APPLICATION OF THE SMART-COMPLEX OF THE EDUCATIONAL DISCIPLINE FOR THE DEVELOPMENT OF STUDENTS' CREATIVE PROJECTS

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Abstract

In the development of the digital economy, the role of professional personnel with digital competence and capable of working in high-tech production is of no small importance. Accordingly, the digitalization of the educational environment should take place with the use of digital technologies, involving students in research and project activities conducted with the help of artificial intelligence. To achieve this, students need to be able to use digital technology with the following didactic properties: ability to freely search for information in the global network; ability to personalize; ability to interact with various digital technologies; ability to use various content types; ability to find and create digital references; ability to appeal to members of different culture groups, etc. At the same time, most students have superficial command of digital technologies and new forms of communication in both the real and virtual world. Consequently, it is time to introduce artificial intelligence technologies in professional education to improve the effectiveness of learning opportunities. Main aim this article to reveal features of Kosko's quasi-neural network application in the development of educational projects by students of vocational education institutions by means of a smart-complex of an academic discipline and to reflect changes in motivation for creative activity

Keywords

Smart-Complex of Educational Discipline, Kosko Quasi-Neural Network, Professional Education, Educational Technology, Digital Skills

1. Introduction

Digitalization is one of the conditions for the implementation of the principles of Industry 4.0 in Ukraine to achieve sustainable development goals of the economy. The relevance of the formation of the digital economy necessitates the digitalization of education, as the achievement of its effect at the state level is possible with personnel trained to operate within the framework of modern ideology and technology. To this end, the digitalization of education aims to ensure the continuity of the learning process, as well as its individualization on the basis of advanced technologies of the use of big data, virtual and augmented reality, cloud computing mobile technology in training. Qualitative application of digital technologies in education, involvement of creative students in independent research, project activities contributes to the formation of relevant competencies of the 21st century, in particular Information and Communication Technology (ICT) -competencies. Accordingly, digitalization of the educational process should be based on digital didactics as a scientific discipline about the organization of learning in a digital environment. The subject of digital didactics is human activity, not the impact of digital learning tools on it. Digital didactics can be considered as a transintegrative sphere of scientific cognition, characterized by mutual transfer of certain scientific ideas and approaches from one sphere to another and their integration.

The specific nature of building a digital educational process is the introduction and use of digital technology with such didactic properties as: ability to freely search for information in the global network; ability to personalize; ability to interact with various digital technologies; ability to use various content types; ability to find and create digital references; ability to appeal to members of different culture groups. It should be noted that natural, human intelligence is not a constant. It is constantly evolving, contributing to the survival and success of a person in a complex, only partially visible and poorly controlled world.

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However, the dynamics of intelligence are conditioned by the same properties and features of the world that have remained constant for millions of years. It is only during the rapid development of such technology clusters as Nano-Bio-Info-Cogno-technologies, sensor, memristor technologies, Big Data-technologies, etc. that radical transformations in all spheres of human life begin to take place. The progress in cognitive science that is being observed suggests the possibility of explaining and describing cognitive processes in the human brain, which are responsible for higher nervous activity [1]. Comprehension of the underlying processes of brain activity makes it possible to create the basis for building systems of powerful operational artificial intelligence, which are inherently capable of independent learning, creativity and free communication with humans.

Modern day youth are quickly adapting to the Internet reality, but in practice, when performing specific projects or creative tasks, they reveal superficial knowledge of digital technology and new forms of communication in both the real and virtual worlds. Consequently, it is time to introduce artificial intelligence technologies in education to enhance human capabilities and protect human rights; to ensure the interaction between humans and machines in life, learning and work, and therefore, the sustainable development of society.

Artificial Intelligence has a powerful potential for innovation in the educational process of vocational education institutions. The rapid technological development of Artificial Intelligence comes with many risks and challenges. Therefore, The United Nations Educational, Scientific and Cultural Organization (UNESCO) is committed to supporting Member States in harnessing the potential of artificial intelligence technologies for education. UNESCO's motto is "Artificial Intelligence for All" [2], aimed at gaining access to innovation and new knowledge: everyone can use the developments of the technological revolution to develop their own careers. In addition, UNESCO, as part of the Beijing Consensus on Artificial Intelligence and Education (2019), has expanded the publication artificial intelligence and education: guidance for policy makers [3] on the need to increase their readiness to implement artificial intelligence and create an enabling environment for a shared understanding of the opportunities and challenges offered by artificial intelligence for education, and its impact on the development of core competencies needed by humans in the digital age. The relevance of the problem, its practical relevance in the dimension of modern pedagogical science led to the justification of the possibilities of applying the Kosko quasi-neural network in the development of projects by students of vocational education institutions by means of the smart-complex of the academic discipline.

