

## COMPLEX THOUGHT, CONCEPTUAL MAPS AND CMAPTOOLS

Liviana Giombini, Teacher Training Supervisor, University of Urbino, Italy  
Email: [livianagiombini@tiscali.it](mailto:livianagiombini@tiscali.it)

**Abstract.** The increasing percentage of dyslexia together with low cultural levels which have been noticed in the most industrialized western countries denounce a diffuse and alarming incapacity in cognitive reading of reality interrelated to the own culture. So, where's the problem? It 's in the lack of synchronization between the world's shape (things around us) and the model of access to the world as it is practiced and taught.

The *organ of language* of new generations develops in a context where its contents are given in a sketchy, chaotic way, in constant evolution with demands for competence to handle this new modality.

If for thousands of years a specific cultural model that had used the linearity as a representative form of the linguistic meaning (e.g. the alphabets) is prevailing, the learning brains has adapted to that method. On the other hand, when the reticular complexity of representative forms is prevailing like nowadays, it'll be necessary to use teaching models based on this new competence

For some years, we are experimenting competent models for the development of The *language organ* that show how the attribution of meaning and language competence (which are basic strategies and cognitive categories already present at the natural language-thought level) become decisive for the development of the scientific and organized thought, because for a child "*the voice of reality as for a mathematician is in the symbol's meaning*". (R.Thom1988).

This paper describes the experiences and the practices (*teaching based on narration, teaching with concrete aims using conceptual maps and hyper-textual writing as for communication and representation*) that help the natural development of language faculties in normal daily teaching and, in this specific case, they combine competence and meta-cognition in order to teach the mind to learn and to use computer technology and Internet (real cognitive branches for the own use) in the most profitable way, thanks to CmapTools.

### 1 Introduction

We have worked for six years on the plan and realization of an ongoing educational method that involves pre-school and school children (2/3-13 years old), teachers and university students (pre-service teachers). In some classrooms of "Volponi" School all regular educational activities are based on the linguistic learning, concept maps and hyper-textual writing that are used to organize and retell one's knowledge. Emphasis was initially given to develop superior forms of children mental processes, i.e. *from concept formulation to organized scientific thought, from linear writing to hyper-textual writing*. Subsequently, this educational experience gave not only excellent results as to the premises, but also astonishing opportunities to reflect on the capacity to prevent or "rehabilitate" particular cognitive pathologies/problems of knowledge such as dyslexia.

Instruction based on story-telling, instruction pursuing concrete objectives, retelling knowledge through concept maps and CmapTools (Cañas et al. 2004), as a system of hyper-textual writing (Giombini, 2004) "create" a framework that teaches children to reflect, from the very early childhood, on the value of scientific thought, on the cognitive role of science, on the centrality of language analysis and on the importance of the logic and standard languages.

In the special form of social interaction occurring in classrooms -- meaning attribution together with linguistic competence, concept maps (Novak, 1984) and writing adaptation to the new interface, i.e. the computer, (hyper-textual writing)-- are "routine" instruments of a Language Acquisition Support System (Bruner, 1983) that make a Language Acquisition Device (Chomsky, 1965) possible.

### 2 Cognitive problems in societies of communication

Time dedicated to communication in advanced societies is so remarkable to make communication be the main human activity. A widespread and obstinate belief says that skills and culture correspond to mass media exposure in a directly proportional manner.

Against, the increasing percentage of dyslexia together with low cultural levels that have been brought to attention in the past few years (*Programme for International Student Assessment OCSE*) denounce a diffuse and alarming incapacity in cognitive reading of reality interrelated to one's culture.

In 1934, at the beginning of our educated society, Vygotsky (1962) already identified instruction not only “as one of the main concept sources for children”, but “also as a powerful tool that directs children’s growth; instruction establishes the fortunes of their overall mental development”.

**So, where’s the problem? It’s in the lack of synchronization between the world’s shape (things around us) and the model of access to the world as it is practiced and taught.**

Chomsky (1971) claimed: “the main problem to interpret the world is to determine the way, through which human beings proceed in their interpretation. It is about studying the interaction between the human mind, a particular and complex system given to the human being biologically and the physical and social world”.

The genetic program of the faculty of language represents only a part of the whole story, the other part is to searched in a support system.

