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APPLYING MIND MAPPING TECHNIQUES TO ACTIVATE GROUP EDUCATIONAL AND COGNITIVE ACTIVITIES OF FUTURE COMPUTER SCIENCE TEACHERS

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In the modern conditions of the dynamic development of the information society, the training of specialists in the field of pedagogy, in particular computer science teacher, becomes especially relevant. The priority task of higher pedagogical education is the formation of a new generation of educators, who must possess not only thorough knowledge of the subject, but also developed skills of social interaction, cooperation, teamwork, freely navigate in the information space, use modern electronic didactic tools, specialist services, information resources etc. The article examines the essence of the concepts «group educational and cognitive activities», «collective forms of learning», «electronic cooperation», «mind mapping techniques». The author analyzed the possibilities of mind mapping techniques as a means of visualizing thinking processes and structuring information. The classification of digital tools for creating mind maps (free and licensed programs and webservices) is presented. Their advantages and features, methodological techniques and basic principles of working with them are considered. The practical experience of using mind maps to activate the group educational and cognitive activities of students is presented. The method of using mind maps in the training of future computer science teachers is proposed, which includes: determining the purpose and tasks of using mind maps; choosing an online service for their creation; acquainting applicants with the basic principles of working with mind maps; their performance of practical tasks using mind maps; discussion of the results of tasks and summing up. Practical tasks and samples of the results of students' joint work on creating mind maps within the educational component «School computer science course and its teaching methods» are presented. It was found that the use of mind mapping techniques is a promising method of activating the group educational and cognitive activities of future computer science teachers, which contributes to the formation in them of the necessary competencies for successful professional activities in the conditions of the information society.

Keywords: mind mapping techniques, mind map, group educational and cognitive activities, collective forms of learning, electronic collaboration, future computer science teacher.

Кисельова О.«Застосування технології майндмеппінгу для активізації колективної навчально-пізнавальної діяльності майбутніх учителів інформатики».

У сучасних умовах динамічного розвитку інформаційного суспільства підготовка фахівців педагогічної сфери, зокрема вчителів інформатики, набуває особливої актуальності. Пріоритетним завданням вищої педагогічної освіти стає формування нової генерації освітян, яка повинна володіти не лише ґрунтовними знаннями з предмету, але й розвиненими навичками соціальної взаємодії, співпраці, командної роботи, вільно орієнтуватися в інформаційному просторі, використовувати сучасні цифрові дидактичні засоби, сервіси фахового спрямування, інформаційні ресурси тощо. У статті досліджено сутність понять «колективна навчально-пізнавальна діяльність», «колективні форми навчання», «електронна співпраця», «технологія майндмеппінгу». Авторкою проаналізовано можливості технології майндмеппінгу як засобу візуалізації процесів мислення та структуризації інформації. Наведено класифікацію цифрових інструментів для створення інтелект-карт (безкоштовні та ліцензійні програми та вебсервіси). Висвітлено їх переваги, особливості, методичні прийоми й основні принципи роботи з

ними. Представлено практичний досвід використання інтелект-карт для активізації колективної навчально-пізнавальної діяльності здобувачів вищої освіти. Запропоновано методику використання інтелект-карт у навчанні майбутніх учителів інформатики, яка включає: визначення мети та завдань використання інтелект-карт; вибір онлайн-сервісу для їх створення; ознайомлення здобувачів з основними принципами роботи з інтелект-картами; виконання ними практичних завдань із використанням інтелект-карт; обговорення результатів виконання завдань і підведення підсумків. Висвітлено практичні завдання та зразки результатів виконаної спільної роботи здобувачів вищої освіти щодо створення інтелект-карт у межах освітнього компонента «Шкільний курс інформатики та методика його навчання». З'ясовано, що застосування технології mindmapping є перспективним методом активізації колективної навчально-пізнавальної діяльності майбутніх учителів інформатики, що сприяє формуванню в них необхідних компетенцій для успішної професійної діяльності в умовах інформаційного суспільства.

Ключові слова: технологія майндмеппінгу, інтелект-карта, колективна навчально-пізнавальна діяльність, колективні форми навчання, електронна співпраця, майбутній учитель інформатики.

Relevance of research. Successful professional activity of a modern educator in the dynamic realities of today requires the ability to navigate freely in the informational space, the proficient use of electronic didactic tools, various professional services, informational resources, and so on, as well as developed collaboration skills, social interaction, and teamwork qualities. «Positive transformations in society cannot be achieved within the framework of the traditional learning model. For the educational goals set at this stage, a change in the fundamental principles of learning and the development of effective teaching strategies are necessary» [14, p. 250]. There arises a need to seek such forms of organizing learning that are based on the application of interactive methods and active interaction among students. Collective forms, in particular, deserve special attention as their use allows for varying scenarios of an effective educational process, optimally combining the principles of the traditional educational system with information and communication technologies. The task of activating group educational and cognitive activities of future computer science teachers is becoming more relevant, as it directly impacts the effectiveness of learning, namely: the retention of knowledge, the development of cognitive interest, the formation of independent thought, and preparation for life. Among the many ways to address this issue, it is advisable to pay attention to the techniques of mind mapping, which allows for the visualization of necessary didactic units

using information and communication technologies, and engages students in active collaboration.

Analysis of recent research and publications. General characteristics of educational activities have been analyzed by M. Barboli, B. Korotyaev, Y. Mashbits, V. Titarenko, and other scholars. Cognitive activities has been examined in the works of L. Aleksashkina, V. Alekseev, D. Bogoyavlenska, A. Vvedensky, E. Vyazemsky, B. Gershunsky, V. Davidov, D. Elkonin, V. Ilyin, A. Leontiev, I. Lerner, J. Piaget, N. Talizina, I. Yakimanska, and other philosophers, psychologists, and educators. Works by Y. Babansky, N. Menchinskaya, I. Ogorodnikov, D. Penner, M. Skazkin, and other researchers are dedicated to uncovering the essence, structure, and content of students' educational and cognitive activities. The psychological foundations of activating human cognitive activities have been investigated by L. Aristov, I. Kharlamov, A. Kyrychuk, A. Matyushkin, T. Shamova, G. Shchukina, A. Verbitsky, V. Vergasov, I. Ziaziun, and others. In the context of our research, important sources are scientific works dedicated to the theoretical and practical principles of organizing group educational and cognitive activities (P. Arends, V. Dyachenko, S. Kagan, V. Korneshchuk, V. Kotov, H. Leimet, M. Long, P. Neishn, N. Pozhar, H. Sereda, O. Sernyak, M. Vinogradov, V. Vykhrushch, L. Yavorovska, and others), as well as pedagogical and didactic aspects of activities on the Internet and the didactics of Internet technologies (A. Andreev, S. Bogdanova, V. Burov, Y. Bykhovsky, L. Fedorova, N. Khmil, A. Korovko, E. Patarakin, B. Yarmakhov, M. Zolotsevska, and others). Many contemporary studies are devoted to preparing future teachers for the use of information and communication technologies, including Web 2.0 (N. Balik, N. Dimentievska, Kaye D. Trammell, N. Khmil, N. Morze, E. Patarakin, Richard E. Ferdig, M. Zheldak, M. Zolotsevska, and others).

According to the opinions of many scholars (P. Anokhin, B. Deporter, R. Gurina, M. Khenaki, V. Yakimanska, and others), visualizing educational information contributes to more successful perception and memorization

of the learning material. Researchers have focused on the use of mind mapping techniques in the educational process within the context of the informational-didactic environment (I. Radchenko), the application of intellectual technologies in the professional activities of teachers of natural-mathematical disciplines (M. Byrka), the examination of mind maps as a modern method of thinking and processing learning content (N. Tereshchenko), the comparison of experiences in creating paper-based (PB-MM) and digital mind maps (D-MM) in technological education by future teachers of natural sciences, and identifying their opinions on these techniques, as well as assessing their impact on student learning and motivation, and methods for their effective use in the educational process (M. Debbag, B. Cukurbasi, M. Fidan). The analysis of works exploring various methods of presenting information has allowed for the identification of radiant thinking theory, developed by American psychologist T. Buzan, as the basis for designing an innovative teaching method called mind mapping. However, despite numerous developments in the scientific literature on the problems of students' educational and cognitive activities, the issue of using mind mapping techniques to activate its collective form remains insufficiently explored.

The purpose of the article is to explore the potential of mind mapping techniques as a tool for activating the group educational and cognitive activities of future computer science teachers.

The research methods employed included theoretical (analysis, comparison, and synthesis of scientific findings from psychological and pedagogical literature by both domestic and foreign authors, including electronic publications and internet resources) and empirical methods (observation of the process of using mind mapping techniques to activate the group educational and cognitive activities of future computer science teachers).

Presentation of the main material. The issue of activating cognitive activities among learners has concerned many researchers in recent times. In pedagogical research (V. Davidova, D. Elkonin, P. Galperin, L. Zankova), the activation of cognitive activities is often viewed as organizing the perception of

educational material by students, where knowledge acquisition occurs through uncovering connections between phenomena, comparing new information with known information, specifying, generalizing, and evaluating educational material from different perspectives. It is also noted that activation is an activities aimed at stimulating the process of students' awareness of their common interests and needs as a single group, defining necessary means and active actions to achieve conscious goals [8, p. 30]. Additionally, it is the organization of learning during which educational material and methods of acquisition become subjects of active mental and practical actions [11]. It manifests in the intensity and productivity of activities, driven by sustained interest.

The use and improvement of various forms and methods of teaching primarily stimulate the activation of the educational process, which subsequently leads to the activation of students' cognitive activities. It is believed that the activation of educational and cognitive activities involves not only increasing the intensity of its course but also mobilizing the student's intellectual, emotional-volitional, and physical efforts. This is accomplished by the instructor using certain means and is directed towards achieving specific educational goals. Moreover, the formation of the personality in the educational process occurs through active engagement and communication with the instructor (teacher) and peers, that is, during social interaction.

In turn, students' group educational and cognitive activities is considered a type of organizational activities that involves fulfilling their need for cooperation and communication. This includes their awareness of a common goal, ensuring conditions for joint interaction, combining the efforts of all participants, coordinating actions, purposeful division of labor, interconnection, mutual assistance, and mutual control among students in the process of solving a given task [22]. The collective form of learning is one of the most effective interactive techniques for intensifying students' educational and cognitive activities. The application of collective cooperation among students during classroom sessions

allows for the full realization of the concept of interactivity through the organization of so-called co-learning or mutual learning [3].

The concept of collective learning is implemented through a system of principles, the main one being the principle of mandatory and continuous exchange of knowledge, where all group members share the material they have learned during the educational process. Technologies that transform the student's role from a consumer of ready-made information to a co-creator of «collective knowledge» should be highlighted. These include Web 2.0, following which the concept of «e-collaboration» emerged. E-collaboration is defined as a set of actions aimed at supporting interaction among people electronically via the Internet, who work together to solve common tasks. Its key elements are a common task that can be broken down into subtasks; a list of roles that help accomplish individual subtasks of the overall task; technologies and services for electronic collaboration; people involved in accomplishing the common task; specific competencies possessed by the involved individuals; the physical (material) environment in which these individuals operate; and the social environment [15, p. 641].

