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CONCEPT MAPS AND CMAPTOOLS: A COGNITIVE WRITING SYSTEM FOR THE GENERAL DEVELOPMENT OF THOUGHT IN SCHOLAR AGE

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Abstract. This paper wants to analyze some possibilities offered by technological solutions available nowadays as *CmapTools*; it wants to suggest some possible progressive outlines aimed to satisfy the need of developing a language/natural thought, and an educational method to meaningful and complex thought in the area of *Computer Supported Collaborative Learning* to be used in the period of primary school which is considered as a crucial time for the development of the thought organ in children of 5/6 to 10/11 years old. The examples taken from the results of common didactic work carried out in classroom describe the technological solutions offered by the software CmapTools to develop the human cognitive ability and in specific "*to the passage from unconscious concepts to conscious concepts along the extension of scholar age"* (Vygotskij) and they show in a evident way and for their own virtues the problematic fecundity of the interaction between language faculty, representation and development of complex thought.

1 Introduction

From the year 2000 to the 2008 we have experimented a didactic process in continuity through natural rhythms of observation, doing and narrating, characterized by inter-disciplinary and collaborative methods aimed to find the most favorable interactive conditions that are going to determine the development of language/thought faculty in the child.

We've started our research with the intent of understanding the internal relation between thought and word at the very first stages of children's development, in pre-school age, in order to carry out a formative process in continuity from infant school to primary school. The systematic observation of the child's language experience in regular school's activities has led us to collect many examples that show how, from the beginning of thought/language development, *the meaning is a global unit of thought and word; generalization and word meaning are synonymous; word meanings develop; education is motif and cause of the thought evolution* (Vygotskij, 1934). For the above reasons, we've concentrated our research on a specific and well defined aspect: how the language/thought faculty develops in children along the period of school age (from 5/6 to 10/11 years old) through writing, (writing as the semiotic faculty that precedes marks creation and that has been defined by *Saussure as " la faculté linguistique par excellence"*), in that special form of social interaction that is carried out at school (Giombini, 2004, p.274)

Actually, starting from the first experimental activities on inter-relation between development and written language (mark-sign, linear writing, meta-cognitive writing – concept maps, hyper-text writing – CmapTools) together with meditative and complex thought development, we can see that this field has grown wider and wider and it's constantly changing and renovating, thanks to the innovation brought up by the software Cmap Tools and thanks also to neuroscience and empiric observations of schoolchildren expressive-language activities that confirm the genetic structure of language/thought faculty. Since then, the research program on concept maps and CmapTools, both considered as a writing's tool princeps and offered to the mind that by directing and mediating its own thoughts through signs and words learns to build itself up, shows in an evident way and for its own virtues the problematic fecundity of the interaction between language faculty, development and performance of complex thought.

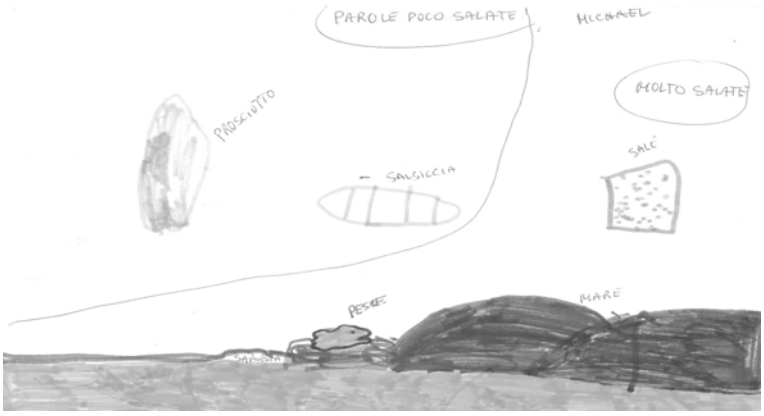
Maybe, after eighty years since the ceaseless question put by Vygotskij *"how is the passage from unconscious concepts to conscious concepts accomplished along the schoolchild's age"* (Vygotskij, p. 233), thanks to science and technology, we have finally found an instrument as CmapTools -- "intelligent" writing interface -- that allows us to plan a linguistic learning context worth the answer.

