



## MIND MAPS AS A TOOL FOR ENLARGING MATHEMATICAL LITERACY

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**ABSTRACT.** *We present mind maps as one of tools suitable for problem solving, improvement creativity and expanding capacity for knowledge in mathematical education at all levels of education. We introduce our experiences with usage open source mind mapping software Freemind. Basic rules for map creating are given.*

**KEY WORDS:** *Mind Map, Open Source, Freemind, Problem Solving*

**ABSTRAKT.** *V příspěvku představujeme mentální mapy jako jeden z prostředků pro řešení matematických problémů, zvýšení kreativity a rozšíření kapacity vědomostí ve výuce matematiky na každé úrovni vzdělávání. Uvádíme své zkušenosti s používáním open source programu Freemind pro tvorbu mentálních map. Uvádíme základní pravidla pro tvorbu mentálních map.*

**KLÍČOVÁ SLOVA:** *Mentální mapa, open source, Freemind, řešení problému*

**CLASSIFICATION:** *C30, Q30*

### Introduction

Mind maps or “similar” semantic, concept or cognitive maps have been used for learning, brainstorming, memory, visual thinking, problem solving by educators, scientists, artists, psychologists and people in general in various spheres of activities for centuries. We should mention Leonardo da Vinci, Isaac Newton, Charles Darwin, Albert Einstein, Thomas Jefferson, Winston Churchill, Richard Feynman and many others.

Modern Mind mapping was invented by Tony Buzan as a special technique for taking notes during his study of psychology, neurophysiology, neurolinguistics and informatics. Tony Buzan is the world's leading author, lecturer and adviser to governments, businesses, professions, universities and schools on the brain, learning and thinking skills. Tony Buzan together with his brother Barry Buzan developed commercial PC programme iMindMap. Nowadays mobile applications are available for Apple and Android [8].

### Mind Maps

A mind map is a diagram used to represent words, ideas, tasks or other related items. They are arranged radially around a central key word or idea. It is used to generate, visualize and classify ideas and structures. It is an image-centred diagram that represents semantic or other connections between portions of information.

The method of mind mapping is based on the assumption that the two halves of the human brain perform different tasks. While the left side is mainly responsible for logic, words, arithmetic, linearity, sequences, analysis, lists, the right side of the brain mainly performs tasks like multidimensionality, imagination, emotion, colour, rhythm, shapes, geometry and synthesis. Mind mapping enables to use both sides of the brain, letting them work together and thus increases productivity and memory retention [2].

The style and shape of a mind map evokes the human neuron including its functions, Fig. 1.

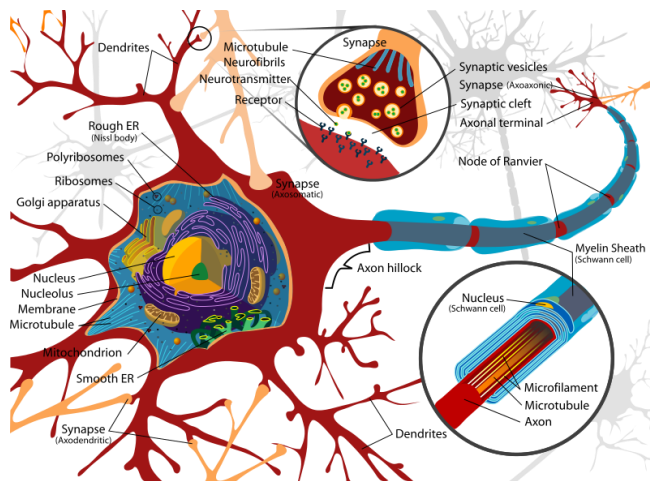


Figure 1: Human neuron

Mind maps are useful for brainstorming – individually or as a group, studying, memorizing and summarizing information, notes, consolidating information from different research sources, thinking through complex problems, presenting information in a format that shows the overall structure of your subject.

### Mathematics as the network science

Mathematics is not a linear subject. It is extremely associative. We can look at any of the notebooks or blackboards of the great mathematicians. They are filled with arrows, boxes, doodles, pictures and all the ‘thinking tools’. Many studies of great mathematicians show that a high proportion of them thought about numbers not as black and white digits but in colours and spatial forms.

Mathematics is the network science. Mathematical objects, such as concepts, definitions, theorems, proofs, algorithms, rules, theories are not only interrelated among each other but also connected with other sciences and the real world. There is a widespread consensus in the actual didactical discussions that mathematics should be cognized by students in its connection not received as a collection of isolated rules and facts. The significance of the previous sentence is apparent from the definition of The PISA Mathematics Domain [5].

*“The PISA mathematics domain is concerned with the ability of students to analyse, reason and communicate ideas effectively as they pose, formulate, solve and interpret mathematical problems in a variety of situations. The PISA mathematics assessment focuses on real-world problems, moving beyond the kinds of situations and problems typically encountered in school classrooms.”*

In the same Pisa study we can also find the definition of mathematical literacy: *“The mathematical literacy is an individual’s capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual’s life as a constructive, concerned and reflective citizen.”*

One method how to support these mathematical domain, enlarge mathematical literacy, express the network character of mathematics is its visualization. Teachers with modern approach to mathematical education use various tools for it [6]. We can use mind maps and concept maps for graphic presentation of mathematical network.

