practical activity, which is manifested in a little realizable, poorly meaningful interpretation and is associated with a low level of development of the ability to comprehend information, its "processing" and interpretation; unwillingness to define and create your own presentation models; lack of awareness of responsibility for learning outcomes; often inadequate self-assessment of methodological activity. According to the ascertaining study, it was found out that the majority of students do not consider it necessary to consider the methodological aspects of preparation both in the performance plan and in the pedagogical one. To a greater degree they are motivated to achieve high performing results due to the recommendations of the teacher. However, they are aware of the problems presence that arises in practice.

The lack of students' ability to use existing knowledge in the context of solving a specific problem was especially evident. Students acted stereotypically, not selectively, according to the principle – "I use everything I know." It was revealed that some students use an intuitive approach, and therefore, even in the process of successful implementation of educational activities, they cannot argue them. Most representatives of the experimental group understood pedagogical communication as memorization of information, and the essence of methodical training was seen in studying the names and characteristics of pedagogical methods and

principles. Only a few students pointed out the understanding and comprehension by students of the artistic and aesthetic content of information. At the same time, students who showed high results during the diagnostics of ergonomic competence according to one of the criteria also showed high results on others.

According to the generalized results of the establishing stage of the research, 48.6% of respondents were assigned to a low basic level of ergonomic competence development, 40.0% to the average, self-instructive, 11.4% to high, creative. The formative experiment involved the use of a complex of organizational forms and methods aimed at developing ergonomic competence among university students. To implement the experiment it was necessary to solve a number of tasks, in particular:

– to test the method of forming ergonomic competence among students;

– trace the dynamics of the formation of ergonomic competence;

– to carry out a comparative analysis of quantitative and qualitative indicators obtained in the course of experienced-experimental work;

– to prove the accuracy of the proposed methodology for the formation of ergonomic competence by using the methods of mathematical statistics.

Table 6: Generalized results of diagnostics of the development of the ergonomic competence of EG students (establishing slice)

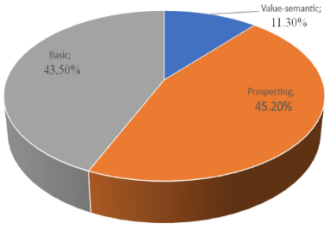
Level	Experimental group (EG)									
	Motivational -targeted component		Information -methodical criterion		Operational -modeling criterion		Systemic -activity criterion		The average rate of development of ergonomic competence	
	N	%	N	%	N	%	N	%	N	%
Value-semantic	6	9.7	8	12.9	8	12.9	6	9.7	7	11.3
Prospecting	29	46.8	31	50	27	43.5	25	40.3	28	45.2
Basic	27	43.5	23	37.1	27	43.6	31	50	27	43.5

Orient on the principles of comparative analysis, from the total number of students, two groups were selected for conducting a forming experiment and identifying its objective assessment: experimental (EG) and control (CG). The number of students was 62 people in each group.

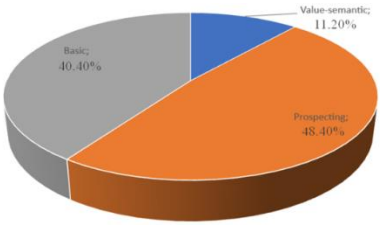
With the students of the experimental group (EG) classes were conducted according to the developed methodology. The formative experiment lasted during the 2017-2018 school year. Diagnostics of the development of ergonomic competence in future teachers of the experimental and control groups was carried out at the beginning of the first semester. The preliminary results of the establishing work are presented in Tables 6, 7, in Figure 2.

Table 7: Generalized results of diagnostics of the development of the ergonomic competence of CG students (establishing slice)

Level	Experimental group (CG)									
	Motivational -targeted component		Information -methodical criterion		Operational -modeling criterion		Systemic -activity criterion		The average rate of development of ergonomic competence	
	N	%	N	%	N	%	N	%	N	%
Value-semantic	8	12.9	10	16.1	6	9.7	4	6.5	7	11.2
Prospecting	31	50.0	29	46.8	31	50.0	27	43.5	30	48.4
Basic	23	37.1	23	37.1	25	40.3	31	50.0	25	40.4



Experimental group



Control group

Figure 2: Diagnosis of the ergonomic competence development of students in experimental and control groups (ascertaining slice)

The summarized results on the coefficients of the development of ergonomic competence are proposed in Table 8.

