Proceedings of 4th International Conference CNDCGS'2024
ISSN 2669-2023 (print) / ISSN 2538-8959 (on-line) / DOI 10.3849/cndcgs.2024.559

Conceptual Mapping in the System of Population Protection Education

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Abstract

Mind and concept mapping represents a progressive approach to the implementation of education. Within the framework of the general approach to the creation of concept maps, it is possible to start from the fact that concept mapping represents a comprehensive system of working with information based on data and enabling the strengthening of a personal and systematic approach to the implementation of educational activities regarding modern technologies in the educational process. The individual elements of the system, thus concepts, represent sub-problems that in their interrelations and contexts represent the potential of systems thinking in dealing with complex problems in the field of education. Mind and concept mapping achieved high utility especially during the COVID-19 pandemic. At that time, teachers at all educational levels were faced with new challenges that were often not easy to overcome. Applications based on mind mapping and concept mapping became very important aids and tools for distance and subsequently face-to-face teaching. They are very effective in transforming linear text, which is often accompanied by supporting explanatory information and often ballast and relatively unnecessary information, into concepts, ideas and relationships between them. The aim of this article is to present the possibilities of using mind and concept mapping in educational practice focused on the issue of population protection. Furthermore, the main advantages and disadvantages of concept mapping are discussed. Several examples are used to show the possibilities of converting linear text into conceptual maps. The paper discusses some of the software products, tools and applications, with the focus on the application of ContextMinds and its use in teaching and learning in population protection. Several examples are used to show the practical possibilities of its use in practice.

KEY WORDS: *ContextMinds; concept map; mind map; educational strategies; relationship; population protection, teaching system*

Citation: Otrisal, P., Hoskova-Mayerova, S., Ralbovská, D. R. Conceptual Mapping in the System of Population Protection Education. In Proceedings of the Challenges to National Defence in Contemporary Geopolitical Situation, Brno, Czech Republic, 11-13 September 2024. ISSN 2538-8959. DOI 10.3849/cndcgs.2024.559.

7. Introduction

Concept mapping is a complex system that integrates various types of information, including visual elements, textual descriptions, and logical relationships, to create a comprehensible and coherent overview of a given topic or concept. Experience so far shows that concept mapping can be a very useful tool in the educational process, not only from the perspective of the teacher but also from the perspective of the pupil or student. During the preparation and de facto decision making process for a sub-topic, both the student and the teacher can create a concept map that includes individual concepts representing the issues that will need to be considered in the preparation process. Based on this initial analysis, the decision-making process can then decide whether the difficulty, interest and relevance of the topic are adequate in terms of the abilities of the target audience. Based on an assessment of the initial linear text and against the background of a running decision-making process that helps to interrelate the concepts into a logically organized concept map, it can be decided whether concept mapping will be beneficial for a given learning unit or whether another form of processing or presenting the information would be more appropriate.

For the purpose of this paper, a concept map is understood as a visually processed (hierarchical) structure of concepts (abstract, technical, exemplary) and relationships (horizontal, vertical, intersecting) among them. It serves mainly to structure knowledge of a predominantly declarative character of one person (usually a teacher) and a group (students).

Working with concept and mind maps, or also concept or mind mapping, is a technique used to illustrate the connections among different concepts. This technique was developed in the early 1970s. The basic principle is that concepts and ideas are connected by described links, forming a branching structure [1]. The relationship between concepts is expressed by a link label, for example, “comes from”, “causes”, and so on (Fig. 1).

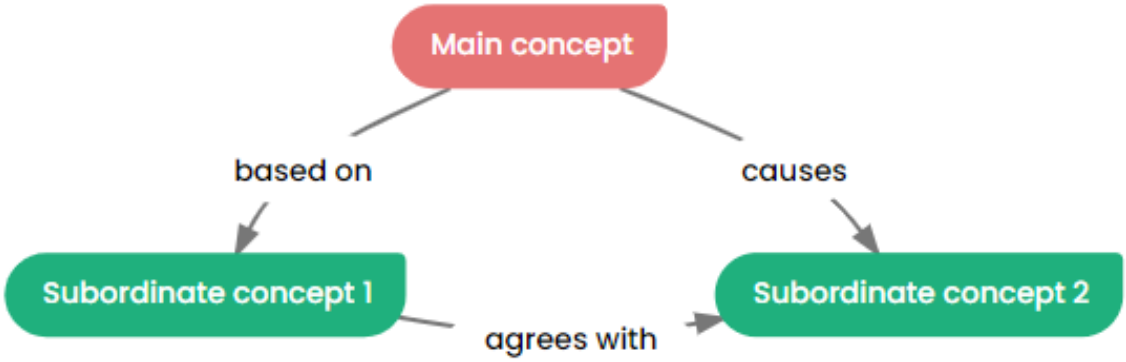

Fig. 1. A model example of the basic approach of creating a concept map (own elaboration).

