"ADDIZIONARIO": a New Tool for Learning between Metacognition and Creativity

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This paper describes a project aimed at using Addizionario (a hypermedia linguistic laboratory designed at the Institute for Computational Linguistics of National Research Council in Pisa in collaboration with the Department of Computer Sciences of Turin University) to create conceptual maps as a strategy to favour the comprehension of descriptive texts and to improve the personal processing and cross-disciplinary use of information. Metacognitive theory considers learning as the result of the activation of several conscious processes. Furthermore, our project intends to support meaningful learning by means of Addizionario and to investigate the processes involved in motivated learning. Motivation to learn is favoured also by a general strategic attitude towards learning, especially when in learning we consider the intellectual peculiarities of the child. This hypothesis is well illustrated in the concept of "multiple intelligence" of H. Gardner, according to which each person has a preference for a symbolic code and through such a code manages more easily to learn and take interest in disciplines, activities etc.

Using Addizionario, we tried, furthermore, to support the development of divergent patterns: in fact, the access and the development of more different symbolic and known universes is anyway an important means of transforming the multiple potentialities of the single child into real abilities, also for creativity and divergent thought. We believe that creative behaviour in childhood is a factor favouring the processes of learning and the psychological well-being of the child.

Povzetek: Opisan je nov način učenja s pomočjo metakognicije.

1 Introduction

Human behaviour is naturally goal-directed, and there are several strategies to support the child in identifying and organising the necessary steps for reaching learning goal (goal setting): among these, in this paper, we have focused our attention on the conceptual maps (Novak, 2001; Novak, Gowin, 1989, Guastavigna, 2000).

Conceptual maps are generally recognised as an important means of information acquisition and memorization, as their visual register helps to focus on major concepts and organize information into an integrated and coherent structure.

The idea of 'conceptual map' was introduced by Novak and Gowin in 1989, and its role as one of the strategies that allow the organization of knowledge has been widely accepted, in particular, in the field of teaching (Buzan, 2000). The core idea was that a graphical representation of knowledge makes the meanings that are inherent in the learning materials emerge (Novak, Gowin, 1989, p.19) and forces reflection on the nature of knowledge as well as on derivative relations.

Similarly to a topographical map that facilitates orienteering in a land, a conceptual map is a tool that helps construct knowledge through the individualization of key concepts and of the relations that are used to develop concepts into reasoning. Therefore, a conceptual map can be described as a graphical representation where concepts (synthetically expressed as individual words) are represented as geometrical forms (nodes) connected by lines (arrows) that show relations between nodes through linking words. This general description encompasses maps of different types and structures, each type depending on the aim for which the map is created.

Using maps we can encourage the schematisation of information and the thought about the meanings that are hidden in a network of sentences, thus making key concepts more prominent and relevant (Jonassen, 1989, 2003).

2 Conceptual maps and meaningful learning: how to build an intentional learning

Meaningful learning takes place only when a potentially meaningful material is integrated and re-organized into previously acquired knowledge and extends it through integration and elaboration processes

The result is personal processing of input, which becomes apparent in the pupil's final summary of what s/he has learnt. Meaningful learning is the result of an intentional process, characterized also by perseverance in reaching goals in general and choosing learning objectives in particular. For this reason, when the goal is the accomplishment of a task, it is important that it is clearly defined, desirable, and desired by the pupils themselves. Meaningful learning is often accompanied by a general increased ability in the use of divergent thought (Williams, 1993) which on its turn is connected to the metacognitive approach.

Cognitive psychology focused on the problem how the ability to use symbolic representation is connected with the development of higher information processing, such as the formation of 'conceptual categories', where perceived characteristics are used to infer other characteristics. Symbolic representation codifies reality in terms that go beyond given information. This is the real essence of the cognitive activity: the human ability to go beyond interaction with objects and manage information to create hypotheses, concepts, and theories.

Ausubel's (1968) theory stretches along this perspective when he claims that cognitive learning not only refers to the acquisition and usage of knowledge, but also entails emotional learning. This is to say that an important interaction exists between information coming from internal signals and cognitive learning – an interaction that has been highlighted also by recent studies in neuropsychology. Ausubel's standing is clearly in line with Novak (2001) when the latter stresses the importance of the interaction of thought, feelings, and actions.

According to Atkinson (1972), the optimal way to provide information is by inserting it into a program that allows individual users to pace the elaboration of the given material in a flexible way, and specify the actions that the computer and the user should take. This method helps both more and less promising students gaining as much as possible from the learning activity, each one at their own pace.

