Concept Maps: Theory, Methodology, Technology
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CONCEPT MAPS IN KINDERGARTEN

Cesarina Mancinelli, Marina Gentili, Giuseppina Priori, Giuseppe Valitutti
Falconara Alta Kindergarten – Progetto Pilota MIUR - Italy

1 Background

Concept maps were used in 21 schools of the MIUR Pilot Project "Le parole della scienza" with the participation of 6,000 Italian children to promote meaningful learning. The experience with concept maps described in this paper refers to scientific language teaching to 4-5 year old children in kindergarten. In 2003-2004 school year 56 children built concept maps in two different classes. Children produced a total of about 180 maps on their notebooks regarding manipulation experiences with the following objects: pumpkin, nest, papier-mâché, vintage, cement, water, orange, sand.

Another significant aspect of the experience in Falconara Alta is the creation of concept maps with drawings, following manipulation and clinical conversation with the teacher. Concept maps proved useful because they stimulated and facilitated children's reflection on experience and experience organization, making meanings and knowledge emerge in children. The comparison and sharing of learning favored the development of verbal and iconic language as well as socialization. In *Meaningful learning* Joseph Novak writes: "We found out that concept maps are a useful system to help teachers organize knowledge for teaching and a good method for students to discover the key concepts and principles contained in lessons, readings, and other teaching material." The experience with 4-5 years old children in Falconara kindergarten is consistent with Novak's findings.

2 Conquering objects and properties

Scientific alphabetization, defined by some as scientific culture, begins in kindergarten, when children's curiosity and desire to learn are at their highest, and will be enriched during the next stages of studies.
In kindergarten scientific teaching is largely based on attentive observation, object manipulation, and use of verbal, iconic, musical and kinesthetic languages to describe properties of manipulated objects.

The project carried out in Italian schools is similar to American SCIS and aims at introducing Sciences as an active process centered on a limited number of **unifying concepts** conquered by children through manipulation experiences on objects, year after year. The unifying concepts to be acquired in kindergarten were: objects and object properties.

Children observed and described a large series of objects during activities in the classroom, at home and walks outside the school. All activities were organized as games played together with other children. Ultimately, children learnt how to use their senses at best to observe surrounding objects.

3 From observation to mental evocation project

Regardless of its level, the perception of an event is not the starting point of a scientific journey. Mere perception does not come first in knowledge processing or building (from kindergarten to primary school and over). In kindergarten and primary school the real engine for learning is the child's **evocative project** according to the meaning given to it by de La Garanderie's Mental Management (La Garanderie. 1980).

The key word of effective thinking is evocation. The starting point is the project, the key that turns on the mental engine that leads to real evocation. The *project* to use the mental resources owned by the child comes first, and then evocation starts. Through evocation the child *slowly* builds meanings of what he/she has seen, heard, touched, etc. Evocation is the voluntary mental reconstruction procedure of all perceptions coming from the external world through senses. This back and forth travel between perception and evocation is repeated

several times and performed in the mobility of metal universe to specify the information to learn. Without such a mental activity, learning is partial and lacks important parts.

Do children have a purpose, a project, a question, a reason that urged them to look for help in observation? If not, the risk is that observation remains a game, without becoming the object of study and effective school practices. The child's brain decodes observation and the teacher's task is to help him/her during reflection on experience. In this way, the observer's mental characteristics affect the contents derived by the child from observation. Both misconceptions (Chi, 1994) and correct concepts emerge during the interaction, perception and evocation process. Situations that involved effective actions on objects were privileged in Falconara Alta kindergarten. Through clinical conversation (La Garanderie's pedagogic dialogue, 1984) children were reached mentally and disclosed their thoughts on their experience. "What do you think …… is?" was the starting question for the dialogue. Guided by the project's success or failure, the child's thoughts progress and adjust slowly, abandoning his/her infantile characteristics.

Also Novak aims at helping children build effective mental tools. Novak believes that a mental project to organize acquired concepts is needed. And this project comes true through the construction of concept maps. Mental Management, on the other side, is founded on a pedagogic approach based on mental reconstruction of visual, auditory and kinesthetic perceptions. Both Novak's constructivism and de La Garanderie's pedagogical approach aim at improving the child's mental functioning and significant learning. Mental Management highlights the importance of discovering (through introspection from Binet, 1886) effective mental habits used by the student in everyday activities. "What comes to your mind when you solve this problem? What comes to your mind when I say cat? What do you mentally do to learn how to cycle? This type of questions reveals the effective mental behavior of students with difficulties in classroom learning. The mental habits used by the student every day are disclosed by the questions, can be enriched and transferred in the classroom.

