Concept maps in math teaching

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Abstract

Most professors, even those with years of experience, are sometimes faced with the problem how to present course or lesson content so that students understand it and accept it through meaningful learning. Solution may be found in reducing the amount of teaching material. Changes are definitely needed, not necessarily in a content, but in finding ways to represent it. A concept map is a diagram that depicts relationships between concepts. It is a graphical tool that we can use to organize and, sometimes more important, to visualize content of lesson or theme. The terms (concepts) are commonly written in the "balloons" and they are linked to each other with lines and , if needed, words that describe the relationship between them. In this article I present an experiment in which two groups of students participated in creating conceptual maps under different instructions. The experiment confirmed excellent applicability of concept maps in mathematics.

Keywords: conceptual maps, learning, knowledge

MSC: 97D40

1. What is the concept map?

A concept map is a diagram that depicts relationships between concepts. It is a graphical tool that we can use to organize and, sometimes more important, to visualize content of lesson or theme. The terms (concepts) are commonly written in the "balloons" and they are linked to each other with lines and, if needed, words that describe the relationship between them. There are few graphical presentations similar on the first sight but different in their approach and functionality so as in use. The most similar among them are mind maps but mind maps serve a different purpose. They help with memory and can be used in brainstorming as a very effective tool. Mind maps are collections of words structured by the mental context of the author itself with visual mnemonics, and, through the use of colour, icons and visual links. Also, algoritam may look like concept map but just on the first sight. Algorithm is a step-by-step procedure for calculations. For making scheme of algorithm we use special notation and symbols.

Concept maps have hierarchical structure. Mapping is the creative process of organizing content and can be used in planning lessons, learning, individual and group work, developing mathematical literacy and fostering mathematical thinking. Conceptual mapping can be easily applied to other school subjects and to everyday life. Once accepted, making concept maps becomes the way of successful learning. Conceptual mapping technique was introduced in the education by Joseph Donald Novak.
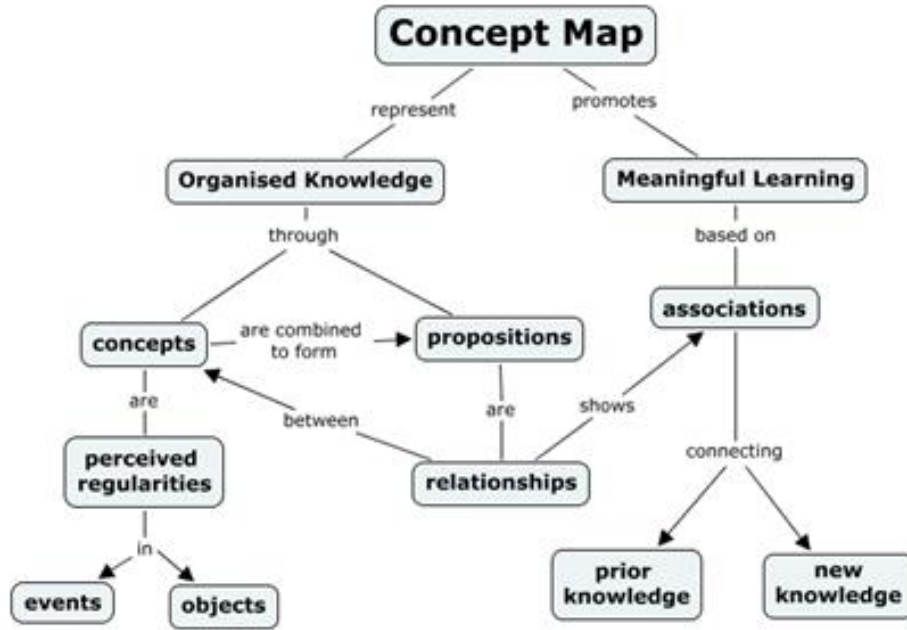
Simple example of meta-map is given below:

Figure 1: *Meta-map (http://books.kmi.open.ac.uk/knowledge-cartography)*

In order to create a conceptual map, we can use special software such as "IHMC CmapTools":
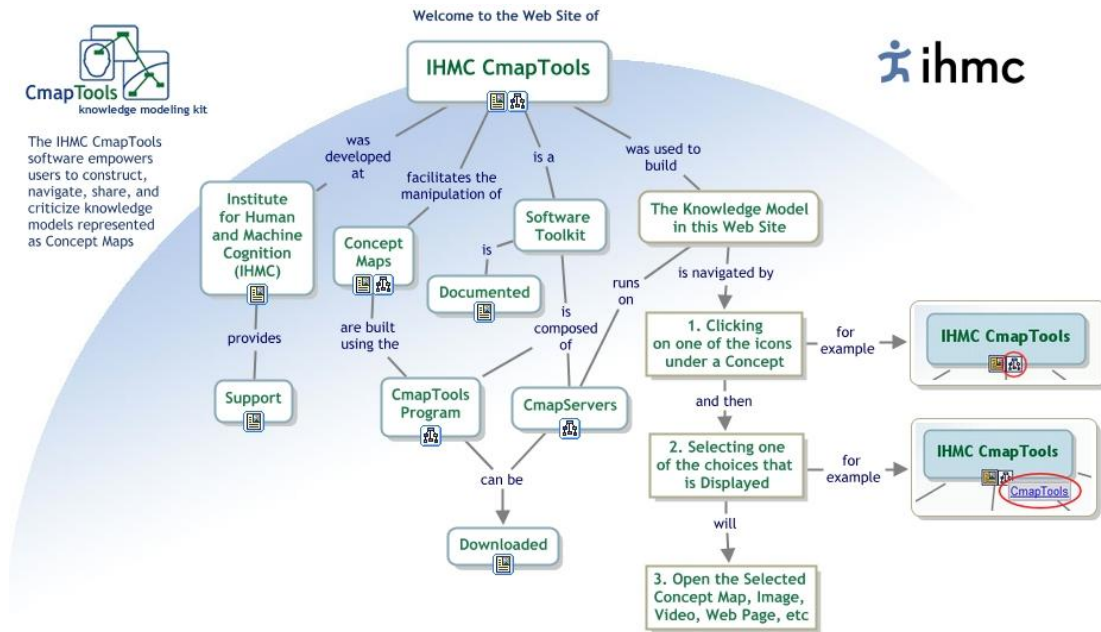

Figure 2: *Concept mapping software example*

2. Two experiments

Two groups of students participated in the experiment with the goal to design a conceptual map. They received different instructions.