New knowledge is supported by intentional learning; the newly acquired pieces of information help the child reconsider their own thought and see them in a different light. This means that the mind reflects upon itself, to use Vygotskij's (1978) terminology, and becomes ever more able to re-think the contents of its own thought.

2.1 Metacognitive Approach and Vygotskij's Theory: Building Meaningful Learning with Addizionario

The most recent metacognitive theoretical models of learning have focused on the centrality and importance of these processes. Clearly, before one can control voluntarily a specific function, one must possess that function.

To give an answer to this issue, Vygotskij (1978) introduced the concept of zone of proximal development. This concept explains how a person with greater competence can help a younger, less competent person reach a higher level of knowledge, such as the level of abstract thinking. By zone of proximal development we mean the distance between one's actual developmental level, measured in terms of autonomous problem solving abilities, and the level of potential development, determined by the ability to solve problems under the guidance of an adult or in collaboration with a more expert peer. In this perspective, the human learning ability presupposes a specific social component through which subjects become ever more expert masters of their actions and the reasons for the actions.

Vygotskij believes that knowledge is constructive: his perspective is not antithetical to the cognitive theories that are at the basis of our study. Learning is not simply storing information, but rather linking new pieces of information to other pieces stored in long term memory. Thus knowledge is constructed, not recorded or received. The construction of knowledge is influenced by the way previously acquired knowledge has been structured and by the interaction between the individual and the environment. This perspective shows us why activity is essential but insufficient for meaningful learning: the children must reflect on the activity and their observations and interpret them.

Meaningful learning could be the better way to increase new ability, using also divergent thought (Williams, 1993), specially in problem-solving tasks.

We think that meaningful learning (Ausubel, 1968, Buzan, 2000) and creativity aspects can, therefore, be facilitated by the use of dedicated software which allows pupils to follow individual content-processing paths. Addizionario (Turrini et.al, 2001) belongs to this type of software because it presents many of the characteristics advocated by Atkinson (Atkinson et al. 1972): in this way, the new knowledge is really supported by intentional learning and the child achieves deep understanding of complex ideas that are relevant for his/her life.

2.2 Computer Lab and Creativity: Is There Any Relation?

According to the theory of multiple intelligence proposed by H. Gardner (1982, 1983), for developing a programme to promote divergent thought and creativity, we focused our attention on the following aspects: attitudes and behaviour adopted by the teachers; attention to the

combination of the different disciplines that form part of the curriculum of studies of the pupil; focusing on the real cognitive and emotive factors of the divergent thought.

Finally, a particular attention towards the metacognitive aspects of the learning was maintained in this work: to stimulate and promote the development of the creative abilities means in fact leading the child towards a route of learning, and in every process of learning the metacognitive aspects play a fundamental role.

Creativity is a resource that can be used profitably within the scholastic field, also in computer lab, to favour a learning that is not simple assimilation or development of competences, but implies instead a personal re-elaboration of every matter or experience. In learning, this means stimulating a behaviour of research in general, giving an incentive for the attitude and the routine to carry out and search for new categorisations and associations between matters and concepts even when these are already known, inserting them into a new structure of knowledge, together with the knowledge of the world already possessed by the student, associations that allows a more authentic assimilation of the knowledge.

This process allows the student to restructure also problematic situations as well, observing them from different and more original points of view.

Creativity, as well as representing an essential factor for the well-being of the child and of the future adult, forms an important resource in order to learn. It is, in fact, a factor of substantial importance in promoting a learning that doesn't remain "inert", relegated to the carrying out of the sometimes artificial requests of the scholastic evaluation, but knows how to come in contact with the live structure and dynamic of the mind." (Antonietti, 1996, p. 10).

According to Petter (1992), in the school (during childhood and the primary school) there are many activities aimed at developing rational activity, but there should also be a lot of activities aimed specifically at favouring the development of the activities of the imagination,: "not only storytelling and literature, (...) but the invention of stories, the drawing from the imagination, symbolic games with unstructured or partially structured matters, (...) the interpretation of a piece of music, or experiences of brainstorming in group discussions , or games like the construction of chains of ideas in freedom, (...) can broadly develop and reinforce the capacity for fantastical elaboration." (Petter, 1992, p. 181). Rationality and imagination have an equal importance: that is the thought, as a structuring activity, can manifest in two different ways: "the two ways are complementary to each other and often present in the very thought processes" (Petter, 2002, p.10).