Table 8: The coefficients of the ergonomic competence development of students in EG and CG (ascertaining slice)

Group	Motivational-targeted component	Information-methodical criterion	Operational-modeling criterion	Systemic-activity criterion	The average rate of development of ergonomic competence
EG	1.75	1.87	1.74	1.65	1.75
CG	1.83	1.90	1.77	1.65	1.78

Table 9: Generalized results of diagnostics of the development of the ergonomic competence of EG students (control section)

Levels	Motivational-targeted component		Information-methodical criterion		Operational-modeling criterion		Systemic-activity criterion		The average coefficient of development	
	N	%	N	%	N	%	N	%	N	%
Value-semantic	20	32.3	22	35.5	18	29.1	10	16.1	17	27.4
Prospecting	31	50.0	32	51.6	29	46.7	34	54.8	31	50.0
Basic	11	17.3	8	12.9	15	24.2	18	29.1	14	22.6

Table 10: Generalized results of diagnostics of the development of the ergonomic competence of CG students (control section)

Levels	Motivational-targeted component		Information-methodical criterion		Operational-modeling criterion		Systemic-activity criterion		The average coefficient of development	
	N	%	N	%	N	%	N	%	N	%
Value-semantic	10	16.1	10	16.1	10	16.1	8	12.9	10	16.1
Prospecting	29	46.8	30	48.4	28	45.2	26	41.9	28	45.2
Basic	23	37.1	22	35.5	24	38.7	28	45.2	24	38.7

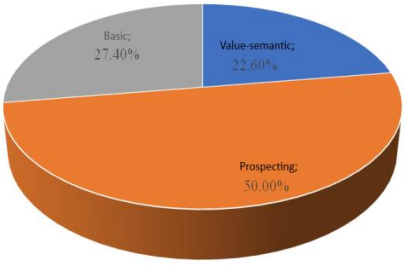
According to the results of processing the results of the first diagnostic slice, it was found that both the experimental and control

groups at the beginning of the experiment had approximately the same level of ergonomic competence. This made it possible in future work to trace the dynamics of the formation of structural components of the phenomenon under study among students. The second (diagnostic) section was conducted at the beginning of the second study semester (in March). The obtained data highlights the final results of the formation of ergonomic competence according to the developed criteria for their diagnosis (Tables 8, 9, 10; Figure 5).

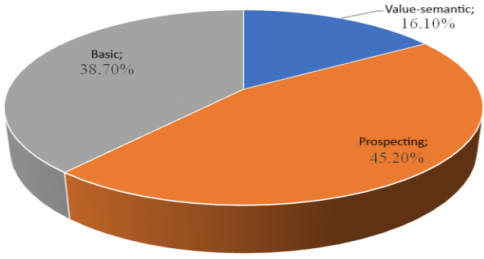
The summarized results on the coefficients of the development of ergonomic competence are proposed in Tables 11, 12, 13 (Figures 3, 4).

Table 11: The coefficients of the development of ergonomic competence of students of the EG and the CG to teaching practice (control section)

Group	Motivational -targeted component	Information -methodical criterion	Operational -modeling criterion	Systemic -activity criterion	The average coefficient of development
EG	2.12	2.14	2.02	1.85	2.03
CG	1.81	1.88	1.76	1.71	1.79



Experimental group



Control group

Figure 3: Diagnosis of the ergonomic competence development of students in experimental and control groups (control section)

Table 12: The results of positive changes in the formation of the ergonomic competence of students of the EG and the CG after the control slice

Experimental group (EG)		Control group (CG)	
Levels	**Indicators of the development of ergonomic competence**	**Levels**	**Indicators of the development of ergonomic competence**
Value-semantic	+16.1%	Value-semantic	+4.9%
Prospecting	+4.8%	Prospecting	-3.2%
Basic	-20.9%	Basic	-1.7%

Table 13: The results of positive changes for each criterion, taking into account the coefficients of students' ergonomic competence development of the EG and the CG after the control slice

Group	**Motivational-targeted component**	**Information-methodical criterion**	**Operational-modeling criterion**	**Systemic-activity criterion**	**The average coefficient of development**
EG	+0.46	+0.27	+0.28	+0.20	+0.28
CG	-0.02	-0.02	-0.01	+0.06	+0.01

