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THE USE OF CONCEPT MAPS IN THE PROCESS OF INDEPENDENT STUDY OF EDUCATIONAL MATERIAL IN HIGHER MATHEMATICS

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ABSTRACT

*The **purpose** of the article is to analyze the impact of concept mapping on the level and quality of assimilation of learning material in higher mathematics in the process of independent study.*

***Methodology**. Based on a review of the main provisions of modern theory of learning and generalization of research results presented in scientific papers on the scope of application of concept maps in the learning process, such a training experiment was conducted. For students of the two experimental groups on a certain topic of the discipline "Higher Mathematics" were offered to build conceptual maps in addition to the common teaching methods. It considered as an independent creative task. In the other two groups, which were under control, students had to study the same topic of the discipline, using traditional methods.*

***Results**. It was determined that the results of the colloquium composed of students of experimental groups were significantly higher than those of students of control*

groups who did not use mapping as a method of learning during independent work. The average score obtained by students of experimental groups for the colloquium was almost 80 points, while for students of control groups it was only 72 points. Using Student's test, the significance of the difference between the values of the sample averages of these indicators proved. If we compare the average scores for different types of tasks, the most significant was the difference in the performance of heuristic tasks, which reflect the ability to apply the acquired knowledge to solve practical problems of economic content.

***Conclusions**. The positive influence of the use of concept mapping in independent work of students established, which proves the thesis about the feasibility of using concept mapping as a learning tool. Further introduction of concept maps in the educational process should be based on the development of complex theoretical and practical, as well as competency-oriented tasks.*

KEY WORDS: *meaningful learning, independent study of educational material, cognitive activity, group work, learning maps, conceptual map, quality of education, competencies.*

INTRODUCTION

Modern indicators of the quality of mathematical training of future specialists in any field, in addition to knowledge and skills, are also the ability to process large amounts of information, independent creative acquisition of knowledge, their systematization and determining the relationship between new knowledge and those, which formed earlier.

Such connections need to be built not only within the studied discipline. An understanding of interdisciplinary relationships is especially important for applied disciplines. Therefore, the educational process in higher education institutions aimed at developing the cognitive activity of students and their ability to master the methods of organizing personal cognitive activities.

Today, the traditional model of education must gradually restructured. A. A. Verbitsky (2018) described the problem of education in the context of informatization of society. He emphasized the importance of not only mastering well-known scientific laws and regularity, but also the ability to turn this information into personally meaningful ways of activity and thus achieve creative development.

In determining the methods that used in the learning process, the teacher should proceed from the peculiarities of perception and memorization of new material by students. It believed that a person remembers as personal knowledge only 10% of what a person reads 20% of what he heard 30% of what he saw, 50% of what he saw and listened at the same time, and 90% of what a person has reached in the process of their activities.

Therefore, one of the trends in modern higher education is to change the ratio between the volume of classroom and extracurricular workload. It can be applied to all disciplines, taught at the university.

Thus, with a constant number of credits, the time allotted for independent work of students increases, and the classroom time allotted for the study of basic topics in higher mathematics, which was already quite limited, further reduced.

However, it should be noted that for students understanding the basic concepts, techniques and methods taught in the course "Higher Mathematics", in the future it could become an intellectual basis for

research and a significant analytical basis for balanced conclusions in professional activities in any field in general and in economics and management in particular.

Therefore, it is advisable at all stages of the process of studying higher mathematics and other disciplines of mathematical direction to choose various new teaching methods, the use of which would increase the level of mastery of educational material and structure the mathematical literacy.

One of the newest methods of training which application promotes increase of efficiency of mastering and the organization of the obtained knowledge in any branch, is mapping, i.e. drawing up of learning maps (or thinking maps).

In this case, mapping is a type of symbolic presentation that identifies the leading components of the knowledge system and describes the relationship between them. The product of mapping is a person's own idea of the content of the problem, which provided in the form of a formal conceptual model.

The effectiveness of the mapping technique explained by the fact that it allows to activate the intellectual processes of man, to focus his attention not only on the content of knowledge, but also on the process of its assimilation. Creating learning maps (or thinking maps) is useful for improving the learning process for both children and adults; as such, maps can be easily adapted to user needs.

Depending on the purpose mapping are carried out and which system of subordination is described by learning maps, there are different methods of mapping. The most common types of maps used in teaching are mental and conceptual maps. Both of these tools are easy to use and find their application in the education of both young children and students and even adults, for example, in the training of experienced professionals.

These types of maps are diagrams that represent ideas as node-link assemblies. They are similar in their main purpose, but they have their own distinctive features, as these cards have different functions. A detailed comparison of these types of learning maps found in the works Eppler M. J. (2006), Gjorgievska K. (2018), Carpineanu S. (2020) and others. Here we give a brief overview of the general features and main differences of these types of maps.

