

## The Mind Map at the Service of Learning



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**ABSTRACT:** Mapping is a technique that helps students organize their knowledge about a topic or idea. This term, also known as heuristic diagram, cognitive map, the English psychologist Tony Buzan or Anthony Peter Buzan developed concept map or «mindmapping», during the 1970's.

This technique allows for a freer, non-linear organization of information, and is often suitable for students with a visual approach to data. It is also very useful for students with learning disabilities. In this subject, we distinguish two major concepts: "mind mapping" and "mind map".

In this work, we present a theoretical outline on the "mind mapping", the "mind map" and the difference between these two concepts, and then we are interested in the elements that can influence understanding, meaning and learning as well as the different mind map applications.

In the end, at the practical part, which concerned a sample of 38 students from the first year of the Scientific Baccaureate, we concluded in this research, that the visual convivial structuring aspects of mind maps help struggling students who have difficulty concentrating in class and understanding information presented in large blocks of text. However, in general, the mind map is a relevant tool for all students, since it allows them to very easily create review sheets.

**KEYWORDS:** mind map, learning, mind mapping, mind map.

### I. INTRODUCTION

Professor Abd El hakim Serge Danler Baumgartner; Organizer and facilitator of educational seminars; Specialized in cognitive development; Teacher of the mental map for more than 10 years answers us:

"A cognitive development tool, the mind map installs useful skills for studies, professional and personal life.

For about 10 years, pupils and students who have used it have been ahead in terms of learning efficiency compared to their peers. On a personal level, it allows you to build self-confidence because you feel in control of your subject and at ease during your presentation. The heuristic scheme is to be used in all circumstances. "

It is very difficult to learn and recover key knowledge and skills when only a limited amount of information is retained at a time. Working memory is an executive function that allows us to hold information in our minds while we use it. It is also crucial during the process of storing information in long-term memory. It plays a key role, too, in retrieving previously learned information from memory.

In fact, the majority of the "work" performed by memory takes place in "working" memory where information is managed, manipulated and transformed. The capacity of working memory differs from one individual to another.

Students with working memory problems retain less distinct information at a time. They listen to what is said, or see what is presented, but as additional information overwhelms their memory system, they forget the prior information they need to complete the task successfully. In addition, once the information is lost, it is unlikely to be recovered.

It is therefore easy to understand why the student becomes frustrated and ends up paying no attention. However, working memory problems are common among students with attention to the deficit hyperactivity disorder, learning disabilities, hearing loss, brain injury or mental health issues.

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How memory problems present for students:

- Having difficulty remembering facts and procedures such as new vocabulary words, or mathematical procedures.
- Demonstrate slowness in retrieving information.
- Proving unable to follow instructions despite their repetition.
- Paying little attention to detail, for example, starting to write a sentence and then having trouble remembering all the words, skipping words in sentences, or writing shorter sentences (to reduce load on working memory).
- Make mistakes in the order to be followed, by losing track of the steps completed or the steps that remain to be completed, by repeating steps unnecessarily or by constantly having to start over.
- Having difficulty starting a job.
- Having difficulty concentrating on a task, often to the point of abandoning it.
- Lose their personal effects.

The mind map is an interesting technique that helps students bring out and organize their knowledge on a subject matter or a main idea. This is the strategy of mental maps or "mindmapping". This term, also known as a mind map, cognitive map, or concept map, was developed in the 1970 by English psychologist Tony Buzan.

It is now established that using a mind map can help students organize their ideas and gain a better understanding of the concepts involved.

Indeed, mind mapping, allows a freer and non-linear organization of information, is often better suited to students who prefer a visual approach to data. Mind mapping is also recognized as being of great use for students with learning disabilities, In the literature, we find two concepts related to mental maps; the "mapping of the mind" and "the map of the mind", in English, "mind mapping" and "mind map" respectively.

In the theoretical part of this project, we present an overview of the theory relating to mind mapping, of the mind map, and the difference between these two terms, as well as the functioning of the brain. We are also interested in the elements and factors that can influence the understanding, the meaning and the learning resulting from all the theories presented.

## II. THE MIND MAP

According to Tony Buzan, the inventor of mind mapping, a mental map or "mind map" is a visual and graphical tool that can be applied to all cognitive functions, especially memory, creativity, learning and all thought forms. It is in a way the "Swiss army knife of the brain".



The mind mapping theorist, Tony Buzan, explained in the 1970s that the mental map favors the stimulation of the right hemisphere of the brain (linked to creativity, to the spirit of synthesis), as well as its cooperation with the hemisphere left (seat of rationality, logic and language).

### A. The difference between "mind mapping" and "mind map".

In the literature, the border is very blurred between the concept of mind map and that of mind mapping, their characteristics are often confused.

We take as a postulate that the mind mapping is in the action, the doing, the design while the mind map is the final product on. Mind mapping is a technique, a process which follows development rules and which aims to produce a mind map.

In French, the mind map or heuristic map is a tool, which makes it possible to graphically represent ideas, concepts, and to show the relations as well as the hierarchy which exist between them.

The mind map is a graphic representation where words, ideas, drawings, colors, etc. are related.