*Meaning attribution* and *linguistic competence* are essential cognitive strategies and categories. They are indispensable for “*the cognitive reading of the world*”; they are evidences of the specific-species faculty of language, an expression of linear and sequential thoughts and also of reticular and process thoughts. When a cultural form using linearity as a representative module (e.g. alphabetical sequences) of meanings, in particular language meanings, has prevailed for millennia, learners’ brains are stirred by methods tuned to that modality and fit in it. On the other hand, when the reticular complexity of representative forms prevails today, it will be necessary to use teaching models based on this new competence.

### **3 Human language: an output and instrument of intelligence**

Given the fact that language faculty has been determined by evolution (with Darwin or Chomsky as for times and methods) or the fact that language in the form of human language has become the most powerful cultural meme (R.Dawkins, 1976), language is what has determined the “form” of human intelligence, i.e. the ability to understand, produce and transform “culture”.

Culture is such a powerful instrument in elaborating plans, i.e. new abilities of acting in the world (Popper, 1989), that its effects can overcome, to a certain extent, the ancient genetic processes from which it was born. Human language is an open and complex system, tool and product of human mind.

Language acquisition or indeed the innate faculty proper of the human species is compared by Chomsky (1988) to the development of an organ subject to natural physiological laws: like any other organ, it can fully develop only if all necessary parameters have been followed.

In theory, three factors need to be considered:

1. the genetically determined principles of language faculty (competence) and of the systems that form the architecture (structure) mind/brain;
2. the culturally-determined principles of the form of knowledge contents and of the means, through which principles are acknowledged;
3. the ‘habitat’ – also culturally-determined, even though it may not be necessarily along with the previous point– in which the child’s knowledge as an individual is formed.

Of the three factors under consideration, only points 2 and 3 have changed significantly in recent years; but, if it’s true that the cultural project never erases the genetic project it however models the skills.

Vygotsky (1962) developed the idea that the development of thought is based on the centrality of social interaction and sign systems and that the individual uses the signs of mediation to master and direct his/her own thoughts. Verbal language is the main occasion for communicative interaction. Words are “*the tool*” of thoughts. Even in Popper’s “open world” the three dimensions of reality -- nature, self conscience (psyche) and the world of objects (respectively world 1, 2 and 3)-- interact reciprocally thanks to reasoning, i.e. the essence of human language. Consequently, the physical world is not causally closed but it can be modified by the human mind that, in its turn, can be altered by its ideas.

“*The organ of language*” of new generations develops in a context, in which knowledge contents are given and offered in a fragmentary, chaotic and evolving manner.

Totally immersed in a computerized civilization, the child's mind can only absorb (Salomon, 1979) a "random" model of a culture that values more fragments and single parts instead of the whole. However, "Nothing has already been, anything is possible" (Popper, 1989).

#### 4 Children, stories and the world

Knowing how "to read the world" for a child (but also for adults) means being aware of his/her own mental constructions, of the interaction between them and the perspective competence of reality observation by selecting all the facts observed. It's the human capacity to make inferences on reality: continuously, we relate events one to the other, we make categories, we classify, we deduct, we select information in order to solve our problems...; we always proceed through trial and error, in a continuous adaptation of what we have learned to create new concept matrices that can maintain the experience from which they were born, and, at the same time, can be "significantly useful" for new experiences.

According to Vygotsky (1962), the development of superior forms of mental processes occurs in children in one direction that proceeds through education from the external reality to the child's internal one, from the social world to the child's intra-personal skills. Learning directs the development of the child through a gradual internalization of his/her intellectual processes that are activated by his/her social interaction. In particular, words "*first act as the means of concept formation, then they become their symbol*". Vygotsky (1962) used to examine all aspects pertaining the particular structure of children's knowledge proposed by instruction: language, scientific thought and mainly written language acquisition as a symbol system of superior mental level that is the essential mediation and that affects the way to make categories, reasoning and thinking in a way we still do not know well.

A *cognitive management of systems and their interactions*, careful to relations between variables and parameters that characterize states and transformations, *help to see and represent* situations in terms of "equalities" (balance, conservation, symmetry, equivalence, invariable, isomorphism etc.) and "inequalities" (up to the inevitable casualty and irreversibility), and construct a net of thinking strategies (looking, doing, telling, etc.), which gradually elaborate new cognitive sceneries more and more defined in shape, stability, and efficiency, in learning proceeding.