From the above model case, a concept map is essentially a diagram that represents a summary of the selected topic in such a way that it selects only the most important keywords (concepts). Like a mind map, it can be in colour. The same groups of concepts are highlighted in one colour to distinguish them from other concepts listed in other parts of the map. Remembering the marked words is easier with this approach, especially because it also better engages visual memory [2].

The created graphic structure, thus a conceptual or mind map, can then be interpreted as a linear text or modified by other verbal expressions depending on the abilities and skills of its author, usually the teacher.

8. Brief History and Development of Concept Mapping and Selected Tools

a. History of conceptual mapping

The concept mapping technique was created by American educator Joseph Donald Novak and his development team at Cornell University in the 1970s as a means of facilitating the acquisition of scientific knowledge by students [3]. Since then, they have been gradually applied in American schools and, over time, their popularity has spread abroad. Research has focused on the psychology of children's learning. At that time, it sought to find out how changes in science learning take place in students. He was inspired by Ausubel's theory of meaningful learning, where learning takes place by matching new information to that already stored in memory. The final product of the whole research was the creation of concept or mind maps. These consist of the smallest semantic units (concepts) and the relationships between them. Since then, it has become apparent that concept maps have found use to increase the effectiveness of meaningful learning, even though they have not been worked with very intensively. Concept maps are also used to represent the expertise of individuals and teams in education and related activities. Experience from applied pedagogical practice shows that learning by this method proves to be more effective, especially for pupils (students) with a variety of learning disabilities. In fact, it has been shown that the use of concept maps makes it easier to remember the necessary information and at the same time to gain a deeper understanding of the context [3].

In the Czech Republic (CR), concept maps are only very slowly becoming known to the public. They are often confused with the better-known mind maps, which have been used for many years in education and have also received detailed analyses in several publications [4-7]. In 2005, Professor Tomáš Janík published a handbook focusing on the pedagogical knowledge of teachers [8]. In the section on methods of diagnosing knowledge, the author of the book analyses mind maps together with their use and examples (Fig. 2). However, the mind map does not contain information on the interrelationships among concepts. Reading such a mind map may cause problems not only for its author but also for pupils (students) who would work with it, for example, in the context of independent study or e-learning. This is because they do not contain relationships among concepts, which, when translated into a linear spoken text, can cause problems not only for the teacher but also for the pupil in his/her process of independent learning and consolidation of the material [9,10].

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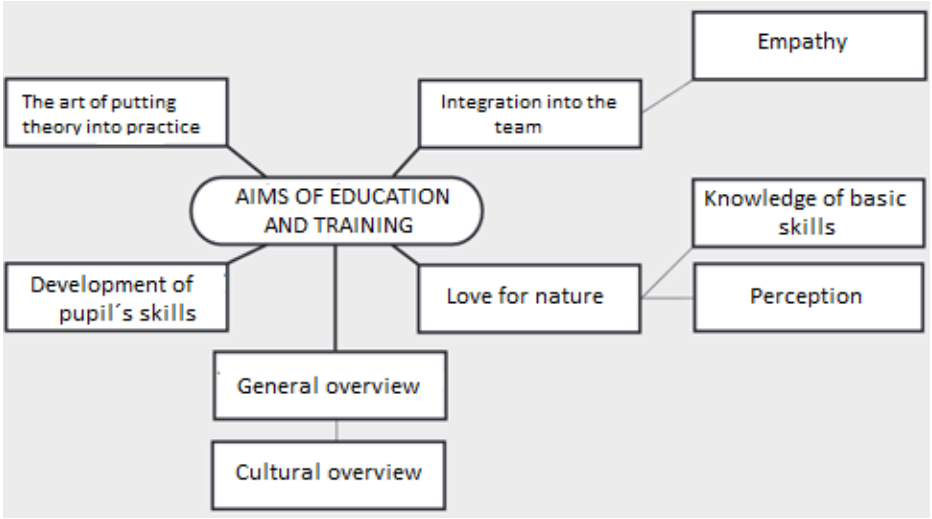

Fig. 2. Sample mind map from the book “Knowledge as a key category of teacher education” (adapted from [8]).

The historical aspects of the conceptual mapping are graphically presented in Fig. 3, which is available for more detailed study on the website https://app.contextminds.com/?m=QJZPd. This figure also summarizes the basic principles of meaningful learning. Fig. 3 is in better resolution also attached as a supplementary file.