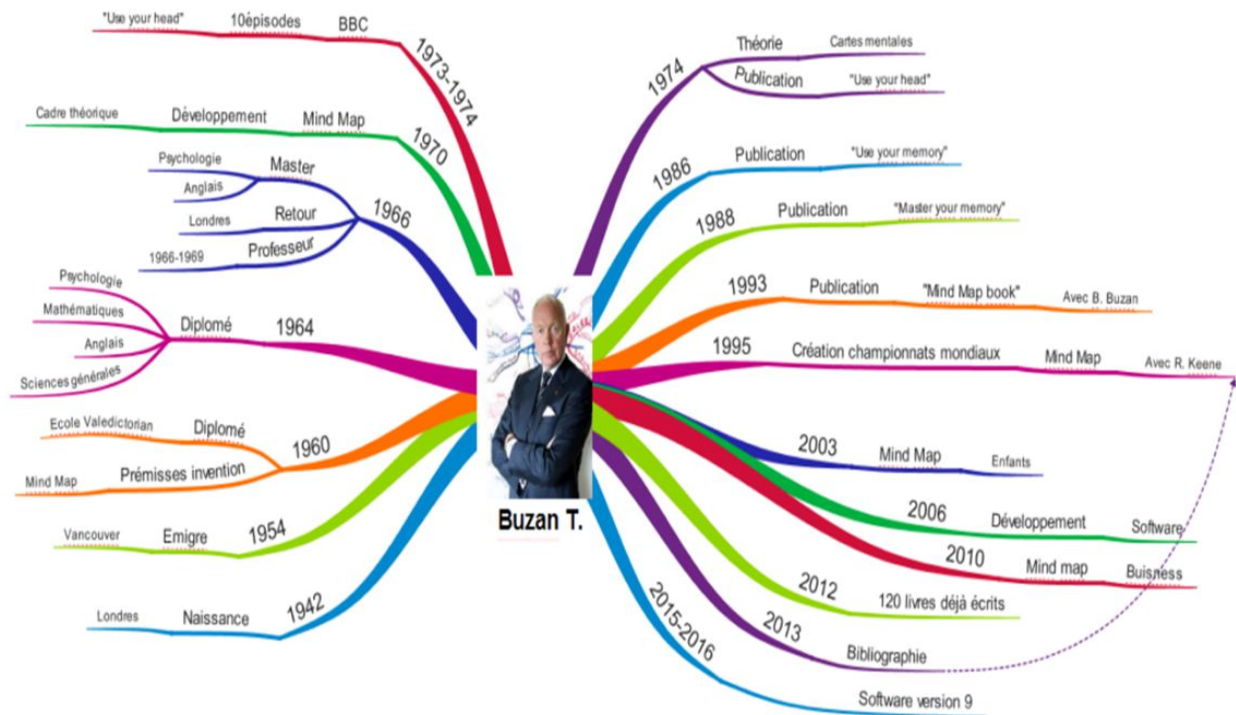
It is reading done, starting from the center where the general theme is inscribed; it is developed in a tree structure.

Its objective is to bring out the information and to structure it by creating links, by installing a hierarchy.

The mind map is both an analysis tool, because it highlights all the elements and links of the theme by organizing everything (left hemisphere) and a tool of synthesis allowing the reader an overview (hemisphere right).

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### B. The biography of Tony BUZAN in the form of a mental map.



### III. MIND MAPPING AND THE TWO HEMISPHERES.

#### A. The mental map and the brain: how to solicit the two hemispheres.

Located under the skull, the brain is the largest part of the nervous system. It weighs about 1.35 kg and consists of two hemispheres: left and right. For there to be optimal brain management in an individual, there must be a synergy between the two hemispheres.

Many folds or convolutions increase the outer surface of these hemispheres and constitute the cerebral cortex. Its thickness is barely 5 mm and its surface is around 0.1 m<sup>2</sup>.

Each hemisphere is divided into four lobes: the frontal lobe, the temporal lobe, the occipital lobe and the parietal lobe.

The left hemisphere controls the muscles on the right side of the body, the right hemisphere controls those on the left side: This is the principle of contra-laterality.

Equally distributed over the two hemispheres, primary sensory areas receive sensory information from the sense organs: hearing, sight, smell, taste and touch.

Near the primary sensory areas, associative areas integrate information from different sources. The sensory areas also follow the principle of contra-laterality. On the other hand, the two hemispheres distribute the main intellectual functions differently. The left hemisphere plays an important role in language. This hemisphere is also responsible for logical and mathematical operations. It will process verbal memories (rational).

As for the right hemisphere, it seems to specialize in image processing (recognition of images and shapes), spatial perception, artistic abilities as well as the emotional dimension of language and bodily expressions. It will process visual memories (intuitive).

The corpus callosum, located deeper, connects the two hemispheres. However, even if the two hemispheres have a recognized dominance in certain areas, they are both competent in all areas.

We thus note the importance of soliciting the two hemispheres during the same task, the same learning process in order to optimize the performance of the brain. The two hemispheres will thus work in synergy.

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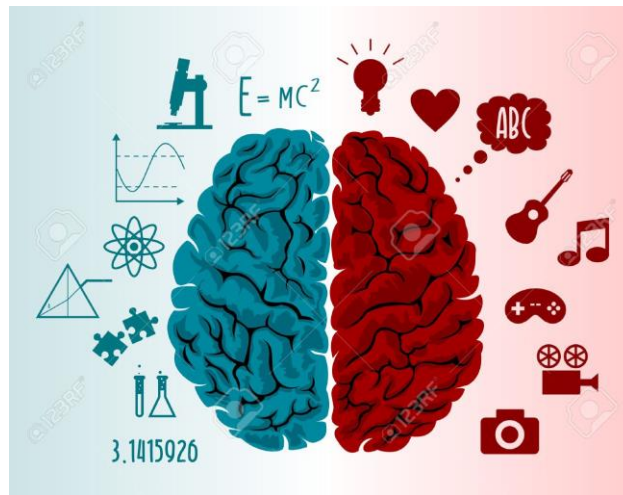


Fig 1. Two hemispheres

If the two hemispheres interact together, they will create a greater performance or even a "response" other than the sum of the performances produced separately by the hemispheres taken in isolation.

We can already sense that mind mapping can cause this synergy, the two hemispheres being solicited, during the development and memorization of the mental map.

### B. Links between characteristics of the two hemispheres, mind mapping, and the mental map.

The different links between the characteristics of the two hemispheres, mind mapping, and the mental map are:

- The primary sensory areas are distributed over the two hemispheres. This is where sensory information is received. In mind mapping, hearing and sight are very much in demand. In the mental map, the view is at the center of the activity, solicited by the tree-like presentation.
- Associative areas integrate information from different sources. In mind mapping and the use of the mental map, the links and the creation of meaning are essential and are made as one reads from the main branch to its sub-branches.
- The left hemisphere (words, logic, details, and links) is used more during mind mapping.
- The right hemisphere (drawings, overview, and presentation in tree form) is more solicited when reading the mental map.
- Mind mapping and the mental map solicit the two hemispheres to different degrees.

### C. Mind mapping and brain function

Sight is greatly solicited when "reading" a mental map or when memorizing it. This is why we wanted to understand how a student's brain works when processing visual information.

Let us take the example of a stimulus materialized by a red right-angled triangle. This visual information is routed via the neurons of the optic nerve and other complex pathways to the primary visual sensory area, which receives the impulse and makes a rough analysis: "We see a colored shape".

The influx is then routed to the adjacent associative area where the detailed analysis of the information will be done by comparison with the information stored in this area and which constitutes the visual memory:

- Analysis by information  $\implies$  It is a polygon with three sides triangle  $\implies$  Analysis by comparison: a right angle  $\implies$  A right triangle.
- Color analysis by comparison  $\implies$  its red.