The first experiment: Only verbal instructions about concept mapping were given to students who had no previous knowledge about it. The basic concept was logarithm and individual production lasted about 20 minutes. Here are some of their products:
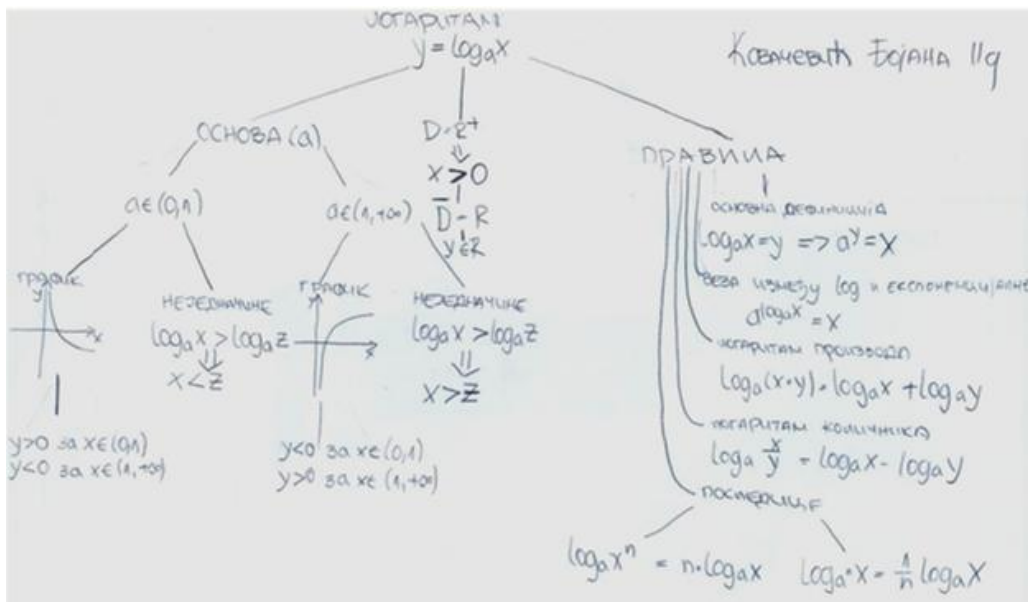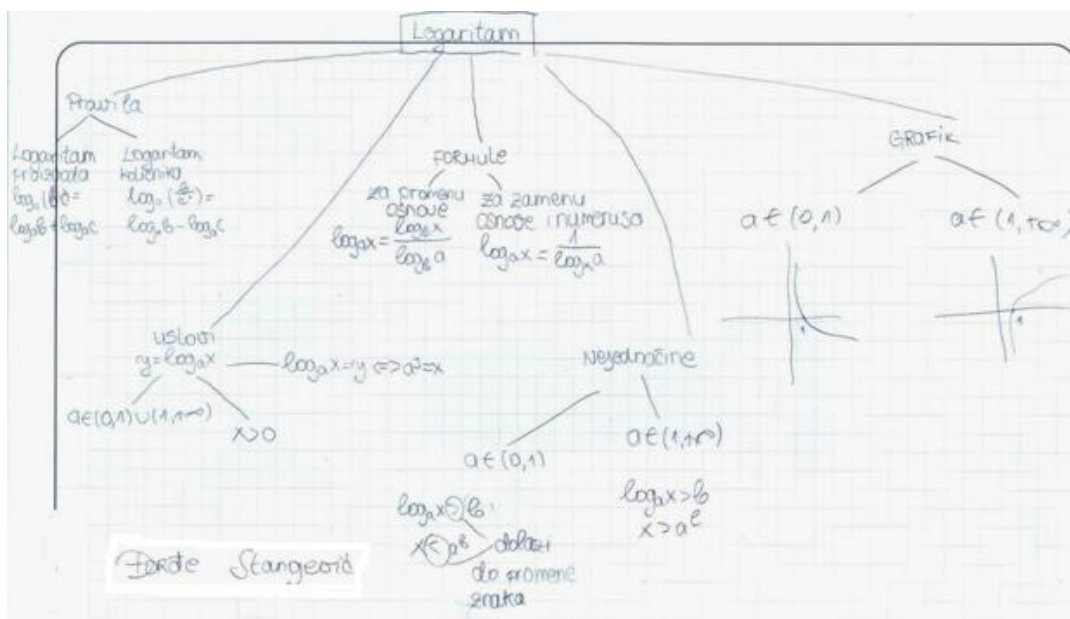