In the opinion A. Kharkivska and V. Malykhina, «the manifestation of competence is assessed on the basis of the total graduate`sskills formedness (that integratively reflects this competence) and its behavioral (psychological) reactions that are manifested in a variety ofsituations» [9].

To activate group educational and cognitive activities and to enhance mental processes such as perception, comprehension, memorization, and rapid reproduction of key aspects of information, it is appropriate to seek visual tools and forms of knowledge presentation based on cognitive visualization. Under such conditions, intuitive tools for demonstrating the thinking process and structuring information in visual form, such as mind mapping techniques , can be applied. It is important to emphasize that in the context of an intensive information flow, the importance of knowledge visualization and the use of mind mapping techniques becomes critical for improving the quality and efficiency of the educational process. The education sector must actively implement innovative methods, among

which concept mapping is recognized as one of the promising strategies for activating the educational and cognitive activities of learners. This approach allows for the creation of convenient and interactive learning tools, as well as the development of students' creative and critical thinking, preparing them for the challenges of the 21st century [25].

According to various researchers, mind mapping techniques is a convenient technique for representing the thinking process or structuring information in a visual form; it is a graphical reflection of multidimensional thinking processes. It is used for generating, demonstrating, structuring, and classifying ideas, as well as an auxiliary tool in learning, organizing, problem-solving, decision-making, and document writing. Mind mapping techniques involves the effective creation and use of mind maps and is a specific method that allows the thinking process or information structuring, objects, and connections between them to be presented in a visual form for better understanding [13]. A review of works by T. Buzan, H. Müller, E. Volkov, and others has refined the definition of «mind maps» (knowledge maps, thought maps, intellectual maps, mental maps, memory maps, concept maps) as a convenient technique for representing the thinking process or structuring information in a visual form. According to Tony Buzan, mind mapping is an effective graphical technique that is a universal key to unlocking the brain's potential, and a mind map is an expression of radiant thinking, which is a function of the human brain [5]. In the study [7, p. 49], the authors interpret digital mind maps as a tool that allows the creation, editing, and organization of information using computer software. In digital mind maps, relationships between concepts are automatically established by computer software, which facilitates the process of reviewing, updating, and storing maps. Digital mind maps also allow the addition of multimedia materials, which increases the visual richness of the maps and eases the processes of information correction.

Mind maps address several groups of educational tasks [6]: facilitating meaningful learning (developing meaningfulness and understanding in the learning process); providing additional learning resources; ensuring feedback from learners;

and assessing learning and its success. These groups of educational tasks can be expanded to include those specific to e-learning or blended learning systems – structuring the informational space of a discipline with the aim of visualizing connections between elements of the discipline and various learning objects, enabling automated transitions between various learning objects, and supporting individual educational trajectories (both pedagogically for constructing comprehensive knowledge and technologically for ensuring transitions between objects in the information system) [20].

Therefore, the pedagogical goals of using mind maps in the educational process are:

- The development of the learner's personality, preparing them for life in the modern conditions of informatization and globalization of society.

- The development of thinking, forming a knowledge system that allows structuring one's cognitive activities.

- The formation and development of learners' ability to carry out information processes such as collecting, storing, and archiving information.

- The development of the ability to thoughtfully perceive integrated information.

In the context of students' group educational and cognitive activities, mind maps can be utilized for planning events, creating to-do lists, developing projects of varying complexity, making presentations, effective communication, intellectual development, idea generation, solving group problems, improving relationships among students, analyzing results or events, summarizing information, and organizing interaction in group work or role-playing activities. They can facilitate effective teamwork during brainstorming sessions, decision-making processes, and knowledge management.

The use of mindmapping techniques fosters the development of specific skills and qualities in learners, such as setting cognitive goals, seeking information, forming concepts and establishing connections between them, structuring knowledge, encoding, recoding, and modeling, synthesizing, analyzing,

classifying, systematizing, and generalizing, communicating and interacting, learning in collaboration, and engaging in discussions. Thus, the core technique of using mind maps is based on the principle of «radiant thinking», which pertains to associative cognitive processes with a central object as the starting point or focal point. This illustrates the endless variety of possible associations and the inexhaustible potential of the brain. This method of recording allows the mind map to grow and be supplemented indefinitely.

The process of creating a mind map is quite simple, accessible, and should be characterized by purposefulness, systematization, completeness, simplicity, clarity, conciseness, associativity, and structure [23]. When constructing a mind map, the following principles must be considered: emphasis (focusing attention on the central image); intensive use of graphic images (color schemes, image depth); synesthesia (combining all types of emotional-sensory perception); variation in fonts, line thickness, and graphic scale; optimal placement of elements on the map; presence of arrows to emphasize connections between elements; coding information and using abbreviations; hierarchical lines, with main branches highlighted in bold and connected to the central image; limiting important blocks with lines; and maximum clarity of drawings [5].

For mind maps, it is crucial to use keywords that help recall meanings and details. When creating a map, avoid writing only one keyword over each branch. This will enhance its accuracy and memorability. Constructing mind maps involves the following stages: the preparatory stage, the implementation stage, and the summary stage.

- *Preparatory Stage*: Identify the main topic or central idea of the mind map. Gather relevant information and resources. Choose keywords and concepts that will be used in the map.
- *Implementation Stage*: Start with the central image or main idea in the center of the map. Draw branches radiating out from the central image, each representing a main concept or category related to the topic. Use keywords, images, colors, and symbols to represent these concepts. Ensure that the branches

are logically connected and clearly labeled. Vary the font sizes, line thickness, and colors to highlight different levels of importance and to make the map visually appealing.

- *Summary Stage*: Review the mind map to ensure all relevant information is included and that it is well-organized. Check for clarity, completeness, and consistency. Make any necessary adjustments to improve the overall structure and readability of the map. Use the mind map as a reference tool for studying, problem-solving, or project planning.

By adhering to these principles and stages, mind maps can effectively facilitate the planning of events, task management, project development, presentations, communication, intellectual development, idea generation, group problem-solving, relationship improvement, result analysis, and interaction in group work or role-playing activities. Mind maps also support brainstorming sessions, decision-making processes, and knowledge management, ultimately enhancing the learning experience and fostering collaboration among students.

Given that mind maps are a relatively new tool in the educational process, it is worthwhile to consider the process of creating them. Today, there are numerous digital tools available for this purpose, each with common features as well as different capabilities. It is convenient to classify these tools into the following categories: free, licensed, and web services. Among the free programs, notable examples include FreeMind, ThePersonalBrain, XMind, and others. The next category consists of licensed programs, which include MindManager, ConceptDrawMindMap, iMindMap, MindMapperJr, and others. Web services, such as MindMeister, Bubbl.us, Mindomo, and Mind42, belong to the web services class. This class is interesting to users because it provides the opportunity to work online.

Let's consider the advantages and features of some of them.

Free programs

FreeMind (https://freemind.sourceforge.io/). This is a free program for creating mind maps. FreeMind is written in Java and distributed under the

GNU General Public License. The program has advanced export capabilities. XHTML export allows you to create a map-scheme with a branched structure and links to external sources. One of the most common free programs for building mind maps (Fig. 1).

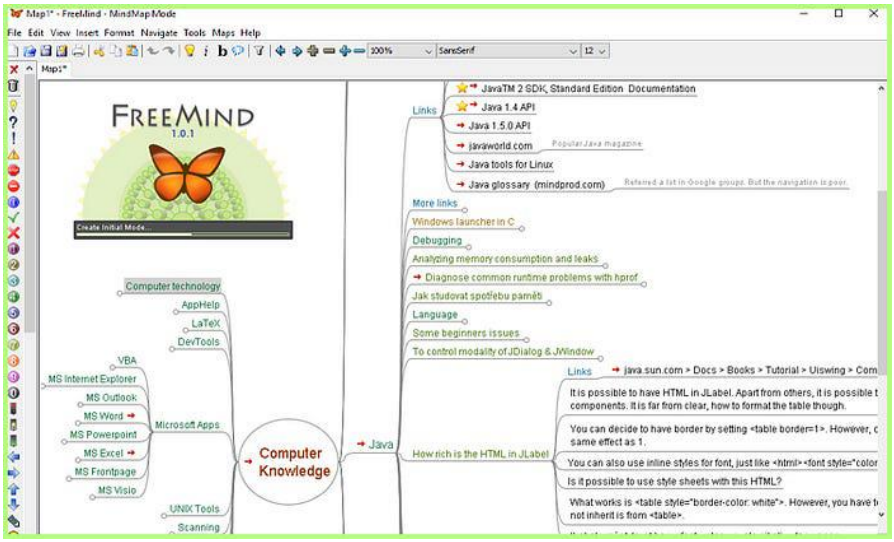

Fig. 1. Mind map created by FreeMind

This program has a number of advantages: intuitive management; availability of basic functionality for building mind maps; the ability to save the map in various formats (JPEG, PDF, HTML, etc.). The features of the program are that it is necessary to install Java before installing the program; it is impossible to attach documents and files to branches; graphic elements are of rather low quality, but you can attach your own [17].

TheBrain (https://www.thebrain.com/). TheBrain, formerly PersonalBrain, is a mind mapping and personal knowledge base software from TheBrain Technologies. It uses a dynamic GUI that displays hierarchical and network relationships. The company «Brain» produces four software products, of which only this one is free (Fig. 2). Among the advantages of this program is the ability to look at the map in different planes (viewing in this way allows you to use spatial thinking), the ability to attach files (in various formats), folders and links to the topic; convenience of creating catalogs of pictures: when hovering over the icon attached to the topic of the picture, it increases to its natural size.

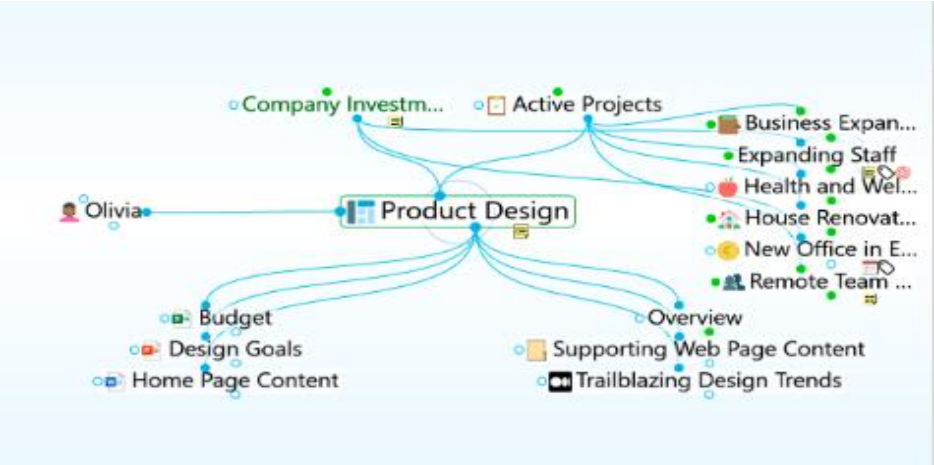

Fig. 2. Mind map created by TheBrain

The features of this program are that there is no own library of graphic elements; it is not possible to see all levels of the map in one space, for this you need to move around the map.