The influx also ending in the associative areas of the other lobes, this will allow, "imagining" a red right-angled triangle.

In addition, visual information also travels to the prefrontal lobe, which may help plan the response in relation to visual stimulation.

- I see the red right triangle  $\implies$  I know it's a polygon, a red right triangle  $\implies$  I decide for example to draw an additional branch to the mind map or to memorize the main branch and the sub-branches

### D. Mind mapping and neurons

According to Buzan, the mental map mimics the functioning of the brain. This is made up of one hundred billion cells exclusively intended to circulate information: neurons. In this part, we therefore approach the structure of the neuron, its ability to circulate information: the influx. Finally, we will focus on the means of communication between neurons: the synapse. We want to highlight the fact that the mental map has been developed to imitate as much as possible the neuron whose essential role is to circulate information.

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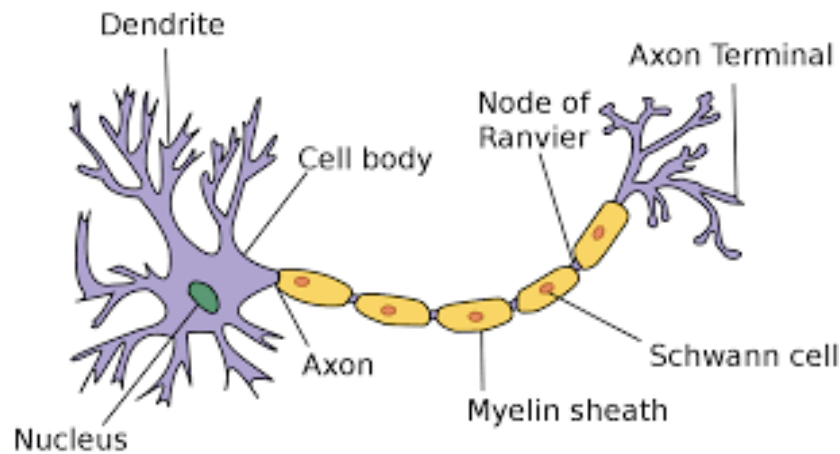


Fig 2. Structure of a neuron.

- **Nerve impulse**

When the membrane of the neuron undergoes a stimulus, movements of ions are triggered across this membrane at the stimulated site. Since ions move, there is therefore an electric current. The latter induces the same movement of ions step by step along the membrane to the ends of the neuron: this is the nerve impulse.

- **The synapse**

At the level of the terminal nerve corpuscles of a neuron, information is transmitted to another neuron by a specialized area called the synapse.

The synapse is made up of:

- From a terminal nerve corpuscle belonging to the presynaptic neuron and containing vesicles filled with neurotransmitters.
- From a synaptic cleft: free space between the two neurons.
- From a portion of the membrane of the post-synaptic neuron.

Information passes from the transmitting neuron (presynaptic neuron) to the receiving cell (post-synaptic neuron) via neurotransmitters. When the nerve impulse triggered at the level of the presynaptic neuron arrives at the terminal nerve corpuscle, it triggers the release of neurotransmitters at the level of the synaptic cleft.

These neurotransmitters then place themselves on receptors located on the post-synaptic membrane. This has the effect of triggering movements of ions on this neuron and therefore of propagating the impulse. The same mechanism of synaptic activity occurs at the level of other neurons, thus making it possible to establish more or less complex nervous circuits, along which one or more pieces of information circulate.

More than one hundred neurotransmitters have been listed and are involved in different types of synapses.

Acetylcholine is the most used neurotransmitter in learning and memorization mechanisms. Similarly, glutamic acid plays an important role in long-term memory.

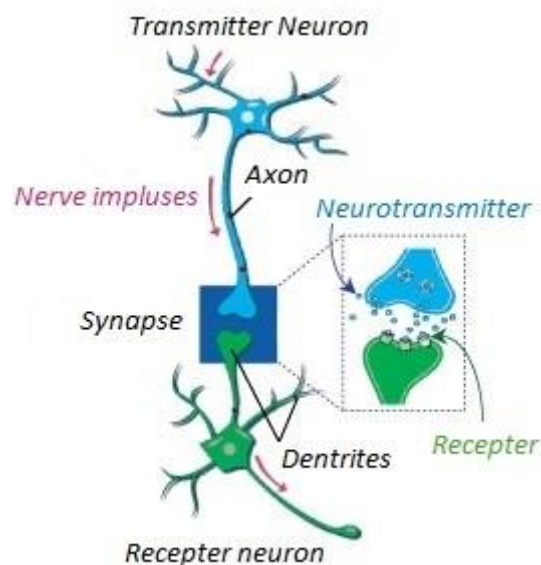


Fig 3: Synapse



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By way of conclusion, the essential role of a neuron is to circulate information: from a transmitting neuron/presynaptic neuron to a receiving cell/post-synaptic neuron via neurotransmitters.

Indeed, the brain, as being a blank page, in front of a set of information will try to format them.

He then looks for a structure that makes sense; he organizes, prioritizes, creates links and tries to fill in the blanks.

### E. The mental map and memorization mechanisms

Memory is the ability to store and access information. How can the establishment of synapses between neurons and the flow of impulses along nerve circuits explain memory activity? In other words, how to do mind mapping or use a map; map promotes memorization?

We can argue that the mental map can be a facilitating tool during memorization. Indeed, it was developed to best imitate the mechanism of the brain: the neural pathway.

It allows a structured approach, promotes repetition and therefore the easy retrieval of information.

