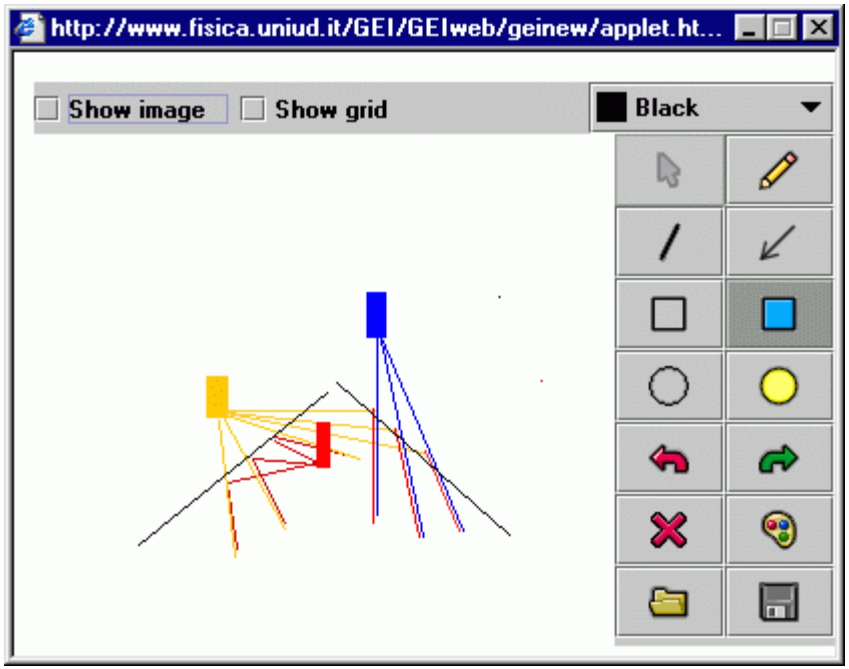
Objectual mesoscopic model for fluids in equilibrium

- building the mesoscopic model of ideal fluids (Besson, Viennot, 2002)
  Water -> Balloons of water as portion of fluids -> Balls of rubber foam
- visualizing the underlying idea of the mesosopic model
- helping the reasoning on the
  - **concept of pressure,**
  - **mechanisms that justify the pressure of the fluid in all directions (Pascal law),**
  - **increase of pressure with depth (Stevino law).**

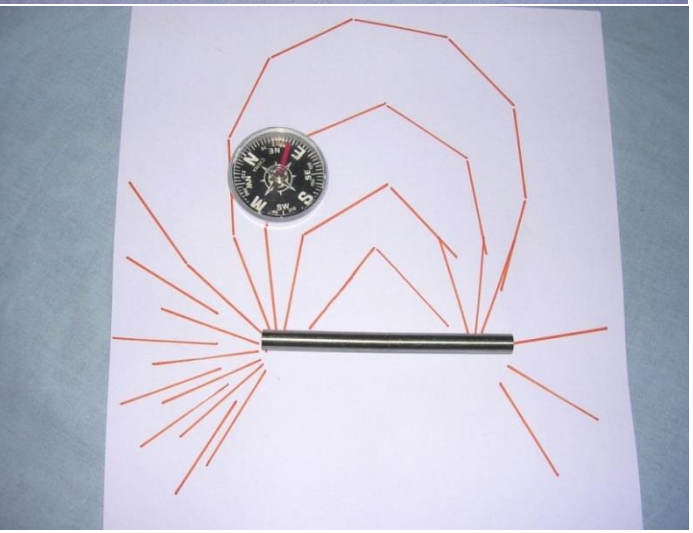
A Java applet on the web (Geiweb)

was planned and used for the representation of models in geometric forms starting from an image of real object



The system acquired photographs of situations and used a design utility which allowed for elements of the model, such as straight lines-directions / rays of light, vectors / velocity / forces, to be represented on the same photo, than the photos is removed in order to concentrate on the model.