The term Mind Mapping, itself proposed in the 1970s and developed by an English educational consultant Anthony Peter Buzan (1993). The focus of the mental map is only one idea (topic). Mental maps are always radial, i.e. they have a common center, from which there is a branching into separate subtopics.

Thus, such a map has a hierarchical structure and describes the relationship between parts of the whole. As a rule, mental maps made by one person and reflect his individual vision of the problem, i.e. they can be mainly personal.

Conceptual mapping as a teaching method also was proposed in the 1970s. Its author is American professor and science researcher Joseph D. Novak (1998). Like mental maps, concept maps have a hierarchical structure, but reflect the structure of several complex concepts, as well as the cross-links between these concepts.

Unlike a mental map, a conceptual map considers a system of interconnected ideas. In addition, if mental maps assume a simple relationship between ideas (usually one-to-one), while the conceptual maps assume a many-to-many relationship between concepts. In this regard, the concept map is more suitable for presenting complex multi-level information.

Concept maps are mainly used to organize and visualize implicit knowledge, analyze complex problems, find solutions and measures that need to be taken while implementing them. They encapsulate more

information in terms of volume and of complexity, and are therefore used to explain how these complex concepts relate to each other. It should be emphasized that, in the process of structuring knowledge with the help of concept maps, you can identify gaps in the knowledge system, if such gaps exist, and identify ways to address them.

Let us focus on another significant difference between mental and conceptual maps. If one person develops the mental map, then the conceptual map is the product of understanding a situation by a group of people. One of the first stages of such thinking is brainstorming. In this regard, the conceptual map more objectively reflects the information, while in the construction of a mental map the reflection is to some extent subjective.

We emphasize another advantage of group cooperation in the construction of concept maps. Their creation involves work in small groups. Take into account that it is not just working in groups, but in small groups. It gives all members of the group the opportunity to take an active part in the work, to develop skills of interpersonal communication, in particular, the ability to actively listen, develop a common opinion, and resolve differences that may arise during the discussion.

Therefore, as an alternative method of increasing the efficiency of learning and understanding the links between mathematics and economic disciplines, we consider independent work of students with the use of concept mapping. In the authors' opinion, this approach to the activation of independent work of students can increase their motivation and creativity, promote the actualization of knowledge.

The **purpose** of this article is to study the impact of the application of the method of concept mapping on the efficiency of learning of material in Higher Mathematics by students of economic specialties in the process of their independent study, which was provided by the discipline program.

The subject of assessment was not exact knowledge acquired in the process of studying a particular topic, but the ability to apply this knowledge in solving complex problems, i.e. the mathematical competence of students. The main feature of this study is that: conceptual maps are developed not by the lecturer, but by the students themselves as a preliminary stage of organizing their independent work on a given topic.

THEORETICAL FRAMEWORK

In today's world, people face the need to process and absorb a large amount of information. In this regard, traditional learning methods based on simple memorization, sometimes even without elements of understanding their relationship with other objects or situations become ineffective. This led to the formation of the theory of meaningful learning, the creation of which is associated with the name of American educational psychologist David Paul Ausubel (1968).

The theory of meaningful learning is as follows. The information that a person receives in the process of learning should be fully understandable and only such knowledge can be used in the future to establish links between the acquired knowledge and other knowledge that has been accumulated previously. This approach to the process of cognition helps in the formation of a system of knowledge, skills and abilities that a person can actively use future.

Meaningful learning is contrasted with simple memorization, i.e. rote learning. When using this method, information is conveyed in the form of lectures (the lecturer teaches and the students listen, take notes and memorize) or practical classes or seminars (again, one student reports and the others listen). This method allows lecturer to transmit information without requiring a full understanding of its content

or the relationship between the new information and real objects or situations.

According to the theory of meaningful learning, knowledge is not an entity that is transmitted as a single entity from lecturer to student. On the contrary, learning requires the active participation of the student for the assimilation of new information and already acquired knowledge. Defining the connection between new knowledge and previous knowledge, understanding this connection, this is what makes learning effective. Thus, meaningful learning is not possible without involving the students in the process of forming their own awareness of the phenomena studied.

Conceptual mapping is one of the tools, the use of which allows the implementation of meaningful learning. J. Novak conducted the first experience of using conceptual mapping in teaching within the Cornell University program.

One of the chapters of this program was to study the change in children's knowledge of the natural sciences through the application of new teaching methods. In particular, his research of the psychology of learning and cognition of children was devoted to finding an effective method of teaching educational material and ensuring the quality of learning.

Now a new book by Dr. Novak (2010) "Learning, Creating, and Using Knowledge: Concept Maps as Facilitative Tools in Schools and Corporations", which focuses on the use of concept maps in teaching, has already been translated into several foreign languages.

Initially, concept maps intended as a means of visualizing the presentation of information to children, and then they began used as a tool in adult education, as well as in research and solving practical problems.