XMind (www.xmind.net)**.** Free program for creating mind maps. This is free software for brainstorming and making mind maps. The program allows the user to record his thoughts, organize them into various diagrams, and use them together with other users. It is enough to register on the website by filling out a small form (Fig. 3) [24]. It has a bright design, opportunities for SWOT analysis, the use of Gantt charts, and is quite effective for team work.

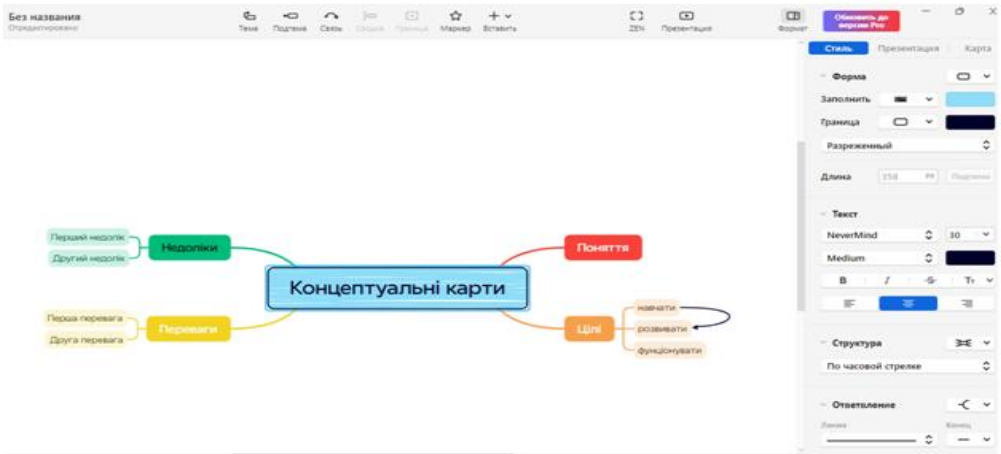

Fig. 3. Mind map created by XMind

The advantages of the XMind program are that after registering on the site, you can post your maps on the Internet resource of the same name; for a small fee,

you can get additional features: audio notes, card sharing, task information, filtering, presentation mode. The features of the program are that the free version does not convert files in PDF format, text document, PowerPoint, MindManager.

EdrawMind (https://edrawmind.wondershare.com/). A free program for drawing mind maps, differs from its counterparts in that it is built on the basis of vector graphics. The construction of mind cards in this program resembles the assembly of a constructor: you can add a picture, arrow, theme, etc. to any part of the workspace (Fig. 4).

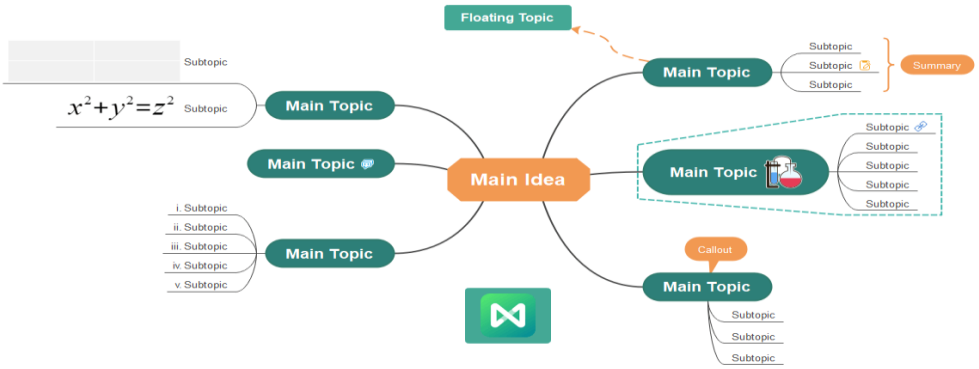

Fig. 4. Mind map created by EdrawMind

The advantages of this program are many design options for graphic elements (arrows, topics, lines, background); a large space for creativity, because elements can be added to any part of the workspace; you can use a «pencil» to draw lines of any shape and size, sign them. Features: the editor is different from the usual work with raster images; if you do not have experience with vector graphics, it will take some time to get used to it.

DropMind (https://dropmind.uptodown.com/windows/download). Only the beta version of the program is available for download from the site (Fig. 5).

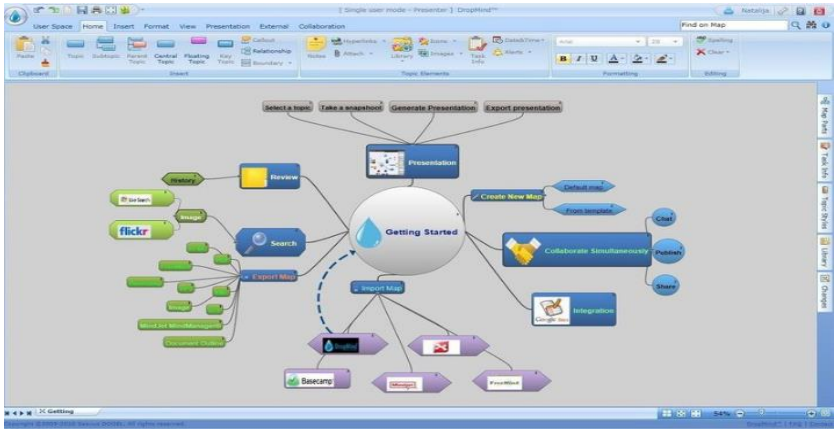

Fig. 5. Mind map created by DropMind tools

The advantages of this program are: a simple interface, convenient navigation, management is similar to MindManager 7 in a shortened version; it is possible to export maps from MindManager (converted without saving pictures). The features of the program are that it is not possible to add pictures from the clipboard, the own collection of pictures is very small; does not integrate with MS Office business programs; download requires registration [17].

Ayoa (iMindMap) (www.imindmap.com). Created by Chris Griffiths, a leading mind mapping expert, and Tony Busan, the inventor of the mind map, it has been a huge success and has been used by millions of people. As a desktop-only program, it limited users' ability to share and collaborate, so in 2019 Chris and the OpenGenius team decided to go beyond simple mind mapping with the launch of Ayoa, a new generation of mind mapping software that delivers the future of work and training. The popularity of this program is quite high. It may be because it was developed for Ukraine. A more accessible and simple (in terms of functionality) analogue of the MindManager program (Fig. 6) [12].

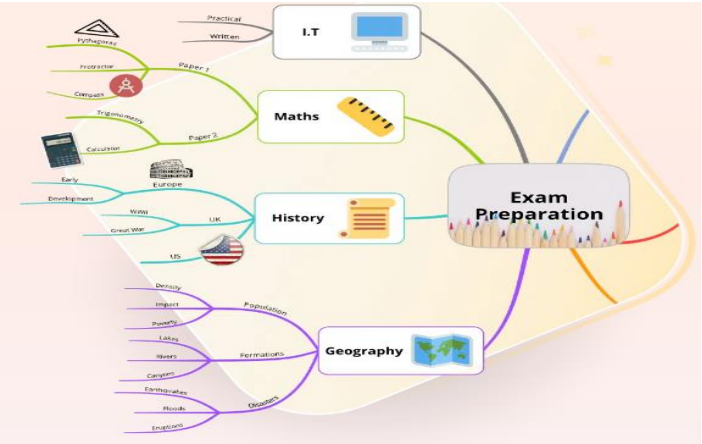

Fig. 6. Mind map created by means of Ayoa

The advantages of this program are: beautiful design of the branches, as if the branches were drawn by hand. You can also change their angle of inclination and add curves; the image can be added not only to a certain place (top or side), but to any place on the map. Pictures can also be freely moved; the program is integrated with MS Office (Word, Outlook, Project); you can import maps in MindManager and FreeMind program formats; the cost is much lower than the Mindjet product. The program offers 4 modes: capturing ideas and thoughts, brainstorming, creating mind maps, converting data into 2D and 3D presentations, pdf files, tables and other formats. Program bonuses include spell checking, adding audio files, and archiving. However, a big disadvantage for the student audience is that the use of this service is not free. The features of the program are that it is not possible to insert diagrams and tables; it is impossible to vary the thickness of the lines; due to the special location of the branches, the map is not compact. Therefore, if you need to record a large amount of information, you will have to spend a little more time on operating the map and navigating on it.

Licensed programs

MindManager (https://www.mindmanager.com/). Commercial mind mapping software developed by Mindjet, which describes the maps created with MindManager as «business maps» for use in enterprises, replacing handwritten memory maps. One of the most popular and most functional programs (Fig. 7).

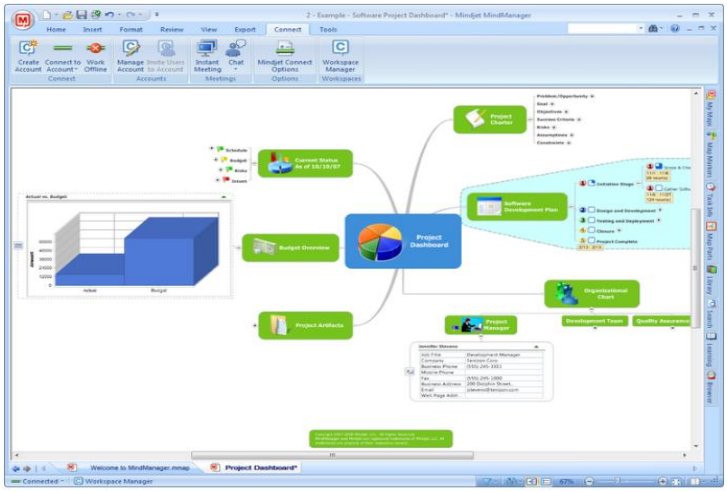

Fig. 7. Mind map created by MindManager

The advantages of this program are that MindManager is integrated with MS Office applications (Word, Excel, Outlook, PowerPoint); the ability to attach any files, links, folders; the interface is similar to Office 2007, intuitive; an incredible number of tools and functionalities. Features of the program are a relatively small number of templates for the appearance of branches; the program has a lot of possibilities, so it will take a little more time to master it; English only.

ConceptDrawMindMap (https://www.conceptdraw.com/). Mind mapping and brainstorming software developed by CS Odessa for Microsoft Windows and Apple macOS operating systems. The visual thinking techniques of mind maps was invented by Tony Busen in the 1960s. The popularity of this program is quite high. It may be because it was developed for Ukraine. A more accessible and simpler (in terms of functionality) analogue of the Mind Manager program (Fig. 8).