2. Previous investigations

In scientific literature, the definition "educational environment" is considered as a naturally or artificially created socio-cultural educational environment of an educational institution, including the content of education through academic disciplines, types and means of learning activities [4]. Therefore, the educational environment is presented as a system of influences and conditions of personality formation according to the pattern, as well as opportunities for its development available in the social and spatial-subject environment.

The implementation of the medium approach is directly facilitated by modern information and communication technologies, the introduction of E-learning, which allows the actualization of smart-education.

The summary of their results suggests that the quality of professional training of modern specialists will improve with the use of smart technologies. This problem has repeatedly attracted the attention of Ukrainian scientists and practicing educators. They analyzed the possibilities of their influence on increasing cognitive activity of students, development of communicative culture in the systems "student-student" and "student-teacher", distribution of individual professional experience in the learning process, as well as their role in adapting the educational process to the needs and demands of the subjects of learning.

At the same time, they reveal an algorithm for forming and improving the information-analytical competence of specialists using smart-technologies. In particular, of scientific interest are the results of research on the characteristics of the learning environment in vocational education institutions [5], the impact of augmented reality on student achievements and self-efficacy in vocational education and training [6]. Situational learning and teaching using digital technologies [7] reveals the genesis of E-learning development, mobile learning, massive open online courses, cloud technologies, and focus on the functioning of smart universities.

In the process of researching the stages of organizing pedagogical interaction between a teacher and students by means of an interactive whiteboard, the scientist Imber [8] reveals the possibilities of the updated software package, such as: an interactive application to organize learning through game technologies (Smart Lab); a new tool for assessing students' learning achievements (Smart-Response); the organization of student cooperation within a single virtual educational space (Smart Amp); students' learning activities on any personal devices; performance of assignments online using (Smart Learning Suite online).

Important in the development and application in the educational process of electronic educational resources are information and communication technologies, which are used to ensure informatization of education and individualization of learning. Special attention should be paid to methodological approaches to the implementation of these technologies in pedagogical activities. It is advisable to note the involvement of artificial intelligence for learning: virtualization of learning; gamification of augmented reality; development and implementation of learning environments augmented reality; augmented reality in science education; augmented reality in professional training and retraining; social and technical issues of augmented reality Research in the field of augmented reality was conducted by Thomas P. Caudell and David Mizell [9], Azuma [10], Cieutat et al. [11] and other scientists. Their works considered the problems of taxonomy, design, and use of augmented reality tools in the learning process and professional activities. In particular, the works of Martin-Gutierrez et al. [12], Restivo et al. [13] confirmed the positive effect of using this technology in learning.

Herbert Simon [14] was concerned with artificial intelligence and made significant contributions in the fields of economics, psychology, cognitive science, artificial intelligence, decision theory, and organization theory. In his research, Herbert Simon was convinced that the human mind, thinking, decision-making, and human creativity are subject to scientific understanding rather than remaining mysterious. It was after he helped create "thinking" machines that the scientist understood human intuition as subconscious pattern recognition. In doing so, he showed that intuition should not be associated with magic and mysticism and that it is complemented by analytical thinking.

The artificial intelligence learning study currently defines directions in five categories: pattern recognition, image processing; text processing; work with language tasks; language recognition, audio signal processing; forecasting events in certain time intervals; machine creativity. We share the approaches of Carter and Nielsen [15] on the use of artificial intelligence to increase human intelligence, and suggest using the achievements of scientists to apply artificial intelligence in the process of teaching students of vocational education institutions. That is why the working hypothesis of the study is to use the capabilities of the Kosko neural network to develop the Kosko quasi-neural network and its application in smart - a complex of academic discipline.

The aim of the article is to reveal the peculiarities of the application of Kosko's quasi-neural network in the development of projects by students of professional education institutions by means of the smart complex of the academic discipline and to reflect the changes in motivation for creative activity.