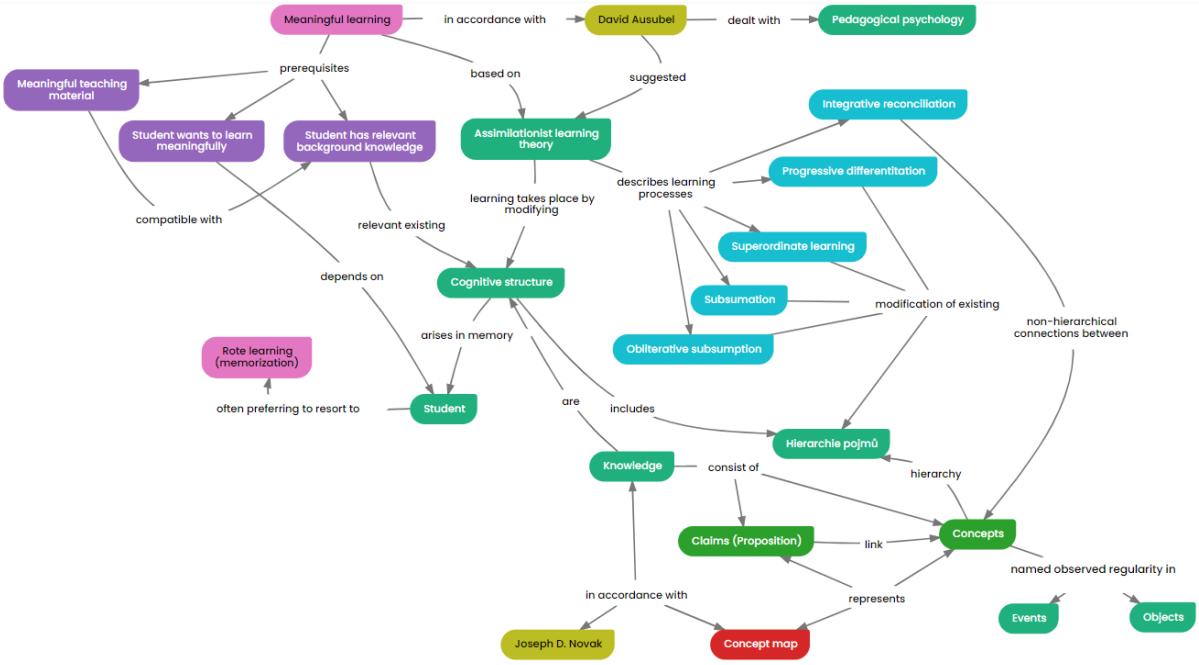

Fig. 3. Basic principles of meaningful learning (own elaboration for detail available https://app.contextminds.com/?m=QJZPd).

The conceptual (mind) map in Fig. 3 shows that the theory of meaningful learning has been implemented in accordance with David Ausubel's approaches. This American psychologist, who contributed significantly to the development of areas related to educational and cognitive psychology and to the development of science education, was also very much involved in the problems of conceptual or mind mapping. The main idea of his theory is that learning takes place by adding new concepts and propositions to those already stored in the interconnected structures of our memory. This facilitates the process of remembering. He posited that meaningful learning works with the basic attributes of well-crafted learning material, a pupil (student) who wants to learn meaningfully, and a pupil (student) who has relevant background knowledge. Thus, meaningful learning using very well-developed materials is interconnected with background knowledge. Meaningful learning is further based on the assimilation theory of learning, which is divided into several basic aspects according to the processes through which learning takes place. On the one hand, learning takes place through the method of so-called cognitive reconciliation, and currently the term integration or inclusion, or inclusive education, is often used in the CR and abroad. At its essence, it is about having to work with a very different quality of target group of pupils (students) and a different approach to the system and the way they work in terms of inclusion amongst "ordinary" pupils (students). In the implementation phase,

it is about creating as similar conditions as possible for pupils (students) to be able to learn and attend common schools with some support. It is important to note that these individuals are still seen as a specific group of pupils (students) with different (specific) educational needs.