Table 14: Generalized results of diagnostics of the development of the ergonomic competence of EG students (final section)

Levels	**Motivational-targeted component**		**Information-methodical criterion**		**Operational-modeling criterion**		**Systemic-activity criterion**		**The average coefficient of development**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Value-semantic	24	38.7	26	41.9	22	35.5	17	27.4	22	35.5
Prospecting	33	53.2	32	51.6	33	53.2	36	58.1	34	54.8
Basic	5	8.1	4	6.5	7	11.3	9	14.5	6	9.7

At the second stage of the formative experiment (system-productive), which began almost simultaneously with the previous one, the second condition was realized – the orientation of students to the value-related attitude to pedagogical activity, self-education and conscious self-development. At the third stage of the formative experiment (productive-reflexive) the following condition was implemented:

providing students with the possibility of sufficient variability in the choice of means and methods for solving tasks (Table 14).

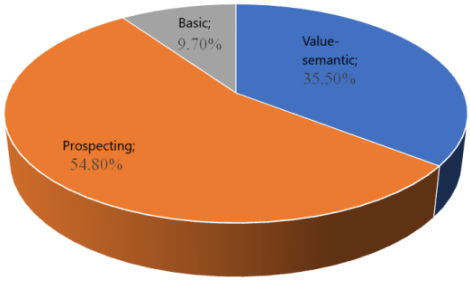
Among the principles on which the methodical work was based on the third stage, we highlight such:

– deductive;
– principle of self-development;
– principle of diagnosticity;
– principle of facilitation;
– principle of communicative partnership and cooperation.

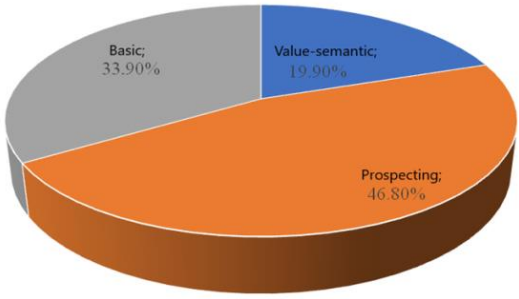
Thus, various innovative forms of organizing classes with future teachers help them to realize that ready-made development of the lessons contained in numerous methodological manuals and journals require creative comprehension. It is this that will lead to the formation of professionally-mobile specialists capable of quick adaptation in educational and socio-cultural spheres, endowed with high creative potential and flexible methodical thinking (Table 15).

Table 15: Generalized results of diagnostics of the development of the ergonomic competence of students of the CG (final section)

Levels	**Motivational-targeted component**		**Information-methodical criterion**		**Operational-modeling criterion**		**Systemic-activity criterion**		**The average coefficient of development**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Value-semantic	11	17.7	14	22.5	11	17.7	9	14.5	12	19.3
Prospecting	30	48.4	30	48.4	29	46.8	27	43.6	29	46.8
Basic	21	33.9	18	29.1	22	35.5	26	41.9	21	33.9



Experimental group (EG)



Control group

Figure 4: Diagnostics of the ergonomic competence development of students of experimental and control groups (final section)

The summarized results on the coefficients of the development of the ergonomic competence of future technology teachers are presented in Tables 16-20.

Table 16: The coefficients of the development of the ergonomic competence of students of the EG and the CG to pedagogical practice (final section)

Group	Motivational-targeted component	Information-methodical criterion	Operational-modeling criterion	Systemic-activity criterion	The average coefficient of development
EG	2.31	2.37	2.25	2.15	2.27
CG	1.82	1.96	1.76	1.73	1.81

Table 17: Results of positive changes for each criterion, taking into account the coefficients of development of the ergonomic competence of students of the EG and the CG after the final section

Group	Motivational-targeted component	Information-methodical criterion	Operational-modeling criterion	Systemic-activity criterion	The average coefficient of development
EG	+0.19	+0.23	+0.23	+0.30	+0.24
CG	+0.01	+0.08	+0.00	+0.062	+0.03

Table 18: The dynamics of the ergonomic competence development of students of the CG and the EG