Now concept maps are used in pedagogy in a variety of contexts, including teaching and learning strategies, curriculum development tools, and as a tool for fixing knowledge structures and assessing of learning results. In the twenty-first century, there is a spread of mapping in all areas of knowledge, as evidenced by the variety of topics presented at conferences on conceptual mapping.

Most often, mapping is used by the teacher as a tool that allows a more structured presentation of new material in areas of knowledge such as medicine (Daley, Durning, & Torre, 2016), economics (Onuoha, Ejimonye, & Eneogu, 2016), pedagogy (Reiska, & Soika, 2015) and other applied sciences. Less common is the use of mapping in teaching of exact sciences.

There are examples of the use of concept maps in the teaching of sciences such as physics (Taie, 2014) and mathematics (Pushkareva, & Peregudov, 2011). However, such works are few. This fact adds to the relevance of our research.

Possibilities of application of concept mapping in pedagogical practice are various. Thus, the lecturer can use mapping to assess the quality of teaching the discipline through the eyes of students. In the future, this will help him improve his course.

Heinze-Fry J. (2004) cites the experience of working with students, when students at the end of the semester present concept maps as an image of their thinking about the sections of the course and its structure.

Another area of application of concept maps in pedagogical practice may be to test students' understanding of the basic principles of the discipline studied. This direction is just beginning to develop. Thus, Ghorai S. and Guha A. (2018) used the method of conceptual mapping to assess the scientific literacy of students, which formed in the study of natural sciences. Students created a concept map on the topics of exercises similar to PISA, which agrees with international standards.

P. Ruiz-Palomino and R. Martinez-Canas (2013) analysed the quality of the use of conceptual mapping as a powerful innovative teaching method at the university level. Such an educational tool, based on the provisions of cognitive theories, raises the level of quality of education and proves the importance of the difference between learning, that is memorization, and learning, which involves, above all, understanding the content.

This tool allows the student to harmonize the process of acquiring new knowledge through the formation of the structure of the creative solution of the problem of developing theoretical material. David Hay, Ian Kinchin and Simon Lygo-Baker (2008) show that the ability to build concept maps, incorporate new concepts into the structure of one's knowledge, signify complex relationships between new and previous knowledge, and also the ability to understand concept maps provide more deep understanding of the topic under consideration.

Visual display, which is carried out by mapping, not only improves memory and develops creative abilities of the student. It promotes better understanding, simplifies structuring and improves task management. Developing this view, Cooper Y. and Zimmerman E. (2020) proposed an approach to the use of concept maps in the context of understanding and conducting theoretical and practical research in the field of art education.

It should be noted that now the possibilities of mapping have significantly expanded. If at the time when the method of mapping was just beginning to develop, maps created using pencil and paper, now there are powerful computer programs for creating any kind of learning maps. Some of these programs focused on creating maps of a fixed type.

For example, you can use software products such as Xmind, Freemind, MindNode, MindMeister, Mind42 and others to create mind maps. Xebece, CmapTools, TheBrain, Aibase, 3D Topicscape, AXON Idea Processor and others used to create concept maps. There are also modern universal tools such as Inspiration 10, Inspiration Maps software and Webspiration Classroom, which are the simplest but powerful visual tools for creating concept maps, mind maps, block diagrams, charts and more.

In addition, Inspiration, Kidspiration, and Webspiration Classroom include various examples of concept maps, templates, and lesson plans to demonstrate to the user how mapping can be easily integrate into the curriculum.

Based on the analysis of scientific works, the authors put forward a thesis on the feasibility of using concept mapping as a tool for studying the theoretical foundations of higher mathematics for economists and managers.

METHODOLOGY

One of the most important goals of education is to help students gain a conceptual understanding of the subject. In order to do it, the lecturer needs to apply cognitive learning strategies that would help the student to structure information and thus affect learning outcomes. Accordingly, it takes extra effort on the part of the learner to relate the new knowledge to the relevant concepts they already have in mind.

According to the constructivist theory proposed by Jerome Bruner, who is one representative of the modern theories of learning, the teacher must be a coach, facilitator of the learning process and creator of a comfortable educational environment.

Constructivism reflects the view of learning, according to which a person can actively build their knowledge by testing concepts on previous experience, applying these concepts to new situations. The learner

picks and transforms information, looks for answers, and constructs hypotheses, relying on a cognitive structure to do so.

In order to test the effectiveness of the use of concept mapping as a learning tool, we conducted such an experiment. Four groups of first-year students were selected by the average score of the current assessment of learning outcomes was the same within statistical significance.

Students of the two experimental groups were asked to perform a creative task, one of the elements of which is the construction of concept maps, within the framework of independent work on the topic "Differential calculus of the functions of single variable" in the discipline "Higher Mathematics". In the other two groups (control groups), students had to study the same topics, but according to traditional method, i.e. reading theoretical material, answers to control questions, etc.