2 The relation between thought and word. Drawings and maps for an empiric confirmation.

We share with Vygotskij, the idea that the relation between thought and word is a process, a real and proper movement that goes from thought to word and from word to thought. In this sense, I think that the following image speaks for itself in a clear way by showing how in children of pre-school age *the thought doesn't express*

itself in the word, but it accomplish itself in the word and, as Vygotskij had written, we can talk about a process of becoming (unit of being or not being) of the thought [*mysl'*] in the word.

The following drawing shows a step of a systematic work carried out with children of 4/5 years old finalized to the monitoring of the conceptual competence of words. The teacher has asked children to "write" (through drawings) all the salted words that they knew, after several direct experiences aimed to discovering the sense of taste. The picture shows Michael's (5years old) "written" answer stating that "*very little salted words*" are *ham, sausages*, while "*very salted words*" are *salt* and *sea*. But when the teacher asked Michael: - why do you think that the fish is salted? –



Michael answered this question saying that "the fish lives into the sea". Michael's thought *is not express in the word, but it is accomplished in the word/drawing of the fish.*

Since early age throughout the sign-drawing, children show us how the word and the thing from that drawn are going to form a unique structure, but also that the meaning of words is not constant. In this drawing, as for all the other children's drawings, we find "*that no matter the associative bound is, the child decided between word and impression of the thing indicated from such a word, nevertheless the meaning of the word is not established forever. It changes in the course of the development. It modifies according to different thought's functions. It represent a more dynamic creation rather than static"* (Vygotskij, p.333). In fact, we can't say that Michael would sustain the idea that the fish is salted for its nature only because it lives in a salted place, the sea.

Drawing is a kind of language used by small children as an intimate shape of thought. It 's rarely understood as described by Antoine de Saint Exupéry (1943) in the book "The little prince". Unlike oral language that is in most cases a shape of dialogic language (from dialogue), drawing, as for all writings, is a shape of mono-logic language (from monologue) so as the inner language. And as the inner language it "preserves" and "express" grammar and syntax.

At the beginning of primary school, the child (5/6 years old) already owns a well developed linguistic and communicative modality (even if only for himself) organized in principles and rules described by Vygotskij as "*a tendency to a predicative attitude, to the reduction of the physic aspect (phonologic) of language, to the prevalence of sense on the word's meaning, to the agglutination of the semantic units, to the influence of senses, to the idiomatic language, to the elision and omission"* and he ascribed all **to inner language**.

Daily school activity show us how the passage from "**silent" language**, the one of the mind, to the spoken one, is not only a simple vocalization of the inner language, but it is a reconstruction of syntax absolutely original and specific of the inner language semantic and phonetic structure that rise to other structural shapes in the external language.

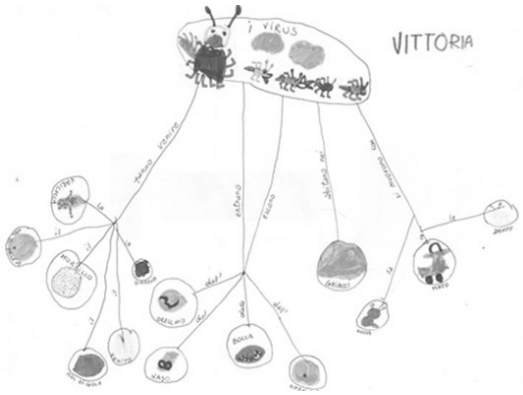
As we all know, *agglutination, omission, substitution of semantic units, omission, postposition of characters in a word, difficulty on recognition and in the reproduction of graphemes, inversion of characters, predicative attitude, lack of subject, predominance of sense on meaning of word,* are going to characterize the written production of every child as learning narration/ reading/ writing in a measure inversely proportional to age and to the awareness of the new modality of writing/ communication, and are going to fade slowly until they disappear altogether around the age of 8 (this is the result that all our schoolchildren achieve around the age of 7 and none of them develop that disturbance of the learning process called dyslexia).