The map in Fig. 3 further shows that it is also possible to talk about learning processes in terms of progressive differentiation, which aims to promote pupils' activity in the learning process and thus contribute to its effectiveness. Intrinsic differentiation means that within a lesson the content of the material and the methods and forms of work of the teacher are adapted to the different levels of the pupils. When implementing differentiated instruction, the teacher asks himself the question of what goal to set for the pupil (student). The teacher also works with the problem of what learning processes will achieve the set goals with the maximum degree of effectiveness. It also deals with the description of ways of appropriately sequencing learning. In practice, this means that the teacher addresses the problem of the appropriate way to combine new data with already learned information. Thus, it is necessary to think of the problem what is related to what, what is superior and what is inferior in terms of information, what the hierarchy of interrelationships is, and with the idea of how these can then be visually represented. Mind maps and concept maps undoubtedly contribute to this process. It turns out that a mind map full of colours and pictures is one of the very effective forms of conveying learning and recording it in the written notes of the pupils (students). Instructional material prepared in this way is very likely to contribute to the best retention of the information presented. Subsumption in the context of meaningful learning means that the correct concept is assigned to its specific meaning. Furthermore, the notion of obliterative subsumption is worked with. This term in the context of concept mapping means that it is a technique used to illustrate the links between different concepts by invoking (showing) the relationships between them, whereby the concepts are linked together in different relationships and there is a summation of knowledge that a given teacher can present to a target audience. It is based on the idea that meaningfully learned material cannot be recalled in the exact form in which it was originally presented. It is further worked with the fact that no one must be forced to learn the material presented mechanically. The basic purpose is therefore to create cognitive material with a clearly defined structure, which in practice means contributing to the creation of positive knowledge about new interrelationships that arise in the memory of the pupil or student. Another possible goal is that the individual concepts form a fixed place in the pupil's (student's) memory in a given hierarchical structure, and that the concept or concepts and the relationships between them support the meaning of the new statements and represent the given concept map, with the understanding that the named and observed regularity will contribute to the formation of the relationships, events and objects that are represented on the map [11,12].

The opposite of meaningful learning, according to David Ausubel, is rote learning or memorization. It is characterized by the repetition of unrelated concepts. Memorization is thus only short lived and yields only shallow knowledge without the ability to grasp connections. It has already been stated that meaningful learning works with a precisely elaborated structure of the communicated information. Meaningful learning is superior to memorization because it already requires working with information stored in our memory. In most situations, it proves to be more effective, as pupils (students) can recall the material more easily and, above all, to learn to understand it in context. This style of learning can be suitably applied in all types of schools and in staff training. In both cases, the recipients of the information need to have a good understanding of the topic and be able to apply it correctly in practice. The fact that nowadays pupils (students) tend to memorize, or so-called rote learning is widely known and has been rightly criticized for a very long time. It must be admitted that in the context of contemporary education and the education system, this is quite often a required fact. Concept maps, by reducing the amount of text to be transmitted, do not contribute to the memorization process. Rather, it is evident that they contribute to the creation of a positive relationship between pictorial thinking and the formation of explanatory concepts and the relatively flexible possibilities of linking their meanings [13].

It should be noted that the use of, and therefore education in, concept mapping is not new. For example, at the Faculty of Education of Charles University in 2008/2009 a course on Authority in Education was opened, where one of the teaching methods used was conceptual mapping. Thanks to this, it was possible to better structure the selected curriculum. According to the study that was subsequently written up, the participants had problems with the first maps. In addition to incorrect wording, they lacked marking the orientation line. These are important for concept maps because they determine the link between concepts and the direction of reading. However, after further time, there was an improvement. Thus, the study shows that concept maps need to be practiced gradually to achieve good results.

b. Methods – Selected software tools and applications for creating conceptual maps

With the development of computer technology and its mass spread among ordinary users, several application and software tools (software) designed to create conceptual maps have been developed. It is undeniable that the creation of conceptual maps is facilitated by a multitude of modern computer programs, allowing their creation, and sharing among teachers, pupils (students) and other users. Computer programs are usually designed as relatively simple and intuitive tools that allow for quick creation, customization and sharing of the conceptual maps created. For example, the ContextMinds project is the first Czech online program for creating conceptual and mind maps. The program does not need to be downloaded and works completely free of charge. You can try working with it by launching the ContextMinds application after typing its name, for example, into the Google search engine. A very important advantage of ContextMinds is that the concept maps are stored on the server (cloud) and it is not necessary to download them to the user's computer when working with them. This approach allows working directly in the browser environment, which significantly reduces the data flow requirements when communicating with the concept map storage.

There are quite a lot of computer programs and tools available for creating mind and concept maps. It has already been mentioned that their use is relatively intuitive and user friendly. The differences among them are mainly due to the amount of conceptual (idea) maps that can be created without having to pay any money. Even though the cost of using the applications listed below is not high, the user usually looks for applications that are completely free. An overview of selected simple programs designed for processing conceptual (idea) maps is given in [14-16].