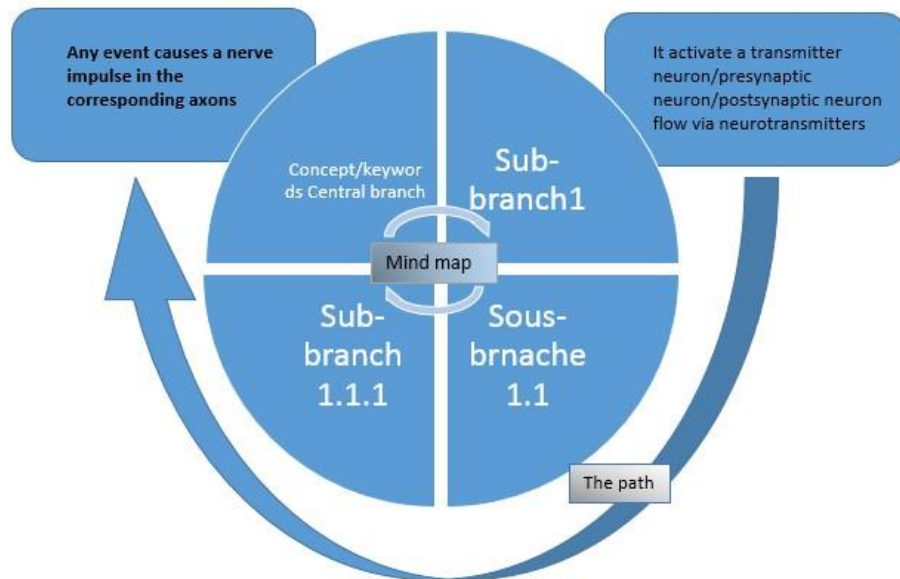


Fig 4. The mental map and memorization mechanisms

Significant solicitation (repetition) is required to begin to build traces of learning. The importance of intense stress favors the repeated propagation of nerve impulses.

The mind map is, by design, a tree structure, a tool that promotes repetition and therefore learning (long-term memory).

Mind mapping itself can initially use short-term memory, but when the student creates branches, looks for links, it causes repetitions and the beginning of learning.

Finally, it should be noted that mind mapping and the mental map, through their methodology and their representation, could contribute to increasing motivation, arousing interest and increasing self-confidence (positive emotion).

This allows the limbic system to pass information to the cortex so that there is learning.

## IV. TABLE CONSTRUIRE UNE CARTE MENTALE

### A. The mental map and memorization mechanisms

#### A.1. The paper medium

If we wish to widen our field of vision, we will choose the panoramic format (known as "Italian" or "landscape") because it is more suited to our anatomy.

In practice:

- We use the sheet of paper in landscape format.
- We use a blank paper of lines and squares so as not to be influenced by a constraining structure.

#### A.2. The Heart of the Map

Our visual system itself, the retina in particular, is based on the principle of central vision, the fovea, and peripheral vision. This system allows us to examine both accurately while observing the surrounding space.

In practice:

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- We put the subject right at the center, which allows us to have a 360° space to spread our ideas or information.
- We use at least three colors and give it a size of around five cm in five cm for A4 format.
- We do not enclose the theme in a square or a rectangle. At most, we prefer a vaporous form like a cloud.

### A.3. Branches

The branches are the expression of a flow, which is expressed by a cascade of ramifications. We are therefore dealing with a structure of fluid and plastic connections. The proximity to the center induces a radiant hierarchy in the service of a more globalizing than sequential approach.

In practice:

- Our branches have an organic aspect, that is to say borrowed from the shapes of nature. They are curved and oblong
- We give them a length identical to that of the word they support, so that when reading, a space does not interfere with the meaning given to their connection.
- We distribute them harmoniously in the space, in order to obtain a clear structure that is pleasant to look at.

### A.4. Keywords

Words are indeed signs, which, like images, carry information.

However, reading words preferentially requires the resources of the left cerebral hemisphere, which is more analytical and precise, attentive to detail and respect for rules.

Words can, however, also be treated as images depending on how they are represented. We use the term "keywords" because they are intended to open to other words or images.

We can consider the keywords used in a map as clues that reveal information, which from an observation, an object, will weave a web made of links leading to a certainty or at least to a likely guess.

In practice:

- We choose keywords for their ability to evoke useful information.
- We write the keywords very legibly on the branches so that they can be understood quickly with a simple glance, because a card is scanned more than it is read.
- We strive to put only one keyword per branch, so as not to lock ourselves into sentences, which are often definitive.
- A keyword may be an expression grouping together several words. The important thing is to only express one idea or concept at a time.

### A.5. Images

"A picture is worth a thousand words". We could also say that a picture can evoke more than a thousand words.

The image emulates the right cerebral hemisphere, which manages emotion, imagination, globality, analogy. It is a medium that quickly brings us to the essentials of what to grasp. Our society makes frequent use of it, especially in the press where the drawing allows us to understand a complex political or economic situation, or at the level of signage to make us understand not to use a mobile phone in certain places, thus tempering the aggressiveness of a prohibition written in full.

In practice:

- We choose simple but evocative images. Regardless of our talent as a designer, the image has no other vocation than to evoke the information to which it must connect us.
- Our images can represent a concept, for example memory or a material thing. The context conditions and reinforces the meaning we want to give it. If we draw an elephant's head, it could represent the concept of memory (from the expression "to have an elephant's memory") or the animal itself.
- To enhance the impact of our images, we use color and shadow and relief effects.

Colors

The colors are able to make a part of the map homogeneous and at the same time to highlight a particular information. Its use can be used to establish a hierarchy and transversal links and its properties promote readability as well as memorization. Color stimulates the senses and contributes to the pleasure of making and using a map.

In practice:

- We preferably reserve a different color for each main branch.
- We use a particular color to highlight a type of information, for example red for encrypted information or emergencies.
- We can give a meaning to each of the colors used, which may be different depending on the cards.

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### A.6. The style

If each of us has a writing style, this is even more true for mind maps, given the multiplicity of materials used. The letters, the designs, the shape of the branches, the color preferences, the material used, all of this contributes to the expression of our personal style. The efficiency of a mind map also depends on the pleasure we have in looking at it.

In practice:

- We use emotion (humor, exaggeration, astonishment, etc.) and movement through lines that evoke it, so that the information contained is apprehended by as many senses as possible.
- We cultivate our style by building a library of personal images, easy to reproduce
- We are inspired by mind maps produced by other practitioners.
- We observe nature (trees, flowers, crystals, rivers) but also human constructions. Our whole environment can be a source of inspiration.

Equipment

If a simple pencil and a sheet of paper are enough to make a mental map, the users of this tool are often concerned about their equipment, a bit like craftsmen for their tools. The choice of material contributes to the pleasure we have in making cards. Everyone will have their preference for such paper, such pencil, such pen, such brand of marker...

In practice:

- We test and try, papers, pencils, pens in order to choose those with which we are most comfortable.
- We choose equipment that is compatible with our environment. Unpacking in a board of directors his case of colored pencils can reserve us some surprises. We will prefer our fountain pen; we can color our map later. It will be a great opportunity to make it our own again.