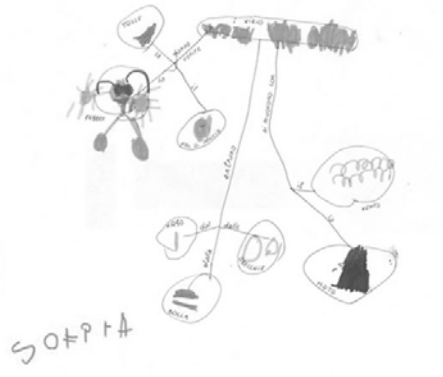
However, it's well known that the persistence of these difficulties beyond the 8 years of age (it seldom regresses spontaneously) is a sign of dyslexia, a serious problem of knowledge that can vary from some memory difficulties to a real impediment in the learning of writing / reading processes.

To obtain a formative success for everybody is a reward not only auspicious, but in our experience acquirable. In this view, maps are a precious instrument because through the reading of conceptual and hypertext writing an extraordinary world of didactic perspectives it's widening to the teacher.
In fact, in our experience:

- In this view, concept maps and hypertext writing become a spontaneous evidence of the trials of the child's mind and they outline the passage from one level of communication to another, from a linguistic modality to another: from the speech of himself to the speech for others, from oral to writing, from internal language to external language.
- These maps "photograph" the relation between thought and word and they document how every steps of development correspond not only to a particular structure of the word meaning, but also to a specific relation between thought and language determined by this structure and they help the teacher in his/her difficult activity of observation and prevention.
- The maps "signal" how the mind works during the time of acquisition / transition from one organizing modality of speech (language mono-logic/ inner) to the other (language dialogic and written language in use), from one level of conscience to another, from several formalized competences (disciplinary) to others, and if the mind has not clear the strategies and the information that will allow itself to carry out a given request, the brain answers using known modalities, even if not suitable, because those are the "only ones it can use".

The enclosed images comment by their own this phenomena. They have been written by two little girls unable to use alphabetical writing because of 4/5 years of age. They have been redacted after a conversation on the absence of many companions ill. After a statement given by one of the present child on the reason that kept so many schoolchildren at home, "because they got the *virus of influenza*", the teacher asked the present children to write "all that they knew about the word virus". The maps show ability of thinking for complexes and a different grade of development of the external language.





Victoria has started "writing" for the others and her drawings have a communicative form, but she hasn't learned yet to write her first name (her name Victoria has been written by the teacher). Apparently, Sofia is writing more for herself than for the others: her marks are very "essential", more like scribbles than drawings. But two hints on Sofia's map are telling us that we are assisting to that passage which will take Sofia *from the inner language mono-logic to the external language, from one level of conscience to another, from a series of formalized competences (drawing for herself: scribbles; drawing for others: figure, map) to other competences (alphabetical writing)*.

In fact, in a concept knot it appears an anthropomorphic figure (virus that get the child sick) and on the border of the paper the spontaneous writing of her name Sofia. The result is though SOFPIA. What can at a first glance be only a mistake (the sound of "F" is repeated twice: in the grapheme "F" correctly, in the grapheme "P" wrongly), it's in fact a reasoning. "**F**" and "**P**" are similar sounds and the word "Sofia" reminds the graphic structure of both graphemes. The little girl in her uncertainty has decided to use both. Now, from the modality of the teacher's intervention would depend if, in which way and how long will Sofia be able to resolve successfully her doubt , after that she will automatically get the correct correspondence sounds / graphemes F – P for ever .

3 CmapTools: "The habitat" in which mind learns to build itself up

Following the theories on the development of the language faculty described by Chomsky (1979) and Vygotskij that had underlined how the child develops his own faculty of language/thought species-specified through linguistic experience involving actively the re-construction of meanings and using Vygotskij's concept of tri-polar thought development (individual mind, other individuals and reality) in which the social mediation is the indispensable pivot of any mental construction, we have conceived / used the *hypertext writing for concept maps as the "habitat"* in which the mind learns to build itself up.

Without a project of continuity, from the year 2003 to 2008, conceptual maps and CmapTools have been offered to children as the instrument and the interface of writing/writings from the very beginning of primary school. The "reading" of all the meta-linguistic writings (free or didactically structured) produced by children has given us an extraordinary chance of empiric observation of the thought-word activity and we decided to direct the curricular didactic action towards a "scientific" project (less arbitrary and casual) of the learning context of every single child (Giombini, 2004, 2006).