9. Results – Identified Advantages and Disadvantages of Concept Mapping

a. Advantages of Concept Mapping

Concept mapping can be considered a very progressive and beneficial approach to mastering the curriculum. They can provide a very effective and quick systematic overview of a given topic. Well-chosen linking words in the link descriptions very appropriately highlight the relationships between concepts. The use of this approach can be beneficial in perceiving what is more and less important in the description of a given problem developed in the form of a concept map, or what falls into the category of a more detailed understanding of the problem being addressed. Artificial intelligence, which is very often processed into the essence of the applications themselves, can also help in the choice of concepts and relationships between them. Their quality can therefore to some extent be automatically assessed by the software tools used and it is up to the map maker to accept or reject them. It turned out to be a very suitable "helper" for the operational creation of ad-hoc concept maps directly during the teaching lesson, which can be used to discover facts and relationships other than those learned so far. From what has already been stated, it follows that concept mapping is very well applicable in methods and forms of teaching that involve a higher form of cooperation between teacher and pupils (students) or pupils (students) than in those methods and forms that are conducted in the form of monotonous interpretation using a linear text. Concept maps are also very effective in involving pupils (students) actively in the process of completing a pre-prepared map, or in a map where the links between the main and subordinate concepts have been deliberately hidden. In these practices, visual memory is engaged and contributes more effectively to consolidation and retention of the material.

Another very important aspect of the use of concept maps is that they can be a very good basis for starting and conducting discussions. In educational establishments and institutions, concept maps can be of practical use in developing (for example, in brainstorming), defending, and sharing proposals for educational programs, curricula and documents of a similar nature. We believe that clear and structured planning information, which integrates elements of the actual long term and short-term implementation, is better presented in the form of interrelated ideas (concepts) than in the form of a linear and often long text. We further argue that, based on critical thinking, the subsequent correction of conceptual maps and incorporation of ideas in the course of collective work becomes a more efficient and easier way of proofreading text documents. In a reasonable way, though very similar in principle, concept mapping can be used to prepare a balance sheet for the preparation and actual organization of a particular course. In this case, it is up to the skills of the teacher to determine the level of detail in which he or she develops the concept maps, what information is referenced, and how the lesson is ultimately taught. However, it is important to point out here that the concept map is also a background material for the pupils (students) and that less is not always more and vice versa. Their main purpose, besides preparing the teacher for a specific subject (lesson), is also to help encourage students in the direction of thinking creatively about the topic, in context and with the possibility of developing prior knowledge within the new topic [17].

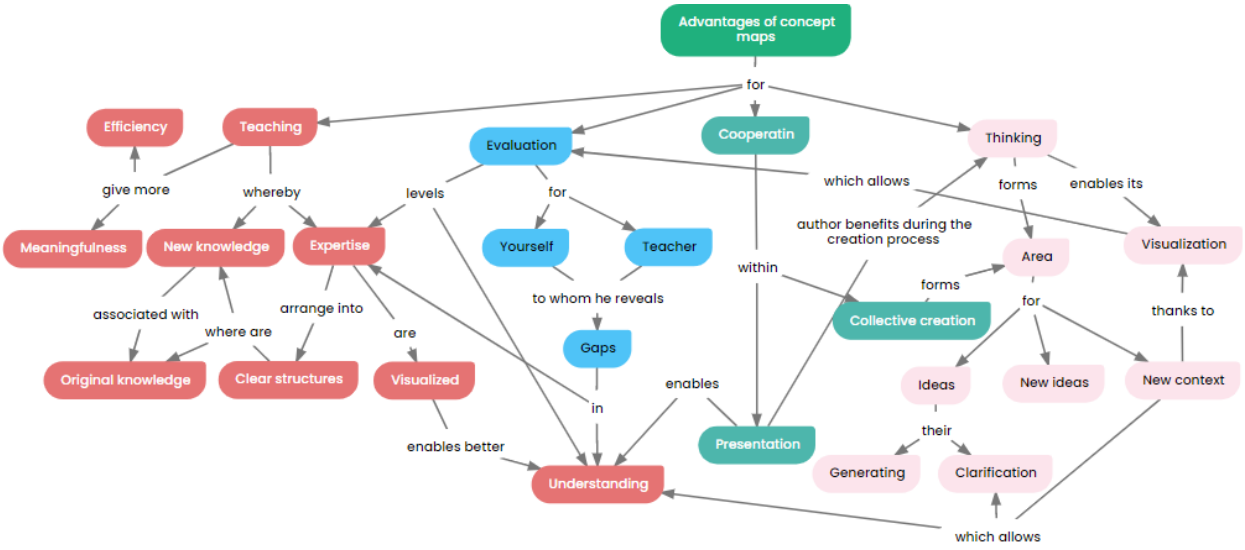

Fig. 4. Advantages of concept maps (own elaboration for detail available https://app.contextminds.com/?m=6EnyN).