3. Theoretical basis of research

The concept of neuronal development is associated with the concept of brain plasticity - the ability to adjust the nervous system to environmental conditions. It is plasticity that is most significant for the neurons of the human brain in the process of information processing. The programming of neuron actions in neural networks of artificial intelligence is similarly organized. A neural network is a set of algorithms organized to recognize basic relationships with a set of data using a process that mimics how the human brain works. In this sense, neural networks refer to systems of neurons, organic or artificial in nature. Neural networks can adapt to variable inputs so the network gives the best possible output without having to rework the output criteria. The neural network is similar to the brain from two points of view, namely: knowledge enters the neural network from the environment and is used in the learning process; connections between neurons called synaptic weights are used to accumulate knowledge [16].

To organize the learning process, a procedure called the learning algorithm is used. It builds the synaptic weights of the neural network in a certain order to provide the required structure of the interconnections of neurons. Changing synaptic weights is a traditional method for tuning neural networks. This approach is very close to the theory of linear adaptive filters, which has long declared itself and is used in various fields of human activity. However, neural networks can change their topology. This is due to the fact that neurons in the human brain periodically die, and new synaptic connections are constantly being created. Differences in computational actions in neural networks are often due to the method of neuron interconnections. According to the set of criteria, the multilayer architecture of artificial neural networks can be divided into static and dynamic. To train students, we considered dynamic neural networks and chose the most suitable for implementation in the environment of creative self-realization of the smart-complex of the academic discipline - the Kosko neural network.

From the standpoint of a systematic approach, we consider an artificial neuron placed in a "black box" (see Figure 1), to the input of which vector signals $\mathbf{x_1, x_2, \ldots x_n}$ are sent, and at the output a vector signal **y** should appear with characteristics no less than, given in the "threshold" **T**.

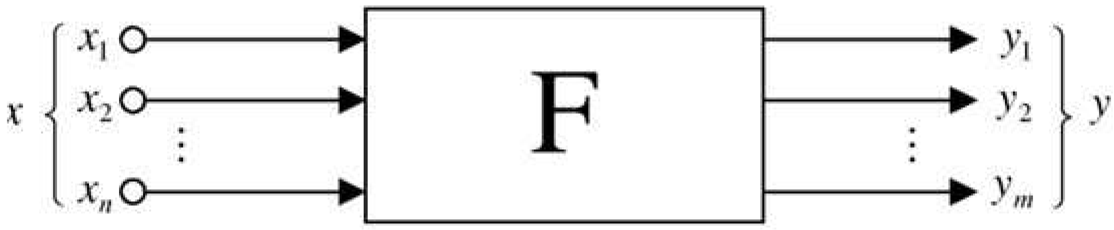
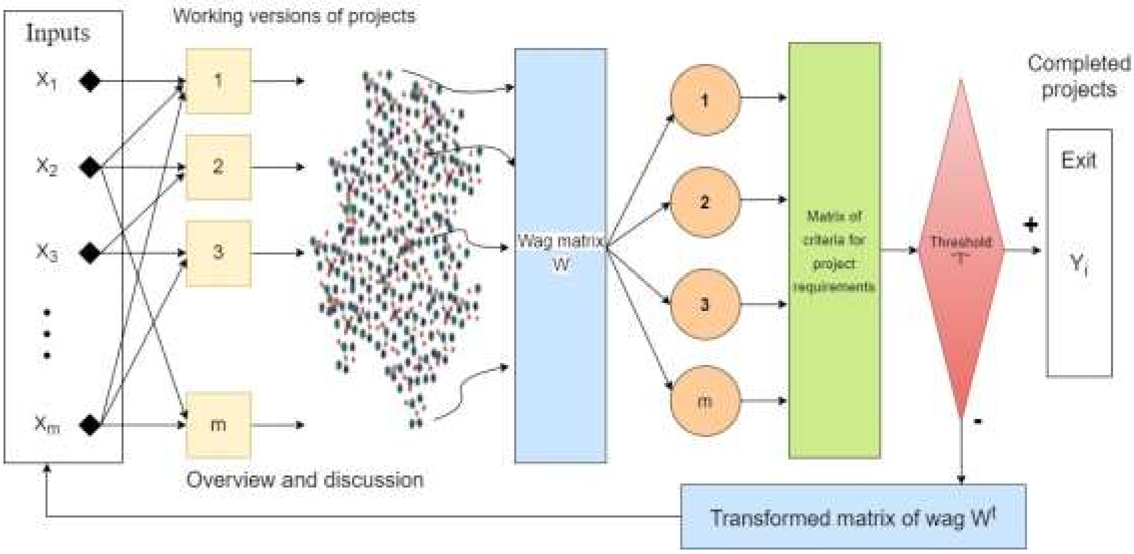


Figure 1: Neural Network as a "Black Box"

The work of the neural network is directed to the search for the optimal process schedule, according to which a certain task - (project) (desirable initial data of the network) will be achieved. In fact, the neural network "learns" to work with an individual student and then "offers" him a suitable job option. If the actual values deviate from the proposed ones, the neural network “adjusts” again to the student’s work and creates the prerequisites for improving his project.