The procedures of the teaching of creativity utilised in the past have always inspired, instead, more or less explicitly, a few directions of the psychological research.

Creativity, in our perspective, is considered as potentiality, to be precise or dimension or complexity of the psychological dimensions of the individual that allow him, in given circumstances, to carry out specific elaborations of ideas aimed at producing appreciated and original results. The creative thought is understood as a process, or to be precise a specific type of mental function or elaboration usually not active. In this way, we suppose that creative thought is made to reside in the activation of particular strategies, and Addizionario can favour in every child the activation of creative processes, not only of cognitive processes..

In this way, we think that Addizionario (Turrini et al., 2001) can be a useful tool for improving creative aspects and divergent thought, in particular. Finally, we want remember that in the past, proposals rarely followed the simultaneous development of multiple intellectual components, but the works were all centred around the direct practice of particular operations (restructurization, combination, free production, etc.) and gives scarce attention to the abilities of the control of such operations. Using Addizionario, the conscious control of such operation becomes a necessity.

2.3 Creativity between Convictions and Beliefs

Dweck (2000) has conducted instead a broad research on the aspects connected with personal convictions and with beliefs, such as the implicit theories and the learning objectives that can lead people to perceive themselves as competent or as inadequate in various situations, independently from the real abilities they possess. It then deals specifically with the relationship between implicit theories and intelligence, the development of these theories and how these influence the relationships of failure, through their effects on motivation, and in particular, on the acceptance of challenges, on behaviour in the face of difficult tasks and on the attributive style (Henderson and Dweck, 1990; Stone, 1988; Elliot and Dweck, 1988).

On these elements or fields, Dweck’s theory seems to build a bridge between metacognition, the theories of the self and creativity.

A specific link with these topics has been highlighted by researchers that analyzed gifted children. Exploring the phenomenon of child prodigies is probably a way to find new developments on the reasoning of this topic, if not an answer: these children, that are unique expressions of certain human processes of development and evolution, represent a phenomenon that “allows us to cast a look at the workings of the human mind.” in its entirety (Feldman, 1991 pag.6). According to Feldman’s theory these children represent a notable connection of biological inclination and of cultural availability in answer to their inclinations. Both more classical studies and more recent studies converge in affirming how the phenomenon of the "Gifted" is determined from the interaction of biological and environmental factors: Sternberg and Lubard (1991) on this subject sheds light on the complexity of the creative thought, affirming how the creative performance is the result of the confluence and of the interactive (and not additive) combination of six elements: intellectual processes, knowledge,

intellectual style, personality, motivation, and environmental context".

2.4 Goals

The project, titled 'Getting to know my town, Pavia', aimed to integrate several school subject matters into the framework of the pupils' everyday life. The first aim was to promote meaningful learning of descriptive texts through the creation of conceptual maps in both traditional and multimedia format (Addizionario, Turrini et al., 2001). A second aim was to guide the children on a knowledge tour around the town, by making them explore, actively and personally, its major historical, geographical and cultural features. The town of Pavia was therefore conceived as a 'world' and studied from four different perspectives: history, geography, science and visual arts. These topics were all in keeping with the school curriculum. From a general methodological perspective, the children were spurred to share their knowledge with their peers, and were allowed adequate time for self-paced individual and group work.

Our program referred also to the 3-dimensional model of Williams (1993), according to whom the fields for developing a programme capable of promoting the creativity must be the following: attitudes and behaviour adopted by the teachers; attention to the combination of the different disciplines that form part of the curriculum of studies of the pupil; focusing on the real cognitive and emotive factors of the divergent thought. Last but not least, an attention towards the metacognitive aspects of the learning was maintained. to stimulate and promote the development of the creative abilities means in fact leading the child towards a route of learning, and in every process of learning the metacognitive aspect plays a fundamental role (Cornoldi, 1995, Dweck, 1999).

2.5 Subjects

The pupils taking part in the project were 21 ten-year-old children, (males = 12, females = 9). The children were subdivided into three groups of 7 pupils each; each group was heterogeneous in terms of learning (Zanetti, Miazza, 2002), computer, and social skills.

2.6 Procedure: Tools and methods

2.6.1 Addizionario

Addizionario (Turrini et al., 2001) is a software implemented at the Institute for Computational Linguistics of CNR (National Research Council) in Pisa in collaboration with the Department of Computer Sciences of Turin University. This product is a hypermedia linguistic laboratory to be used by children in the six to fourteen year range for the study of the Italian language at various levels of difficulty and from different points of view.