We owe to the re-reading of Vygotskij, Chomsky and Novak's theories, through the filigree of "writing" expressed in a conceptual, meta-linguistic, hypertext and cognitive modality thanks to the new "immaterial" support the computer, this vision of extraordinary didactic perspectives. In fact, the monitoring of the functional role of the word's meaning in the act of thinking, along the period of school age, has supplied us, in time, with remarkable confirmations on the "generative" capacities of language faculty's principles and rules and has allowed us to represent in its basic outlines how the evolution of the verbal thought process takes place in its whole.

Knowing how the system mind/brain (thought organ) learns, what specialized systems it uses in order to learn and what strategies planes for reutilizing competences and notions, has given us the opportunity to meditate on the problem of variability and dynamicity of the relation between thought and word and has brought us to "investigate" on the problem of meanings generalization and the functional role of the word's meaning in the act of thinking.

But above all, it has allowed us to perform two crucial actions for the interaction teaching / learning / thought development as follow: a) *to detect the optimal period of learning;* b) *to plane in a consistent way the formative actions* since the evidences of our data show in a constant and clear way that:

- it's in the *discard (difference) between individual concept maps (evidence of the inferior threshold of learning) and expert concept map (evidence of the superior threshold of learning)* that the central point of thought's faculty development is placed in every child. **The point** was called by Montessori "**sensitive period**" and by Vygotskij "**area of next development**" in which "*learning wakes up and keeps alive several functions that are usually latent, while formal discipline of each subject is the field in which the influence of learning is accomplished on development"*(Vygotskij, p. 275);
- it's in the writing of the expert map and moreover in its hypertext re-writing on CmapTools interface (used for research activities with the possibility of finding sources given by the software for documentation) where, for every child, the *possibility* of improving *from what he's able to do on his own to what he learns doing in collaboration* is accomplished. *This is going to be a sensitive point that will eventually characterize the dynamics of his development and his success in the learning activity"* (Vygotskij, p. 276);
- it's in the writing / reading of the *structure maps (Maps of Learning Objects)* where the child *becomes aware* of his intellectual product (map of a dominium and of his knowledge) and he empathically fixes a new threshold of learning by reaching a different level of conscience.
- it's in the ability of cognitive and shared reading first and in the tribute to the conceptual expert writing on CmapTools later, that the teacher's maieutic (from greek "maieutiké – Socratic method) role is exercised as a truly and proper "Magister ludi"; it's in taking part (primus inter pares) to the collective hypertext writing where the teacher has the possibility to indicate new aims and draw new routes and while doing that he/she determines the exact area of the next disciplinary development of the whole group and of each single individual.

4 CmapTools as the "intelligent" interface of the measure of generality

For a hundred years, the human social language has been "conditioned" by technologies that have given us the communicative interactivity, typical of oral language, but only in the private area. Finally, the computer and internet have given the word back to the world and social language has been able to reuse its own dialogic essence with the bilateral direction (I→R; I←R) that was lost.
But all this is happening on a level different from oral, which is a characteristic princeps of language faculty species-specific anthropologically evolved, and it reuses the dialogical structure of communication on a different and improper linguistic level: the writing.

This is the point of all the issue: for the first time in its history, the language, the most powerful mean for exercising the specie's vocation, requires the complete mastery of expanded competences of writing. An expressive typology of sign-meaningful that doesn't reproduce the oral language evolution but that requires a high level of abstraction for its minimum development.

In the brain's development as an organ, the acquisition of abstract competence is not a question of time, or "maturity" of mind. The innate faculties of the thought organ, in order to develop the potentialities inborn in the genetic background, require that certain "physiological" conditions are respected and promoted. For the child, passing to abstract language means not using the mental language and so *not using the word*, that in Saussure's (1916) description it corresponds to the psychic aspect of human language and it has an individual sense, *but the representation of the word* (meaning of word in the language or generalization).
This phenomena is not without consequences: if the world's language is mostly expressed in *"sense"* instead of *"meaning"* it means having more difficulties in the child's development of the language faculty.