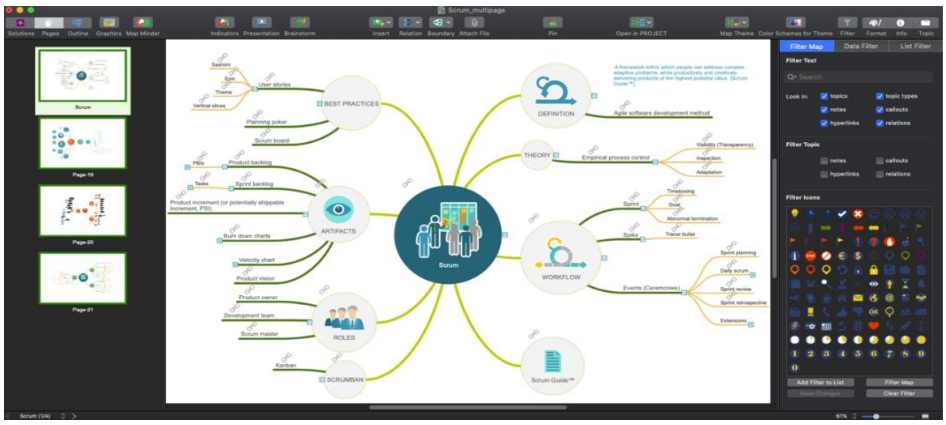

Fig. 8. Mind map created by means of ConceptDrawMindMap

The advantages of this program are: very simple navigation, nothing extra; the ability to attach folder files, links; a powerful graphics module, the ability to draw lines, add beautiful pictures from the library. Features of the program are: it is not possible to insert charts and tables; it is not possible to add a map to the presentation; copies of maps converted to other formats can only be opened in Concept Draw applications (no integration with Microsoft Office), English only.

MindNode (https://www.mindnode.com/). Paid application for creating mind maps on Mac/IOS. The program has a modern minimalist design and is very easy to use. It supports integration with all Apple devices, works well both on the iPad and in the mobile version. The application allows you to export the created mind maps in the following formats: JPG, PDF, TIFF, text formats, and also supports the export of mindmaps in the format of the competing program Freemind. For users unfamiliar with the program, a trial version of the program with a limited set of MindNode Lite functions is available (Fig. 9).

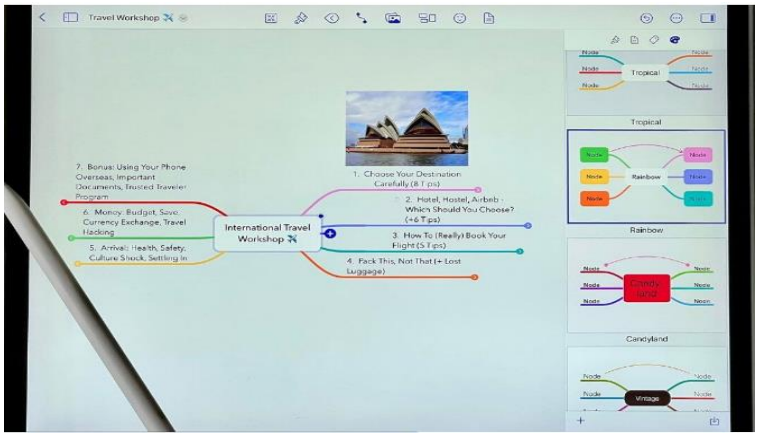

Fig. 9. Mind map created by MindNode tools

Mapul (https://www.mapul.com/). Paid online application for creating mind maps. The Mapul service works on a monthly subscription basis. The program is distinguished from all other applications by its whimsical design of mind maps (Fig. 10).

Fig. 10. Mind map created by Mapul

Scapple (https://www.literatureandlatte.com/scapple/). Scapple enjoys the distinction of being developed by writers for writers. The group «Literature and Latte» was formed in 2006 with the sole purpose of offering writers a simple way to develop their skills (Fig. 11).

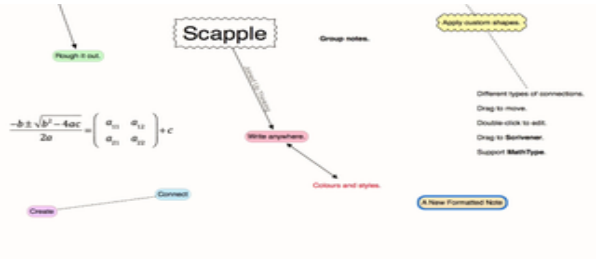

Fig. 11. Mind map created by Scapple

Scapple enjoys the distinction of being developed by writers for writers. The group «Literature and Latte» was formed in 2006 with the sole purpose of offering writers a simple way to develop their skills. The result has been one of the best-known mind map tools on the market today. On first launch, Scapple invites users to double click anywhere on the blank canvas to create a note. You can repeat this process as many times as you wish to offload your initial 'brain dump'. Scapple also supports importing text files, PDF's and even images. You can then work out how to link various ideas together. Scapple has been particularly praised for being easy to master compared to other mind map software due its small number of mind map tools. This does mean however that more advanced features such as embedding audio & video aren't supported. Although the program itself is lightweight, Scapple won't burden your purse too heavily. There's a 30-day

free trial, which only counts down those days on which you actually use the software [4].

Online programs

WiseMapping (www.wisemapping.com)**.** WiseMapping is a free, open source, HTML5 mind mapping online application. The program can be used directly on the developers' website, or you can download the open code of the program and install it on your own web server. The application has the entire set of functions for working with smart card techniques (Fig. 12). This program allows you to export in text format or to Excel, classic image capabilities, but there are difficulties with drawing additional nodes [21].

Fig. 12. Mind map created by WiseMapping

MindMeister (www.mindmeister.com)**.** Collaborative mind mapping software that allows users to visualize their thoughts in the cloud. Program for creating mind maps online (Fig. 13).

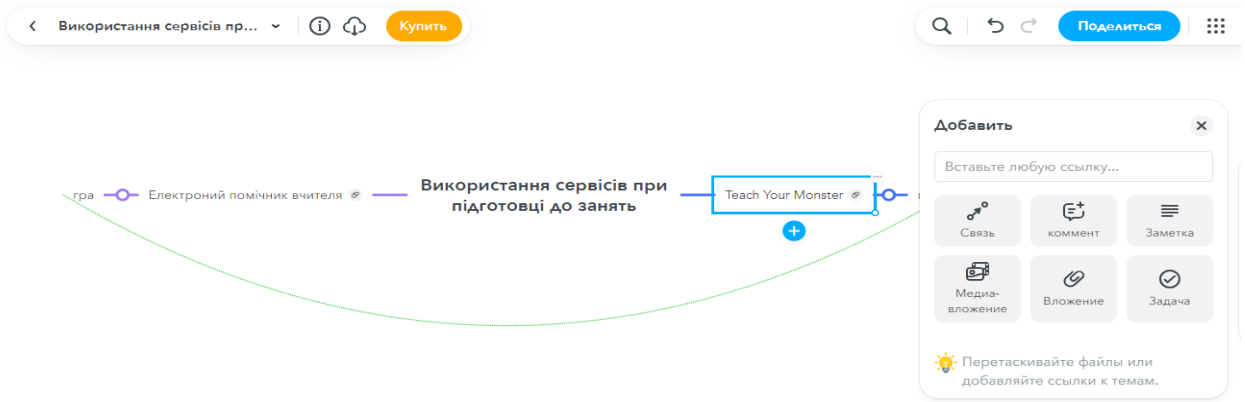

Fig. 13. Mind map created by MindMeister

The advantages of this program are: the ability to import and export maps from MindManager and FreeMind; the ability to save maps on the server and access them from any computer; the ability to attach files to branches; there is a free version of Baisic. Free version (with functional limitations). The features of this program are that the graphic symbols are very small in size, and their selection is small; it is not possible to vary the color of the lines and their shape; registration is required before accessing the resource [17].

Draw.io (https://www.drawio.com/). Free online service for creating diagrams and flowcharts, various forms and structures. Features of Draw.io: No registration is required, instead, when you first log in, you have to choose where to save your files. If in the cloud (for example, Google Drive), then authorization through the corresponding service is required. Files are not stored in Draw.io, but in cloud storage – on Google Drive, OneDrive, or your computer's hard drive. A multifunctional tool. In addition to mind maps, you can make flowcharts, infographics, visualize business processes and even design page layouts. There are online and desktop versions. The tool is free without any restrictions (Fig. 14).

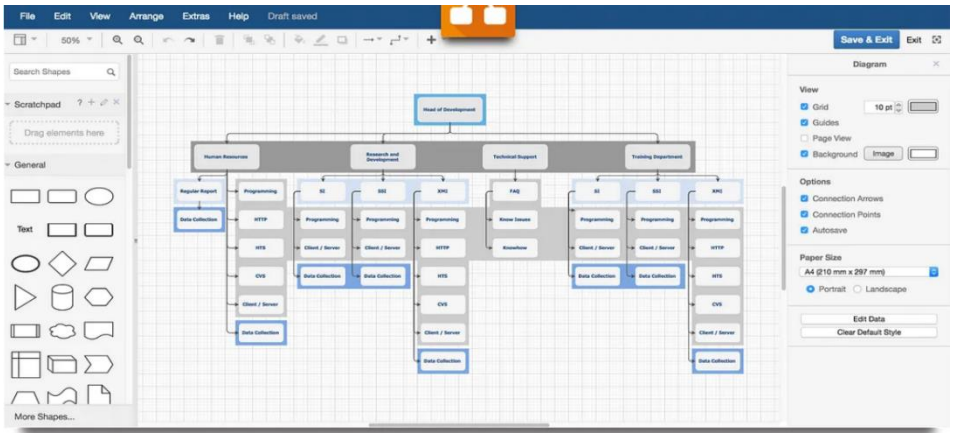

Fig. 14. Mind map created by Draw.io

MindMup (www.mindmup.com A program for creating mind maps, written mainly in JavaScript and designed to work in HTML5 browsers. It can also be used to create argument maps and concept maps. Features of MindMup: the ability to create a knowledge map from the Google Drive application, all the basic possibilities for creating a high-quality design are present, simple management,

free export to PDF (the link is available within 24 hours), maps are synchronized if there is one acanthus on the devices, import of pictures from disk or cloud in 2 clicks, free package: (users of the free version can create public maps up to 100 KB for a period of 6 months) (Fig. 15). The program contains all the possibilities for high-quality design (for example, the ability to upload photos), is quite simple for beginners, allows you to import pictures from disk or the cloud in 2 clicks. However, the positive effect of free export to PDF is balanced by the fact that the link can only be available for a day [21].