4. Result and Discussion

Having made changes in the structure of the Kosko neural network, we developed the Kosko quasi-neural network (see Figure 2) for the project activities of students in the environment of creative self-realization of the smart-complex of the academic discipline. According to the authors, the Kosko quasi-neural network is a real-time interactive system with multiple inputs and outputs that students work with to support and extend the problem-solving process to complete educational projects.



x_i – list of students in the group who were assigned to develop individual projects

Figure 2: Kosko Quasi-neural Network (Developed by the Author)

Smart-complex of an academic discipline [17] is an integrative information environment formed on the basis of a combination of creative, authorial, non-verbal, encyclopedic, information and communication, self-realization and self-evaluative components of the personality of a future specialist in each of them. That is, smart-complex of the academic discipline is an electronic educational resource designed to provide a continuous cycle of educational activities for students of vocational education institutions. One of the components of the smart-complex of an academic discipline is the environment of creative self-realization for the development of creative potential by updating the creative potential of students, which manifests itself at the level of operational components of productive cognitive (educational) activity, and the main function is stimulating - stimulating their creative educational activity.

We propose to use the Kosko quasi-neural network when creating projects using a "synergistic effect" (subject to the interaction of two or more factors, their action significantly exceeds the effect of each). Offers of low weight of influence are overlapped by offers of greater weight - both high final results of students' activities are ensured in the framework of achieving correctly marked educational goals, and promotion of maximum self-realization based on their potential in project activities.

We conducted an experiment, during which students of 19 institutions of vocational education (540 students: 250 students were in the experimental group, and 290 in the control group) from different regions of Ukraine were asked to implement a creative project, adhering to four stages: organizational and preparatory, structural, technological and final (see Table 1).

Table 1: Stages of Project Implementation in the Environment of Creative Self-realization

№	The content of the work
	Organizational and preparatory stage
1	Analysis of technical specifications. Selection of a technological object. Analysis of the project - analogues
2	History reference
	Construction stage
1	Making a technical drawing and drawing of an object. Registration of accompanying documentation
2	Making a technical drawing and drawing of an object. Registration of accompanying documentation
3	Tools and equipment
4	Selection and analysis of materials for the production of the project. Product cost calculation
5	Choice of production technologies. Acquaintance with the technical and historical solution of such developments

6	Development of a technological map for the manufacture of a product Discussion on the Padlet platform with classmates of the working version of the project. Accounting for comments and suggestions on the project
	Technological stage
1	Product markup
2	Safety in the production of work
3	Product manufacturing
4	Product finishing
	The final stage
1	Reviews about the Padlet platform with classmates of the manufactured product. Product correction, self-analysis of the result
2	Defense of the project at the Internet conference
3	Advertising

At the *organizational and preparatory stage*, students analyze the terms of reference, select a technological object, consider models - analogues on the Internet. (see Table 2).

Table 2: Project Analysis (on a Five-point Scale)

№	Quality indicators (criteria)	Product project №1	Product project №2	Product project №3	Product project №4	Product project №5	Product project №6
1	Aesthetics	3	1	2	3	4	5
2	Functionality	5	1	5	5	5	5
3	Technical excellence	3	1	5	5	5	5
4	Economy	5	1	3	3	2	2
5	Ease of manufacture	5	1	4	4	3	3
6	Originality	2	5	2	3	4	5
7	Waste management	5	1	3	4	1	1
8	Manufacturing time	1	5	2	3	3	4
9	Difficulty level	2	5	3	4	3	4
10	Creativity at work	1	2	1	3	4	5
	Total points:	**32**	**23**	**30**	**35**	**34**	**36**

Based on the results of the analysis of models - analogues, students draw conclusions and make suggestions:

1) all samples correspond to their purpose;
2) are quite simple to manufacture;
3) model №. 1 has a lower level of complexity in manufacturing;
4) model №. 2 has the greatest difficulty in manufacturing;
5) model №. 4 is more interesting and modern, has a good aesthetic appearance.