Usually, the student (teacher?) is left alone with these needs and often he/she is not able to understand reality in articulate/coherent modes. On the contrary, there is a need for a planned and structured mediation so that knowledge and skills (at all levels) can improve in a successful way: if we do not build knowledge and mental tools necessary to understand, we will not be able to understand and we will refuse to understand. So, what is the task of adults considered as "*translators of meaning*?"

We can not forget as Vygotsky (1962) would say, that learning within every human being occurs through the mediation of verbal language and always occurs "*with the collaboration of an adult, who gave explanations, asked questions and made corrections*".

Let's remember that teaching means "*show through finger*" that is we have to add the nominal meaning to the demonstrative one to give children the most possible information because "*In any moment there is more than the eye can see, more than the ear can hear, some areas or sights remain unexplored. Nothing is separately experimented but always relating to adjacencies to the sequential events and memories of preceding experiences...*" (Lynch 1964)

I agree with Umberto Eco who (2005) says "*I am among them, who think that also scientific knowledge should take the form a story-telling*" to help the child reflect on the "magic" of experience through activities that teach how to see, listen, and remember in order to be able to do things and tell stories and activities. "Story-telling" that make the "*universe of fantasy—where we imagine worlds to create stories—distinct but close to universe of reality—where we create stories to understand the world*".

## 5 Stories, maps, texts and hyper-texts to “read/write” the “world” “Volponi” School’s experience

In our project we try to foster the development of language faculty through readings oriented to make the child deal first with the words and story, then with the *signs* considered as means that allow to remember, understand, rebuild and translate. All instruction activities begin and end with a reading: the first reading is the teacher’s reading and it creates the context for learning, the second reading is the student’s reading. The student “retells” his/her writing to show how much he/she has understood, remembered, related ... In this way, the child exercises his/her critical thinking; through the reading of his/her signs, the child develops his/her process of abstract synthesis.

Examples of activities related to the child’s crucial learning phases follow: (1) “Scribbles” by 3-5 year-old children, with no writing. (2) The phase when the child learns how to write and contextually learns how to use writing software and CmapTools (5/6 years). (3) The cultural acquisition of language principles and rules (7 years)—(4) The competent use of hypertext writing (8/12 years)

### 5.1 Drawings and concept maps by 3-5 year-old children with no writing

The *language faculty* shows all its complexity in children: expression of sequential and linear thought, but also process and reticular thought. Drawing is the first child’s writing form and it is an example of hyper-textual narration: it is narrative expression, but also expression of complexes of ideas.

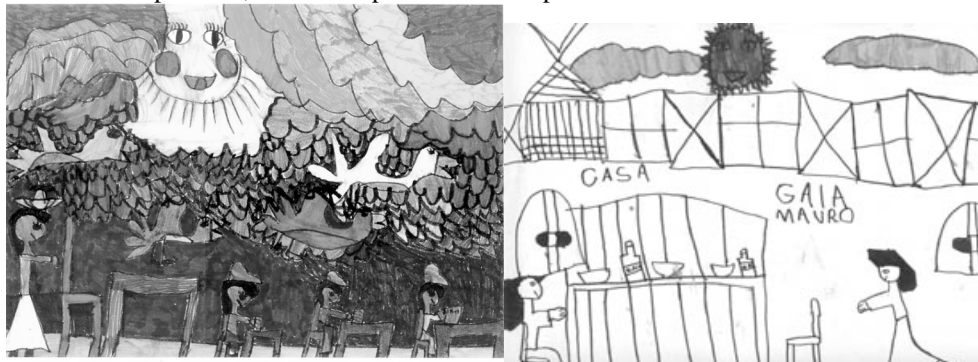


Fig.: “School-House” Example of an “hyper-textual” narration type: colours, words, full use of the space: front and back page Age: 5/6 years

The following examples illustrate how children go through the step described by Piaget (1926), where words keep for a long time for children a *meaning that is not only affective but almost magic or at least related to special actions* (4 years old), to the first spontaneous conceptual narrations, to the acquisition of composition rules of conceptual maps (5 years old).