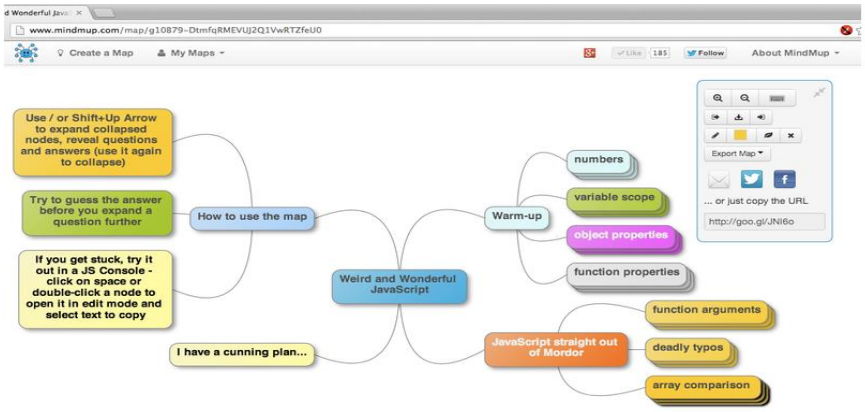

Fig. 15. Mind map created by MindMup

Visme (https://www.visme.co/). You can create maps online for free using the Visme editor. The editor offers many templates, among which you will definitely find the one suitable for your ideas. You can always create your card from scratch. Grab the shapes and lines from the Diagramming section of Visme's sidebar and create your own mind map, perfect for your next brainstorming session (Fig. 16).

Fig. 16. Mind map created by Visme

Canva (https://www.canva.com/uk_ua/). An online editor that includes a large set of templates for design. Functionality allows you to create attractive photo collages, presentations, infographics. There is a free version (Fig. 17).

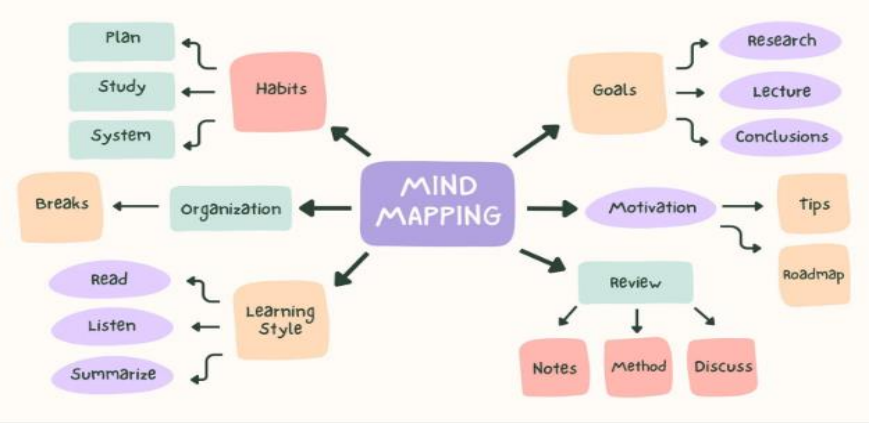

Fig. 17. Mind map created by Canva

Mindomo (https://www.mindomo.com/). Free online program for building mind maps with convenient navigation. Ideal for brainstorming (Fig. 18).

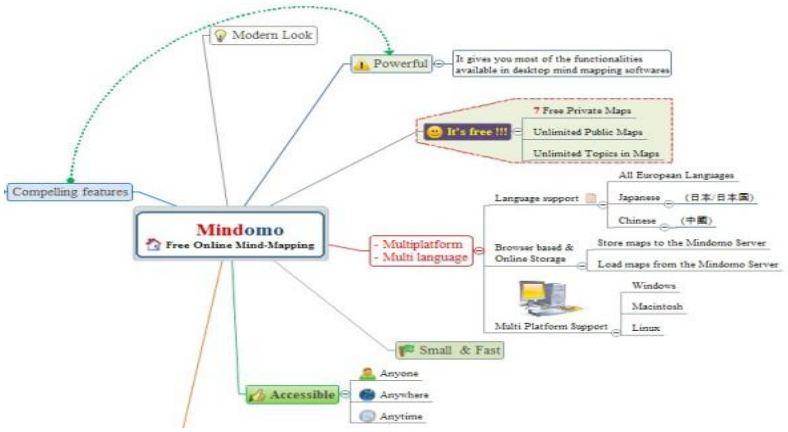

Fig. 18. Mind map, created by Mindomo

The advantages of the program are that it supports most operating systems and browsers; support for several languages; the possibility of importing smart cards in other formats. The features of the program are that it is impossible to remove advertising blocks from the page on which the map is created; the maximum number of cards that can be saved is 7.

Mind42 (www.mind42.com)**.** A free online software application that supports the creation of mind maps. It is a specialized tool for quickly creating,

managing and editing the data structure required for mind maps. Mind42 is useful for creating, organizing and improving ideas in a graphical form (Fig. 19).

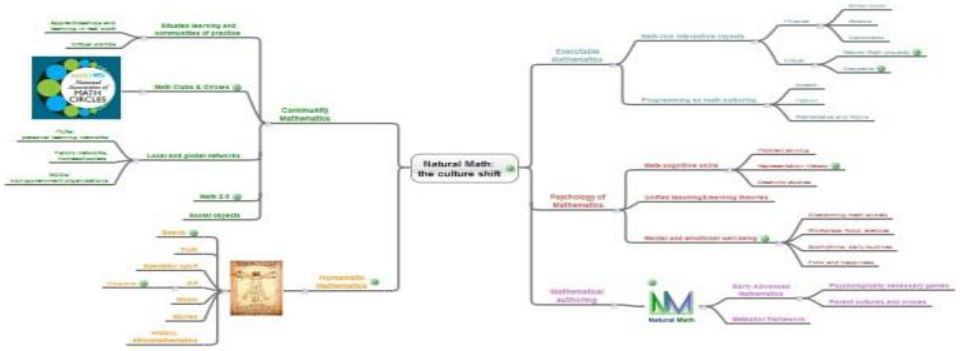

Fig. 19. Mind map created by Mind42

Its charms are the possibility of simultaneous involvement of several people in the creation of the map; the ability to import maps from other programs, integrated image search from Google, Yahoo, Flickr. Disadvantages of the program are the impossibility of downloading to work outside the Internet network connection, the need to register to access the resource, adding pictures only as links [21]. In addition, the advantages of this program are that several people can work on the map at the same time; it is possible to import maps from other extensions: Mind42.com (*.m42), Freemind (*.mm), MindManager (*.ttar; *.XML); integrated image search by Google, Yahoo, Flickr, it is possible and accessible if you click on the icon to add an image. The features of the program are that registration is required before accessing the resource; it is impossible to add pictures from files, only as a link.

Attention should also be paid to other online programs for creating mind maps (Fig. 20-26) [16].