Students chose product project № 4.

At the first stage of the project implementation in the Kosko quasi-ironic network, students provide a historical background on the use of analogues of the object being developed. This is important for getting acquainted with the technical and historical solution according to the algorithm of work in a quasi-neural network.

At the *construction stage*, the production of a technical drawing and a drawing of an object, the preparation of accompanying documentation are provided. At this stage, the teacher tests students, developers of educational projects.

The assessment procedure includes several stages: • 1) development of a competency model. • 2) conducting a business game in which selected competencies are revealed. The theme of the game may not coincide with the content of the employee's work. Exercises can be done in a group or in pairs. The teacher observes the students' behavior; • 3) individual interviews with each participant based on the results of the game. It is advisable to conduct the Horilla test; • 4) overall assessment. All observers express their opinion about the behavior of their teammates during business games and discuss the overall assessment.

Each participant of the experimental group of the educational institution, taking into account the information of the technical and historical analysis of such a task, weighing the comments of classmates (Test Gorilla), is ready for the completed project. To set the "threshold **T**" (vector signal **y**, students demonstrate their product in the Padlet. If, during the review by experts, the development of projects turns out that the characteristics of the model being produced do not meet the "threshold **T**"), and work on the project continues from the first stage.

Before starting the preparation of the project, it is necessary to determine the motivation of students for this work. To this end, in the environment of creative self-realization of the smart-complex of the academic discipline, according to the concept of the motivational complex of the professional activity of the individual, developed by Professor A. Lytvyniuk, the interrelations of internal and external motivation are taken into account to predict the student's professional behavior. For this stage, the significance of the factor (numerator) and the degree of satisfaction of the needs (denominator) of students from the implementation of each factor should be measured during the survey and placed sequentially on a scale from 0 to 1 with a step of 0.1. The value 0 corresponds to the definition of completely unsatisfied, and 1 - quite satisfied (see Table 3).

Table 3: Motivation of Students' Participation in Project Development

№	**The reasons**	External and internal motivation	Group № 1	Group № 2	Group № 3	Group № 4	Group № 5
1	Earnings from the successful implementation of the project on the Internet	Significance	0.7	0.2	0.8	0.7	*0.7*
		Pleasure	0.5	0.6	0.4	0.5	0.2
2	The desire to make a beautiful, aesthetic product	Significance	0.3	0.7	0.8	0.7	0.6
		Pleasure	1.0	0.9	0.6	0.5	0.4
3	The desire to avoid criticism from the teacher or classmates	Significance	0.4	0.7	0.9	0.7	0.7
		Pleasure	0.2	1.0	0.8	0.5	0.5
4	The desire to avoid possible troubles	Significance	0.3	0.7	0.4	0.8	0.5
		Pleasure	0.6	0.8	0.9	1.0	0.4
5	The need to achieve social prestige and respect from classmates	Significance	0.7	0.9	0.7	0.7	0.7
		Pleasure	0.8	0.5	0.9	0.7	0.5
6	Satisfaction with the process itself and the result of the work	Significance	0.4	0.7	0.7	0.6	0.8
		Pleasure	1.0	0.6	0.5	0.5	0.7
7	The possibility of the most complete self-realization in this project	Significance	0.7	0.7	0.8	0.8	0.7
		Pleasure	0.5	0.9	0.5	0.5	1.0

According to A. Lytvyniuk, indicators of internal (IM), external positive (EPM) and external negative (ENM) motivation of students are calculated according to the following formulas:

$$\text{IM} = \frac{value\ (n.6\ \oplus n.7)}{2}$$

$$\text{EPM} = \frac{value\ (n.1 \oplus n.2\ \oplus n.5)}{3}$$

$$\text{ENM} = \frac{value\ (n.3\ \oplus n.4)}{2}$$

The indicator of the severity of each type of motivation will be a number ranging from 1 to 5 (including possibly a fractional one). On the basis of the obtained results, the motivational complex of creative activity of students of vocational education institutions is determined. The motivational complex is a type of correlation between three types of motivation: IM, EPM and ENM (see Table 4). The following two types of combinations should be attributed to the best, optimal, motivational complexes: IM > EPM > ENM and IM = ENM > ENM. The worst motivational complex is the ENM > EPM > IM type. Intermediate (in terms of their effectiveness) motivational complexes are concluded between these complexes. During interpretation, one should take into account not only the type of motivational complex, but also how much one type of motivation is superior to another in terms of severity.