Figure 3: *Concept map (Bojana)*
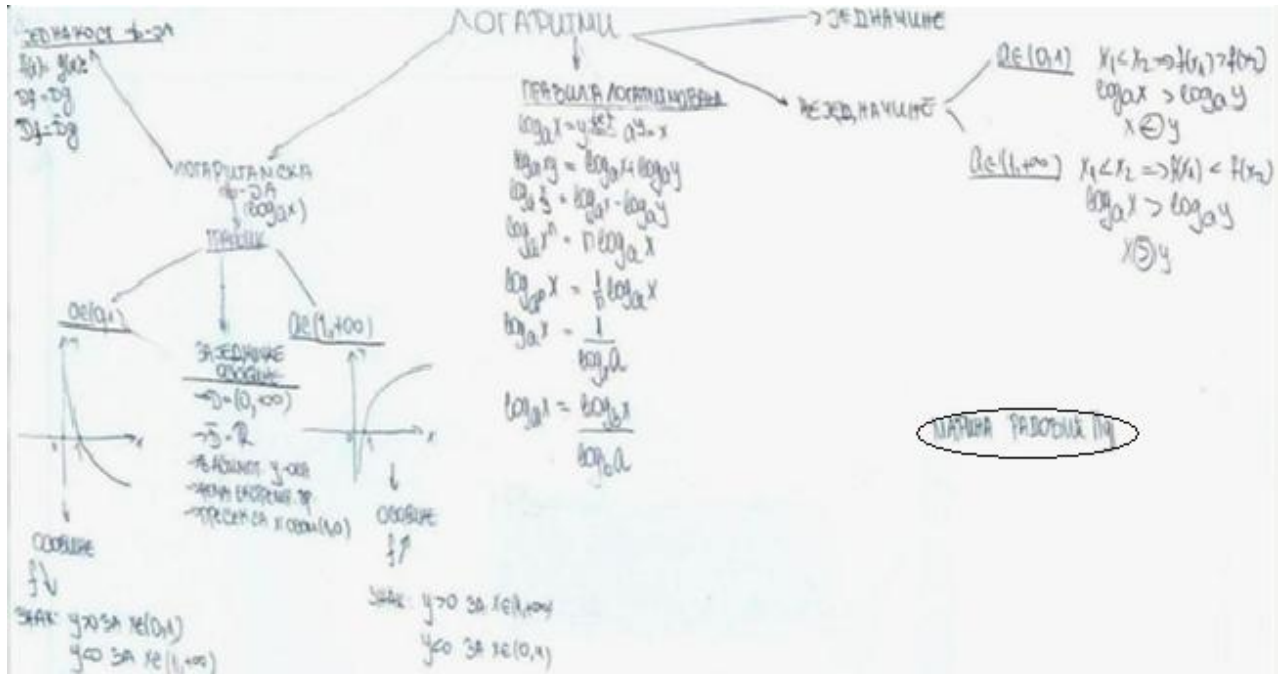

Figure 4: *Concept map (Djordje)*

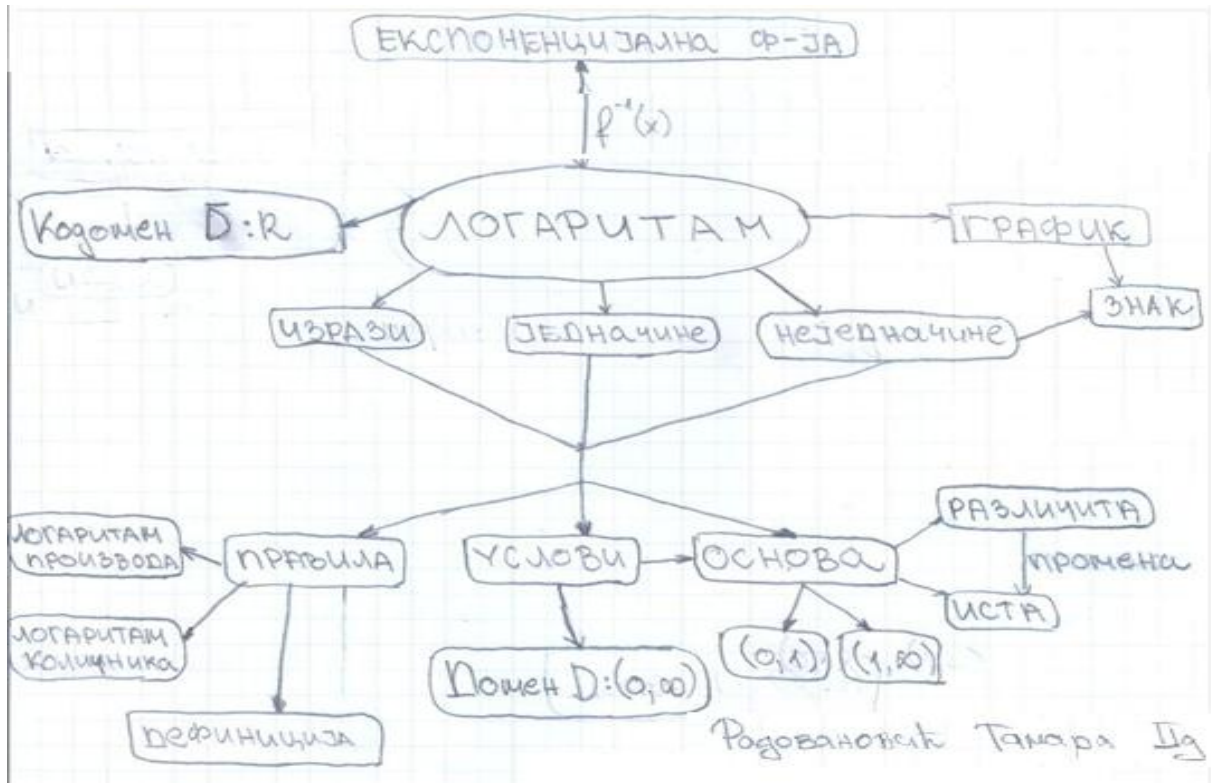**Figure 5**: *Concept map (Marina)*

Figure 6: *Concept map (Tamara)*

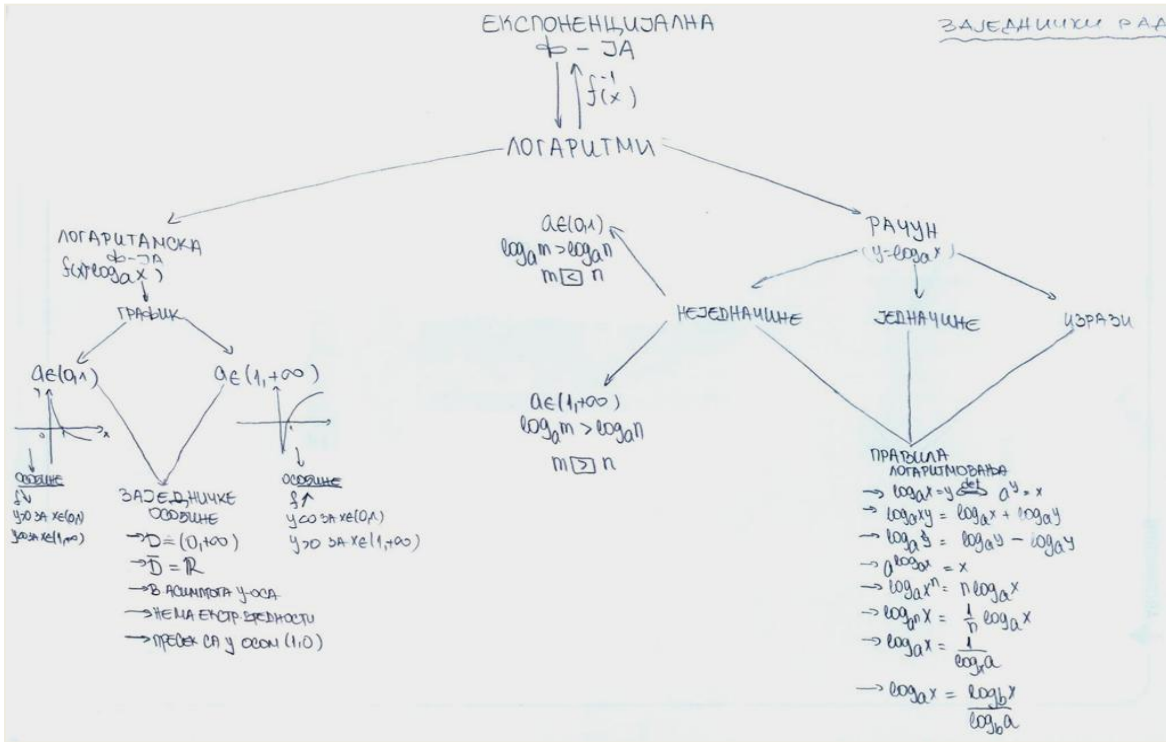After that, they compared their maps and created a new one:

Figure 7: *Concept map (Final)*

The final map had a good hierarchical structure and concepts are clearly arranged and well linked. The second experiment: Instructions were given in the form of concept map.
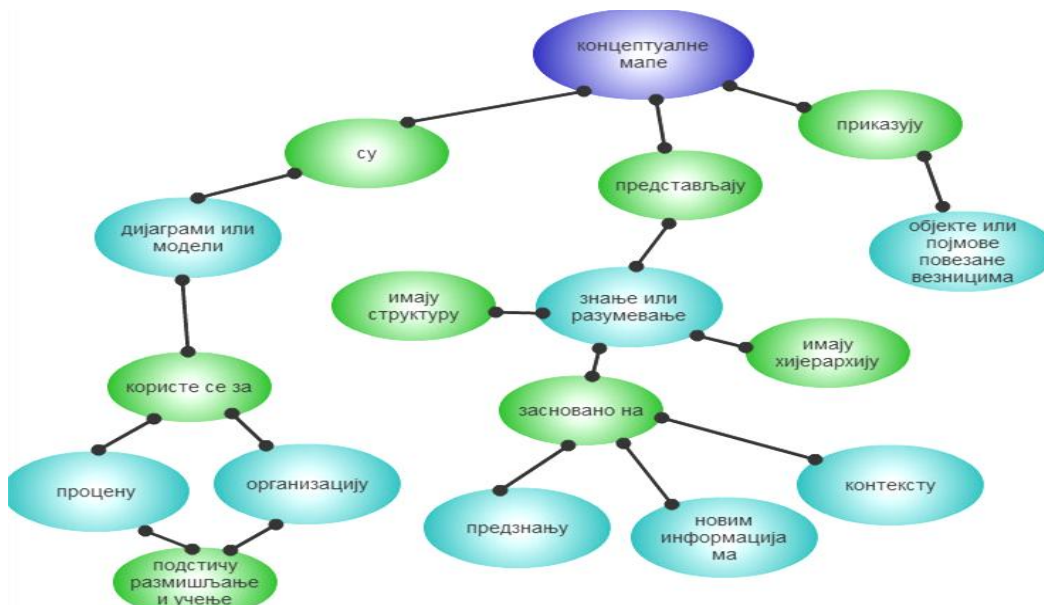