Experience also shows that concept mapping helps pupils (students) with ADHD, who usually find it difficult to present unstructured ideas in the form of linear text. In this case, the principle that less is more in terms of the effectiveness

of the educational process very often applies [18-21]. In this case, the diagram and structure of the material should be more in line with the situation where it also corresponds to the way the material is written [22,23]. The text presented in this chapter can be converted from linear form to the form of Fig. 4. This figure is available for more detailed study at the website https://app.contextminds.com/?m=6EnyN. This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation, as well as the experimental conclusions that can be drawn.

b. Disadvantages of Concept Mapping

Conceptual mapping is not exclusively associated with benefits. When working with applications and software, it is necessary to consider that a significant majority of them are in a language other than the teacher's mother tongue and are usually bound by licensing agreements. It follows from the principle and nature of concept maps that they are usually used for declarative knowledge. However, this deficiency can be partially overcome through a sequential or cyclic concept map. Concept maps are not universally applicable. However, even this disadvantage is only relative. It is easy to copy the concept map and adapt it for the purpose of a specific lesson with significant help of pupils (students). The fact that concept maps do not benefit learners who have not mastered prior knowledge perfectly can be considered as a relatively major disadvantage. Furthermore, they are very difficult to use for pupils (students) who do not prefer visual learning or for pupils (students) who prefer linear text and for whom structured, and partly creative thinking is problematic. Since some languages (typically Czech) are quite complex languages in terms of their grammar, it should be noted that concept maps do not support declension and conjugation for these types of languages. The text presented in this section can be converted from linear form to the form of Fig. 5. This figure is available for more detailed study at the website https://app.contextminds.com/?m=wvLx8 [17].

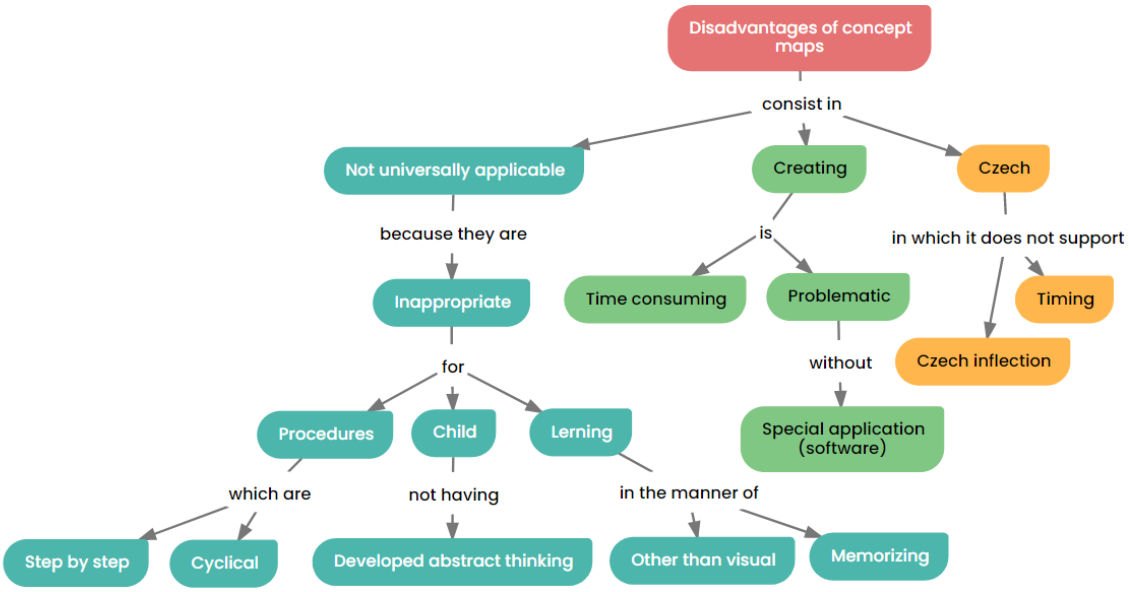

Fig. 5. Disadvantages of concept maps and concept mapping (own elaboration for detail available https://app.contextminds.com/?m=wvLx8).

10. Applications – Use of Conceptual Mapping in Population Protection

The branch of population protection integrates a wide range of knowledge based on a considerable amount of theoretical and practical knowledge. Achieving a level of knowledge in this field that can then be applied meaningfully in practice requires mastering, understanding, and interconnecting a considerable amount of information. We will mention at random that this information is based on knowledge of the rules of nature (chemistry, biology, radiation chemistry and others), earth sciences (geography, topography, hydrology, etc.), as well as knowledge of the laws and decrees in force within the integrated rescue system and many others. To achieve the highest level of effectiveness, it is necessary to prepare appropriate materials for so called meaningful learning. It turns out that a suitable solution for making learning more meaningful is to integrate concept maps directly into teaching. In contrast to mind maps, concept maps make it possible to represent all the important relationships between concepts in a single diagram. Thus, well-designed concept maps make it easier for pupils (students) to understand how concepts are related and to relate them to their prior knowledge [4].

