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Cognitive Simulation as Integrated Innovative Technology in Teaching of Social and Humanitarian Disciplines

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ABSTRACT

Currently, teachers are searching for innovative educational technologies that enhance the effectiveness of educational activities. The purpose of the paper is the development and approbation of cognitive simulation technology in teaching of social and humanitarian disciplines. Based on the integration of sources of innovation, the authors developed the technology of cognitive simulation aimed at the formation of a structured system of knowledge for social and humanitarian disciplines' subject area. Various forms of cognitive map methods used in the learning process (analysis, synthesis, projection, and simulation) allow developing the analytical and predictive abilities of students, and strengthening their educational motivation. The technology use is proposed for the first time for all socio-humanitarian disciplines in the process of vocational training, which contributes to the formation of inter-subject communications, spatial understanding of events, and transformations of reality. The empirical study carried out by the authors on the implementation of this technology in the educational process (the students of 3 universities, totaling 315 people participated in the study) confirmed the productivity of the technology and the possibility of its adaptation to various disciplines of social and humanitarian sphere.

Keywords: education, educational technology, innovations, cognitive simulation, social and humanitarian disciplines

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State of the literature

- The processes occurring in the higher education system are multidirectional, but are not mutually exclusive; they must combine innovative and classical forms of education, which is not sufficiently reflected in modern pedagogical practice.
- Modern social and humanitarian education requires the strengthening of inter-disciplinary and intra-disciplinary connections in order to ensure its fundamentality.
- Most technologies in teaching social and humanitarian disciplines do not take into account fully the achievements of psychological science and practice, in particular in the field of cognitive simulation, as technologies for achieving learning goals.

Contribution of this paper to the literature

- The use of cognitive simulation technology aimed at the formation of a structured system of knowledge in the social and humanitarian sphere is proposed.
- For the first time, it is proposed to use this technology for all socio-humanitarian disciplines in the process of vocational training, which contributes to the formation of inter-subject communications, spatial understanding of events, and transformations of reality.
- Various forms of using the method of cognitive maps in the learning process allow developing the analytical and predictive abilities of students, strengthening their educational motivation.

INTRODUCTION

Innovation, in general sense, involves the implementation of previously unused changes in the structure of activities, significantly improving the effectiveness of the process. Pedagogical innovation should be based on deduced knowledge and offer unused conditions for the implementation of pedagogical activity, which determines the achievement of its productivity. Educational innovations can include: changes in the positioning of the education system and the level of its public funding; organizational changes in the activities of educational organizations; changes in the content of training; changes in the requirements for learning outcomes of the education system; changes in forms, means or methods of teaching; changes in the entity positions of participants in educational relations.

Analysis of scientific literature (Gostev & Kipriyanova, 2008; Khutorskoy, 2005; Postalyuk, 2004; Osmolovskaya, 2010) in the field of the implementation of pedagogical innovations made it possible to determine the following criteria for selecting innovative pedagogical projects: the degree of development of theoretical approaches to innovation; frequency of implementation of planned teaching and education methods; availability of author pedagogical conditions for implementation; the productivity of innovation being implemented and its empirical proof.

Consideration of the pedagogical achievements in the field of teaching social and humanitarian disciplines on the specified criteria led to the allocation of innovative directions that allow increasing the effectiveness of teaching: the idea of humanizing education and the implementation of humanistic educational practices; the idea of optimizing the training and educational process through organizational, managerial, informative, communicative transformations of pedagogical activity; an idea based on the construction, adaptation, modification of teaching technologies (Il'ina, 2012; Babintsev & Segedin, 2008; Kravchuk, Kamenskiy & Battle, 2010; Hannan & Silver, 2000).

I. Podlasiy (2013) notes that the development of a modern pedagogical system can be carried out in two main ways:

- **intensive one**, which is built on the use of internal reserves of the pedagogical system, for example, the identification of new psychological and pedagogical properties (Cao, Kurbanova & Salikhova, 2017);

- **extensive one**, which is carried out on the basis of attracting additional investments (material, technological, organizational) in pedagogical activity.

It is obvious that individually both of these variants have a finite number of variations of innovation. Indeed, the possibilities of internal reserves of pedagogy are already rather limited, positional changes do not provide with productive changes, and are based to large extent on established norms. The extensive way of development is also currently experiencing stagnation. A breakthrough caused by information technologies and their adaptation to education is now reflected in the emergence of multi-faceted forms and adaptation mechanisms in the framework of educational disciplines, teaching methods, and material capacities of educational organizations (Nemec et al., 2017; Van Dijk, Van Der Berg & Van Keulen, 2001; Oliveira & Oliveira, 2013).

The authors consider that the integration of sources of innovation due to the internal reserves of the system and using the most adaptive components of various learning technologies can significantly increase the productivity of educational activity (*research hypothesis*).