Difficulty in learning, misconceptions, difficulty in expressing his/her own thought, it's always a **question of words**, *Learning Objects of the mind***.** Words are Learning Objects of thought: real and proper knowledge units auto-consistent, with communicative and didactic intents well established, of reduced dimensions, to use and use endlessly in apprehension contexts, easy to get through descriptions or tutors. For children, words are meaning units they play with, just like they do with Lego bricks (Giombini, 2004, p. 274). But, very often the child is not aware that elementary meaning units (words, lines, graphemes, numbers…) can be put together to make sentences grammatically correct but without meaning or that combining the lexicon elements through syntax we can form meaningful sentences grammatically correct without a correspondence in reality. The autonomy of language interpretations is the base of creativity, but also of illusions / misconceptions.

In the fracture between *sense* and *meaning* lays the first point of the whole issue. The second point, not less important, is the passage from one level of speech to another. To overcome this passage, the greater difficulty is in the fact that mind's language is only thought and not spoken, and this gives much more problems to the child that is acquiring the mastering of writing. Initially, written language is a process without interlocutors but the child himself; it's a speech without real sound, it's only thought and it needs a representation, a symbolization. A learning child finds more difficult to acquire written language than oral language, just like algebra is more difficult than mathematic.

A systematic use of CmapTools creates the right conditions to reach the level of abstraction in a harmonious way, since it helps the child in the hard development of the writing's skill and in the conceptual development of words. Throughout the traceable "resources" of computer's memory or web with internet, the teaching of new shapes of words or concepts becomes the source of a superior development of the concepts already own by the child and this work establishes *"not the end, but the beginning of the development of scientific concepts"* (Vygotskij, p. 208)

The following images no.1 and no. 2 are the "*Structure Maps /L.O.*" redacted by schoolchildren of different age and in different time. The first was redacted by children of 7/8 with the help of the teacher, while the second one by children of 9/10 on their own. We decided to call them "*Structure maps*" because they reassume the entire process. It has been possible to make them thanks to the versatility of the software CmapTools. In the place of the concept word, the knot has the map (or resource) used to illustrate a conceptual generalization. Tanks to that function that allows us to write concepts with drawings, even children unable to use writing can draw, we have transformed maps in drawings and then we have reused them in order to visualize all the expansions and connections.

"Structure maps" are an extraordinary didactic moment / instrument, since they are map that re-illustrate, by visualizing it, the whole work carried out in both ways, individually and collaborative.

They document a modular work, scanned by the following passages: **a**) writing of individual concept maps as evidence of meaning competence and ability to think for complex thoughts → **b**) redaction of expert hypertext cmaps as evidence of competences of more individuals (cooperative learning; E-learning)→ **c**) redaction of "Structure maps" to become aware of the entire process. They all are obligatory steps finalized to the development of " *a complete series of functions, as the voluntary attention, logical memory, abstraction* (points **a**, **b**), *comparison and distinction* (point **c**)" that Vygotskij had placed at the centre of the development of language / thought faculty: they start from "*development of concepts and meanings of words"* and end in the production of Learning Objects.

"Structure maps" represent the visual and organizing instrument of "*becoming aware"* since they "re-discuss" the conceptual organization of the whole conscience dominium, they also become fantastic inductors of memory and, above all, the extraordinary and effective occasion for the development of **measure of generality**. In fact, through the re-collocation of all the expansions generated by "the conceptual explosion" of the mother's-word, the child experiments directly *"that the existence of a measure of generality of any concept allows the relation with all the other concepts, the possibility to get from certain concepts to others, the foundation of relations among them according to numerous ways infinitely variable and the possibility of equivalence in concepts* [Vygotskij, p. 300]. In establishing logical and casual links (WHO, WHERE,WHEN, WHAT, WHY) *children become aware of their own thought and concepts will eventually evolve from unconscious to conscious.*