To achieve high efficiency of meaningful learning, it is necessary to adapt the learning material to the level of the learners' (students') initial knowledge. It is therefore necessary to prepare differently designed concept maps for primary school students than for students of subject oriented universities. For this reason, it is necessary to keep in mind the pupils' (students') prior knowledge of the material being discussed and to select the ap-propriate topic accordingly, together with the materials used to create the concept map.

Another important assumption is because the pupil (student) wants to learn in a meaningful way and is sufficiently motivated for this form of knowledge acquisition. The teacher can influence this part mainly by explaining the new material and by managing the motivation of the pupils (students) to be interested in learning more about the topic. Consequently, it is also important how the level of knowledge achieved is tested and verified. If the teacher chooses a test method based on simple short answers only, he/she is leading the pupils (students) towards mere memorization. It is therefore important that the teacher tries to create questions during the test that lead the pupils (students) to think more deeply about the topic.

a. Example of using concept mapping

In terms of using the principles of meaningful learning and applying them to concept mapping, we present the following example. Act 239/2000 Coll. states that the protection of the population means the performance of civil protection tasks pursuant to Article 61 of the Additional Protocol to the Geneva Conventions of 12 August 1949 relative to the Protection of Victims of International Armed Conflicts, in particular in the field of warning, evacuation, shelter and emergency survival of the population and other measures to ensure the protection of their life, health and property. This relatively inexpressive definition, written in the form of a linear text, can be translated in a simplified form, for example for primary and secondary schools, into the form of the concept map shown in Fig. 6. A more complex form, which would meet the requirements of subject specific university students, could be as shown in Fig. 7 and Fig. 8. Fig. 8 is in better resolution also attached as a supplementary file.

Even in these cases, the maps can be studied in more detail on the websites https://app.contextminds.com/?m=may8Y, https://app.contextminds.com/?m=a2xEN and finally https://app.contextminds.com/?m=z6XN0 [14].

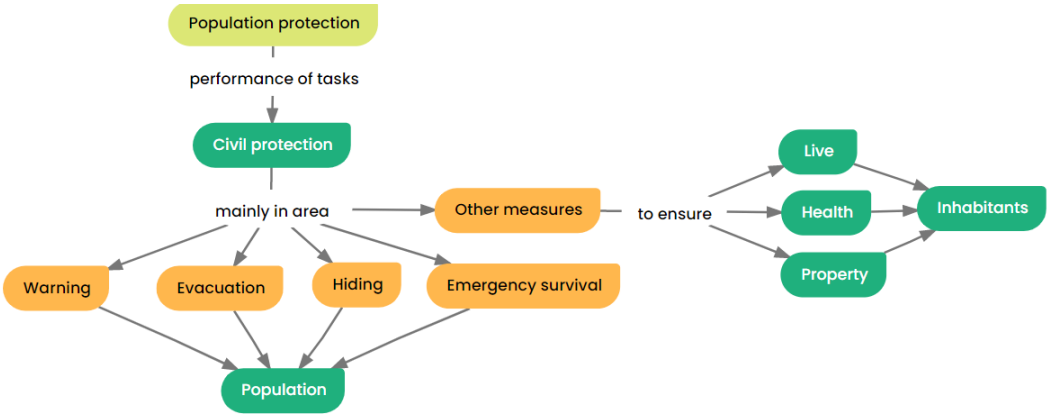

Fig. 6. Public protection for primary school pupils without information containing details of Article 61 of the Additional Protocol (own elaboration for detail available https://app.contextminds.com/?m=may8Y).