Analysis of scientific works on psychology (Brown, & Pedder, 1998), pedagogy (Uvarov, 2001) and demonstration of positive experience in creating concept maps by a group of researchers (Shih, & Chang, 2020) show that independent work is more effective if the group consists of three people. In the course of such work there is a group self-check.

The participation of a partner student significantly restructures the psychology of another student, allows to develop not only his communicative competencies, but also to gain autonomy to perform independent work and demonstrate responsibility for its quality. Therefore, students of the two experimental groups were divided into subgroups, the composition of which determined by the students' own wishes.

Then the students of the experimental groups presented with a concept-mapping algorithm, which involves the following stages:

- determining the context of a particular topic of the discipline with the help of focus questions that clarify the plan and objectives of the topic;
- the identification of key concepts that define this topic. It is advisable that their amount was 15-25 concepts;
- brainstorming, the purpose of which is ranking of the list of concepts: from more concepts that are general to specific (the concepts of the topic in the list are grouped according to the theme plan);
- construction of a primary map, which establishes hierarchical connections between concepts related to one issue of the topic;
- building links between concepts that characterize different issues of the topic (these are links between concepts in different segments of knowledge on the map, which help to illustrate how these domains are related to each other);
- checking the map and adjust the map to the "input-output" or hierarchical view (more general ideas are displayed at the top of the map, and related concepts are displayed below according to the hierarchy).

During creation of concept, map the cross-references and multiple connections use to visualize ideas. According to the above algorithm, students of two experimental groups performed independent creative work on selected topics in higher mathematics. Each subgroup of these experimental groups carefully studied the theoretical material and compiled conceptual maps that included concepts (general notions and the relationships between them.

Given the experience of Aşıksoy G. (2019) in improving students' ability to understand material using computer programs, certain computer platforms suggested in experimental groups to display concept maps.

Presentation of the generated concept maps carried out at the last lesson in each experimental group. Students presented their work and explained the basic concepts

and types of connections between them. During the discussion, students argued their answers, which also allowed checking the degree of assimilation of educational material.

It should be noted that the lecturer not only asked questions and controlled the correctness of the answers, but also carefully guided the process of discussing the conceptual maps but not declaratively, only as a moderator. This helped to create a relaxed atmosphere, and the discussion took place with the active participation of students.

It should be emphasize that due to concept mapping clarity of the idea and its visualization are an integral part of the learning process. Experience has shown that visualized learning material assimilated faster and more efficiently than consistent verbal.

Figure 1 shows a fragment of a concept map, which one of the subgroups of students built.

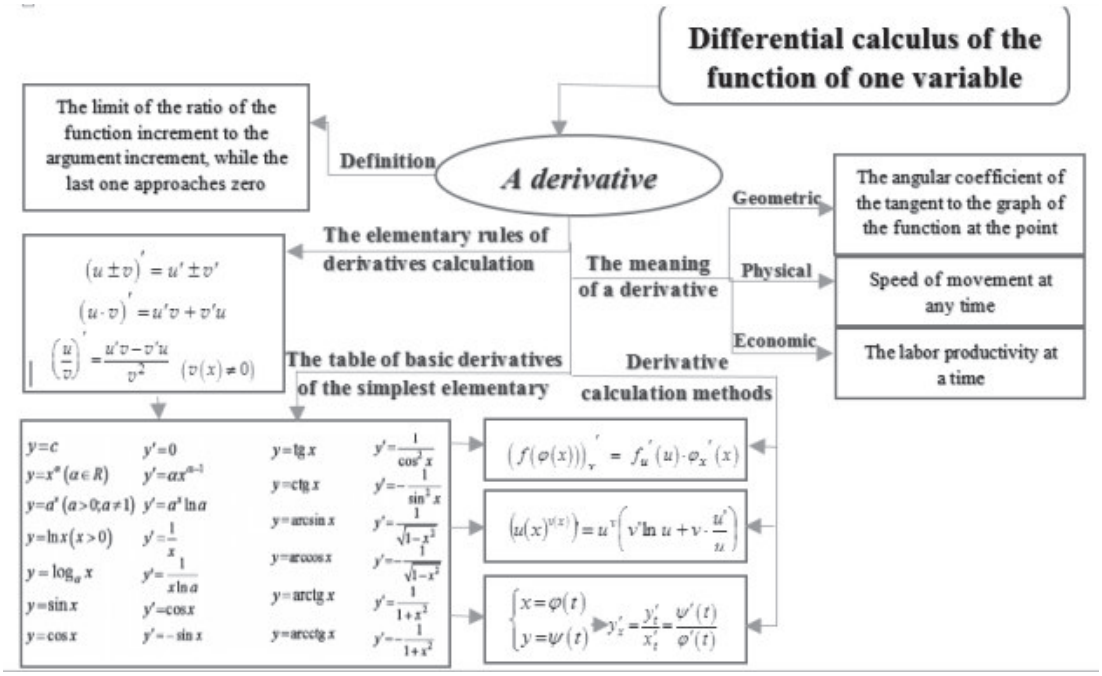

Figure 1. *Fragment of a conceptual map*

This fragment of the concept map shows the concepts and connections between them from the description of the "Derivative" question of the topic "Differential calculus of a function of one variable".