Table 4: Motivational Complexes (Example)

Motives for creative activity (№)	IM	EPM	ENM
1	1	2	5
2	2	3	4

Both the first and the second motivational complexes belong to the same non-optimal type ENM > EPM > IM. However, it is clear that in the first case the motivational complex of the student's personality is much more negative than in the second. In the second case, compared with the first, there is a decrease in the indicator of negative motivation and an increase in the indicators of external and internal motivation. Satisfaction with the completed work on the project has a reliable correlation with the optimality of the motivational complex of the student's personality (positive significant relationship), r = + 0.409). Consequently, students' satisfaction with the chosen project is the higher, the more optimal its motivational complex is: a high weight of internal and external positive motivation, and at the same time a low weight of external negative one. In addition, a negative relationship was established between the optimality of the motivational complex and the level of emotional instability of the student's personality (significant relationship, r = -0.585). The more optimal the motivational complex and the greater motivation of the student's personality by the very content of the activity, the desire to achieve certain positive results in it, the lower its emotional instability. And vice versa, the more the activity of the individual is conditioned by the motives for avoiding condemnation, the desire to "not get into trouble" (those who begin to take precedence over the motives associated with the value of the activity itself, as well as over external positive motivation), the higher the level of emotional instability.

The students were asked seven questions, which they evaluated from 1 to 5 points. On the basis of these scores, calculations were made according to the above formulas. Analysis of the results showed that 65.73% of the students surveyed had emotional instability associated with motives to avoid condemnation, punishment, getting into conflicts or troubles. According to this characteristic, students do not understand the value in the development of the proposed project. Positive motivation will be fixed in the case when external positive motivation will prevail over external negative and internal motivations. And among the 540 students surveyed, there were only 34.27% of them.

Before the expert evaluation procedure, the selection of candidates for experts was carried out. The main task was to determine the level of competence of the expert in the proposed research problem: the experience of the expert's participation in such studies, his personal position on the importance of individual procedures in the organization of the presented experiment was taken into account.

As a result of personal interviews with candidates for experts, as well as the use of the method of coordination of candidates, an expert group of 19 participants was formed (see Table 5). Thanks to mathematical tools for checking the consistency of candidates for experts, the concordance coefficient was calculated using the Kendall formula, which, in the absence of matching ranks, looks like this:

$$W = \frac{12S}{m^2(n^3 - n)}$$

where:

m – number of candidates for experts;

n – number of questions,

$$S = \sum_{i=1}^{n}((R_{\mathrm{i}} - R_{\mathrm{sr}})^2)$$

where:
R_{sr} – average rank of the indicator;
R_i– total rank.

Table 5: A Fragment of a Spreadsheet for Determining the Coefficient of Concordance of Experts

Experts	Aesthetics	Functionality	Technical excellence	Economy	Ease of manufacture	Originality	Waste management	Manufacturing time	Difficulty level	Creativity at work	Total points:
1	3	4	3	4	5	3	1	4	3	3	
2	3	5	3	4	4	3	1	4	3	3	
3	4	4	3	3	5	3	1	4	3	3	
4	3	4	3	4	4	3	1	5	3	3	
5	3	4	3	4	5	3	1	4	3	3	
6	3	5	2	3	5	2	2	4	3	3	
7	4	5	2	3	5	3	2	4	3	2	
8	3	5	2	3	4	3	2	4	3	2	
9	4	5	2	3	4	3	2	3	3	3	
10	3	5	2	4	4	3	2	3	3	3	
11	3	4	3	4	4	2	1	4	2	3	
12	4	5	3	3	5	2	1	4	3	3	
13	5	4	3	4	5	3	1	4	3	3	
14	3	5	3		5	3	1	4	2	2	
15	4	4	2	4	5	3	1	4	2	3	
16	2	4	2	3	5	2	2	3	2	3	
17	3	4	2	3	4	3	2	4	3	3	
18	3	4	2	3	4	3	2	4	3	3	
19	4	5	3	3	4	3	2	4	3	3	
$\sum R_i$	64	85	48	16	86	53	28	74	53	54	561
R_{sr}										56,1	
$\Sigma R_i - R_{sr}$	7,9	28,9	-8,1	-40,1	29,9	29,9	-28,1	17,9	-3,1	-2,1	
$(R_i - R_{st})^2$	62,41	835,21	65,61	1608,01	894,01	894,01	789,61	320,41	9,61	4,41	5483,3
W											0,82