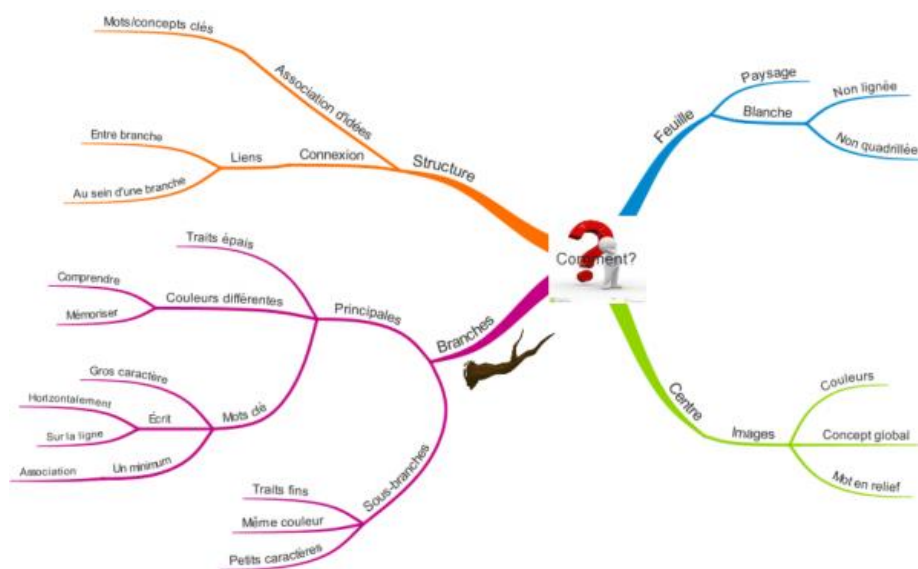


Fig 1. How to Create a Mind Map

### B. Mind-map applications

The mental map does not only have a purely pedagogical vocation. It can be used in everyday life when developing projects, to set goals to achieve, to solve problems. This approach also makes it possible to organize self-assessments and self-regulations. Mind mapping also allows taking notes, organizing information according to the logic of each individual. The latter elaborates it by analyzing the data, by creating a hierarchy between them. Taking notes under this graphic representation makes it possible to propose a tool that diverges from the linear predominance.

- Highlighting concepts, keywords: they are not lost in a flood of words.

Thanks to its polychrome appearance, monotony due to chromatic uniformity and lack of relief is avoided. On the other hand, attention is solicited and interest is amplified.

Saves time: researching keywords avoids dwelling too much on the details.

Stimulation of the brain: it tries to make connections, to create meaning... it is constantly looking to fill in the "blanks", and create new possibilities.



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The mind-map can also be used for



Fig 5. Other applications

### C. Build a mind map with software

#### C.1. Advantages of computer-made maps

Advantages of computer-made maps with dedicated mind mapping software:

- Rapid learning of the software with keyboard shortcuts (when you know a software, you intuit the others).
- Rapid modification of the structure: we change the side branches, we add / delete some.
- Instant change of keywords.
- Library of symbols and codes to catch the eye. Links to information located in different places: documents on my computer, web pages. Deployment/folding of branches and sub-branches, for example according to the needs of a presentation.
- Map that can span one or more other interconnected maps.
- Computer-made maps often "cleaner" than hand-drawn ones, therefore easier for others to understand.
- Teamwork on the same card, on remote computers.

#### C.2. Mind map software

All these dedicated software allow:

- FLEXIBILITY - to add, delete, move ideas.
- COLORS - to use colors to isolate branches from each other, to emphasize an idea, to identify relationships between ideas, to brighten up the map.
- ILLUSTRATIONS - to insert images of the software or those gleaned from the Web to capture attention and facilitate memorization, sometimes without having to read the idea. The symbols and codes of the software, or those that I invent, remind me that I must seek an answer, perform an action, communicate with a comrade, etc. It is not necessary to insert an image for each idea.
- LINKS - to link ideas to:
  - One of my files (opens associated program).
  - A web page (opens a browser);
  - Another one of my mind maps.
- CLOUD - to put a main idea and its sub-ideas in a cloud to make it stand out, or to put all the main ideas in a cloud in order to isolate them from each other (not very aesthetic in my opinion).
- ANNOTATIONS - to enter annotations about certain elements of the map for which I must deepen my research, consult a person, etc.
- EXPORT - to export my maps:
  - In PDF format;
  - As a png, jpeg, svg image...
  - In one of the Microsoft software: Word, PowerPoint...;
  - On my website (fixed or interactive maps).

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I limit the size of my map; the branches must not exceed four levels. If the map becomes too crowded, I narrow my topic or produce another map (linking it to my first map).

### C.3. Software selection criteria

- Here are the criteria for choosing the software we offer:
- Their free in whole or part of the solution
- Simple and intuitive use.
- The possibility for most of them to integrate media, photos, videos...

### C.4. List of software selected according to these criteria

- Free mind: the free software reference is very easy to use.
- Lucid chart: The solution for creating mind maps and other diagrams (flowcharts, flowcharts, decision tree, etc...). It has many features including the ability to import previous creations from Word, PowerPoint and others. A free and unlimited version is available for teachers and students.
- Free plane: created from the source code of free mind, it offers a more playful graphics and is part of free software.
  - Xmind: not free but with a free solution: more up-to-date graphics with very practical themes and templates for formatting. Good general ergonomics.
  - Edraw: many formatting possibilities and creation of mental maps but rather intended for people who master Excel.
  - Framindmap: here it is not a software but a completely free online service for creating a mind map. A clean design, no media to integrate but great ease of use. Ideal for making a mindmap with children.
  - Thinkmapping: after an online registration, this site offers you a multitude of blank mind maps.
  - Coggle: its particularity is the possibility of creating mindmaps in collaborative mode. Once your card has been created, all you have to do is share your notes and cards with whoever you want by sending them an invitation directly from the application. Your contacts will even be able to modify them.

If the creation of mental maps by your child himself is still too complex, first offer him turnkey maps that will familiarize him with this tool. When he is more comfortable with mind, he can then start making them himself.

### C.5. Mind Map in Physics

A mind map is a way of organizing ideas that allows you to structure knowledge, implement an approach, approach a new concept and facilitate note taking.

In order to better understand the educational advantages of mind maps in the physical and chemical sciences, several examples of maps organized according to their contribution are offered.