RESULTS

Positive experience in the use of conceptual mapping techniques in the process of group independent work of students gained in the 2020/2021 academic year in classes on higher mathematics of first-year students of Simon Kuznets Kharkiv National University of Economics.

The level of mastering the educational material checked in the form of theoretical and practical tasks of the colloquium on the topic "Differential calculus of the function of one variable". The colloquium questions consisted of three blocks.

The first block contained questions that tested knowledge of the basic concepts of the topic. The answer to the second block question involved understanding the meaning of key terms. The third block

contained heuristic tasks, which tested the ability to use the acquired knowledge on the topic in solving practical problems of economic content. The tasks of each block evaluated on a 100-point scale.

The overall grade that the student received for the colloquium defined as the weighted average of the grades obtained for each block of tasks. The weight of the tasks of the first block was 25%, the second block - 30% and the third block - 45%.

Figure 2 shows a histogram of the distribution of general grades for the colloquium received by students of the studied groups.

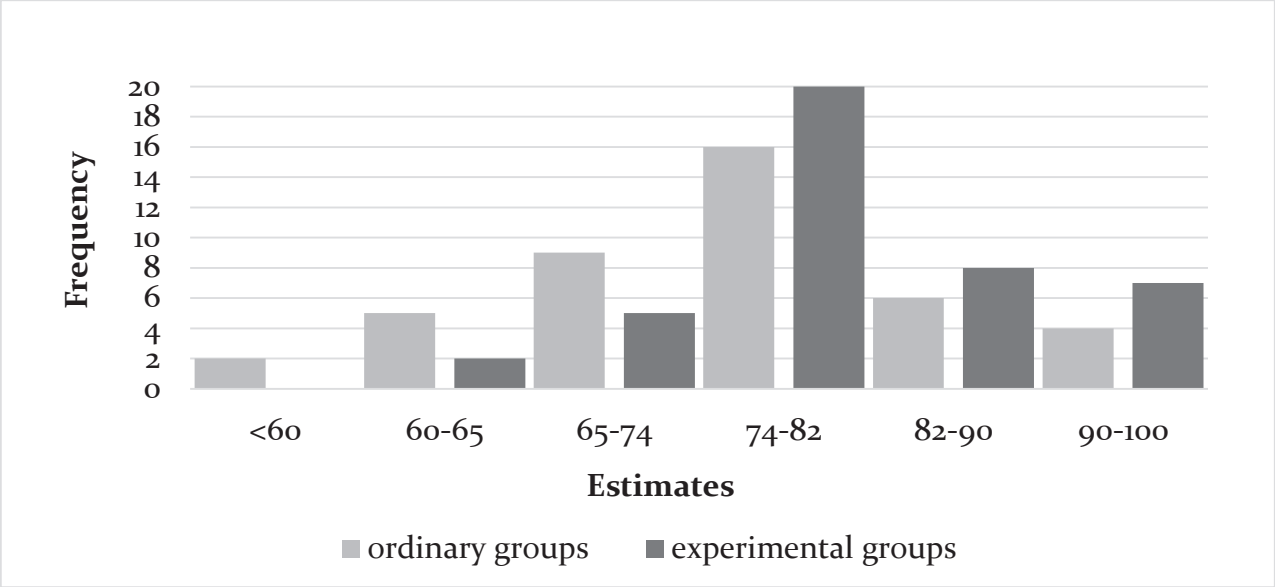

Figure 2. *Distribution of colloquium grades*

Grades received by students for answering the colloquium questions considered as data from sample populations. It established that the average score of knowledge assessment of students of experimental groups is almost 80 points, students of control groups - 72 points.

Average scores are marked:

$$\overline{X_1} = 80, \overline{X_2} = 72.$$

The question arises as to whether there is a statistically significant difference between the values of these sample averages. **Student's t-test** used to answer this question.

The null hypothesis to be tested formulated as:

$$H_0 : \overline{X_1} = \overline{X_2}.$$

According to this hypothesis, two independent random samples have the same mean, i.e. these samples belong to the same general population. It follows that the impact of the use of concept maps on the level of learning is not statistically significant.

On the contrary, the alternative hypothesis emphasizes that the difference between the values of the sample averages is statistically significant:

$$H_1 : \overline{X_1} \neq \overline{X_2}.$$

Accordingly, it recognized that the use of concept maps affects the quality of learning.

Suppose the samples drawn from a normally distributed population when the population standard deviation is unknown.

Since the sample size is small, we use the following formula to calculate the t-score:

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

In this formula n_1, n_2 are the sizes of samples, S_1^2, S_2^2 - the variances for samples.