The calculated value of the concordance coefficient **W=0.82** is significant, which indicates the consistency of all participants in the created expert group. The implementation of the project on the use of the Kosko quasi-neural network contributes to the development of students' research skills (collecting information, analyzing it from different points of view, putting forward hypotheses, summing up) and analytical thinking. To analyze projects carried out by students of vocational education institutions in experimental groups (250 participants) and control groups (290 participants), criteria were developed (see Table 6), namely: the desire to develop creative projects; develop projects with subsequent implementation and receipt of financial rewards for the purchase of modern equipment; study and apply new technologies and tools; develop group projects involving participants from different regions; to get acquainted in depth with technical achievements; get the approval of parents and classmates; to enjoy intellectual activity.

Table 6: The Results of Assessing the Motivation for the Implementation of Projects products by Students of Vocational Education Institutions at the Beginning and After the End of the Experiment (%)

Student groups	Zero control cuts and dynamics of changes	Motivations for the development of product projects						
		Desire to develop creative projects	Develop projects with subsequent implementation and receipt of financial rewards for the purchase of modern equipment	Learn and apply new technologies and tools	Develop group projects involving participants from different regions	Get an in-depth look at technical advances	Get approval from parents and classmates	Enjoy intellectual activity
Experimental groups	Zero cut	10% (25)	9% (22)	15% (37)	21% (52)	23% (57)	65% (162)	12% (30)

of students (250)	Control cut	54% (135)	61% (152)	67% (167)	52% (130)	71% (177)	67% (167)	78% (195)
Control groups of students (290)	Zero cut	11% (32)	7% (20)	17% (49)	23% (67)	20% (58)	49% (142)	14% (41)
	Control cut	12% (35)	9% (26)	31% (90)	25% (72)	22% (64)	53% (154)	18% (52)

A graphic representation of the results of the assessment of the motivation for the implementation of projects by students of vocational education institutions at the beginning and after the end of the experiment is shown in Figures 3, 4.

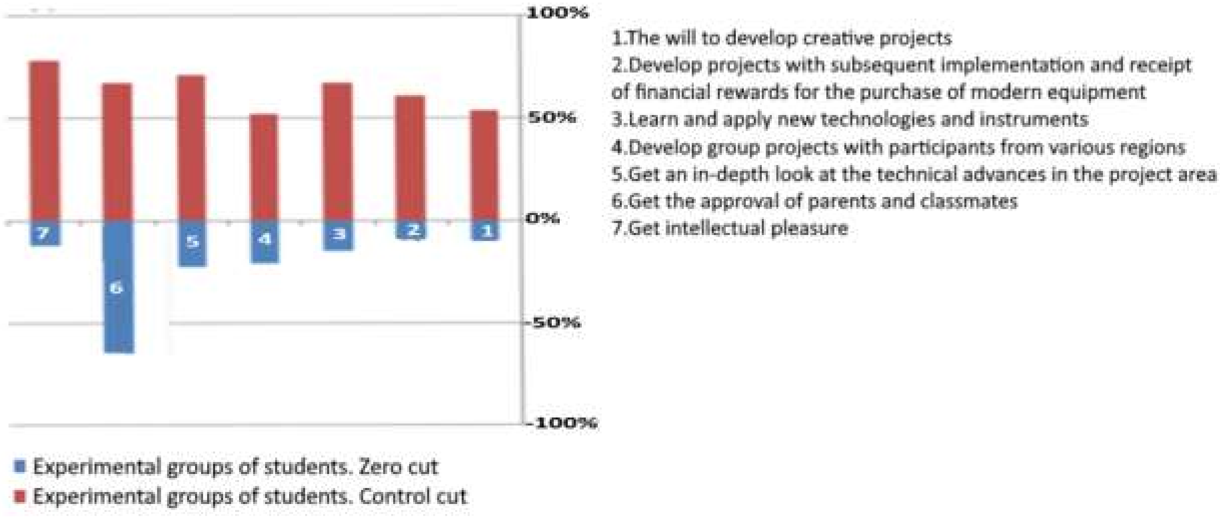


Figure 3: Comparative characteristics of the dynamics of the motivations of students of the experimental group to perform product projects