4 Manipulation, clinical conversation and concept map

Starting from a perceptive, motor and manipulative basis, the child discovers, explores, gets to know, shares while playing (with different materials and spaces). Active and creative participation, attentive observation of experience stimulate the child to ask questions to himself/herself and formulate the first hypotheses. Essential steps in building a concept map of experience and/or scientific concepts are:

- Object manipulation;
- Conversation;
- Preparation of drawings and construction of concept maps.

Students worked in "space – map" identifying it first on the classroom floor and then on paper. In space they first placed objects and then drawings that labeled concepts. Through language and guided conversation with the teacher they established the first relations between objects or between words and drawings.

Each drawing included in the concept map refers to the child's thoughts. The situations that are suitable for the evolution of a specific element are also suitable for the development of other elements.

Let's now describe the experimentation procedure in the classroom in detail. Children put themselves in a circle and shared behavioral rules are established: talk and let others talk. In this way discussion and reformulation of thoughts are favored. This paper continues with the description of the experience made with newspapers and pumpkin manipulation.

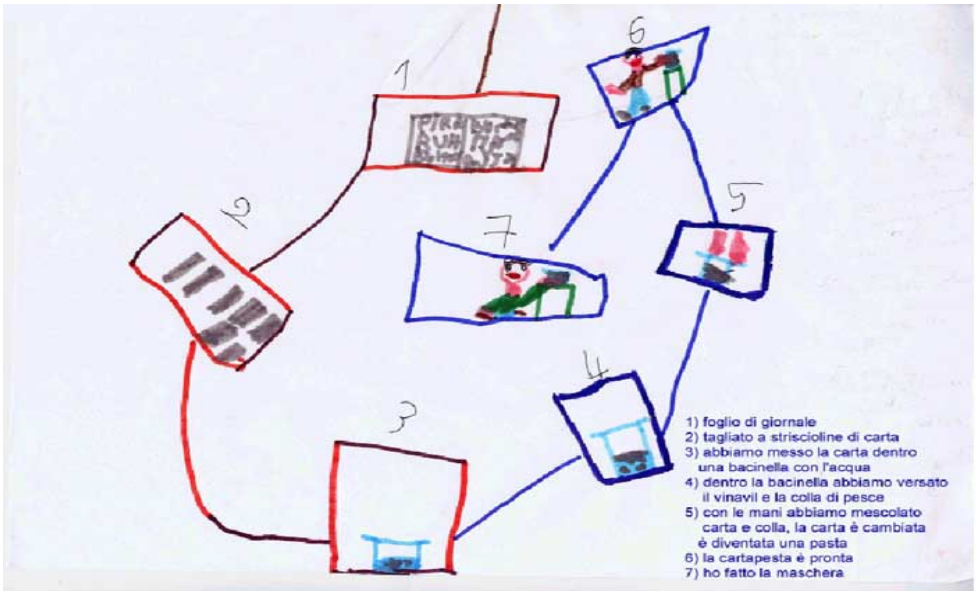
Papier-mâché

Paper was macerated in water for two days. Children notice the change right away and indicate the properties of macerated paper.

A. Clinical conversation after observation
Tommaso: it changed color, from light to dark gray.
Elisa: it's darker and softer.
Rachele: the paper is wet.
Lara: it is soft, wet and smooth.
Caterina: I raised my hand half an hour ago, I want to say something, the water got darker because the ink of the paper melted down.
Marta: before water was transparent.
Loris: words and drawings colored the water.
Elisa: paper changed, it got softer.
Beatrice: it's softer and sticky.
Camilla: the paper got sticky after we put fish glue and glue.
Francesco: it was the glue that changed the paper.
Alice: it become like a paste to make masks.

B. Concept maps
Attentive observation, significant experiences through "action", clinical conversation are essential to build a scientific concept with a concept map.
Children tell the concepts they have acquired through their drawings. After drawing the different steps, the children connect the drawings in the concept map.
Concept maps facilitate reflection, experience organization, making meanings and knowledge emerge in children. They favor the development of language and socialization.