To calculate the t-score, the Two-sample t-test procedure used. This procedure is one of the Analysis tools of the MS Excel software environment. The results of its implementation for two random samples of students are given in table 1.

Table 1. *Two-sample t-test for means*

Statistical indicator	Experimental groups	Ordinary groups
Mean	79,62	71,93
Variance	66,44	99,73
Observations	42	42
Pooled Variance	0,93	-
Hypothesized Mean Difference	0,00	-
df	41	-
t - Stat	13,13	-
P(T<=t) one-tail	0,00	-
t - Critical one-tail	1,68	-
P(T<=t) two-tail	0,00	-
t - Critical two-tail	2,02	-

In this study, the level of significance at which the null hypothesis rejected was 0.05. Since the empirical value of the t-criterion (t - Stat =13,13) turned out to be greater than the critical one (t - Critical one-tail = 1,68 and t – Critical two-tail = 2,02) the null hypothesis should be rejected in favour of the alternative one. It means that the effectiveness of the use of concept mapping in the educational process should be considered significant.

To investigate the structure of the impact of the use of concept maps on the quality of education, an analysis of grades for the tasks of each block of the colloquium performed.

Figures 3 - 5 show the distribution of grades for the tasks of individual blocks of the colloquium.

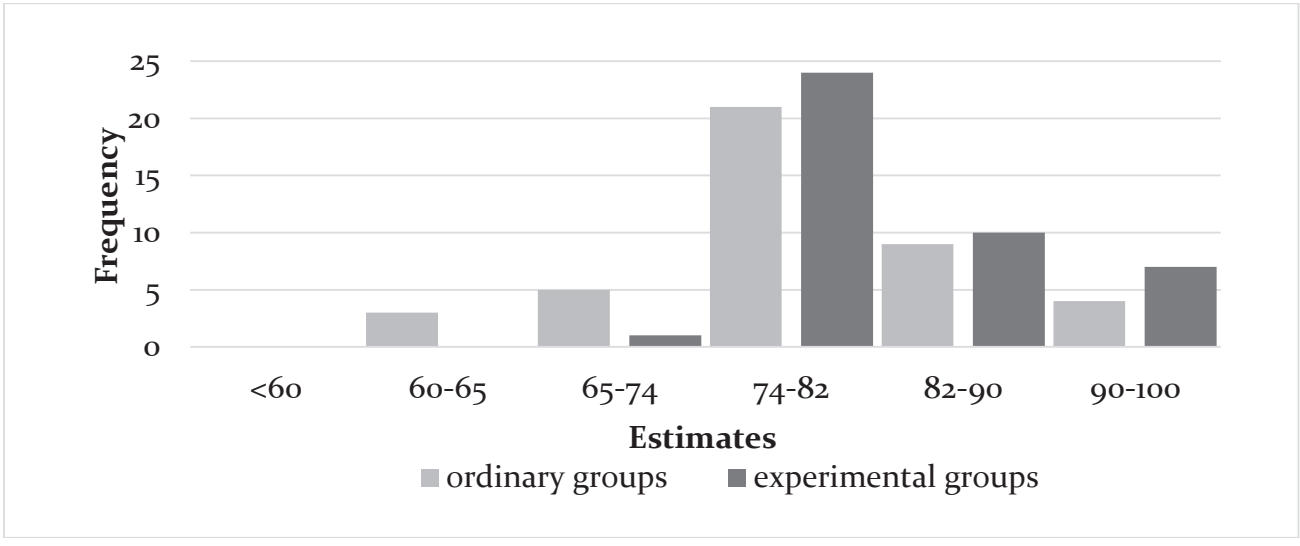

Figure 3. *Distribution of grades for knowledge of the basic concepts of the colloquium*

The tasks of the first block of the colloquium allowed revealing the level of mastering by students of the basic concepts on the topic "Differential calculus of the function of one variable". This is the basic level of knowledge in the discipline that is being studied. Both the students of the experimental groups and the students of the control groups demonstrated practically the same level of knowledge when performing the tasks of this block.