The role of REPRESENTATION
Magnetic field line
as a model – a conceptual tool



- To interpret magnetic interactions
- To distinguish magnetic:
  - Field: direction of orientation
  - Force: direction of starting motion
- to produce reasoning in terms of flux,
  - recognizing its constance
  - relative consequences (close field lines, not separability of poles)
  - interpreting e-m induction

The case of magnetic phenomena

Literature present student difficulties on magnetic phenomena
(see Borges, Gilbert 1999)
quoting specific learning knots
(see Bagno Eylon et al, Guisasola 2007)

Children:
- do not identify the phenomena

Children:
- have difficulties in recognizing poles,
- identify magnetism with the attractive effects of a cloud
- cannot identify magnetic field

We have evidence of the way to overcome this problems

Offering field lines as conceptual tool and monitoring dinamical evolution of reasoning

sample: 10 classes - 250 pupils – 6-10yo

The building of formal thinking in vertical curriculum perspective

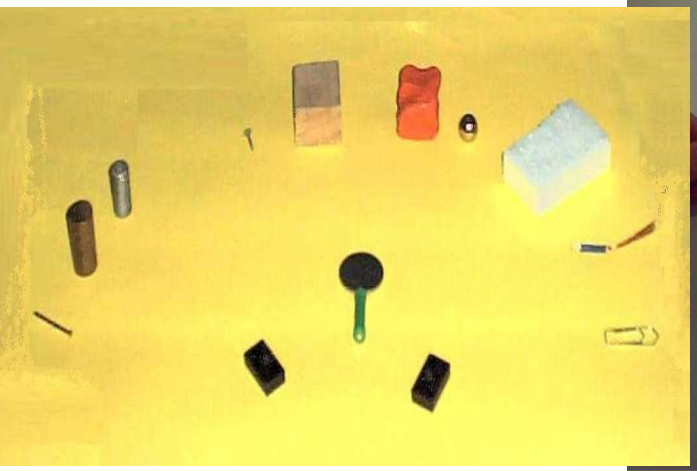
Conceptual referent

is done by means of field lines as a conceptual referent for the field

- from the analysis of the interactions of a magnet approaching objects made of different materials… to recognize
  - The kinds of interactions (3-60%)
  - The idea of a magnetic property into the space around a magnet (or a current) (70%)