Based on the hypothesis put forward, the *purpose of the research* is determined as the search for innovative teaching technology that can significantly increase the productivity of pedagogical activity within the teaching of social and humanitarian disciplines.

The proof of the research hypothesis requires the fulfillment of a number of *tasks*:

1. to reveal the potential of cognitive simulation in pedagogical activity;
2. to justify the criteria for integrating the reserves of pedagogical system and means of instruction for the implementation of cognitive simulation;
3. to provide technological development of cognitive simulation in pedagogical activity;
4. to prove, empirically, the productivity of cognitive simulation as an innovative teaching technology in the teaching of social and humanitarian disciplines.

RESEARCH DESIGN

The experimental base of the research is Kazan (Volga region) Federal University (higher education institution 1), North-Eastern Federal University named after M. K. Ammosov (higher education institution 2), RUDN University (Peoples' Friendship University of Russia - higher education institution 3).

Students who mastered bachelor's programs in the areas of Sociology and Pedagogical Education (315 in total) made up a control and experimental research group.

Those identified by the authors within the subject area of social and human sciences involve students studying disciplines where the object of research is either a person or a society (Tsvyk, 2007; Krayevsky, 2003; Bakhtin, 2000; Kokhanovsky, 2005; Sezginsoy & Akkoyunlu, 2011). Humanitarian knowledge is aimed at understanding the goals and motivations of a person, the development of his or her targets. The social direction is connected with the study of facts, laws, and transformations of the socio-historical process. In general, this subject area is aimed at understanding, forming and realizing the future occupational activities of humanistic values for the preservation and development of modern civilization; contributes to the understanding of modern concepts of the picture of the world on the basis of the worldview formed; determines the ability of an objective cognition of oneself and other people, their actions and predicting of their behavior.

Appeal to active teaching methods is now the basis of any pedagogical technology (Prokofieva et al., 2015; Zarukina, Loginova, & Novik, 2010; Khutorskoy, 2007). For the development of socio-humanitarian disciplines, the use of whole spectrum of these methods is proposed, the integration of which is carried out on the basis of personal development factor of the learner.

The advantages of this approach are:

- step-by-step solution of problematic learning situations that are as close to future professional activity as possible;

- the introduction of educational material as a goal of pedagogical activity, and not as means;
- generalization of knowledge of the subject sphere regarding the potential of their application in the real field of activity;
- emotional-personal orientation of education, teaching of quasi-professional communications and interactions.

The implementation of the proposed technology is aimed at producing the system of their own knowledge by the students and their implementation in the process of solving educational and professional problems.

The model in the context of the problems of scientific research is used to refer to an analogue of an object, phenomenon or system on which real research is difficult to carry out (Levina, 2013; Baidlikh, 2004; Salso, 2002; Safronova, 2002). Under the cognitive model, an artificially created phenomenon is understood, substituted by the main factors of the present phenomenon for the study of personal or social regularities of reality (Martyshenko & Stepanenko, 2017; Gorelova, 2013; Ginis, 2015).

The essence of cognitive simulation as an educational technology is in the theoretical and practical study of a phenomenon (process, activity) artificially created for cognitive purposes, which is capable of reflecting the original objectively and substituting it at the stage of study with the reproduction of basic laws of its functioning; thus, providing objective information about the Object itself.

The result of cognitive simulation is the cognitive map of the phenomenon (process, activity), which in the most general case, is a formal reflection of a limited subject area with a description of cause-effect relationships (Putyato, 2011).

So, the simulated system is described by a finite set of notions (concepts) and cause-effect relationships between them:

$$S = < K, L > \tag{1}$$

where $K = \{k_1, k_2, \dots, k_n\}$ – a variety of concepts of the simulated phenomenon (process, activity). The concept here appears as a significant characteristic of the subject area, its qualitative (relative) or quantitative (absolute) indicators;

L – binary (plus / minus) relation on the set K, specifying the connections between the concepts; $L = \{L_+\} \cup \{L_-\}$, where L_+ is a subset of positive, and L_- is a subset of negative links.

Then, the concept k_i and k_{i+1} are considered to be related by the relation $((k_i)L(k_{i+1}))$, if the change in the value of the concept - reason k_i leads to a change in the value of the concept - consequence k_{i+1}. The causal-consequence relationships between the concepts k_i and k_{i+1} differ in the strength of the action, they can be positive (reinforcing the concept) or negative (reducing, inhibiting the concept).

The stages of implementing this technology of training are shown in **Figure 1**.

Here are some examples of educational cognitive maps and associated variations of study assignments.

Task 1. (discipline - History, work in groups of 5 students).

a) Based on the highlighted concepts (**Figure 2**), make a detailed description of the Anglo-Boer War, the Russian-Turkish war, the Napoleonic wars, the US Civil War.
b) Build a common cognitive map of the events presented, indicating the relationship.
c) Determine the significance of the events presented for world history.