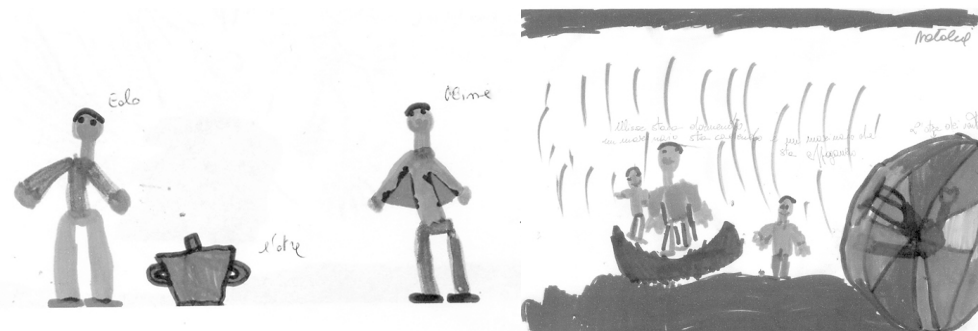


Fig.1. “Example of linear correlation-word concept”

Fig.2. “Example of complexes of ideas and potential concepts: use of metaphor”

These drawings made by five year’s old children illustrate an Odyssey episode “*Eolo, the God of the wind, gives Ulysses the winds’ goat-skin*”; The drawing no.1 shows Ulysses, Eolo the God of wind, and the winds’ goat-skin: the interaction of word-concept is linear. Although the “goat-skin” is an huge container for water, wine, or oil and it’s nowadays in disuse, we can notice that the first child knows it (fig.1); in the second case the drawing shows what

Piaget had already identified in the following sentence: “*children transform words in long lasting meanings which are not only effective, but almost magic or in any case related to special actions*” the drawing also shows what we conceive as the ability to understand complexes of ideas and elaborate them into combined meanings as a natural human mind process, together with the metaphoric use of language. They have a communication value related more to a semiotic than semantic type structure.

Fig.2: On the ship Ulysses is asleep, and a sailor is about to fall out the ship; in the sea a sailor is drowning ; on the right there is a special colorful wheel with a figure drawn at the centre as to represent the winds’ goat-skin. Is quite clear that the child has never heard the word “goat-skin” and never saw the object, so in order to translate into image the complex of ideas suggested by the word “winds’ goat-skin” he draws a big cloth parachute with colored segment (item that he had probably seen different time blowing in the wind) placing at the centre of it the anthropomorphic image that confirmed the “writing” as an authentic metaphor which is in my opinion perfect and poetic: in fact, what is better than a cloth parachute that stretches out, blows up and embraces the wind to represent the “winds’ goat-skin”?

The following drawings are “written stories” in absence of text. They are conceptual maps that are narrating experiences. Both maps No.1 and No.2 tell direct experiences. The first describes a didactic episode of observation: from a concept through a linear connection become visible the six concepts. The second tells an experience in science, concretely conducted, where is explain the correlation “plant-flower-fruit”; the connected-symmetric structure is concerning the logical-temporal interaction of the passages “plant-flower-fruit”. The map No.3 is identified as the map “virus” ; it combines six lines of conceptual development: “virus”= get in-go out; attach-hit; live in; make sick (who?); provoke (symptoms); expel (cures): to these, 14 concepts are being added and connected in a correct way.

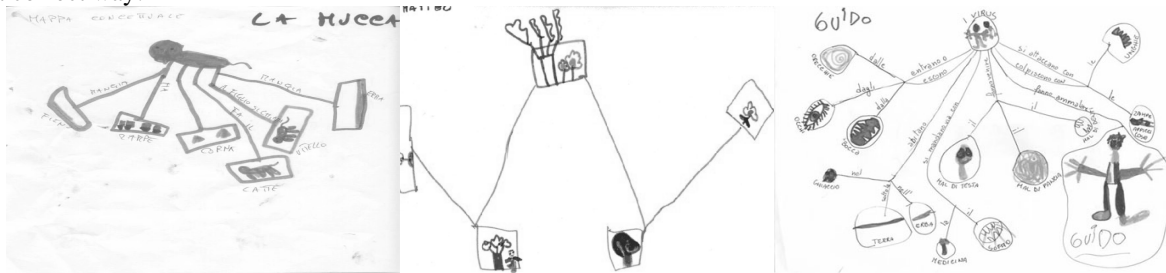


Fig.1 “Milch cow”- connected structure Fig.2 “Tree”- connected and symmetric structure Fig. 3 “Virus”- symmetric and branched structure

These maps show two thinking modes: the linear and sequential thought as mean and product of competences, and the reticular thought which puts in relation competences and turns them into culture. Conceptual maps reveal to be writing instruments: they transform complexes of ideas in organized narrations, they are detectors of writing as the organizing principle of human mind.