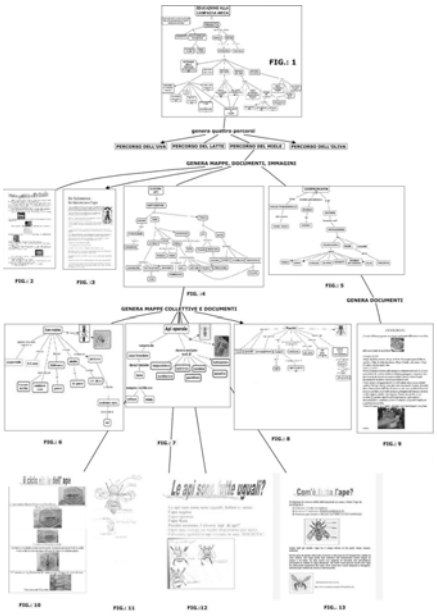


Fig.: 1 Structure map, L.O. "THE HONEY" 7/8 years

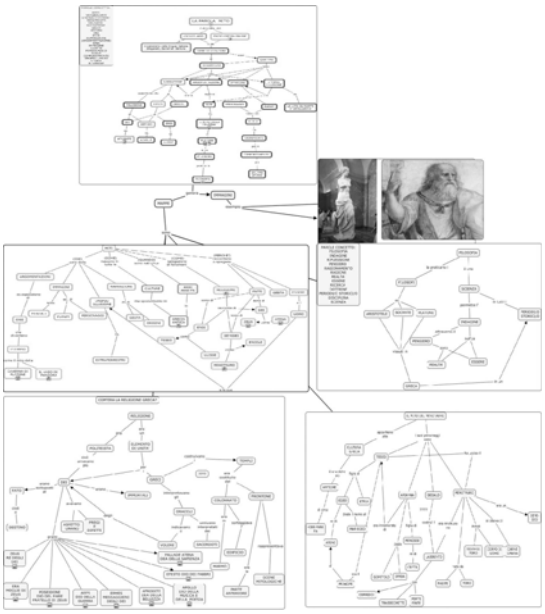


Fig.: 2 Structure map, L.O. "THE MYTH" 10 years

Apparently similar, these two images document how very small children (from the second year of primary school: 7/8 years) can use successfully hypertext writing in its full function provided by CmapTools and, above all, they are evidence of how as soon as the child *"masters a kind of superior structure as to become aware and learn how to use certain concepts, he's able to transfer the structure directly, once he has established it on concepts previously elaborated"* (Vygotskij, p. 283). This is exactly what has happened with the "invention" of writing maps: it was sufficient that children understood that a map could be saved as an image in order to establish automatically the following relation: map=image→ knot=image→ structure map.
Maps in general and the structure map in particular perform a fundamental function: they help the child to mature trough language the category of adversative relations, which, in a spontaneous reflective thought and without an adults' help, appear much later than casual relations. The editing among hypertext maps, and especially the collaborative and final redaction of the structure map, imposes definite choices as to "attack" an answer instead of another. *In this way, the child, throughout an experience with* "ALTHOUGH", *becomes aware of the different relations sited on a superior level of conscience and of argumentation, the abstract ones.*

The following images, figure no.3 and no.4, are frames of the structure map " The Myth". These hypertext maps show how the systematic use of CmapTools together with the representation's method of concept maps, allow children to be the protagonists of their own development, since they become aware and can guide the will of the act of learning. In fact as you can see in the image no.3, the map of "WORD MYTH" is illustrated from a meaning's point of view with the help of dictionary and web research (which the map's authors of 9/10 point out with ability of quotation) and it's declined in its **four generalizations** of meanings: **narration, argumentation,**

image, utopia / illusion (a myth is…). Each of these generalizations gives life to a research. For example, the generalization "**argumentation**" develops several concepts (**argumentation** → unfold→ "**ideas** " → example→ "**The allegory of cave** " → of→ "**Plato**" → is a→ "**philosopher**" →practices → "**philosophy**") that are here illustrated with other maps (philosophy) or documents (the allegory of cave) or images found in history of art (Plato).