## Mind Maps in Mathematical Education

Mind mapping have been used in many fields since they were established. Mind maps can be used for problem solving, exploration, development of thinking and individual expression of creativity, memorizing, concentration, motivation, mental literacy, improving memory, presentations, organization, preparation, brainstorming, work planning and others [3].

Although mind maps have been often used in education, they are seldom used in mathematics in spite of the special technique of mind mapping which uses both halves of the brain and lets them work together what is very useful for mathematical thinking, which requires engagement of both hemispheres. The left hemisphere is suitable for analytic deduction and arithmetic, the right hemisphere for spatial tasks, e.g. geometry. The constant emphasis on rules and algorithms in mathematical education which we can see in our educational system for many years may prevent the development of creativity and spatial ability. The balance between logic and creativity is very important.

### Rules for Creating Mind Maps

It can be easy to create a map. We need a paper and pencil or the computer, especially when we create more sophisticated or comprehensive maps, and our brain and pedagogical skills of course.

At first we must decide if we will create a map using a large sheet of paper and coloured pencils or using a mind mapping software which can be used effectively to organize large amounts of information, combining spatial organization, dynamic hierarchical structuring and node folding. Software packages can extend the concept of mind mapping by allowing individuals to map their thoughts and ideas with information on their computers. The main advantages we see in the facts that maps created using a computer are graphically neat, can be complemented, corrected and reorganized continuously, supported by pictures, uploaded into the internet, sharing with several people.

Mind maps are hierarchically structured and it is necessary to observe some principles when we are creating a mind map. Following rules are recommended [1]:

- Use a large sheet of paper without lines in landscape format or desktop.
- Place the topic of the mind map in the centre of the desktop (paper). The topic of the mind map should be displayed in an eye-catching way, preferably by a coloured image. If a picture does not seem appropriate, the topic should be named by a well-chosen keyword.
- From the topic draw a main branch for each of the main ideas linked to the topic. Write keywords denoting the main ideas directly on the lines. Use printed letters. If a special order is needed for understanding the topics, the branches may be numbered or ordered clockwise. If possible, only one word per line, preferably a noun, should be written down. As 90% of the words in texts are unnecessary, using a few meaningful keywords will be sufficient to remember the entire context.
- Starting from the main branches you may draw further lines (sub-branches) for secondary ideas (sub-topics) and so on. The order follows the principle: from the abstract to the concrete, from the general to the special.
- Use colours when drawing a mind map.

Add images, sketches, symbols, such as little arrows, geometric figures, exclamation marks or question marks, as well as self-defined symbols to your mind map.

### Open source programme Freemind

We use open source program Freemind. This mind mapping software is written in Java. Free download and Freemind User Guide are available from [7]. This Mind mapping software has wide range of usage as any commercial programme. We put down our ideas, structure and expand and connect them. Freemind also works as a tree editor. We can create foldable trees of plain text, notes enriched with colours, icons, cloud-shapes, and other graphics. This will help us to customize our map. For example, we can use clouds to group together the nodes that are interrelated, colours to differentiate between completed tasks and other tasks, and icons to prioritize a node. We can add hyperlinks to web pages, local files in our computer or email addresses.

Freemind gives us the option to export and import data. It is possible to export an entire mind map or just a branch to HTML, XHTML, PNG or JPEG picture and Open Office Writer document. We can import folder structures and Internet favourites into Freemind. We can print the whole map into one page or to several sheets of paper. Freemind web applet enables other users to view mind maps from their browser. We must download and install the Java applet at our website so that users having Java 1.4 or a higher version can browse through our maps.

The great positive of the Freemind is its usability. The presence of a simple and intuitive interface makes the application easy to use and understand. It can be almost fully controlled by the keyboard. The initial desktop of the program is in Fig. 2.

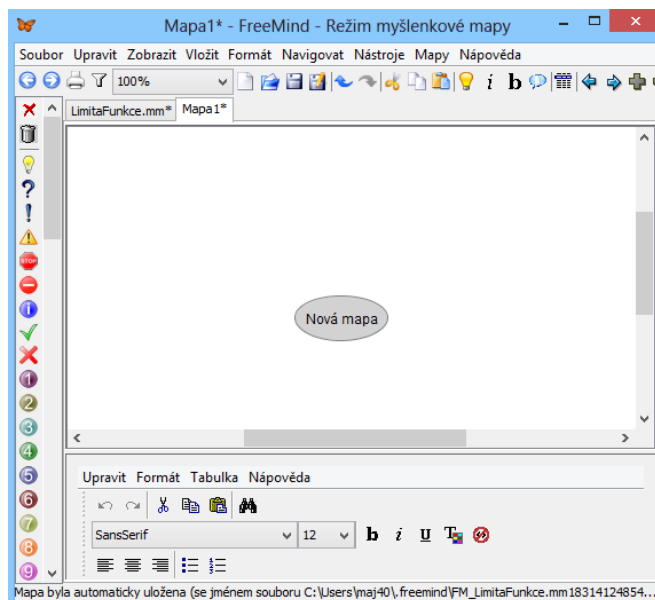


Figure 2: Desktop of Freemind

### Mind Maps in Calculus

We create and use mind mapping to help students to master basic theorems, features, links and solving methods for more complicated topics such as Limits, Derivate, Integrals, etc. Visual layout helps to clear orientation and facilitates remembering. Mind maps are