#### ✓ The advantages and disadvantages of the teaching method by having used it in physics lessons:

Using the mind map the student:

- Has a permanent vision of the central theme
- Sees ideas build around this theme (which is not possible with oral brainstorming)
- Can come back to a previous idea to complete or question it
- Understands the association of ideas according to the group
- Participate in the construction of the course
- Associates the image with its representations and key words, which will increase its memorization skills by using the right brain.
- Has a global vision of the elements of the course
- The time required to write the course in class is shorter

The students copy the mind map made on the board

- The more they are used to the technique in class, the more they copy it simultaneously (24/26 students do it after 3 months) and spontaneously
- Otherwise, they are offered a time to copy it into their notebook
- Students appreciate the colorization of their lessons. They personalize their course, which will facilitate memorization

#### ✓ The reaction of parents

Some parents of students wanted to meet me to talk to me about the teaching method I use, the feedback from their child is very positive:

- Better memorization of lessons

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- Improved academic results
- Pleasure of their child during lessons
- Increased motivation

### ✓ Disadvantages

Not all mind map features are used:

- The mind map is copied by the students in landscape format, but in a notebook in portrait format
- The pupils do not use a white sheet without a line or else it is a question of changing habits...
- The use of keywords is only possible when the student has acquired solid writing skills.
- The oral questioning of several students seems necessary and useful to me after the presentation, to check that they are able to replace the key words in elaborate and complete sentences, which they really like!
- My experience shows that students know how to reconstruct a complete and personal sentence during homework.

### ✓ Examples: production by students



## D. APPLICATION

### D.1. Mathematical

#### ❖ Part 1. stated

The context in which the educational system is set up is in the first year of the Scientific Baccalaureate.

Having different classes in different high schools in Casablanca during our internship, we choose to set up an educational device based on the use of heuristic diagrams in one of them.

This allows us to analyze the benefits, advantages and obstacles of our device and to what extent students will enjoy using it.

This choice of class will arise at the high school Chawki, provincial direction Casa-Anfa in Morocco for a month. We teach, function study, for five hours a week for 2 weeks.

During the exercise sessions, and in the presence of our internship supervisor, we introduced the notion of mind mapping to the students.

#### **The objectives set for our mathematics course:**

- Students are used to studying their notions of theory in a textbook as well as their class notebooks. They discover, thanks to heuristic diagrams, a new way of synthesizing concepts not in a linear way but in a tree-like way.
- When creating their diagrams, the student prioritizes the themes into sub-themes according to the meaning, according to the processing of information, elements...
- This phase allows the student to raise the key words, to understand them and to integrate them into a tree representation.
- Mind mapping invites the student to look deep into his knowledge and his already-there (previous patterns) for information, it also encourages him to make associations (create meaning) in order to enrich each theme or sub-theme with the aim of not leaving any "blanks".

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- The student, during mind mapping, starts from a main concept and processes it, analyzes it in order to create links, meaning between each branch. The student may also discover, as he creates his mind map, that certain elements he needs to enrich a sub-theme may belong to another sub-theme. This allows him to discover similarities, differences, he thus deepens his knowledge.
- The individual creation of his own mind-map allows the student to more easily appropriate the concepts as well as the links uniting them. Indeed, the mind map forces the student to focus on the meaning because without it, it is impossible for him to develop this diagram. This approach asks the student to question himself, to revisit his own knowledge and to challenge the teacher so as not to leave any term understood. Meaning is therefore the common thread.
- In addition to links, meaning, motivation and understanding of concepts, if we propose to develop these mind maps, the student is in a process requiring the repetition of keywords, links, meaning, etc... The repetition provokes the beginning of the memorization, which it deepens during the study of the mind map. It is easier for a student to remember what he has built himself.

Finally, the approach to mathematics in a new form and the development of a new tool for memorizing arouses in the student and interest in “doing math differently...” Once interest has been aroused, the student dares to try it out.

### The session of Thursday, December 6, 2018 2:30 p.m. to 4:30 p.m.

First we started with a theoretical session about mental maps lasting an hour, then we moved on to another practical session, taking the course on functions as well as the Barycentre as a support for develop a map that summarizes these courses. These maps were collected for the study on compliance with the criteria.

In order also to allow students to appropriate mind mapping, we suggest that they create at home a heuristic diagram of their life, who are they? The only constraint imposed is to respect the rules of mind mapping and the development of at least five main branches. The concepts found on the main branches are therefore not imposed. Each student is free to approach the concepts that are important to him.

### ❖ Part 2: Study of mental maps produced in class according to the criteria.

#### Sample

We have a sample of 38 students in the first year of the Scientific Bacallaureate, with 25 girls and 13 boys.

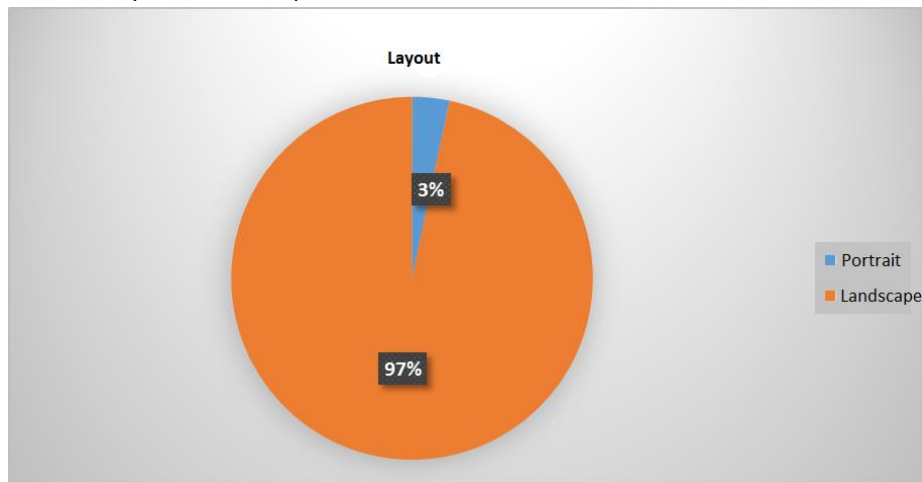
The whole class having taken the same course on functions with the same teacher.