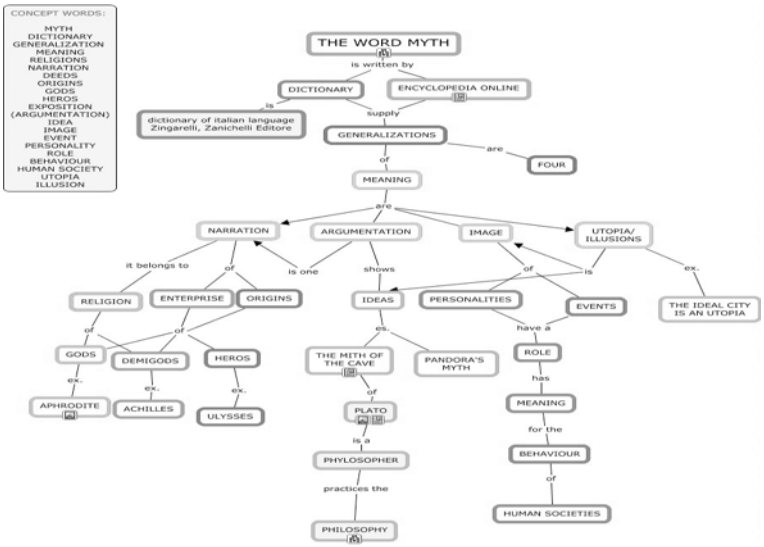


Fig.: 3 Hypertext map "WORD MYTH": (10 years)

The image no.4, the hypertext map "Myths", is a resource of the "Word myth"(fig. no.3) and it develops according to logical and casual links the following enquirers : **who, where, when, how, why.** In this way the child, in outlining his dominium of conscience, acquires concrete disciplinary competences (language, history, geography, history of literature, Greek / Roman's mythology, history of art) and methodological competences (research's methodology, also on web, and acquisition of competence of meta-linguistic writing). This map, as for all the other maps, is an opportunity for complex reflective thought, since it shows and demonstrates how becoming aware it's not only a sum of the speech's functional parts and/or of thought, but also a development of the links (linear and sequential thought and processing and reticular thought).

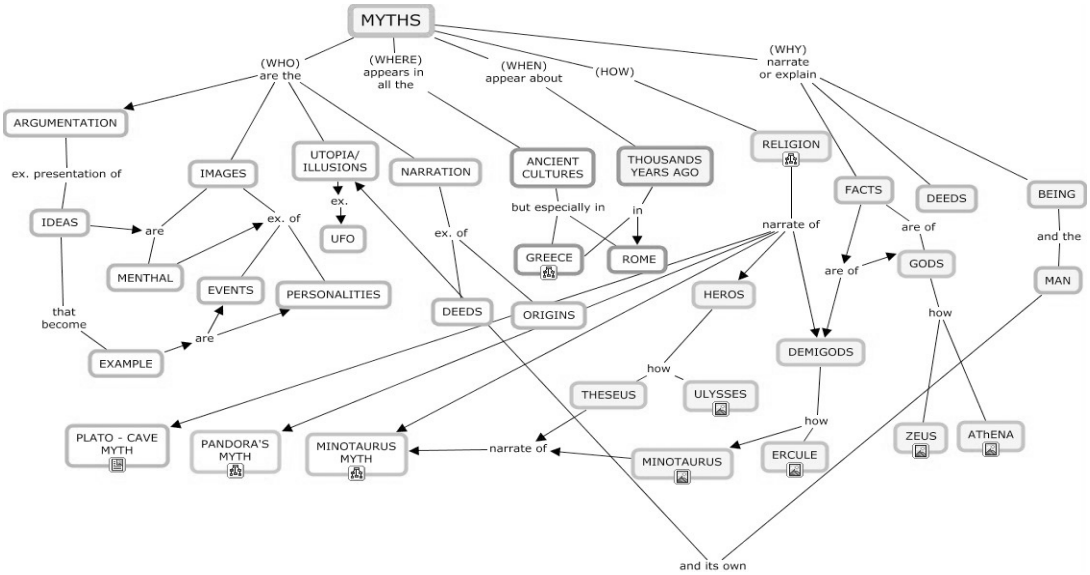


Fig.: 4 Hypertext map "MYTHS" (10 years)

5 Summary

Finally, the systematic use of concept maps and CmapTools, as a writing system, supplies the mind with the most favorable conditions, which, through mediation signs, learns to build itself up. In specific, it sustains in an

harmonious way the passage from an organizing modality of the theme (inner speech/mono-logic) to another (dialogic speech and written language in use), from one level of conscience to another, from several formalized competences (disciplinary) to others superior competences. But, above all, concept maps and CmapTools allow the monitoring of the whole process, from the steps of thought's development for complexes already covered by the child to a new and superior step, the abstract one that in most cases takes place around the age of 10 (slightly earlier than the one indicated by Vygotskij of 12/13).

6 Acknowledgements

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