Furthermore, they show the reorganization of standard three-dimensional visual field – the appearance of perspective in different stages that depend on alphabetization progress – on the abstraction of language – on the psychological inwardness of writing as thought form.

They are very interesting in showing how some paradigmatic modalities are innate (connected structure, sequential structure, symmetric and branched structure, cyclic structure and semi-sequential structure): they visualize graphically the hierarchy order, the meaning attributed to words, the connection between concepts.

*The concepts*, expressed under a summarized form (words-concept), are *contained within a geometrical image* (a plane figure), which corresponds to a junction point; they are *linked* between each other *by lines*, which narrate this relation through *link-words*

## 5.2 Reading and writing learning in the computer era

Expression, representation, relation and critical thinking are “describers” (key words) of the species-specific “language faculty” that exercises the property of discrete infinity (Chomsky1988) through a syntactic decomposition of reality into basic meaning units. It is about a potentiality of combinations that allow human communication to

find forms, principles, and parameters and transform one's creative confusion into a powerful discernment of "language".

The following images are pages of an exercise-book belonging to a 5 year's old girl. It is an example of what we call LASS (Language Acquisition Support System) in relation to what Chomsky suggested about the terms of *legibility* imposed by other systems (ex.: *sense-drivers*) on generative processes. The first word that we intend to teach children is "Io"(English translation is. "I"). The choice is strategic:

1 – It's the word most used by a six year's old child in its life's egocentric phase; 2 – it's composed only by two characters (two vocals), but at the same time it has an accomplished sense (global method: language comprehension starting from the whole to the single characters); 3 – clear phonetic comprehension; 4 – legibility (visual system): the characters are graphemes (signs) made by vertical and horizontal lines ("orthoptic" facility of reading); 4 – reproductions of signs (hands drivers): vertical and horizontal lines to be reproduced on a 10 mm. grid (emotions' role: an enjoyed result of the child simplify the re-reading and the signs' memory); 5 – use of the stamped capital character (used by computer's keyboards, new alphabet); 6 – driving and linguistic games on a grid drawn on the ground to easily memorize the sense-drivers' routes to get to the expressive signs reproduction (emotions' role regarded to memory: happiness of learning).

The following figures show the importance of the vision (story) and of reading as analysis of the component elements of the sign-drawing (Fig.1 and 6); their "reproducibility" arranged according to motor, modular, topological and rhythmic rules (Fig.2); the semantic and paradigmatic possibility of the sign-drawing (Fig.1, 2 and 3...); the "constructive" and concept consciousness of graphemes I and O (Fig 3 and 4); in the end, the drawing up of IO (engl. "I") (the beginning of the discrete infinity) (Fig. 5)

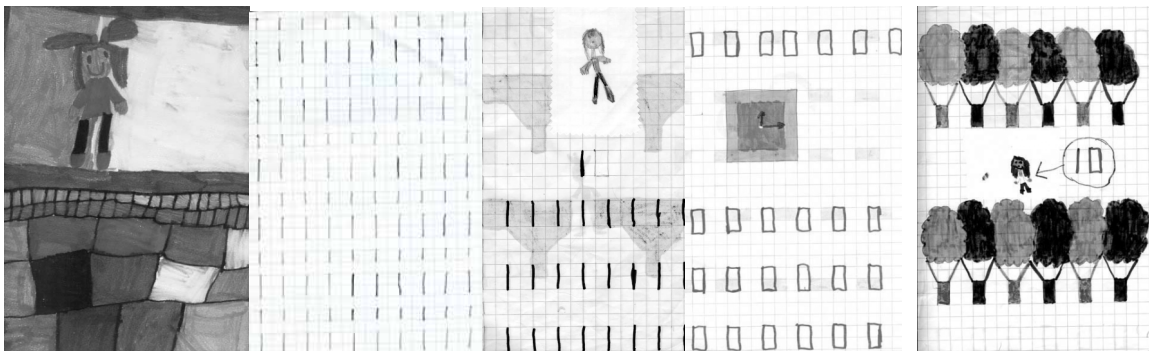


Fig. 1 Free-hand drawing "I" Fig.2 A "calligraphic" drawing Fig.3 Grapheme I Fig.4 Grapheme "O" Fig.5 Word "IO"(engl. "I")