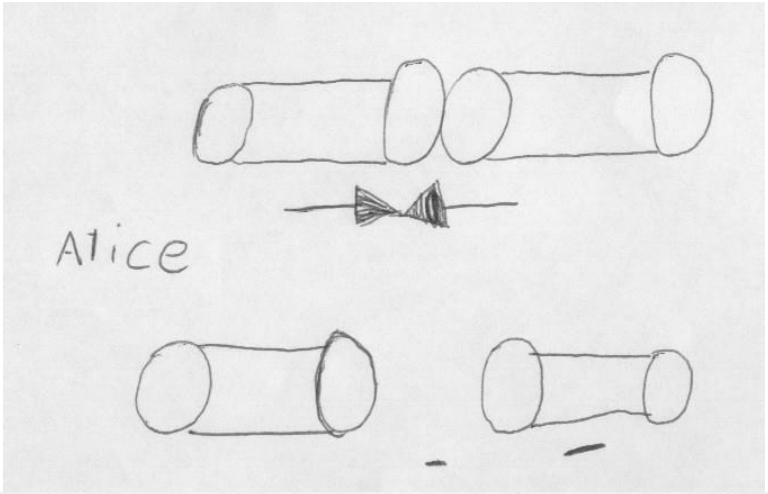
the compass is individuate as

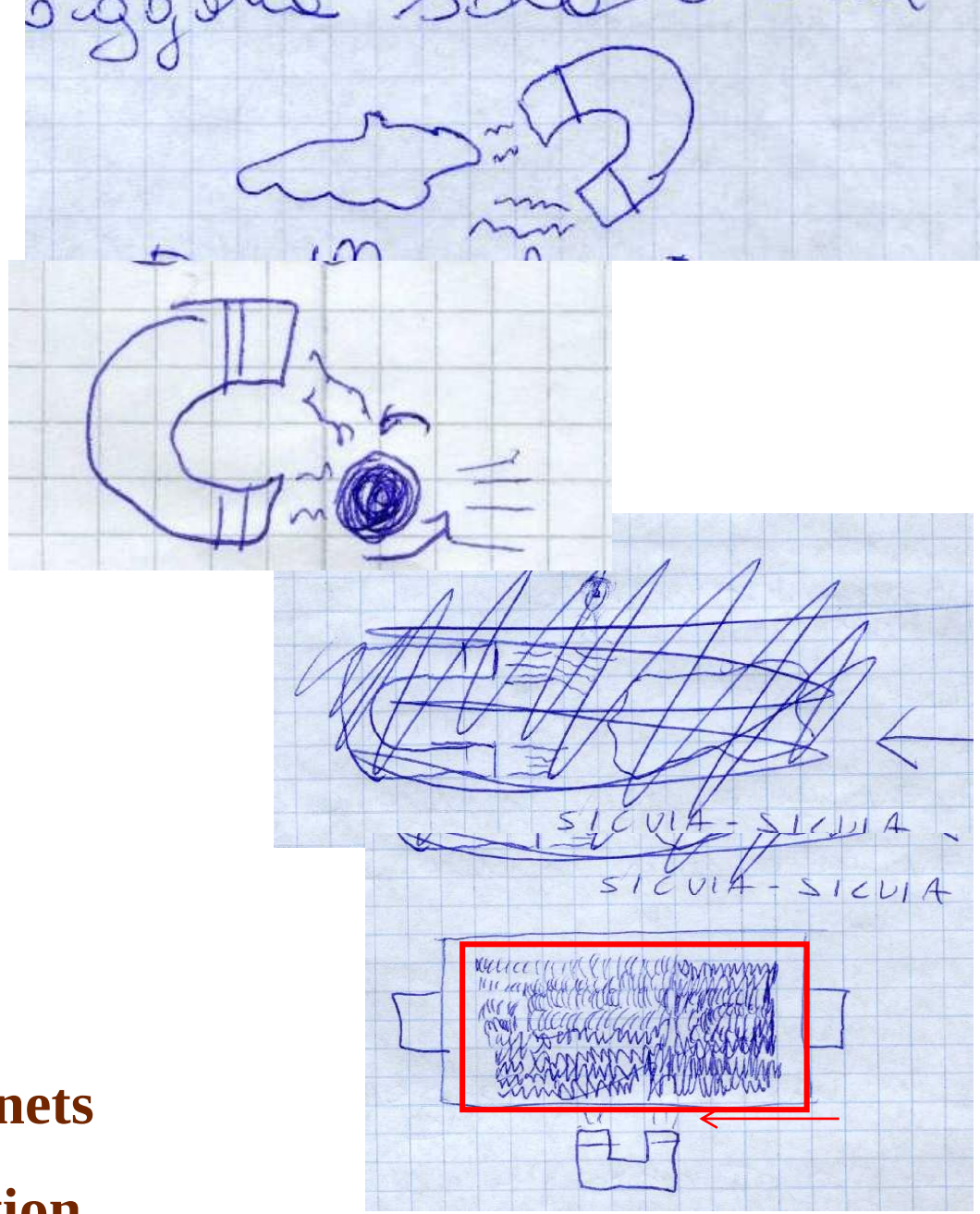
- an explorer of the magnetic properties of the space (66%)
- a magnet itself (68%)