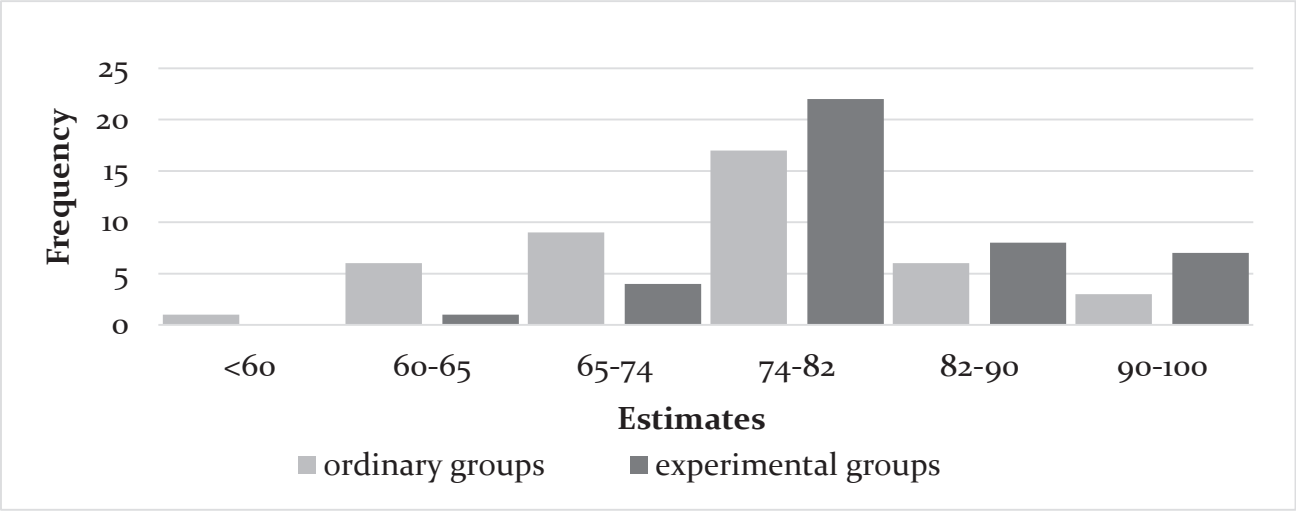

Figure 4. *Distribution of grades for understanding the content of key terms of the colloquium*

The tasks of the second block of the colloquium appeared as diagnostic tasks, which determined the student's ability to use their acquired knowledge and skills to solve typical problems. According to the results of the tasks of this block, we can also say that the differences between the scores obtained by students of the experimental and control groups were insignificant.

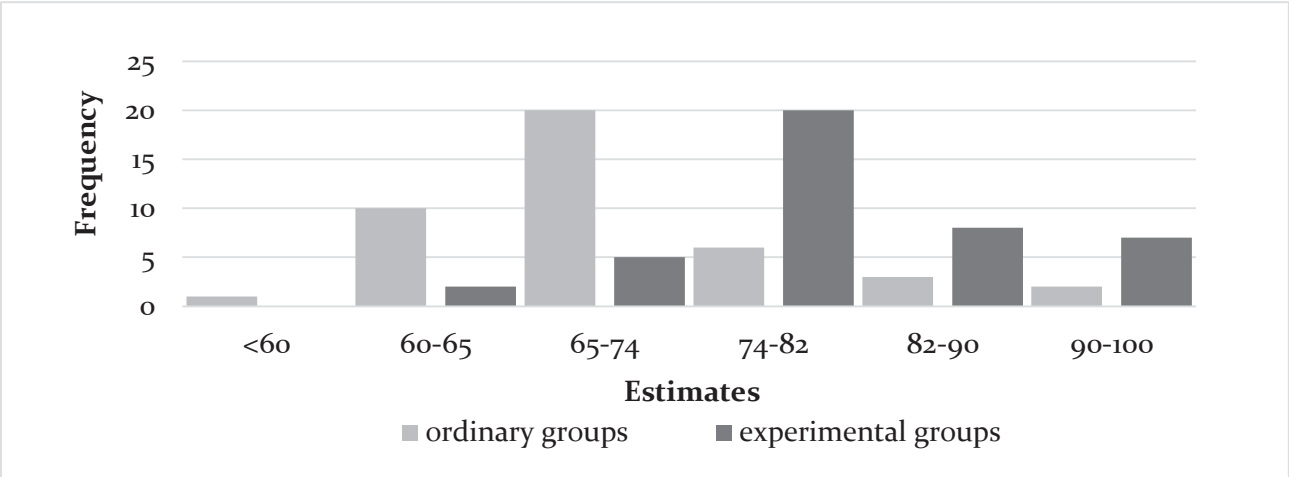

Figure 5. *Distribution of grades for the ability to use theoretical knowledge on the topic of the colloquium in solving practical problems*

The most significant difference between the scores obtained by students of experimental and control groups was found during the test of the ability to use the acquired knowledge in the heuristic problems of the third block of the colloquium. Most students in the experimental groups (83% of the total) successfully solved such practical

problems on a given topic of the colloquium. Among the students of the control groups, only 26% of the total coped with heuristic tasks.

The tasks aimed at establishing creative potential and acquiring competencies, creative activity, independence and efficiency turned out to be too difficult for these students. Thus, in addition to increasing the level of assimilation of theoretical provisions, the use of concept maps in the independent study of educational material helps to form an understanding of the practical application of knowledge and make more effective the ability to apply them.

The peculiarity of using the technique of constructing concept maps in the process of independent work is that the student is given the opportunity to determine their own educational search. That is, he has the opportunity to act as a real subject of personal educational and cognitive activities, which is implemented through a system of various educational, intellectual tasks.