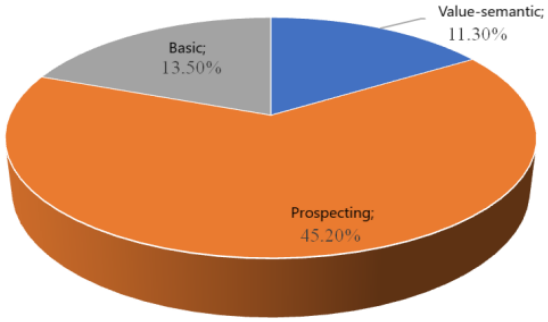
Levels	Ascertaining section				Control section				Final section			
	EG		CG		EG		CG		EG		CG	
	N	%	N	%	N	%	N	%	N	%	N	%

Value-semantic	7	11.3	7	11.2	17	27.4	10	16.1	22	35.5	12	19.3
Prospecting	28	45.2	30	48.4	31	50.0	28	45.2	34	54.8	29	46.8
Basic	27	43.5	25	40.4	14	22.6	24	38.7	6	9.7	21	33.9

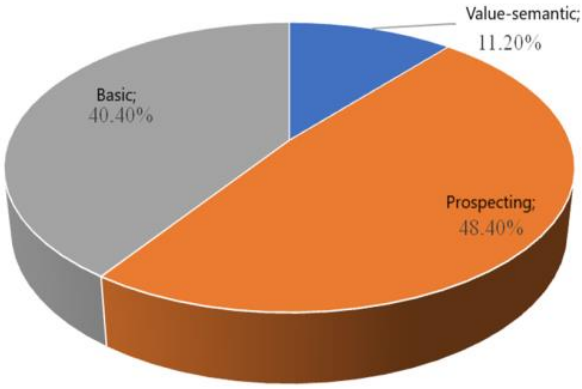
Table 19: Results of positive changes in the formation of the ergonomic competence of students from the EG and the CG after the final section

Experimental group (EG)		Control group (CG)	
Levels	**Indicators of the development of ergonomic competence**	**Levels**	**Indicators of the development of ergonomic competence**
Value-semantic	+8.1%	Value-semantic	+3.2%
Prospecting	+4.8%	Prospecting	+1.6%
Basic	-12.9%	Basic	-4.8%

At the beginning of the molding experiment:

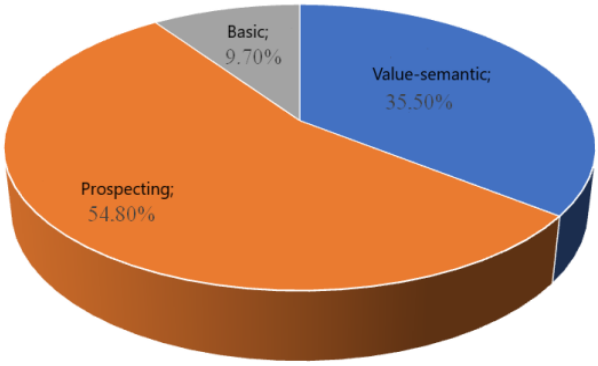


EG

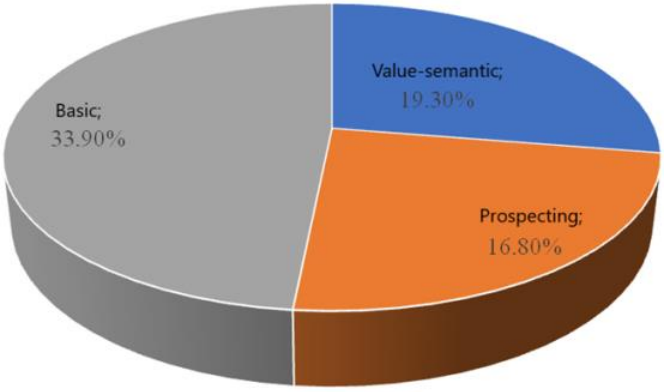


CG

After completion of the molding experiment:



EG



CG

Figure 5: The evolution of the ergonomic competence development of students of the CG and the EG

Table 20: The evolution of the ergonomic competence development of students of the CG and the EG by coefficients

Groups	Ascertaining section	Control section	Final section
	coefficients	coefficients	coefficients
EG	1.75	2.03	2.27
CG	1.78	1.79	1.81

We decided to prove the statistical persuasiveness of the discrepancies between the indicators in the experimental and control groups at the end of the molding experiment using the Fisher multifunctional criterion φ* (Fisher's angular transform) because:

1) the study involved two groups of students (EG, CG);

2) the number of students in groups was more than 5 people.