The last figure (number 5) is very important, because it conveys the conscious passage from sign-drawing to writing. The graphemes I and O are used to form the word IO (engl. "I"), and the "discovery" of writing is so important that it is marked and linked, with line and arrow, with her picture. The author has just written her first word, she knows only the two graphemes used, but she completes her story "inventing" communicative signs: the concept word "IO" is contained (recognized) in a graphic space, a line links it to another concept, the arrow shows the reading direction, that is, it identifies the starting point of thought and underlines the arrival that, in turn, can extend still further. At the same time the usual modalities of language (thought) appear: the linear and sequential one which makes it possible to write a word, and the reticular and processual one that transforms knowledge and competence into culture.

At this stage the use of computer can be started off, and on this support, too the children's outputs respond to two separate statutes: play (free and expressive drawing) and need (learning to do in order to be able to do). The screen turned out to be a very good sign memorization inductor, as well as the keyboard that, at this stage, plays the role of alphabet cards, with all the advantages of speed, easiness and fun. CmapTools has proved not only to be an excellent system of "memorization and electronic restoration of the knowledge based on conceptual maps" (Cañas by Novak 2001), but also a system to educate brains to exercise and increase the natural memory's potential. Basically CmapTools offers a concrete way of using the evocative power of visualization as an induced memory's activity (a well known power which had already been used and described by the ancient Greeks and Romans on which they based a truly art of memory). The figure is also evidence that starting children off on drawing maps is not only possible but it is a spontaneous writing modality in very young children, and that the passage to the use of software CmapTools is as much natural in only six year old children.



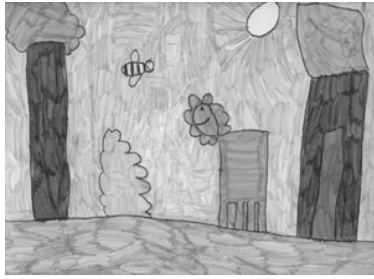


Fig 6 Drawing "The lion's story"



Fig 7 C-map "Lion"



Fig 8 Map "The lion's den"

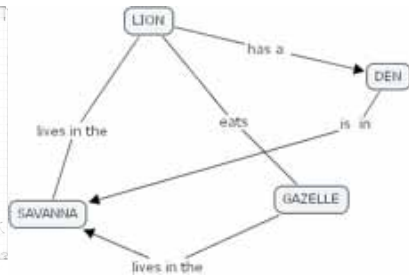


Fig 9 Map "Lion" by CmapTools

### 5.3 Writing and conceptual maps: an experience of semiotic approach to poetry text

One of the "signals" that can announce problems in learning, and especially dyslexia, is the difficulty of association between sign and meaning, between instrumental capacity (when acquired) and cognition; it's an evident incapacity of relating *noesis-semiosis*, (intuition and competence, competence and culture). The semiotic analysis of text is used as a strategy to improve the LAD (Language Acquisition Device). In favoring the "underneath biological matrix that provides a situation in which the language improvement develops"- "a system of principles, conditions, rules, that are [...] the essence of human language"(Chomsky1979), the child realizes the abstraction of determined peculiarities, their synthesis, their symbolization throughout a sign.

In a natural way the child is educated to acquire a scientific method to learn reading the reality beyond the *surface* and to codify messages more and more complicated. The following images illustrate some of the steps of our experience, fully reported, made with seven years' old children. We've used a poetical text, which for its nature is the closest to creative experience of the use of language.

1-Teacher's reading aloud of the poem →2- Empathic selection of some of the words- concept: flower, ground, sea, ...; to start linguistic games: phonetics chains and of meanings →3-Writing of poetical text (chosen for its shortness and richness of images): "*it's all crowned of flowers the ground / of multicolor flowers. / Golden buds were growing / along seashores. (SAFFO VII-VI B.C.).*" (fig.1) → 4- Reading and first analysis of text to select concept-words and binding-words (list of words written on the board) →5- Selection of isomorphic (same words) and phonic isotopic (pieces of same words) (Fig.1) →6- Selection and list of sensorial isotopic: classification and grouping of visual isotopic, of movement, of space and phonic. (Fig.2) →7- Drawing up of the poem's concept map. (fig.3) → Drawing up of concept map of isotopic. (Fig.4) →8- Identification of the syntagmatic and paradigmatic axis→ 9- Drawing up of concept map of the word- metaphor (Fig.5)