Task 2. (discipline - Economics, individual work of the student).

a) Establish relations between the selected concepts and complement the presented cognitive map of the supply / demand formation (**Figure 3**).
b) Define a concept marked with a question mark.
c) Determine what changes may occur in case of an innovative breakthrough production technology.

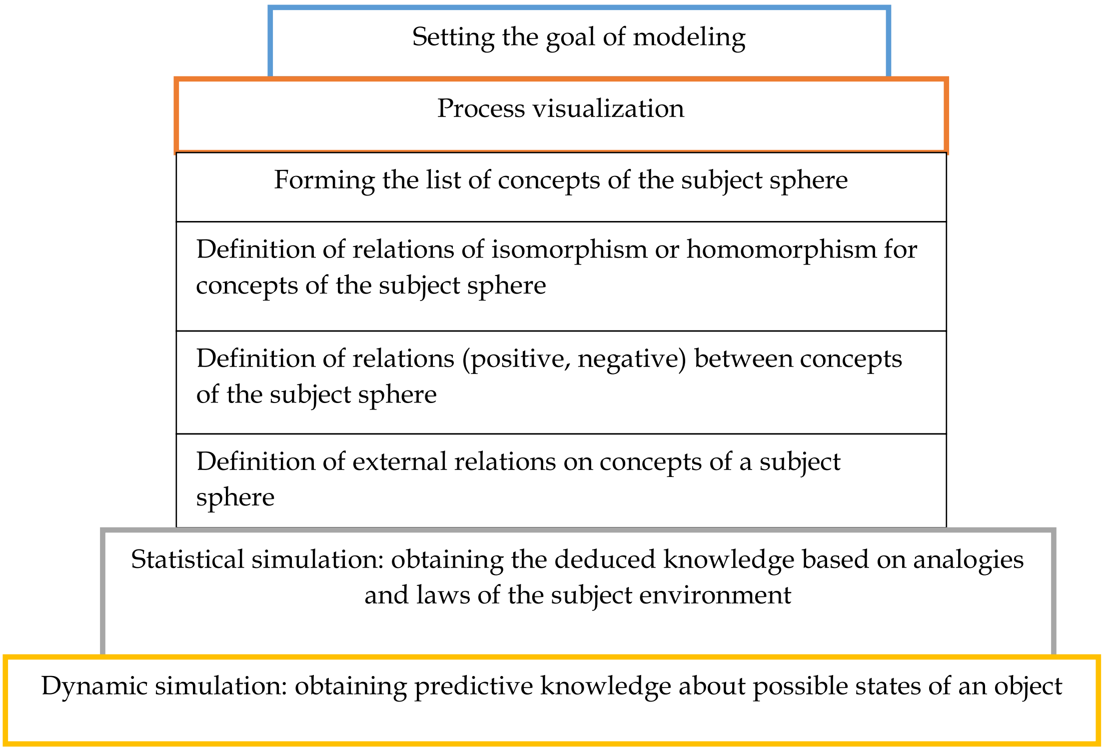

Figure 1. Stages of realization of cognitive simulation technology

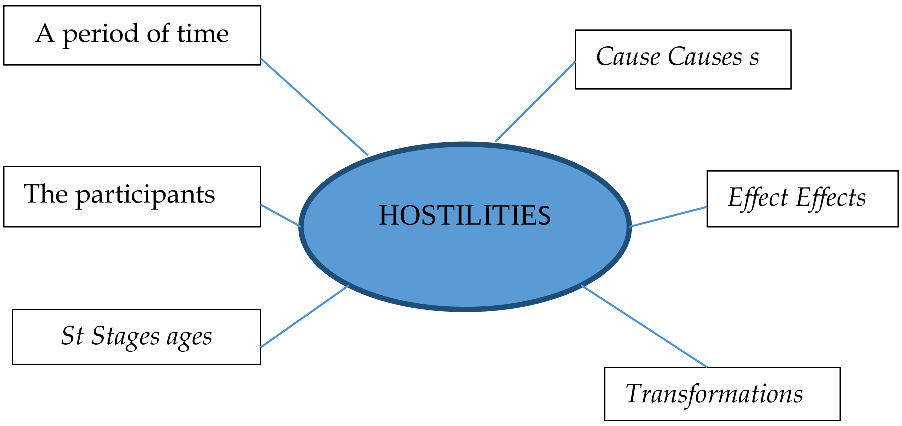

Figure 2. General cognitive map of the historical military event

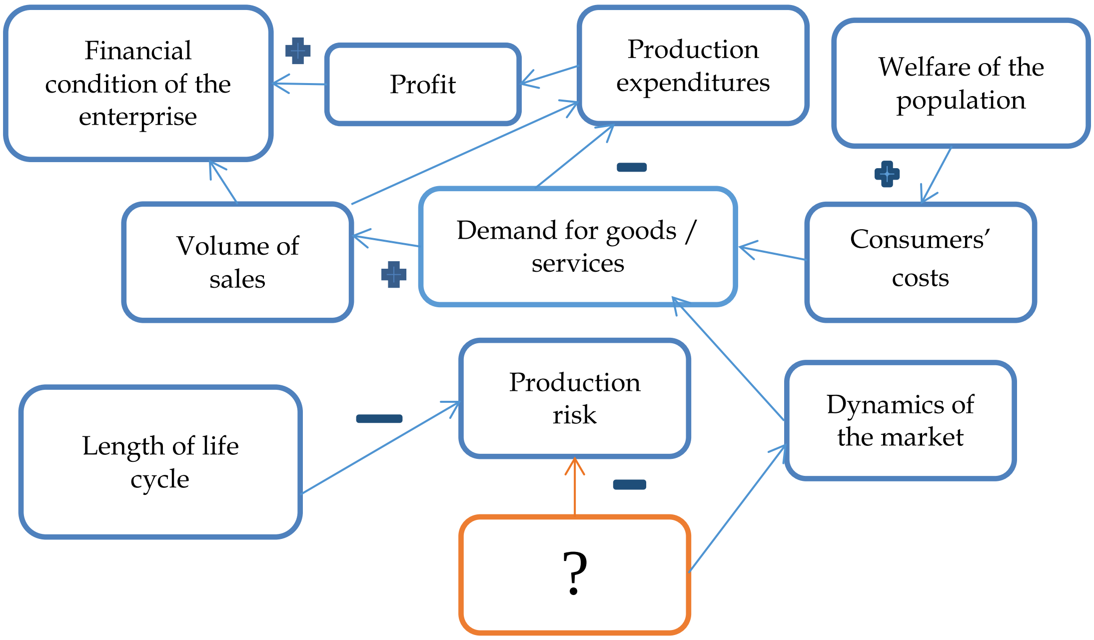

Figure 3. Incomplete cognitive map of the formation of the demand / supply of goods / services

Task 3. (discipline - Social work, individual work of the student).

Investigate 3 families according to the scheme given above (**Figure 4**). Write a description of each of them in the form of an individual cognitive map.

Task 4. (discipline - Psychology, individual work of the student).

Conduct a survey among at least 30 respondents (20 to 40 years). Establish factors that affect their satisfaction with life. Present the results in the form of a cognitive map.

An example of an assignment carried out by one of the students is shown in **Figure 5**.

The reproducibility of this technology is determined by the availability of information basis of the simulation, the visualization of information components of the process or phenomenon on the basis of features' presentation of the phenomenon and the relationships (cause-effect relationships) between its characteristics. This type of activity can be done by any teacher who fully knows the laws of the subject area. Changing the presentation of educational information requires the development of a system of assignments and tasks, from "simple to complex" for group and individual work. These tasks can be applied in the framework of the students' learning and independent activities.

The presented technology was introduced in the course of the experiment conducted in the framework of professional training of university students in the social and humanitarian field.