The laboratory is made up of two interacting tools: "Addizionario", a computer dictionary for children, written and illustrated by the children themselves, and a multimedia Activity Book in which the child, working by himself or in collaboration with others, can create his own personal dictionary.

The idea of getting the child involved in the creation of a dictionary specific to his own needs derived from the reflection on the current state of children's lexicography.

Although an essential didactic tool for language acquisition, the dictionary has not always managed to fulfill the requirements of the users.

With some exceptions, the products for young children available on the market seem to be abridged versions of adults' dictionaries, without taking in due consideration the tastes and interests of the young readers.

We feel that in Addizionario (Turrini et.al, 2001) the above requests have been satisfied, and the modes of expression of the children respected as much as possible. The children have less difficulty in understanding the definitions contained in the dictionary and therefore use the product with greater pleasure and enthusiasm.

The core dictionary, which is for consultation only, contains an approximate 1,000 concrete and abstract nouns, verbs and adjectives, chosen according to usage frequency criteria, for which around 400 Italian children from the last three years of primary and first two years of junior high schools have provided their own definitions, examples, associations and drawings.

Apart from the most obvious spelling mistakes which have been removed, the material was maintained as much as possible in its original form, so as to respect the children's modes of expression, descriptions of family and school environment, presentation of everyday life and experiences.

All the material available in the look-up dictionary was arranged by us not only in alphabetical order but also in "worlds of words". These worlds are eighteen, and include that of animals, food, clothes, but also of emotions, and reflect different semantic areas, which do not always coincide with the categorizations of the children.

By using the Activity Book at his disposal, the child can "create" worlds which correspond to his personal ways of classifying reality, organizing his lexical knowledge in such a way that he can retrieve his own material easily when necessary.

The possibility of constructing special groupings of words can also be exploited during the lessons by the teacher, for example to help the child overcome particular spelling difficulties.

The Activity Book is the authoring component of the laboratory linked to the core dictionary, but at the same time independent, where the child can work at the construction of his own personal dictionary. He can perform both linguistic and non-linguistic activities,

transporting into his Activity Book any of the material available in Addizionario (paradoxically, even copy all the contents!), tailoring it to his own needs.

For the linguistic activities, the system puts at the disposal of the child writing environments to produce the definition, examples, free associations, idiomatic expressions, synonyms and antonyms if they exist, as well as verbs and adjectives somehow associated with

the word in question. The non-textual activities concern drawings and sounds, which the child can produce personally or he can use the material already available in the archives of the system. Furthermore, the child himself can record the pronunciation of a word using his own voice, or assign a sound to an object or to its parts.

The drawings are one of the most stimulating aspects for the children, and a suitable site for making connections. These are particular links between words and drawings, useful not only for navigation, but also to encourage the child in the creation of new words.

The drawings can be enlarged, reduced, or changed in colour, using the elements contained in the drawing ambience. Once all the information relevant to the newly introduced words has been completed, the child can take inspiration from the drawing, in order to write a story interacting with the drawing itself.

The various tasks should preferably be carried out at the presence of the teacher, acting as guide and supervisor, and directing the work of the children according to the types of activities involved. The children should work individually or collaborate together around the computer in small groups, on a give-and-take basis, where each individual in the group can benefit from the knowledge and experiences of the others. The children can create their own paths through the system, sharing them with their classmates.

Further information can be achieved from the solicitation or aid given by the teacher, who can plan varied programs of study in which each child can express himself at his best. The Activity Book with its typical characteristics of interactivity, updating, multiple-access, etc., is an extremely appealing and flexible tool, easy-to-use, which can help the children participate eagerly in the various language activities. The child takes a lively interest in this tool where he is allowed freedom of action, and is encouraged to take the initiative. Acquisition and enrichment of vocabulary – often felt as tedious and boring – become pleasant tasks, able to grip the attention of the users.

2.6.2 Fases

The project required subdivision into phases, in order to allow the children to become familiar with the software tool. In this preliminary 'playing' phase in the use of Addizionario (Turrini et.al, 2001), the children made their own discoveries and shared them with the rest of the group. This favoured establishing a positive climate in the classroom, in which each individual discovery would become a common revelation. A second phase saw each child create a conceptual map in traditional pen-and-paper format, starting from a common basic schema. The resulting graph, that included drawings, postcards, photos and other types of images, served as guiding structure in the subsequent phase where the information were reorganized in electronic format.

Pen and paper activities started with History and Visual Arts. This project work started with a search for, selection, and preparation of useful materials and were carried out during class hours and integrated into ordinary curricular activities.