Fig. 20. Mind-map created by Dream-X

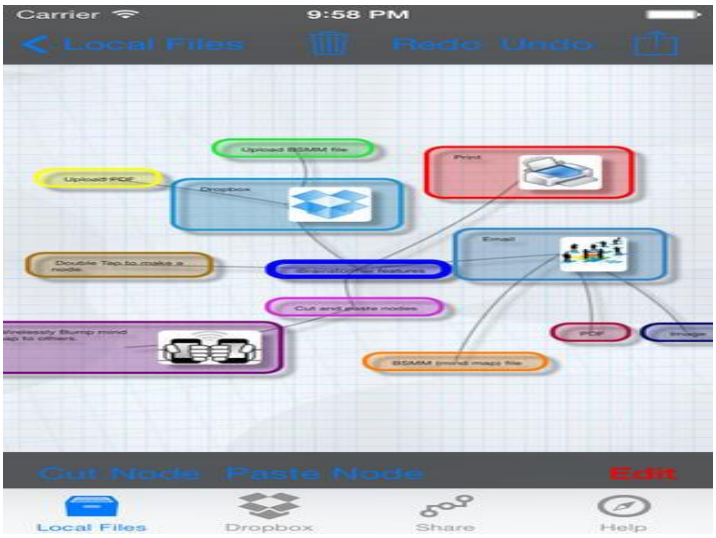

Fig. 21. Mind map created by iBrainstormer

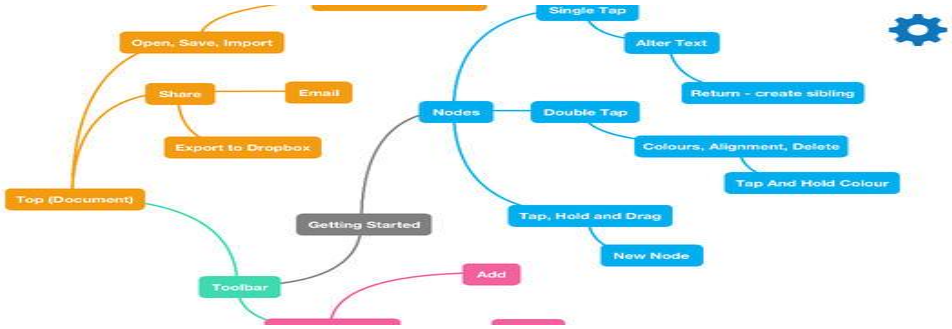

Fig. 22. Mind map created by Fluent Mindmap

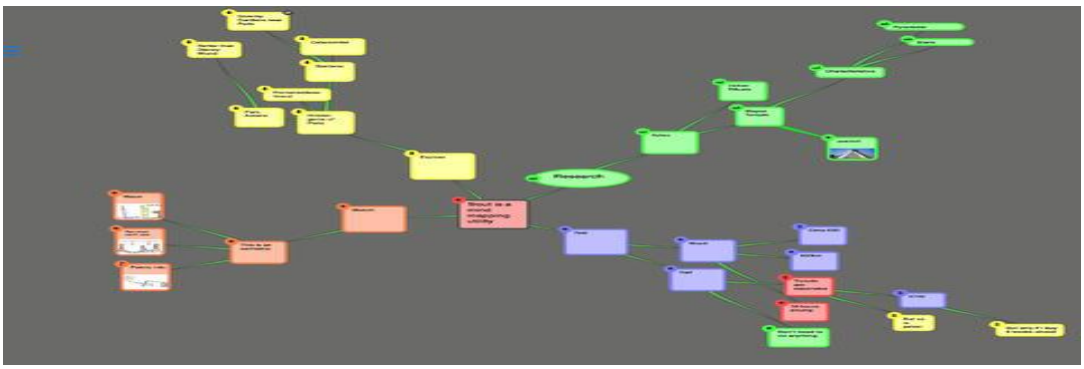

Fig. 23. Mind map created by Trout

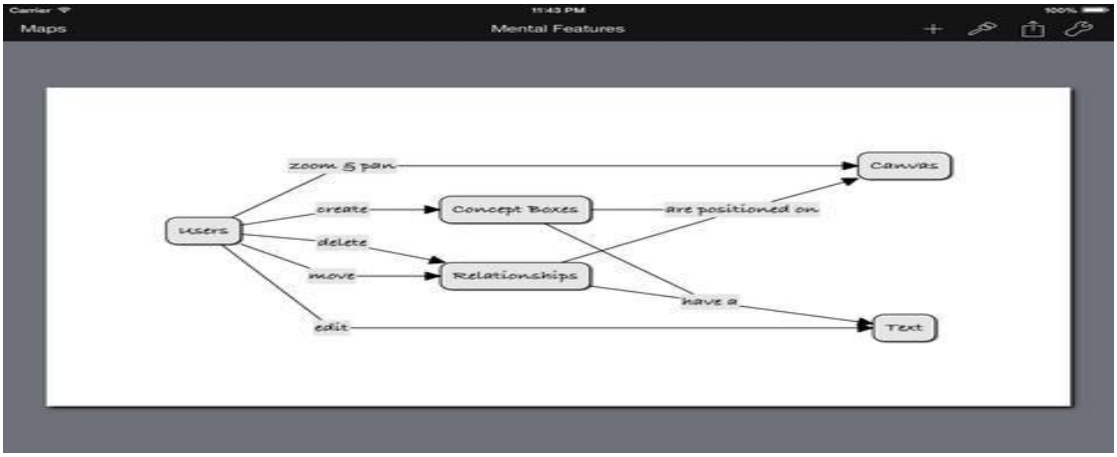

Fig. 24. Mind map created by Mental

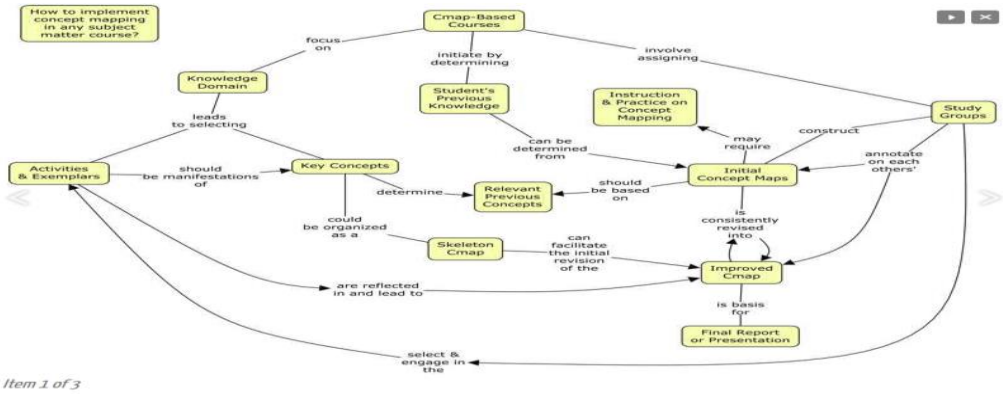

Fig. 25. Mind map created by CmapTools

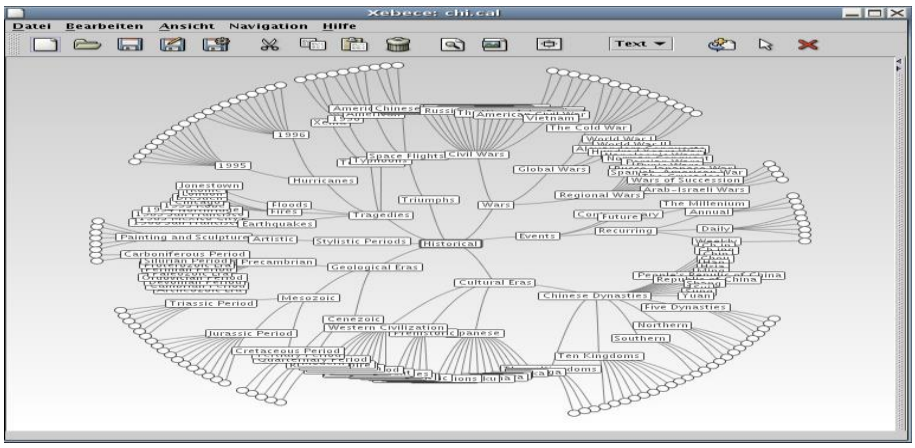

Fig. 26. Mind map created by Xebece

Coogle (www.coggle.it). An online application for creating mind cards, which provides a free tariff plan (Fig. 27). We consider the main attractions of this program to be the ability to return to the previous version of the map, all changes made by the author are instantly displayed in the browser, which allows you to create collective mind maps. With a free subscription, authors are provided with 3 private diagrams and unlimited public diagrams and images for download, as well as about 1,600 icons, auto-arrangement of branches, shared folders, embedded diagrams [21].

Advantages of the service [18]:

• Nothing needs to be downloaded or installed, the service works in a browser.

• In this program, it is quite easy to develop convenient and beautiful mind maps from the first time.

• The program supports the use of images, individual color schemes and the ability to view the history of the document.

• Saving the history of changes allows you to return to previous versions of the created mind map.

• Mind maps created in Coggle can be exported in PNG or PDF format.

• Coggle supports team collaboration on projects. The program interface is quite simple, the prompts are nearby, so it is not very difficult to understand the management.

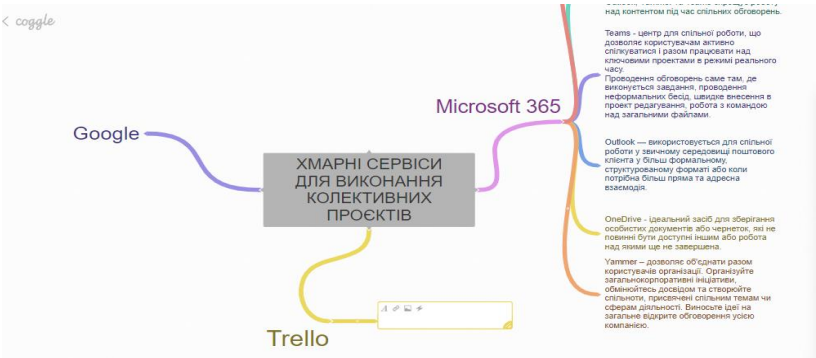

Fig. 27. Mind map created by Coggle

Cacoo (https://nulab.com/cacoo/)**.** An online drawing tool that makes it possible to create various types of infographics, including sitemaps, page diagrams, UML (Unified Modeling Language) and network diagrams. The service allows joint work in real time, which means that several users can share with each other and add one diagram to the blog at the same time (Fig. 28) [24].

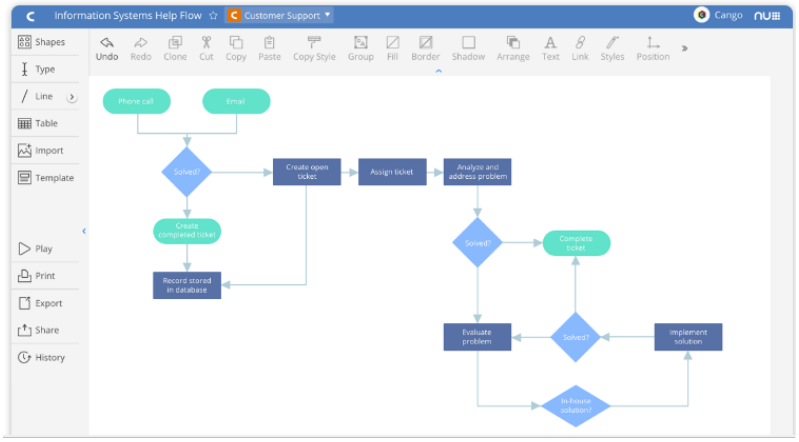

Fig. 28. Mind map created by Cacoo

Visual Paradigm (https://www.visual-paradigm.com/) is a comprehensive tool for creating mind maps, characterized by wide functionality and support for various modeling standards. Consider the key features and benefits of Visual Paradigm: modeling and analysis; animation and visual effects; cooperation and communication; templates and privatization (Fig. 29).

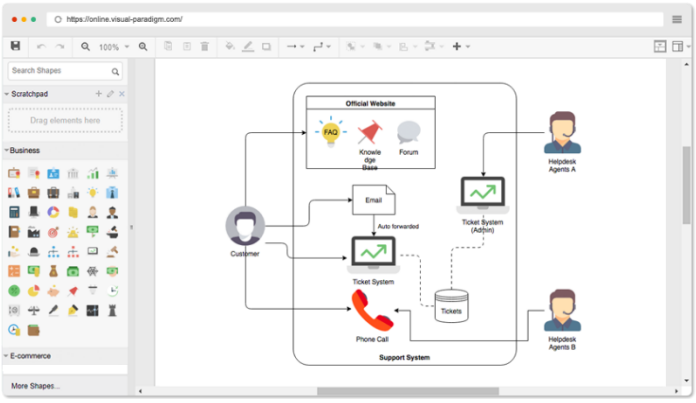

Fig. 29. Mind map created by Visual Paradigm

Popplet (https://www.popplet.com/). An easy-to-use and functionally powerful service that allows you to create mental maps. It allows you to add clouds with text, pictures; add videos from YouTube and Vimeo; change the colors of each cloud and the background of the map as a whole; edit the map together; save the map as an image or pdf file; publish a mental map; show the map in presentation mode; make a recording during the demonstration of the finished mental map screen; print the map; work on an iPad (Fig. 30) [10].

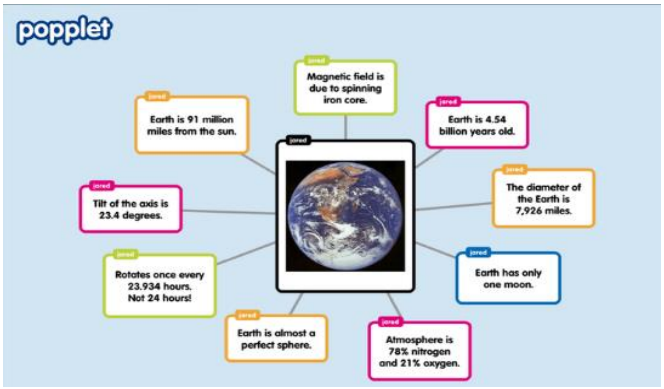

Fig. 30. Mind map created by Popplet

Algor Education (https://www.algoreducation.com/en). A service with which you can automatically synthesize your texts and create mind maps in two clicks: you add text, and the system will create a scheme for you, all you have to do is adjust it as needed. In the free version, you can create 3 maps, get 30 AI credits, host 50 MB of materials and trade with your other maps. Use the blog

posts (https://www.algoreducation.com/blog) for a better understanding of how to use memory cards in education (Fig. 31) [2].

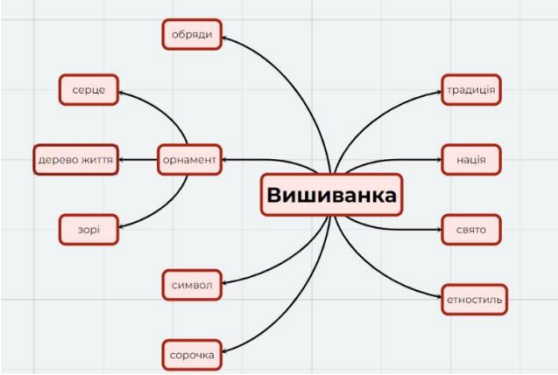

Fig. 31. Mind map created by Algor Education

Miro (https://miro.com/). This is a set of templates that help structure and organize planning or brainstorming. Here you can conduct online lessons, create a work plan or fix tasks that need to be completed. It is possible to invite participants via a link and by e-mail. The interface of the board, although in English, is intuitive. It is convenient to manage it - move the desired templates and other elements with the mouse. The board can be used from a computer or from a smartphone. The advantage of Miro is a variety of tools. Allows you to create endless boards as well as mind maps. You can upload documents, tables, images, draw diagrams and graphs, create collages and much more. Write with a pen or enter text with a change of font, size, color. You can add stickers to the board. Important ideas will remain on the field, users will be able to record ideas or comments, and you will be able to stimulate collaboration and feedback (Fig. 32) [17].