inserted into elearning course in CMS Moodle. Unfortunately the Freemind does not enable the export of mind maps with all its interactive tools. The mind maps are inserted into CMS Moodle as a static bitmap. But students can download the programme Freemind to their computers or portable flash disks and use the mathematical mind maps with all dynamic advantages. After mind maps are presented in the mathematical course students are able to use them at home, adjust them or create their own mind maps.

The limit of function belongs to one of the most important concepts and sometimes to one of the most difficult as well as by students the most ignored topic of Calculus. We started to support difficult definitions of the limit in our mathematical courses by applets before five years [4]. But students confuse the methods of computation of the limit in the definite point with the limit in the infinity as well as the limit of rational function with the irrational function.

The special techniques of mind mapping organise the mathematical knowledge in a clear and concise overview of the connectedness of mathematical objects around a main topic and enable the balance between logic and creativity. Students see them on one sheet of paper. The mind maps introducing the limit of function are in Fig. 3 and 4.

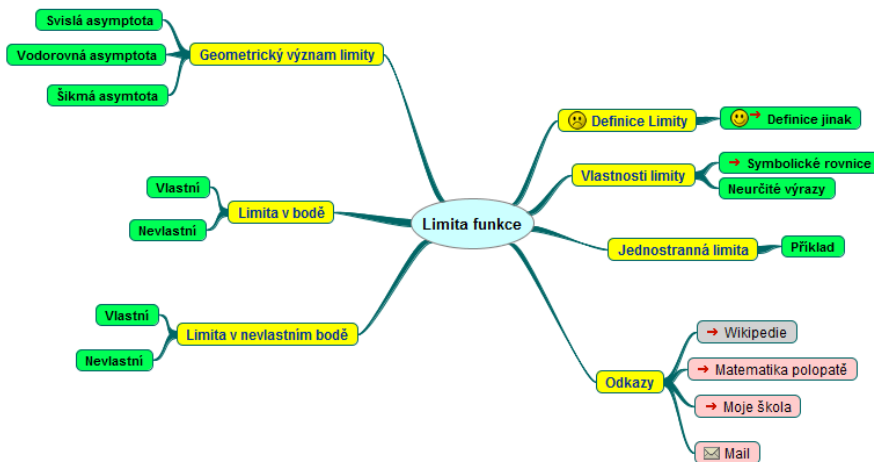


Figure 3: Limit of function - Basic definition

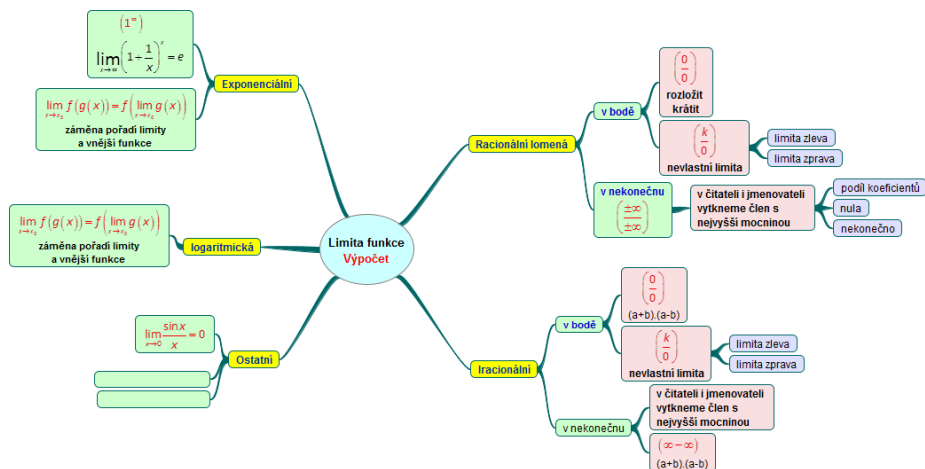


Figure 4: Limit of function - Basic rules

Some of subtopics contain the link to the file in PDF Format or web pages. The connected files include basic information relating to the given topic. If a node contains the arrow it means that it is the hyperlink.

In a subject like mathematics, students often forget important results, theorems or methods and they are not able to apply them in the related questions. But with mind maps they can remember the results in an order. Mind maps have an open structure and anybody including students may add own concepts, methods or thoughts.

## Conclusion

Mind maps are more compact than standard notes. Mostly we need one paper or screen. Using mind maps enables us to make relations, dependences and generate new ideas and conclusions. A good mind map shows the structure of the problem, importance of individual items, and all interrelationships among them. We can quickly refresh and repeat any topic. Students like to work with them. We recommend using an open source programme for mental mapping because of its interchange ability, flexibility, reparability and possibility of sharing.

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