We used the Fisher criterion to compare and juxtaposition the quantitative indicators of the experimental and control groups of participants in the formative experiment, as well as to check the equality of the variances of the two samples. This criterion is attributed to dispersal criteria

To prove the statistical persuasiveness, the following hypotheses were formulated:

– per the initial hypothesis H0 the assumption is accepted according to which the share of future technology teachers with a basic level of ergonomic competence in the EG at the end of the formative experiment does not significantly differ from those in the CG;

– the alternative hypothesis H1 is based on the assumption according to which the author's method of forming ergonomic competence is effective and, accordingly, therefore, the proportion of students with a basic level of development of the phenomenon under study in the EG at the end of the formative experiment is much less than in the CG.

The values of empirical frequencies for the two features are proposed in Table 21.

Table 21: The values of empirical frequencies for the two features

Groups	Value-semantic and research levels of development of ergonomic competence		Basic level of development of ergonomic competence		Total
	Amount of students	Share	Amount of students	Share	
EG	56	90.3%	6	9.7%	62
CG	41	66.1%	21	33.9%	62

According to the table of angles φ, for different percentage shares, we determine the values that correspond to the percentage shares in each of the two groups.

$\varphi_1 = \varphi(33.9\%) = 1.243$

$\varphi_2 = \varphi(9.7\%) = 0.633$

We calculated the empirical value of the user φ* by the formula:

$$\varphi^*_{\text{emp}} = (\varphi_1 - \varphi_2)\sqrt{\frac{n_1 \times n_2}{n_1 + n_2}} \quad (1)$$

where n1 = 62; n2 = 62;

$$\varphi^*_{\text{emp}} = (1.243 - 0.633)\sqrt{\frac{62 \times 62}{62 + 62}} = 0.61 \times 5.568 = 3.396$$

In our case, $\varphi^*_{emp} = 3.396$. So, $\varphi^*_{emp} > \varphi^*_{crit}$

The result obtained refers to the zone of significance. So, there is a statistical difference between the indicators of experimental and control groups at the end of the formative experiment; therefore, the H1 hypothesis is accepted: The result obtained refers to the zone of significance. So, there is a statistical difference between the indicators of experimental and control groups at the end of the formative experiment; therefore, the H1 hypothesis is accepted: the proportion of students with a basic level of ergonomic competence development in the EG at the end of the formative experiment is significantly less than in the CG.

Consequently, the data obtained at all stages of the study indicate that the developed method of forming the ergonomic competence of the future teacher of technology has ensured the development of all components of the phenomenon under study. The results of the experimental work confirmed the effectiveness and expediency of its application in the process of preparing university students.

The article describes the content of experimental work, in particular, reveals the state of formation of ergonomic competence of university students, as well as the possibility of applying the developed methodology for the formation of the phenomenon under study. Experimental work was carried out in the conditions of the natural course of the educational process in accordance with the established purpose and objectives of the study.

Criteria for evaluating students of higher educational institutions of ergonomic competence, namely: motivational-target, information-methodical, operational-modeling, system-activity – were established and scientifically grounded. This made it possible to determine the state of development of the studied phenomenon in the process of molding work. The attraction of a significant number of respondents, the use of a variety of diagnostic techniques provided a qualified conducting of establishing experiment.

The results obtained in the process of diagnostics of the development of the methodical competence of university students allowed determining three levels of development of the phenomenon under study and basic, prospecting, and value-semantic (low, medium and high). The application in the ascertaining experiment of the method of integral assessment of the levels of ergonomic competence development on the basis of a reasonable criterion-level approach showed that the majority of

students have an average and low level of development of the specified phenomenon. Thus, the results of the study confirmed the need to apply a special method of forming the ergonomic competence of students.

According to the purpose and objectives of the study, a methodic was developed for the formation of methodical competence, which is based on the implementation of certain pedagogical principles and conditions. Practical testing of the proposed method took place during a formative experiment, which consisted of three stages – locally-receptive, systemic-reproductive, productive-reflexive. The precise organization of the educational process at each stage of the experiment ensured the purposeful development of all components of ergonomic competence in the learning process.