After collecting the 38 mind maps, a study is conducted according to the rate of compliance with the criteria presented below:

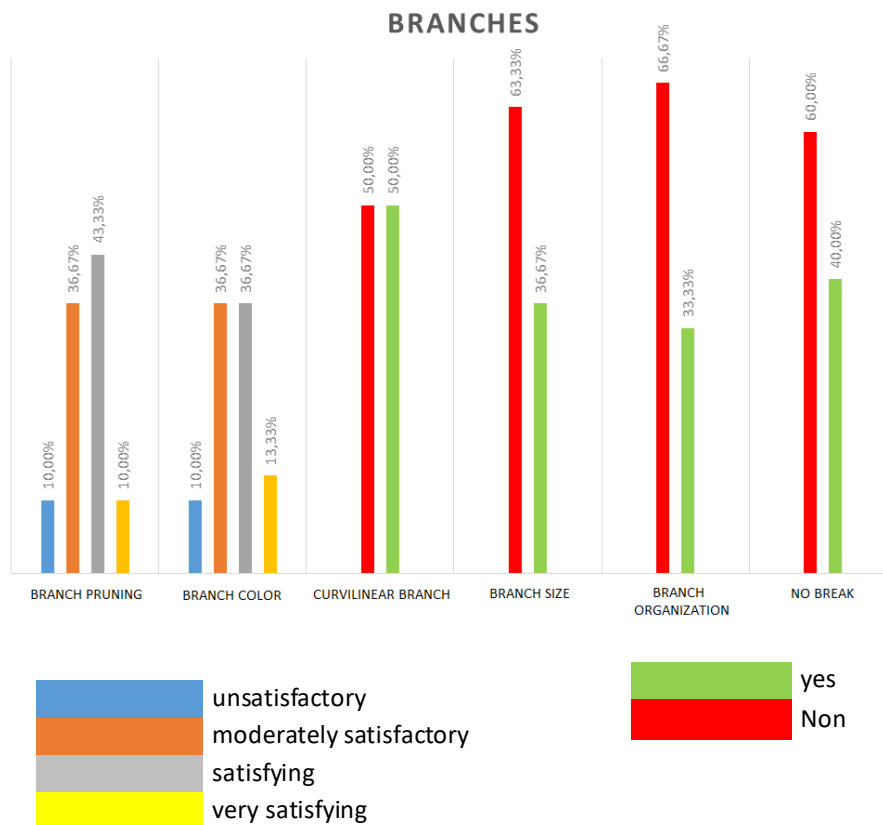
Criterion Mind map paper out	indicators
digital Layout	Landscape, Portrait
Central theme/concept	Position the heart of the card Well- proportioned size (ex. 5cm square for an A4 sheet) text or picture, the font used or chosen picture...
Branches	Branch size, color, font and picture chosen, spacing between branches, curvilinear branches, branch size equals word size, clockwise branch arrangement, no break between the branches....
Key words	Choice, uppercase font, one word/branch, horizontal writing, location on branch, phrases, branch size equals word size
Colors	Harmony, maximum of 5 to 6 colors/card, the color of the ramifications is identical to the mother branch....
Pictures, icons, symbols	Integration, Adequacy, definition, size, clarity, source, location.
Weaving links between the branches	Integration
Visualization	Arrangement, spacing between branches, general aesthetic
Hypertext links for digital map	Integration, functional, good Adequacy
originality	Creativity

## The Mind Map at the Service of Learning

We present, in statistics, the study of mental maps in 30:

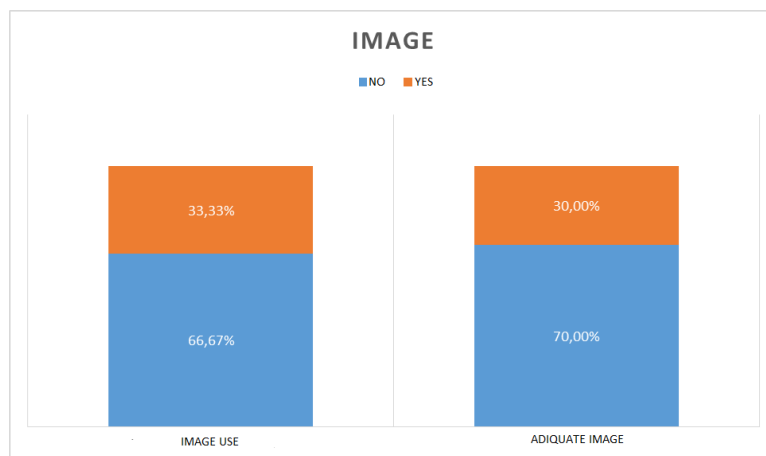
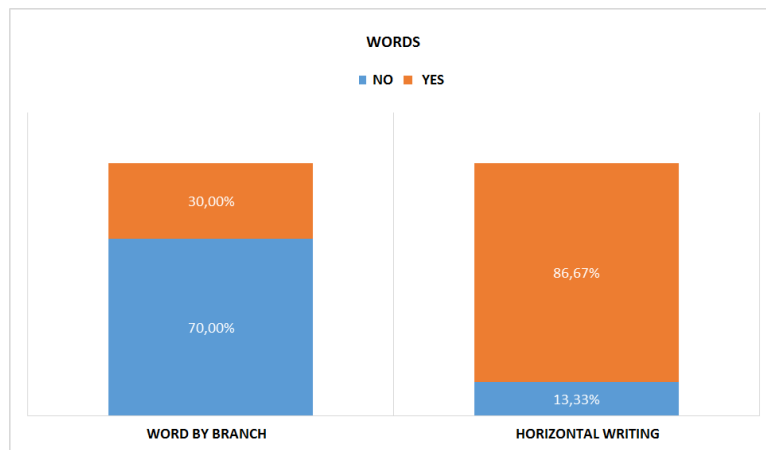


- Only one person used the sheet in portrait format.