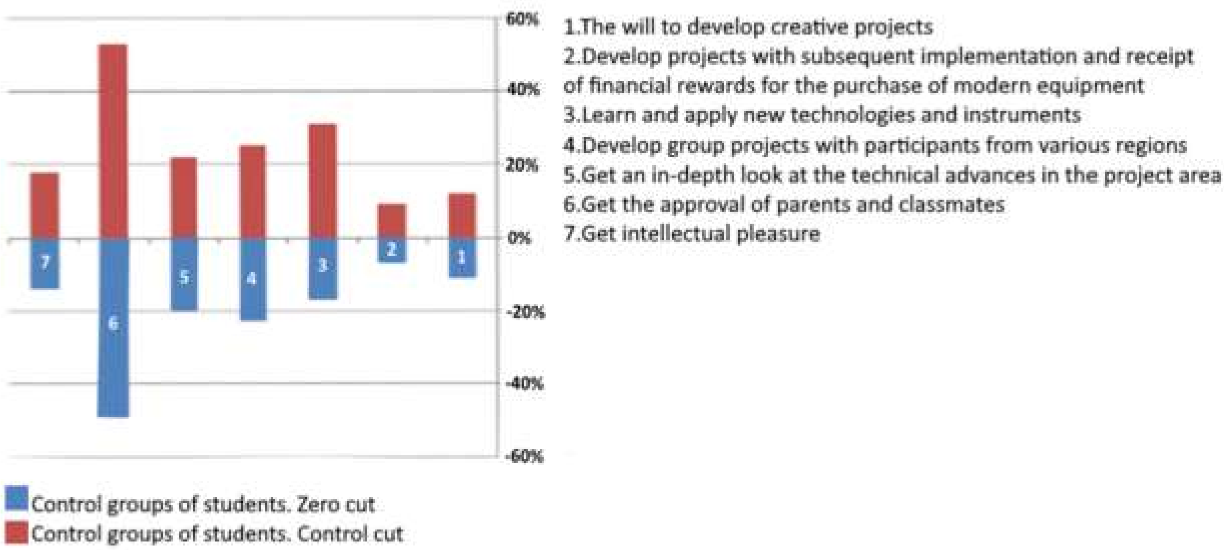


Figure 4: Comparative characteristics of the motivation dynamics of students of the control group to perform product projects

From the result obtained, we conclude that in all respects, the participants in the experimental group significantly exceed the results of the participants in the control group. The result of the 7th position is especially important in our study: "Enjoy intellectual activity" – students of the experimental groups, developing educational projects in the environment of creative self-realization of the smart-complex of the academic discipline, get significant pleasure from intellectual activity compared to students of the control group. Thus, the considered working hypothesis about using the capabilities of the Kosko neural network to develop the Kosko quasi-neural network and its application in the smart complex of the academic discipline was confirmed.

5. Conclusion

The suitability and adaptability of the Kosko quasi-neural network, provided it is used, helps to increase the motivation of students of vocational education institutions to carry out creative educational and scientific projects, which positively affects the effectiveness of the educational process.

It is relevant to use the achievements of scientists in the direction of teaching artificial intelligence to train people. In order to deepen human intelligence, we considered dynamic neural networks and chose, in our opinion, one of the most suitable for implementation in the smart complex of an academic discipline – the Kosko neural network. Having carried out structural changes in the Kosko neural network, we developed a quasi-neural network for the development and deepening of human intelligence in the project activities of students as a synthesis of Artificial intelligence and Intelligence amplification in Artificial Intelligence to Augment Human Intelligence, according to the term proposed by Shan Carner and Michael Nielsen (2017).

To determine the elements of the weight matrix of the Kosko quasi-neural network, the potential of the project activity of students of vocational education institutions was differentiated into two components: intellectual and creative. And according to the complex methodology, the potential of students' project activities was calculated taking into account the integral indicator. However, a precise assessment of the capacity in the measurement of broad comparative field studies is not yet available due to the lack of appropriate pedagogical conditions at the level of vocational education institutions and adequately trained teachers to lead research activities, for example, in the form of implementation or intervention studies. In general, the transformational potential of the Kosko quasi-neural network will give students positive and equal opportunities to work on creative projects, which will have a positive impact on the development and deepening of their intellect.

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