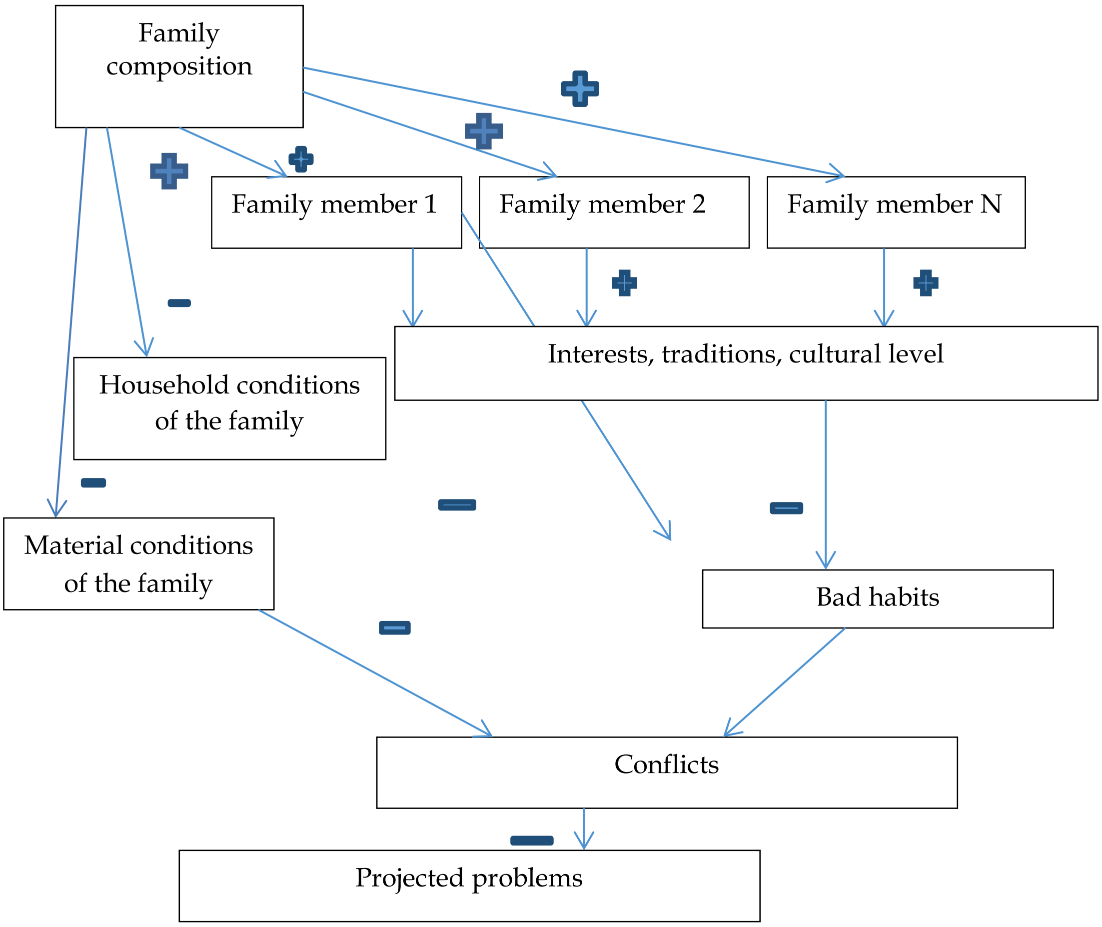

Figure 4. Scheme of research on the possibility of conflict situations in the family

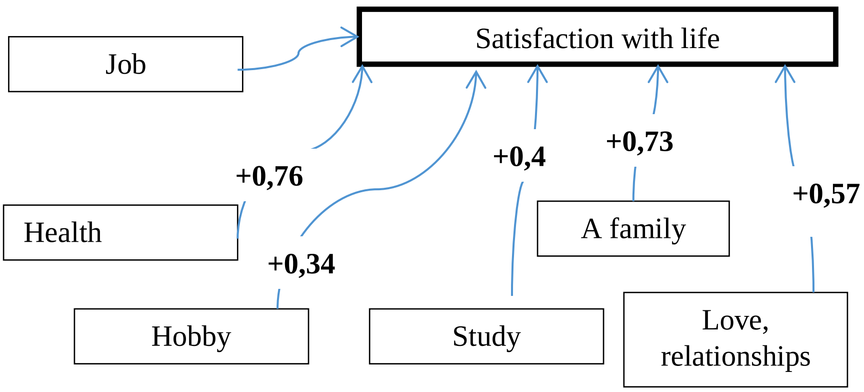

Figure 5. An example of a cognitive map

Table 1. Distribution of students in higher education institutions and areas of training, people

higher education institution 1				higher education institution 2				higher education institution 3			
Sociology		Teacher Education		Sociology		Teacher Education		Sociology		Teacher Education	
49		63		56		58		51		48	
EG	CG	EG	CG	EG	CG	EG	CG	EG	CG	EG	CG
24	25	31	32	29	27	28	30	26	25	25	23
TOTAL for three HEIs											
Sociology						**Teacher Education**					
EG			CG			EG			CG		
79			77			84			85		

Table 2. The results of ascertaining stage of the experiment comparing the results of the introductory tests (according to the average score of the unified state examination)

Subject	Sociology		Subject	Pedagogical Education	
	EG	CG		EG	CG
Mathematics	62,3	61,9	History	76,3	78,4
Russian language	74,3	75,2	Russian language	71,1	70,9
Social studies	77,6	77,8	Social studies	77,9	79,2

The pedagogical experiment was conducted in 3 stages:

- *the ascertaining stage*: for a selected sample of students, the results of entrance examinations for the chosen specialty were assessed. The basis was the average scores of the unified state exam in three disciplines. For the purity of the experiment, the groups were compared in pairs in specialties and in higher education institutions;
- *forming stage:* the introduction of the proposed cognitive simulation technology in experimental groups was carried out, the problems of technology were identified, and its correction was carried out;
- *control stage:* the final results of training in the disciplines of social and humanitarian cycle were evaluated in the framework of professional training program. Statistical analysis of the results was carried out.

RESULTS

The ascertaining stage of the experiment was aimed at comparing the results of introductory tests for students of experimental and control groups (**Table 1**).

It is necessary to clarify that more than 600 students from three different higher education institutions were involved in the whole within the experiment in different areas of training. Data are given only for students who have completed a full cycle of training using the technology of cognitive simulation from 1 to 4 courses.

For the selected areas of professional training (Bachelor in Sociology and Bachelor of Pedagogical Education - profile History and Social Studies), the average scores of the results of unified state examination were assessed (**Table 2**).

As can be seen from the presented table, the results of the entrance tests for the students of the control and experimental groups (in the directions) are very close to each other, which makes it possible to talk about the possibility of their comparison in the future.