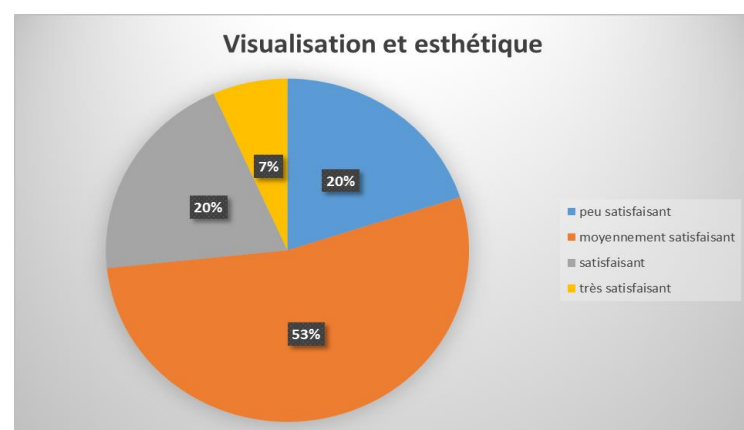
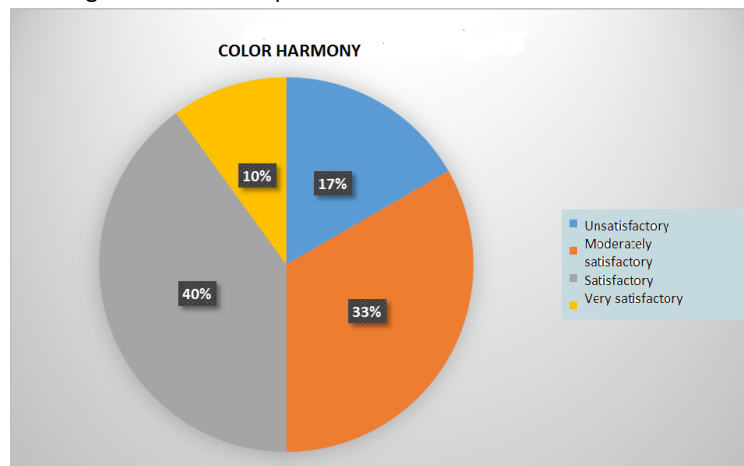


The different criteria on the branches were evaluated, including the size of the branches, their shapes, the breaks as well as the choice of color. It can be seen that almost the same percentages that pass one index of the criterion pass the others. Hence the correlation between the different elements of the criteria on the branches.

## The Mind Map at the Service of Learning

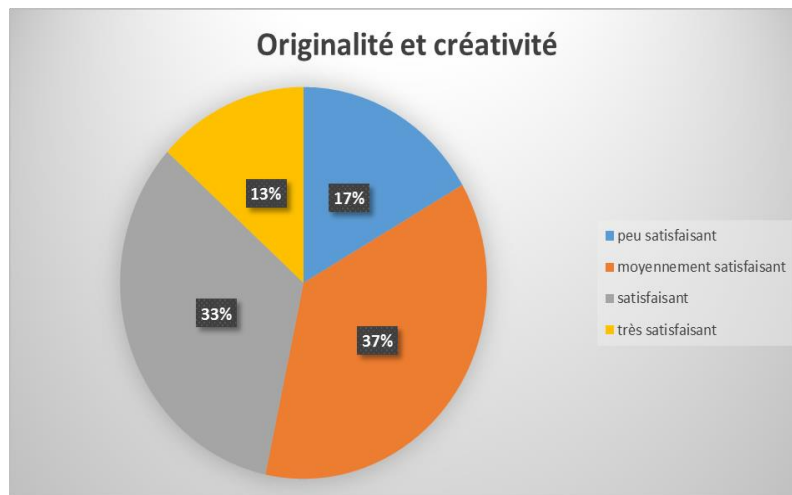


It can be seen that almost all the images used are adequate with a deviation of 3%





## The Mind Map at the Service of Learning



Finally exposing us statistics on the color harmony rate; visualization and aesthetics to close the evaluation on originality and creativity, which is thus one of the objectives of this educational tool.

### ❖ Part 3: Student feedback via the “feedback” questionnaire

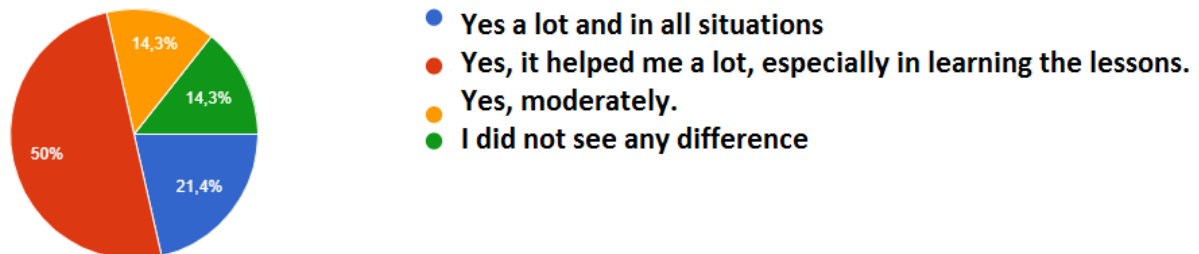
We wanted to discover the impact that the use of mind maps could have on students during the development of lessons, the effects of its use during memorization as well as note taking.

For this, we wanted to observe how the students used the mind-map and determine the interest and pleasure they found in this technique.

After a week on the introduction of mind-map, we quote their answers on a questionnaire dedicated to study the impact of the maps on their motivation:

**In general, do you think that working with mind maps has been useful for you?**

14 answers



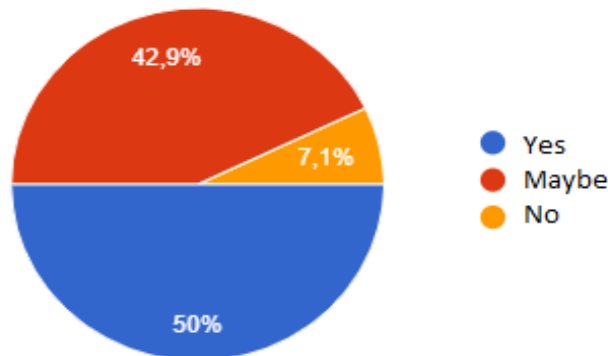
**In your opinion, have these cards brought you any help and if so which one?**

11 answers

Yes they help us learn the lessons and spoke easily  
 To learn my lessons  
 Facilitates data storage  
 They will help to develop our ideas  
 Learn lessons faster  
 She helps me fix the information after I learn it  
 For summary or revised  
 Yes it helped me to be sure of my revision  
 During the class

### Do you plan to continue using mind maps :

14 answers



### If so, in what specific cases?

10 answers

Review
To make summaries of my lessons
Learn my lessons
Lesson summary
To learn history and geography easily
Planning
Especially in communication
Review
To make summaries of my lessons

### Sentez-vous un plaisir de travailler avec la carte mentale vos cours ?

13 answers



After a global reading of the questionnaire, we present, in a few words, the answers of the pupils.

Examples of student mind maps (Common core science / 1st scientific baccalaureate):

Personal heuristic diagram



## The Mind Map at the Service of Learning

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