Another positive point is that in the subgroups of control groups there was 100% involvement of students in the creative process. Concept mapping is a collaborative process, so it is the ideal way to build a team that works together to solve a problem. Cooperation of students within the own subgroup in combination with competition with other subgroups strengthened the motivation and intellectual activity of students, contributed to the process of search of reasoned conclusions and theoretical knowledge that were obtained during the construction of concept maps.

DISCUSSION

The authors agree with Guzanov B.N. & Morozova N.V. (2014) that in the new conditions combinations of classroom and extracurricular work can be used in other qualities. A reasonable and creative combination of these types of educational work will allow the student to acquire directed professional knowledge and relevant functional skills independently.

Although higher mathematics is one of the exact sciences, which requires the acquisition of skills to solve practical problems, understanding the theoretical foundations of any practical method is a very important requirement for mastering the material in this discipline. The results of this study confirm the findings of E. Taie (2014), P. Ruiz-Palomino & R. Martinez-Canas (2013), who studied the effect of using concept maps in the learning process.

We propose to expand the range of concepts-mapping application and implement them in the teaching of disciplines of the mathematical cycle.

In addition, the positive experience of the authors in the direction of this study was presented in the work of L. Norik & I. Lebedeva (2020) on the example of independent creative work students in the discipline «Applied Mathematics». In the process of studying this applied discipline, concept maps make it possible to implement the brainstorm to generate new information because of combining new and old ideas.

CONCLUSIONS

The study has some limitations. It covered a small number of students in only one educational program. In addition, the experiment was conducted on only one topic of the discipline and its duration was limited in time. In the future, it is advisable to conduct a similar experiment, using a larger amount of educational material, and compare the effect of the use of concept maps in the learning process of students of different faculties.

Of course, the introduction of concept maps in the process of independent work of students is also of great educational importance. Group work on creating a map

forms leadership qualities and the ability to defend one's own opinion. This should be considered not only as a set of certain skills and abilities, but as also character traits that play a significant role in shaping the personality of a modern competent specialist.

Our research has shown that the use of group independent work in the educational process using the technique of constructing concept maps on the topics of higher mathematics promotes the development of students' ability to organize their learning, the formation of self-development and creative application of knowledge.

The authors see the further development of the introduction of mapping in the educational process in providing students with information about computer programs used to build concept maps. It is also advisable to use concept maps to assess students' perception of topics not only in higher mathematics, but also in other mathematical disciplines, which are taught in the training of future economists and managers.

This would allow students to develop an understanding of the relationship between specific topics of mathematical disciplines and their use in the study of economic processes and phenomena.

CONFLICT OF INTERESTS
The authors declare no conflict of interests.

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АНОТАЦІЯ / ABSTRACT [in Ukrainian]:

ВИКОРИСТАННЯ КОНЦЕПТ-КАРТ В ПРОЦЕСІ САМОСТІЙНОГО ВИВЧЕННЯ НАВЧАЛЬНОГО МАТЕРІАЛУ З ВИЩОЇ МАТЕМАТИКИ

Метою *статті є аналіз впливу концепт-картування на рівень та якість засвоєння навчального матеріалу з вищої математики в процесі самостійного вивчення.*

Методологія*. На підставі огляду основних положень сучасної теорії навчання та узагальнення результатів досліджень, викладених у наукових працях щодо сфери застосування концептуальних карт в процесі навчання, проведений навчальний експеримент. Студентам двох експериментальних груп з певної теми навчальної дисципліни "Вища математика" було запропоновано окрім звичайних методів навчання в якості самостійного творчого завдання побудувати концептуальні карти. В інших двох групах, які були контрольними, студенти самостійно вивчали ту ж тему дисципліни, використовуючи традиційну методику.*

Результати*. Визначено, що результати колоквіуму, складеного студентами експериментальних груп, були суттєво вищими, ніж у студентів, які не використовували концепт-картування у самостійному навчанні. Середній бал, який отримали за колоквіум студенти експериментальних груп, дорівнював майже 80 балів, тоді як для студентів контрольних груп він становив лише 72 бали. За допомогою критерію Стьюдента доведено, що різниця між цими показниками є значущою. Якщо порівняти різницю між середніми балами за різні типи завдань, то найбільш значущою вона була за виконання евристичних завдань, які відображають вміння застосовувати набуті знання до розв'язання практичних задач економічного змісту.*

Висновки*. Встановлено позитивний вплив застосування концепт-картування в самостійній роботі студентів, що підтверджує тезу про доцільність використання концепт-картування у якості інструменту навчання. Подальше впровадження концептуальних карт в навчальний процес повинно ґрунтуватися на розробленні комплексних теоретико-практичних та компетентнісно-орієнтованих завдань.*

КЛЮЧОВІ СЛОВА: *осмислене навчання, самостійне вивчення навчального матеріалу, пізнавальна активність, робота в групі, навчальні карти, концептуальна карта, якість навчання, компетентності.*

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