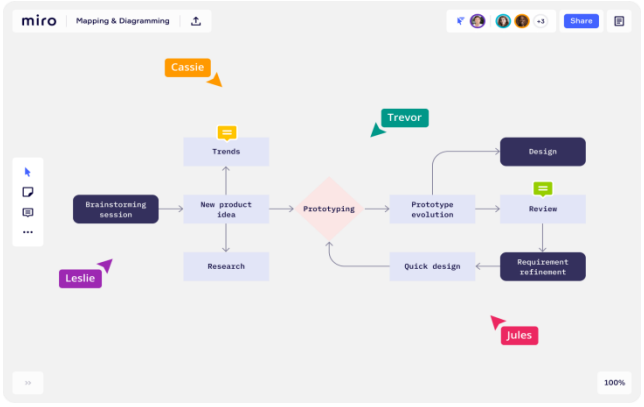

Fig. 32. Mind map created by Miro

Creately (https://creately.com/). Creately is a powerful diagramming tool offering unlimited visual collaboration to create diagrams, including mind maps. Since Creately easily integrates with third-party tools, like Microsoft Teams, Slack, and Zoom, it becomes extremely easy for the team to manage their receptive tasks (Fig. 33).

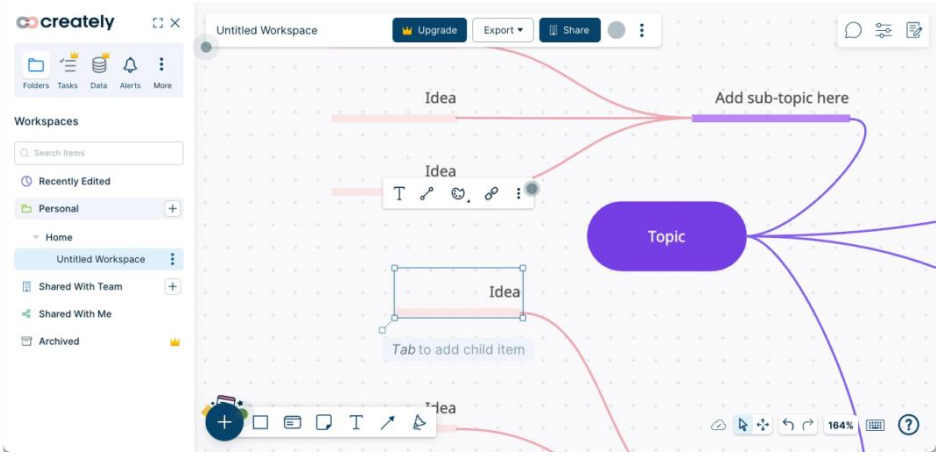

Fig. 33. Mind map created by Creately

Has 70 types of diagramming standards, also provide 200,000+ examples and 8,000+ professional templates. However, the free plan of Creately offers very limited features, encouraging the users to go ahead with either Starter or Business plans. Some beginners might find that there is a learning curve with this tool [1].

Venngage (https://venngage.com/features/infographic-maker) is considered one of the best infographic software for everyone. Apart from infographics, Venngage also lets you create timeline diagrams, mind maps, reports, project management, and more – making it a good graphical organizer. What sets Venngage apart from the others is that it has 3+ million stock photos and 40,000+ icons and illustrations. Pros: 7,500+ pre-made infographic templates. A simple drag-and-drop editor that helps in creating extensive diagrams. Cons: since it is an infographic maker, all your mind maps will look like elaborated infographics. The premium version that lets you export the mind maps in PNG format costs $19 monthly, which is considered a hefty amount for students and beginners (Fig. 34).

Fig. 34. Mind map created by Venngage

ClickUp (https://clickup.com/) is considered one of the best productivity tools out there. From creating tasks to working on different whiteboards, ClickUp offers everything you might require to create dynamic mind maps. Pros: integrates with tools like Zoom, Google, Zapier, Okta, Outlook, and more; offers an automation feature to easily assign tasks and post comments with other tools. Cons: the tool might be a little too complex for beginners and starters who only wish to focus on mind mapping; few users have suggested that ClickUp's customer support team can be improved (Fig. 35) [1].

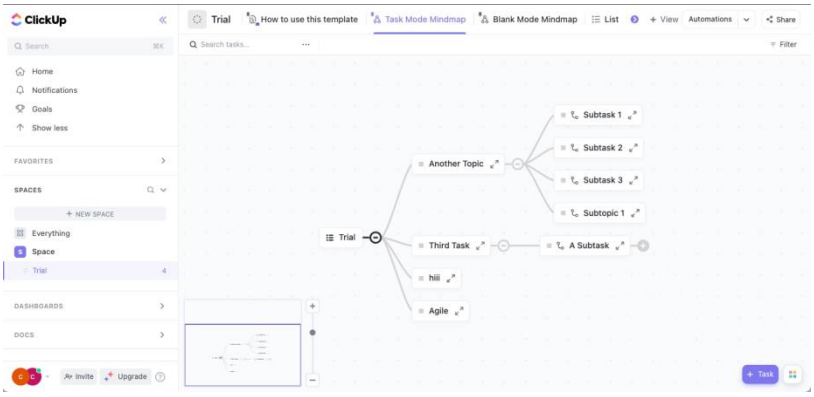

Fig. 35. Mind map created by ClickUp

Boardmix (https://boardmix.com/) is an online collaborative tool that offers a whiteboard, which helps the teams to boost their efficiency. With Boardmix, users can create complex mind maps and use it as a brainstorming and Scrum tool. Teams can also use this mind-mapping software to create flowcharts. It lets you create fishbone diagrams, organizational charts, and concept maps. The free version of Boardmix comes with 200 objects per board. However, there is no

online support system. The team uses a third-party chat option (Telegram) to communicate. Video-sharing options are not that intuitive (Fig. 36).

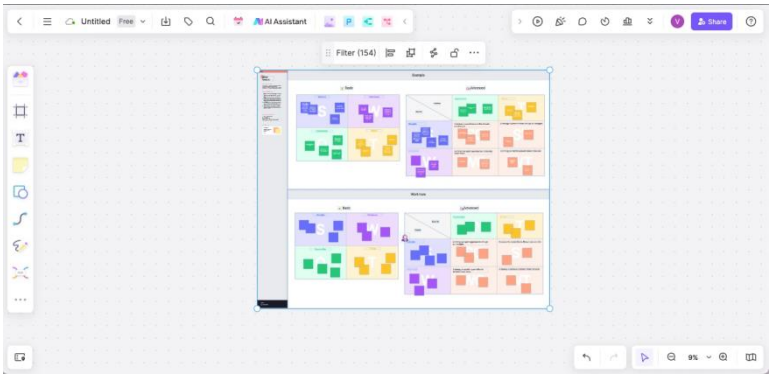

Fig. 36. Mind map created with Boardmix

EdrawMax (https://www.edrawmax.com/online/**)** is a powerful mind-mapping tool that lets you create 280+ other diagrams. From mind maps to network diagrams, flowcharts, floor plans, science diagrams, and HVAC diagrams, you can choose from a wide range of diagrams to make. Pros: EdrawMax provides free cloud storage to all. The tool comes with built-in templates and has 25,000+ vector symbols. Cons: EdrawMax offers online collaboration, but it's not in real-time. The tool has limited mind-mapping functionalities (Fig. 37) [1].

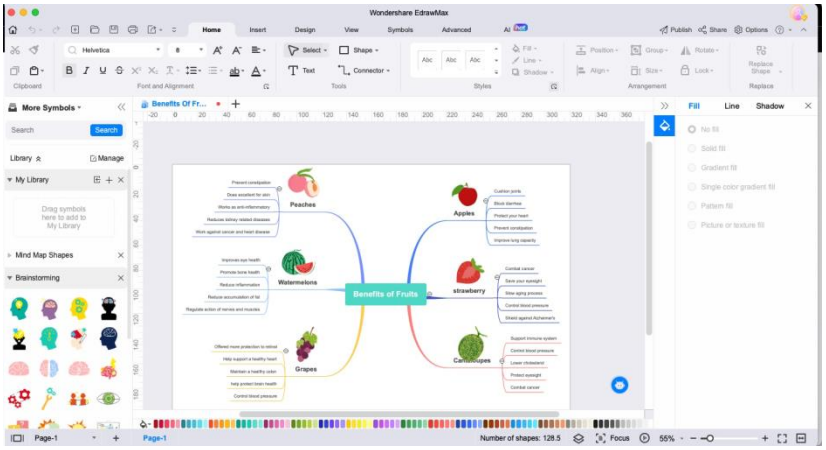

Fig. 37. Mind map created with EdrawMax

In order to choose among such a variety of tools for creating mind maps, it is worth using certain criteria. Yes, to begin with, such a tool should be user-friendly and have detailed online resources to help beginners get started with their first mind mapping scheme. Drag-and-drop features, built-in AI engine, and free

templates are also a few things to look for when choosing a good mind mapping tool. We will list the best software for creating mind maps in 2024, according to Brian Turner, based on a comparison of these tools according to many criteria (from their interface and ease of setup to their customizability and learning curve, also their third-party integrations, collaboration features, and pricing plans) in the following nominations: best overall (Scapple), best all-in-one (Miro), best by features (Mindomo), best for business (MindManager, best for ease of use (Bubbl.us), best free (XMind) [4].

In addition to the above, there are many others that also deserve the attention of educators: Coggle (https://coggle.it/), WiseMapping (https://www.wisemapping.com), IdeaFlip (https://ideaflip.com/), LucidChart (https://www.lucidchart.com/), etc.

According to Wondershare, the following are among the top ten programs for creating mind maps: EdrawMind, MindMeister, MindMup, Venngage, Canva, Miro, Creately, ClickUp, Boardmax, EdrawMax [1].

Today, the direction of using services with built-in artificial mind is very relevant. The construction of mind maps is no exception. For example, the **Mapify** (https://mapify.so/) (formerly Chatmind) service (Fig. 38) is such an artificial intelligence tool that helps to quickly and easily create intelligent maps. With it, users can enter text, and the tool automatically creates a mind map, highlighting the main points. The platform also allows you to customize the map with colors, images and links, providing a unique experience tailored to the user's needs. Another similar free tool based on artificial intelligence that generates visually attractive chronologies of key events for any topic in the form of timelines or mind maps is **MyLens.AI** (https://mylens.ai/) (Fig. 39) [17]. This direction is quite progressive and needs more in-depth research in the future. Of course, artificial intelligence can facilitate the routine work of a teacher, but it is worth observing ethical norms, principles of academic integrity, as well as constantly using critical thinking, since these language models of artificial intelligence can be biased, contain "hallucinations".