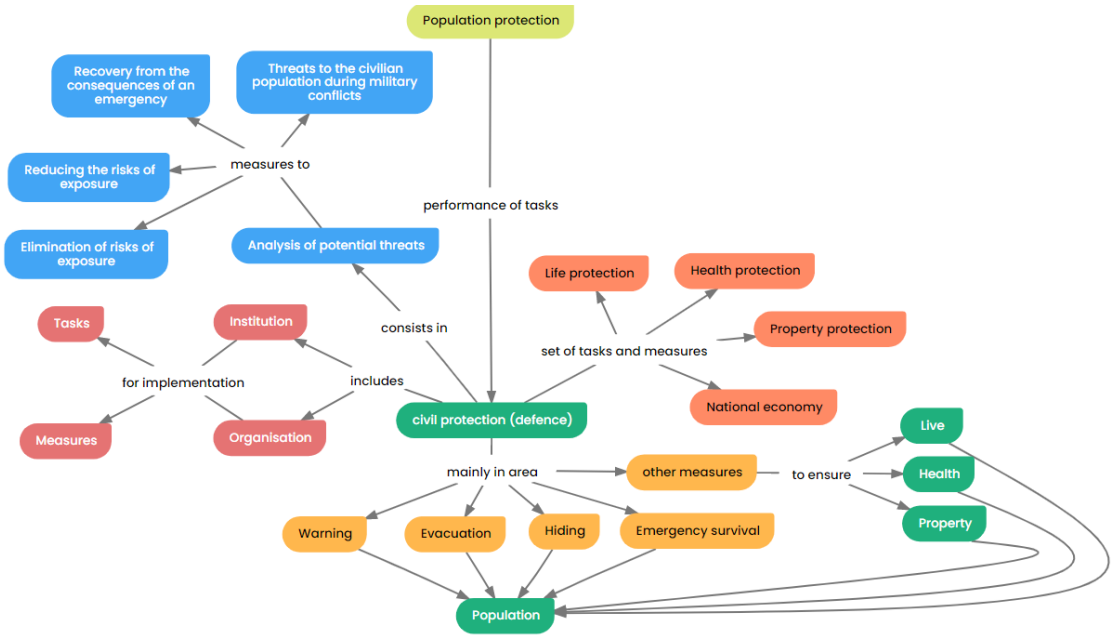

Fig. 7. Protection of the population for students of specialized universities without information containing details of Article 61 of the Additional Protocol (own elaboration for detail available https://app.contextminds.com/?m=a2xEN).

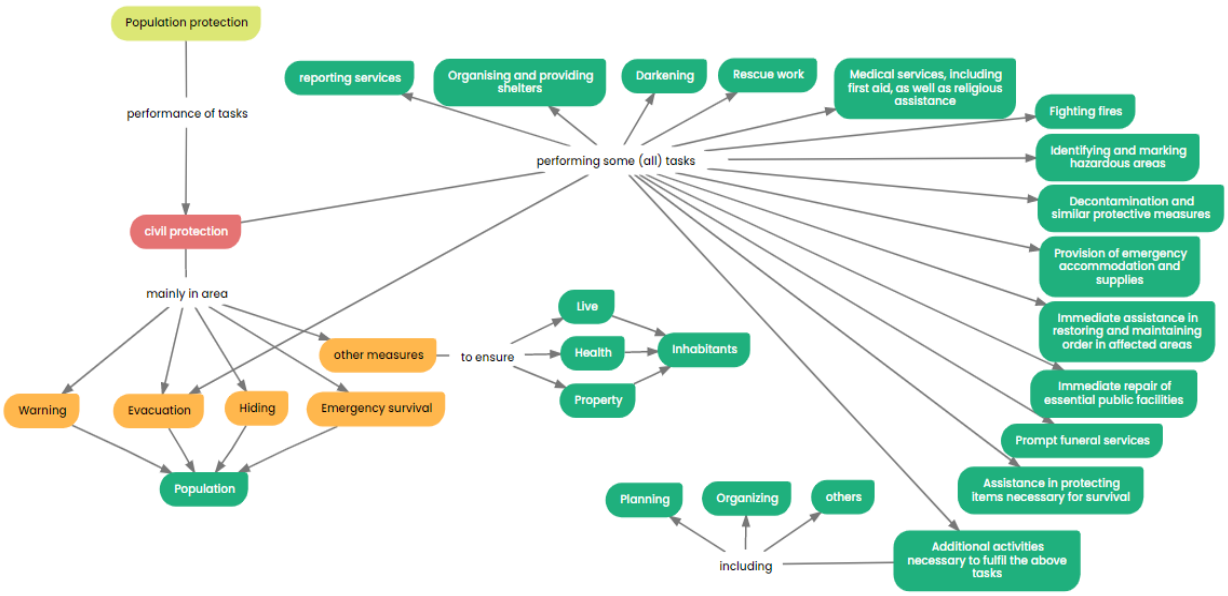

Fig. 8. Protection of the public for students of specialized universities with information containing details of Article 61 of the Additional Protocol (own elaboration for detail available https://app.contextminds.com/?m=z6XN0).

Conclusion

Concept mapping is currently a relatively progressive approach to managing large amounts of information. It allows teachers and pupils (students) to work with information by converting long linear text into structured concept maps. Although there are a number of software and application tools on the market that can be used to create concept maps for free or for a relatively low fee, it should be noted that only a small number of them are programmed and fully usable in multiple languages. Despite the considerable user intuitiveness when using application tools for creating concept maps, it is still preferable to work with applications that are created in the teacher's native language.

In this paper, attention was further focused on specifying the advantages and disadvantages of concept mapping. Furthermore, one specific example was given of how concept maps can be used in a particular field. This illustrative example shows that concept maps can be adapted not only to the level of pupils and their knowledge, but also to the level of individual schools. For this reason, we believe that concept mapping should be used as one of the very advantageous methods and forms of presenting the curriculum to pupils and students.

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