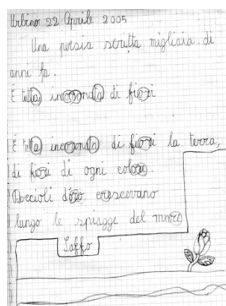


Fig 1

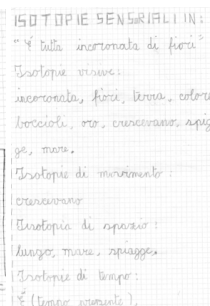


Fig 2

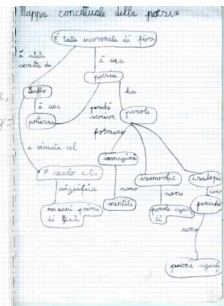


Fig 3

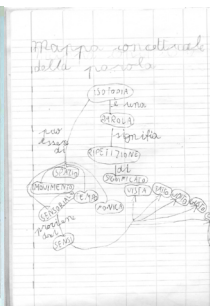


Fig 4



Fig 5

### 5.4 Competent use of hyper-textual writing

Our experience has confirmed that to acquire competence in any field it is necessary (most of the times) to use the active, iconic and symbolic modality which represents thought at the same time, according to a not pre-ordinate progression but that re-combines and re-replaces continuously, that is it mixes according the characteristics of the context and the intentions because for a child "*the voice of reality as for a mathematician is in the symbol's*

meaning” (R.Thom, 1988). The computer is the opening door for an immaterial place, of the context where children develop their potentiality: “the *apparent flow, a definite discontinuity: this non-phrase was not something that did not have the power of accessing the phrase, that was before the phrase: it was what is eternally and superbly out of the phrase*” (R. Barthes, 1975).

The computer is an instrument that lets the aggregation or the break-up of meanings and forms which children can use profitably with the help of an expert adult. What follows is only an home-page example of many hyper-textual works pupils of this Institute regularly produce as a conclusion of their formative processes: “Friend Country” (Age 8/9 years) on <http://skat.ihmc.us:80> (ICVOLPONI-URBINO-IT); “Interaction” (9/10years) published on the web site [www.lwparoledellascienza.it](http://www.lwparoledellascienza.it); “Journey in Scotland” (12 years) –available on [www.icvolponi.it](http://www.icvolponi.it).

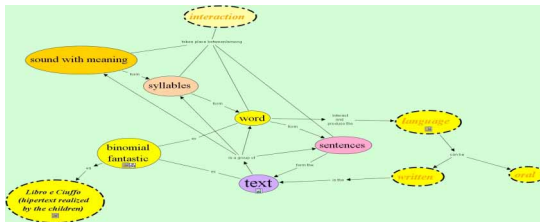


Fig. 1 Map: “Interaction- word”

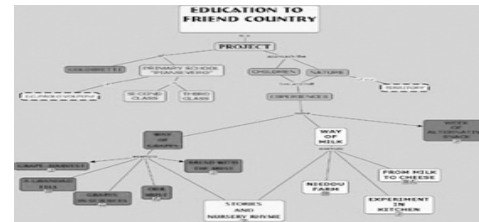


Fig. 2 Home page hypertext “Friend Country”

These “hyper-textual maps” show how *meaning attributions* and *language competence* (Novak, 1998) (the bases on which the knowledge formalization processes start and develop and make disciplinary knowledge be structured in a net of correlations) and together with their “rearrangement” of writing on the new multimedia software (3-7 years), become decisive for the scientific- organized thought development (8-12 years).

## 6 Summary

Based on our firm belief that language faculty, an instrument and output of species-specific intelligence, is a matrix of social interactions and sign systems (essential tools for communication and transmission of knowledge between generations), our educational method has found its natural modalities of communication and representation of knowledge and skills in the use of concept maps and CmapTools. This has brought to significant learning for all students, mainly for those, who had language problems when entering school. The positive and regular results strengthen our firm belief that language is matrix of sense and that evidence of meaning together with the extraordinary plasticity of the organ of knowledge are a valid instrument for prevention/rehabilitation of pathologies of knowledge such as dyslexia.

## 7 Acknowledgements

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