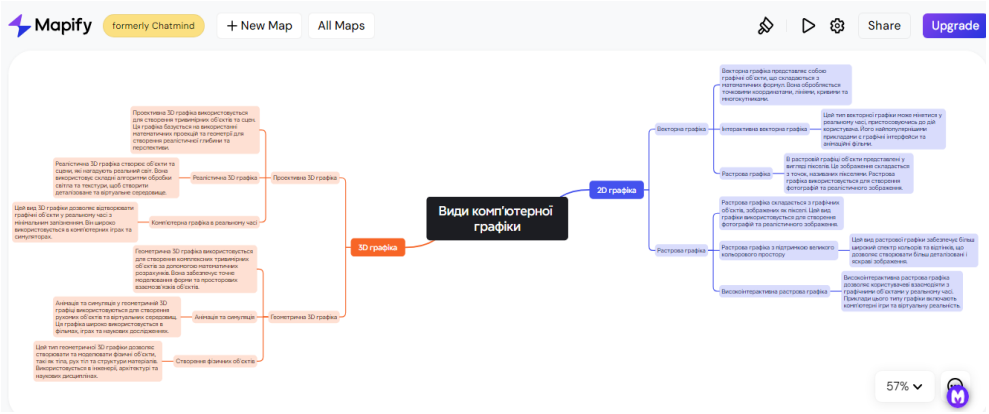

Fig. 38. Mind map created by Mapify

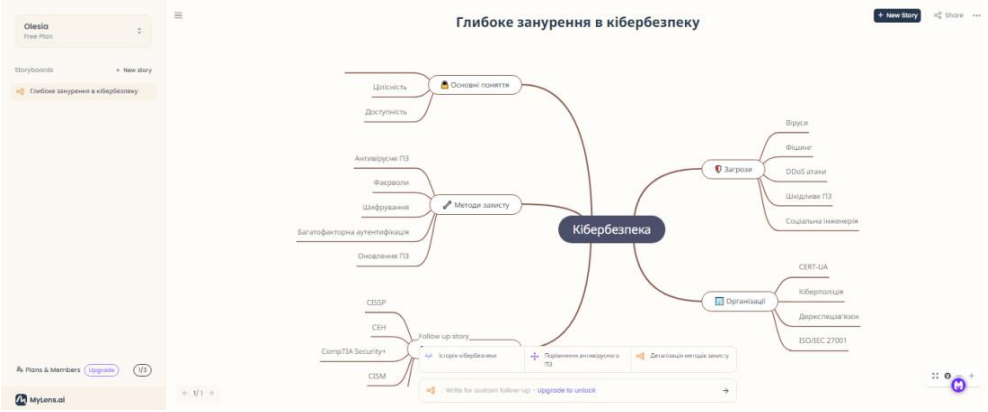

Fig. 39. Mind map created by MyLens.AI

In our opinion, **Bubbl.us** (https://bubbl.us/) is a free online program for building mind maps with convenient navigation, the advantages of which are: the ability to print, post the created map on a blog or website; the ability to work on the map for several people at the same time; you can save the map as a picture or send it to e-mail. Its features are that it is impossible to add pictures; can be distinguished only by color or location in space. Ideal for brainstorming (Fig. 40). The relative freeness (only 3 cards) and not very convenient management can be defined as a minus.

Fig. 40. Mind map created by Bubbl.us

When implementing mind mapping techniques in computer science classes, several specific aspects arise that contribute to the activation of the group educational and cognitive activities of students.

Visualization of concepts and relationships. The creation of mind maps allows you to visualize the main concepts of computer science and connect them to the relevant links. For example, higher education students can create a map in which objects, classes, and programming methods are represented as interconnected elements that help build an overall view of the program code.

Systematization of subjects. Mind maps allow you to structure computer science topics by placing them in a logical order. This makes the recognition and learning of information more organized. For example, you can create a map for the topic «Fundamentals of Algorithmization», which will show a series of steps for creating a program (Fig. 41).

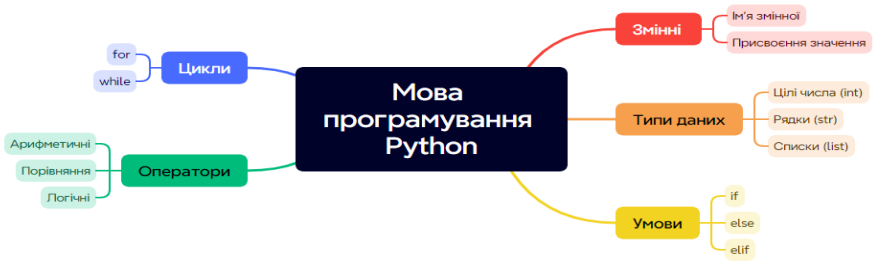

Fig. 41. Demonstration of creating an Mind map using Python as an example

Interaction between subjects. With the help of an mind map, students can see the relationship between different subjects of computer science. For example, when creating a map on the topic «Computer networks», you can pay attention to the impact of network technologies on software development and the use of databases.

Project concept. The use of mind maps contributes to the creation of concepts for information projects. Higher education students can use maps to plan and identify the stages of solving specific problems or developing software products.

Assessment of level of understanding. The use of mind maps can be an effective tool for assessing the level of understanding of the material. The teacher can analyze the student's map, determine his depth of knowledge and ability to think logically.

Encouragement of creative thinking. The creation of conceptual maps contributes to the development of students' creative thinking, as they independently determine the coherence and structure of concepts. This can affect the ability to solve non-typical problems in the field of computer science.

Mind mapping techniques can be an effective tool at various stages of studying any topic of the educational component, helping in the formation of skills, control and systematization of knowledge.

We will give examples of mind maps created by students during a practical session within the educational component «School computer science course and its teaching methods», presented in fig. 42-44. Yes, during the explanation of new material on the topic «Computer graphics». the teacher should invite students to jointly create it, gradually adding components (Fig. 42). Thus, this form of work involves the active interaction of participants in the educational process, that is, the student simultaneously acts as a recipient of educational material, a transmitter of knowledge and a generator of new creative ideas.

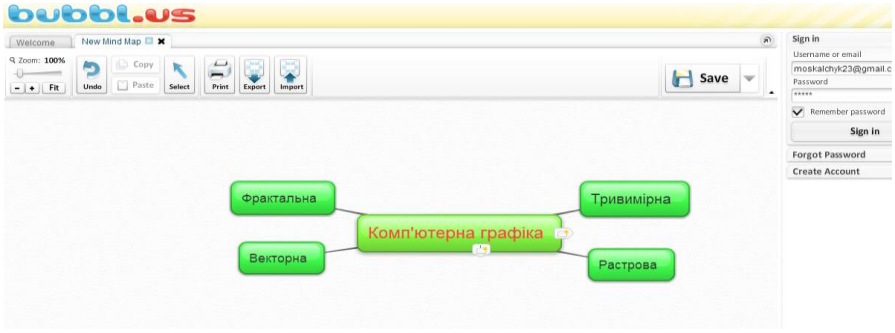

Fig. 42. Mind map with key concepts of the topic "Computer graphics"

To begin with, a key word or phrase is chosen, to which secondary concepts and statements are gradually added. In this case, these are types of graphics. Next, each block should be explained and defined. In addition, you can specify the details if necessary, for example, the expansion of raster formats. As a result, we received a generalized scheme as a result of collective interaction (Fig. 43). During such work, students cooperate, carry out social interaction as a means of constructing knowledge in order to solve a joint educational task, research an important problem and create their own, creative product.

Fig. 43. Generalized mind map on the topic "Computer graphics"

At the stage of knowledge control, students are invited to fill in the mind map template independently, in groups (Fig. 44). For example, students can be given the task of finding errors in connections in a map of the representation of one of the studied concepts; to determine the order of each of the characteristics on the scheme of the concept; removal of the unnecessary in the map with the wrong branch of the main concept. Such training takes place, in which the team

trains each of its members, and each member of the team takes an active part in the training of their comrades in joint educational work [13].

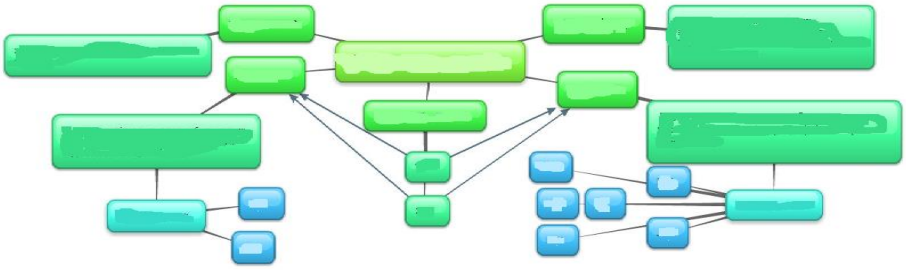

Fig. 44. Mind card for testing students' knowledge

So, in the view of A. Prokopenko, future computer science teachers «should realise that mastery of digital technologies and their application in their own professional activity is an urgent requirement of our time» [19, p. 306].

Conclusion. Thus, the use of mind maps in the context of group educational and cognitive activities contributes to the formation of certain skills and qualities, in particular, informational and communicative competences in those who study. On the basis of the analysis of scientific works and pedagogical experience, we have found out that the use of tools intended for the visualization of complex data structures and their presentation in the form of schemes has a significant didactic potential, which can be successfully implemented in higher pedagogical educational institutions. It is worth noting that the use of mind mapping techniques during the group educational and cognitive activities of future computer science teachers contributes to:

• systematization and deeper understanding of the educational material, transformation of the knowledge of individual students into the achievements of the entire team;

• formation of communication skills;

• development of creativity, critical thinking skills, ability to study and work in a team;

• acquisition of skills of effective interaction and partner exchange of information;

• coordinated cooperation in the process of solving joint educational tasks.

Mindmapping techniques is an effective tool for activating the group educational and cognitive activities of future computer science teachers. Its use will contribute to the formation in them of the competencies necessary for successful professional activities in the conditions of the information society.

The results of this study can be used to improve the methodology of teaching computer science in higher educational institutions, develop new methods and forms of organizing the educational and cognitive activities of future teachers of computer science, and improve the quality of their training.

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СУТНІСТЬ АДАПТИВНОГО УПРАВЛІННЯ ЯКІСТЮ НАВЧАЛЬНИХ ДОСЯГНЕНЬ СТАРШОКЛАСНИКІВ ІЗ ПРЕДМЕТІВ ХУДОЖНЬО-ЕСТЕТИЧНОГО ЦИКЛУ

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Статтю присвячено системі адаптивного управління в закладі загальної середньої освіти з погляду адаптивного управління якістю навчальних досягнень старшокласників із