The history teacher brought books, photos, magazines and brochures to class and invited the children to search their houses for further similar resources about the history of Pavia and bring them to school. All the materials thus available were collectively examined and the most interesting ones were selected. Then, the teacher read out legends of the origin of Pavia and invited the pupils to compare them to historical documents dealing with the birth of the town. This preliminary investigative phase was followed by a collective discussion during which the children were helped understand the basic and most important elements in the selected texts. The children were then asked to summarize the texts. These activities resulted in a series of written materials that included both individually- and collectively-produced texts and documents.

As part of the Visual Arts curriculum, the children were made in charge of taking digital photos of the Romanic churches, the medieval castle, the covered bridge and other major monuments of Pavia. The photos were then shown in class and the children were asked to compare the monuments and observe similarities and differences in terms of architectural style, building material, and other features. Finally, the children made and scanned drawings and edited the digital pictures, producing personalized visual materials to populate the worlds in Addizionario.

The following historical events and artistic landmarks were analysed: legend of the origin of the town, the Ticino river and the history of the town, life in the pre-Roman village, religion, the Roman period and its legend, the covered bridge, the Barbarian invasion, under the reign of Theodoricus, the Longobardic period (king Alboin and his wife, queen Theodolinda; king Liutprand), the Romanic period: churches and the crowning of kings, Commune: the towers; life in the commune, from commune to seignory: Gian Galeazzo Visconti and the castle

As part of geography and science curriculum, the children were helped locate Pavia on a map of Italy, and on a map of Lombardy. Subsequently, on a political map of the region, they highlighted the province of Pavia and the other major towns in Lombardy. Finally, the attention shifted to the town itself and to the four areas into which the town is divided (heritage of the ancient Roman urban structure). The children where helped locate their school and the landmarks that they would visit in the following months.

During science classes, the children talked about the four watercourses that cross or touch the town and studied the natural habitat of one of them, the one closest to the school. The route of the watercourse was analysed from spring to mouth, both in terms of its physical characteristics (meanders, banks, marshes, and terraced areas) and its flora (trees, bushes, herbs, and fungi).

Special attention was dedicated to trees. The children went to the area around the watercourse, observed and photographed the trees and then, for each type of tree (ash-tree, alder, plane-tree, weeping willow, crab, and

poplar), created a sort of 'passport' describing its features (shape, bark, leaves, flowers, and fruits). With the help of a professional mycologist, detailed attention was also given to fungi. A similar approach was adopted for the local fauna: several animals that were either known to the children or easily observable, such as the woodpecker, the pheasant, and the hare, were classified and described in terms of class, physical characteristics, habitat, feeding and breeding habits .

The pen-and-paper material produced by each child was collected into a personal book called "Pavia, my town".

The third and last phase of the project was carried out in the school computer lab, where the three subgroups took turns in the use of Addizionario. Under the supervision of teachers and a psychology expert in the use of Addizionario, the children created worlds and populated them using their conceptual maps as guideline. This project work started in mid November 2003 and ended in June 2004, i.e. at the end of the school year (weekly timetable included three hours of work in the computer lab and eight hours of 'traditional' class work, two for each subject).

3 Results

The children were monitored throughout the school year and the results of this learning project were assessed according to the following parameters: their ability to create a conceptual map was assessed in terms of number of details and links in the final product on CD-Rom; their final level of knowledge was assessed by means of questions; the increase in the child's knowledge was assessed by comparing the first and the second versions of the graph, in terms of number of pieces of information and links.

Assessment of individual productions (CD-Rom, graphs, oral presentations to the class, written texts, and the all pen-and-paper material produced by each child was collected into a personal book called "Pavia, my town") showed a general increase in the children's knowledge about the town of Pavia, not only as far as the number of pieces of information is concerned but also in terms of their ability to make links between data and organize them in hierarchical form (schema–driven knowledge). Furthermore, the children showed increased skills in the use of the software tool and in collaborating with each other.

To conclude, the creation of conceptual maps with Addizionario in the framework of this interdisciplinary research project proved a valid teaching method. We think that it helped facilitate the acquisition of data as well as of important skills, too. With this work, it became possible to widen knowledge of a topic from different perspectives, by applying metacognitive procedures and strategies. This is a collaborative work, in both pen-and-paper and multimedia tasks, that allows the development of individual potential abilities in the classroom context of both horizontal and vertical tutoring. This is the ideal context for the children to reach their 'zone of proximal development'.

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