Example of papier-mâché concept map (each child built his/her map)

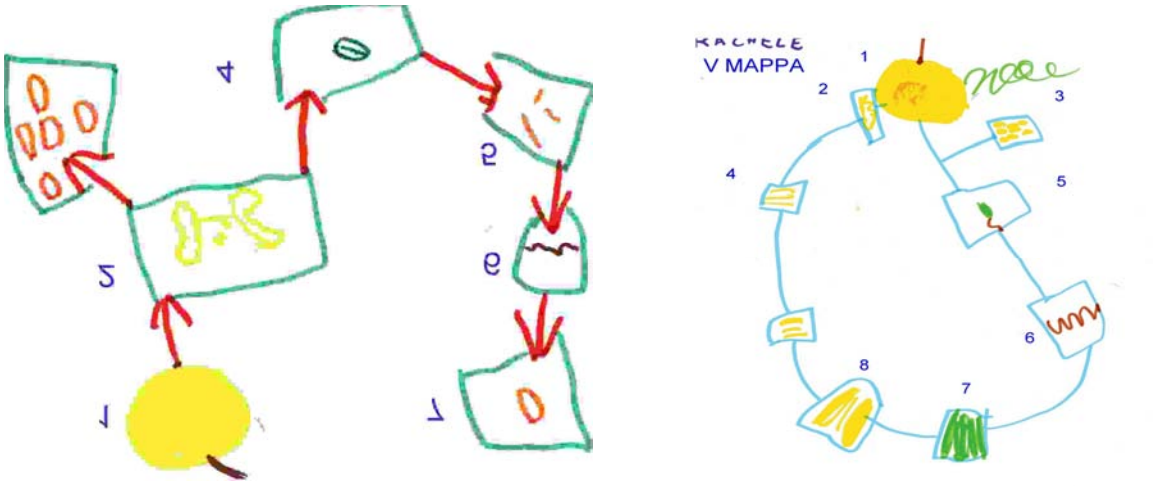


Children's experiences (4/5 years old): investigate the pumpkin

The experience with the pumpkin originated from children's curiosity since they wanted to see the pumpkin inside.

A. Clinical conversation after observation and pumpkin manipulation
Caterina: it was the pumpkin from the garden with all the things from nature.
Marta: the part that we eat is inside.
Loris: the pumpkin is a fruit.
Tania: the seeds are used to make soup
Caterina: yes, when she cooks, my mom puts the seeds in the soup ("mis-knowledge" is highlighted).
Matilde: a thread keeps the seeds together.
Tania: my hands are slippery
Caterina: (with her hands inside the pumpkin) I feel the roots of the pumpkin, but these are not the seeds of the soup.
Sara: it's soft inside.
Alessandro: yucky, the seeds are slippery.
Elisa: it's slippery, because it's wet.

B. Building the concept maps
Each child draws the manipulation experience with the pumpkin and builds his/her own concept map. 25 concept maps on the pumpkin were drawn on the children's notebooks. Following are two of the maps.



Two examples of pumpkin concept maps (each child built his/her map)

1. Entire pumpkin; 2. Broken pumpkin; 3. Seeds; 4. Leaf; 5. Pumpkin threads; 6. Soil; 7. Seed to plant.
1. Entire pumpkin; 2. Broken pumpkin; 3. Seeds; 4. Pumpkin threads; 5. Leaf; 6. Soil to plant seeds; 7. Color of leaf; 8. Color of seed.

5 Conclusions

The next objective of Falconara Alta teachers will be learning evaluation based on concept maps. The hundreds and hundreds of studies on the use of concept maps as a new evaluation means (Markham, et al., 1994) indicate the many positive aspects of this technique. A study, for instance, showed that the concept grid disclosed by the map basically reflects the same structure of children's interviews and drawings. The central element of the map is the statement that connects two or more concepts. In concept maps statements form a tree-like branched structure and reveal correct and/or incorrect conceptions of what the students learnt in and out of the classroom. For this reason a systematic study on students' misconceptions and effective means to avoid them will be started, with special reference to scientific concepts. Another part of the investigation will refer to the children's intellectual growth monitored throughout the first five grades of primary school. Learning of children who used concept maps will be compared with other children who followed parallel studies without using concept maps.

The aim is to verify whether the systematic use of concept maps can improve the overall quality of the child's intellectual growth.

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