At the forming stage of the experiment, the authoring technology of cognitive simulation was introduced into the educational process of the students in experimental groups within the framework of realization of the disciplines of social and humanitarian cycle. During the entire period of mastering bachelor's programs in the areas of Sociology and Pedagogical Education, from the first to the fourth year, a set of study assignments developed by the authors, built on the method of cognitive maps, was simultaneously implemented within several disciplines in all three higher education institutes:

- In the direction of Sociology, disciplines: History, Philosophy, Economic Theory, Psychology, Fundamentals of Law (1^{st}-2^{nd} semester); Demography, Pedagogy (3^{rd} semester); Economic sociology (4^{th} semester); Sociology of the family (5^{th} semester); Sociology of organizations, Sociology of conflicts (6^{th} semester); Social work (7^{th} semester);
- In the direction of Pedagogical Education (profile History and Social Studies), disciplines: Theory of State and Law, Archeology (1^{st} semester); Ethnology, Psychology (2^{nd} semester); Economic theory, Pedagogy (3^{rd} semester); Educational Right, Philosophy (4^{th} semester); The History of the Ancient Russia; History of the Ancient World (5^{th} semester); History of Russia, General History (6^{th} semester); Political Science, Newest History (7^{th} semester);

The specifics of the introduction of this technology consisted of the fact that it was introduced in the framework of many disciplines and strengthened the inter-subject connections of social and humanitarian subject area.

It should be noted that the introduction of the presented technology caused some difficulties, both for teachers and for students.

Teachers working with this technique noted that it required special training and counseling, especially with regard to tasks control, and to the determination of compliance between the necessary assessment of competences and the diagnostics of assigned tasks performance. This problem was solved through training seminars, counseling. As the technology progresses, over time (already in the second semester of training), the teachers were able fully to adapt, and noted, on the contrary, positive changes in the work, the development of high motivation of the learners from the experimental groups, the formation of a clearer system of knowledge about the students of the control groups.

Students of the experimental groups also experienced difficulties in understanding the tasks, the requirements for compiling cognitive maps, the analysis of tasks, and the understanding of the control criteria. However, according to the results of the survey after the first semester, most students (63%) noted that such a delivery of tasks makes learning material more interesting and contributes to its structuring and memorization. By the end of the first year of training, a survey of students in experimental groups conducted by us showed that 86% already consider this technology to be successful for teaching, which helps to understand and remember complex processes and phenomena. It is also interesting that the survey conducted at the end of the third year of study (6^{th} semester) demonstrated not only positive feedback from students on the understanding of interdisciplinary connections, cause and effect events and phenomena, but also the fact that when learning other disciplines, students independently use the method of cognitive maps (52%). At the control stage of the experiment, conducted at the end of each semester of training, the final results of mastering the disciplines of the socio-humanitarian cycle were compared on the average performance indicators in groups (**Tables 3 and 4**).

The presented results contain the averaged data on the progress of experimental and control groups for all three HEIs. In general, despite the different traditions in higher education institutions, the diversity of pedagogical styles, the pedagogical conditions of the organization, the results of students in experimental groups are about 20% higher than in control groups in all disciplines and areas of training, which confirms the effectiveness of author's technology. As can be seen from the given data, the results of mastering the first semester training programs for experimental and control groups are not too different from each other, and then a qualitative leap takes place, and the difference becomes obvious. For the purity of the experiment, we also evaluated the results of the state examination and diploma work for all students, which are the final assessment of students' achievements.

Table 3. The final results of mastering the disciplines of the socio-humanitarian cycle for the training direction Sociology (for three higher education institutes, control (CG) and experimental (EG) groups, average score on a 100-point scale)

Semester	1st Semester		2nd Semester	
Groups	**CG**	**EG**	**CG**	**EG**
History	64	75	63	79
Philosophy	61	65	59	72
Economic theory	68	67	67	78
Psychology	65	72	63	76
Law basics	63	67	64	79
Semester	**Semester**			
Groups	**CG**		**EG**	
Demography	66		82	
Pedagogy	70		84	
Semester	**Semester**			
Groups	**CG**		**EG**	
Economic sociology	64		76	
Semester	**Semester**			
Groups	**CG**		**EG**	
Sociology of the family	72		84	
Semester	**Semester**			
Groups	**CG**		**EG**	
Sociology organizations	67		81	
Sociology of conflicts	65		83	
Semester	**Semester**			
Groups	**CG**		**EG**	
Social work	68		83	

The results (see **Figures 6 and 7**) showed that the students in the experimental groups in all three HEIs received higher scores than students in the control groups.

We checked the homogeneity of the control and experimental groups at the ascertaining and control stages of the experiment using the student's t-test. At the ascertaining stage, the tabulated value of the t-test is greater than the calculated value t.table (1,984) > tcal (0,175), which indicates that the null hypothesis (about the absence of differences in the group) is not rejected and the two samples belong to one general totality; namely, they are homogeneous for a confidence level of 0.05. At the control stage, on the contrary, the t-value of the student's t-test was equal to 2.68 with the probability of an allowable error of no more than 0.05, which confirms the hypothesis about significant differences between the results of control and experimental groups.