Figure 8 : *Concept map for second experiment*

Group work procedure:

1. Focus concept - logarithm

2. Sticky notes and whiteboard for mapping

3. Organize sticky notes

4. Link concepts with linking words

Figure 9 : *Group work (Zemunska gimnazija high school)*

3. Conclusion - Advantages and Disadvantages

Here are some conclusions:

- Meta-map confirmed its utility
- Conceptual map is good for teaching as well as for learning
- It provides sense–making and meaningful learning
- All students were active, although they had different prior knowledge.

Benefits of using a conceptual map

Maps enable students to:

- Perceive the concepts and relationships among them
- Visualize, organize and distinguish concepts by their importance
- Develop mathematical literacy
- Connect a new knowledge with the old one
- Evaluate learning process
- Expand their knowledge
- Apply mapping method to other contents

- Be more active
- Get better results by working in groups or pairs
- Develop their communication skills through the presentation of conceptual maps and discussion.

Maps allow teachers to:

- Teach students how to learn with understanding
- Provide comprehensive view of the lesson
- Organize teaching material
- Visualize the teaching process
- Introduce new concepts and link them with the known
- Decompose complex ideas
- Check the level of understanding
- Identify weak points
- Explore the reasons for misunderstanding among students
- Encourage student activities
- Connect interdisciplinary

Disadvantages of the concept mapping

Technical :

- Paper (if we restrict ourselves to A4)
- Duration of a lesson (45 min)
- Related to the content
- Lessons with a lot of new or similar concepts
- Lessons that have linear structure
- Mapping can not be used at any time (for different reasons), but we can use already made maps

Concept maps are covering most of higher levels in learning process which can be shown schematicaly as in figure 10.
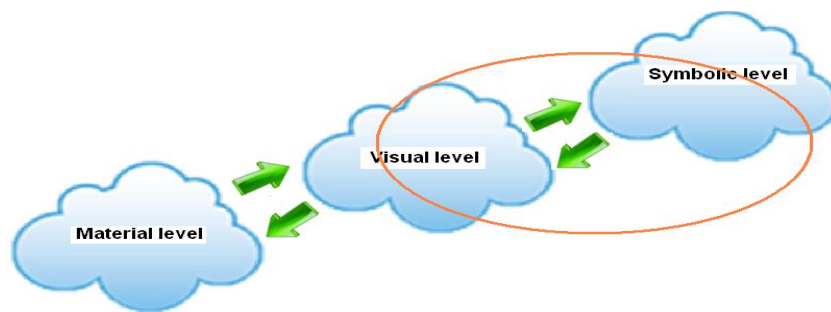

Figure 10: *Process of learning*

In the Bloom's taxonomy, learning at the higher levels is dependent on knowledge and skills at lower levels. Visualization through concept maps can help to link those parts and estimates answers on cognitive verbs.
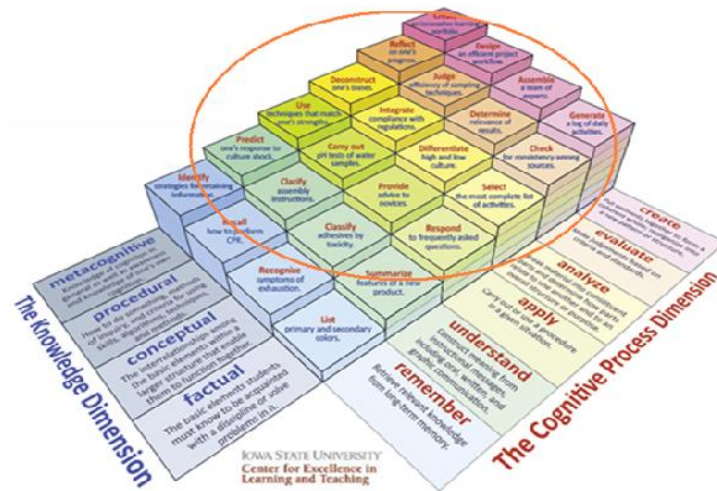

Figure 11: *Bloom's taxonomy*

Concept maps are facilitative tools which help to improve learning, creating and using knowledge based on reasoning and sense making. They help to develop a way of organized thinking that can be applied as well in everyday life.

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