Thus, the hypothesis of the study is proved, and it is confirmed that the technology of cognitive simulation really improves the effectiveness of teaching, contributes to the structuring of the material and to the establishment of inter-subject connections, develops the creativity of students, and strengthens their independence and motivation for learning.

DISCUSSION

The authors scientifically substantiated and experimentally tested the technology of cognitive simulation, aimed at the formation and development of competencies of students through the potential of academic disciplines. On the basis of the cognitive presentation of educational information (Ahn & Medin, 1992; Künsting, Kempf, & Wirth, 2013) students are offered a set of diverse study assignments for social and humanitarian disciplines that

Table 4. Final results of mastering the disciplines of the social and humanitarian cycle for the training direction pedagogical education, profile history and social studies (for three higher education institutions, control (CG) and experimental (EG) groups, average score on a 100-point scale)

Semester	Semester	
Groups	**CG**	**EG**
Theory of government and rights	62	64
Archeology	58	67
Semester	**Semester**	
Groups	**CG**	**EG**
Theory of government and rights	61	73
Psychology	59	71
Semester	**Semester**	
Groups	**CG**	**EG**
Economic theory	67	83
Pedagogy	73	88
Semester	**Semester**	
Groups	**CG**	**EG**
The educational right	70	86
Philosophy	59	74
Semester	**Semester**	
Groups	**CG**	**EG**
The history of the ancient Russia	62	73
Ancient world history	64	77
Semester	**Semester**	
Groups	**CG**	**EG**
Russian history	71	86
General history	67	83
Semester	**Semester**	
Groups	**CG**	**EG**
Political science	59	78
Newest history	63	77

help understand the essence of events, phenomena, their logical and inter-subject connections, and the development of students' independence. The peculiarity of this technology is not only the visualization and structuring of information, but also its wide implementation within the whole process of professional training.

The effectiveness of pedagogical activity obviously evolves in an equal measure the educational opportunities (abilities and readiness) of students and the way that the pedagogical process is organized (projecting of the content of training, technology of training, staffing). The introduction of educational technology of cognitive simulation showed an increase in the productivity of students' educational activities within the framework of socio-humanitarian disciplines by an average of 20%, and an increase in the level of diploma work of 50%.

The choice of teaching technology is based on the objective (material, personnel, organizational) capabilities of the educational organization, the specifics of the content of the academic discipline, and the characteristics of the students (Mukhina, 2013). However, there are a number of factors inherent in the technology of teaching: pedagogical justification; observance of vale logical conditions for the implementation of educational activities; availability of the training tools used; reproducibility of the pedagogical stages to achieve the goal of education; availability of criteria quality indicators of learning outcomes; adaptability with respect to organizational forms and content of training in the selected subject area; low level of subjectivity of pedagogical support (Zaitsev, 2012).

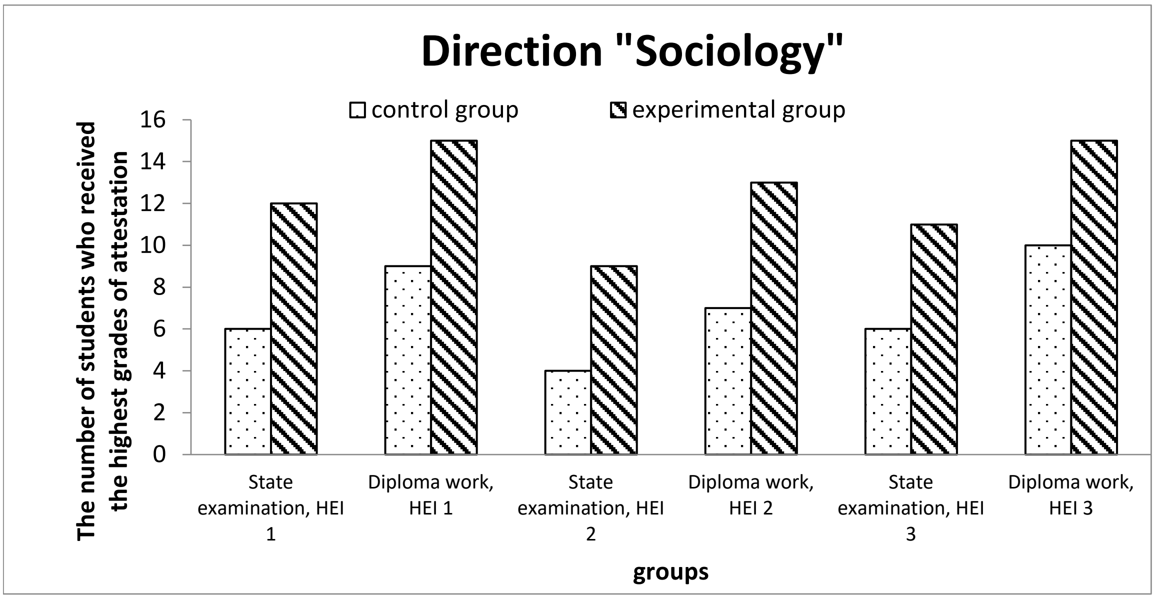

Figure 6. Results of final tests of students on higher education institutions (direction Sociology)

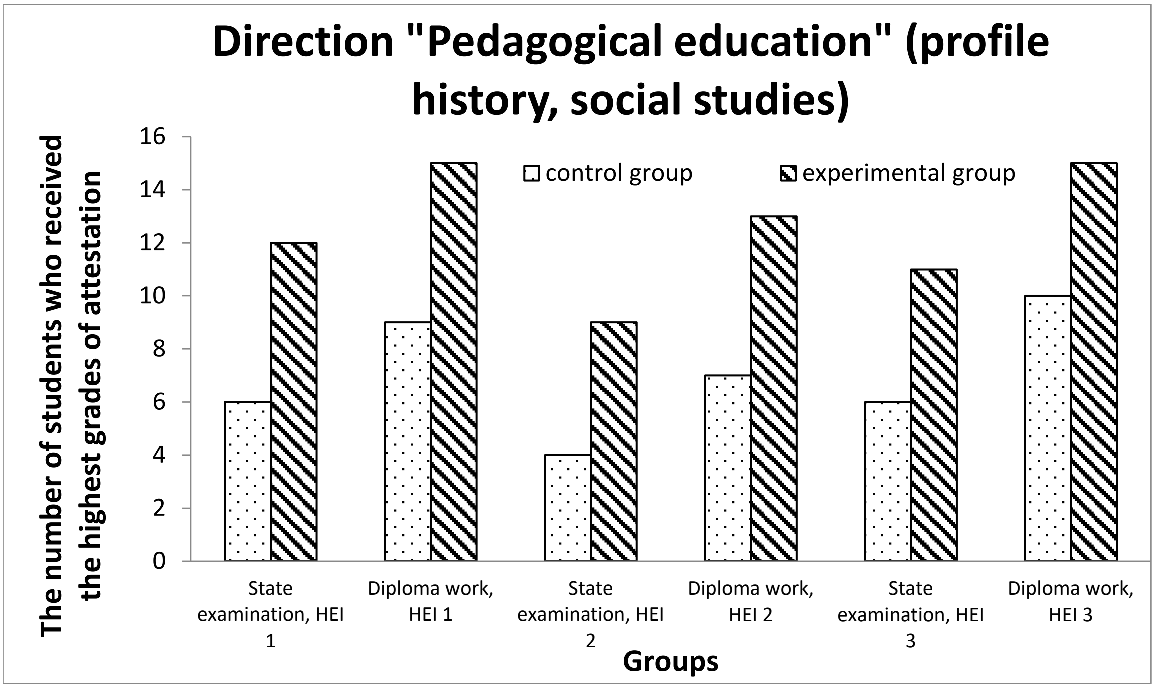

Figure 7. Results of final tests of students on higher education institutions (direction Pedagogical Education, Profile - History and Social Studies)

The author's proposed technology really meets the stated characteristics; the highlighted problems in its implementation are easily eliminated by a teacher with professional knowledge and adaptive abilities.

CONCLUSION

The conducted research led us to the following conclusions:

- the search for new learning technologies should be built on the integration of sources of innovation: the potential of the individual and the potential of the educational system;
- optimal learning technology should be aimed at ensuring student's active learning activities through increasing motivation and interest in learning, a clear understanding of the goal of learning, ensuring independence in achieving learning goals;
- pedagogical innovation was carried out due to the integration of psychological and pedagogical achievements in the field of information representation, development and implementation of the system of study assignments based on the method of cognitive maps;
- the developed technology of cognitive simulation consists of subject description of the process or phenomenon, the establishment of a system of connections, and interdependencies of the concepts of the subject area;
- the variety of variations in the forms of tasks (development, analysis, synthesis, addition, the search for concepts, the definition of links and their orientation, etc.) makes it possible to significantly expand the range of study assignments for the disciplines of the social and humanitarian cycle;
- the introduction of technology of cognitive simulation requires additional training of teachers and the adaptation of students, but after getting used to such information presentation, it becomes quite convenient and is easily applied for mastering the educational material;
- the productivity of cognitive simulation as an innovative technology of learning in the teaching of social and humanitarian disciplines has been empirically proven. With an accuracy of 95%, this technology significantly increases the effectiveness of pedagogical activity;
- according to the authors' estimates, the productivity of this technology can be further enhanced by introducing it to the entire spectrum of academic disciplines.

Practical application and adaptation of this technology is possible for the whole range of disciplines of the social and humanitarian cycle.

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