Documentation

6 year old





Interaction between two magnets

Attraction, rotation fo attraction

sample: 10 classes - 250 pupils – 6-10yo

Field idea

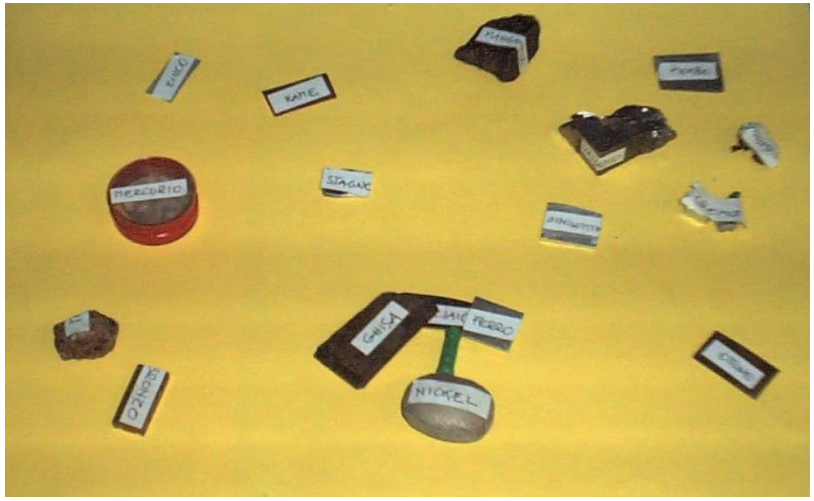
key experience are offered in dinamic perspective

sample: 10 classes - 250 pupils – 6-10yo

PEC strategy *in INQUIRY LEARNING*

SITUATION A cluster of objects of different materials and a magnet

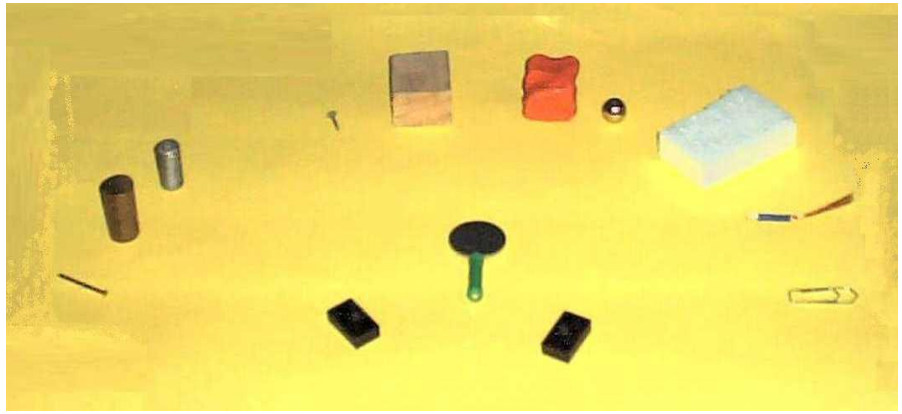
PREVISION on the interaction between a magnet and different objects / materials



What you observe?

Try!

COMPARISON
Similarity … Differences…
How can you explain what you observe?



…we found in pupils reasonings:

- **contingent descriptive rules**
- **general rules with conditions «when … than…»**
- **local, global, causual interpretations**

Developing vertical paths on electromagnetism and superconductivity from primary to upper secondary school

Micro-steps of Conceptual Lab of Operative Exploration (CLOE) are carried out in building the formal quantities characterizing B

direction of the compass needle change? Explain
Explain how can we change the direction of the needle

to the neighborhood of the compass? Explain

5) Placing two magnets on two floating polystyrene pieces

How do the two magnets interact? Do the experimental results concorde with your previous answer? Explain

6) Consider a suspended magnet and a compass

Do you think the needle of the compass a magnet? Can you experimentally prove your answer.

3) Approaching a clip with magnet

Describe what do you observe:
Is it the magnet that gets attracted to the clip or is it the clip that gets attracted to magnet?
How can you prove (experimentally) your answer?
Do the experimental results concorde with your previous answer? Explain

4) Approaching a magnet with another placed on the table

Before the experimentation: What type of and how many interactions would you expect to observe?

1) I have a box with several objects.

How can you identify the magnet(s) among them?

2) Holding a magnet, when I approach different objects

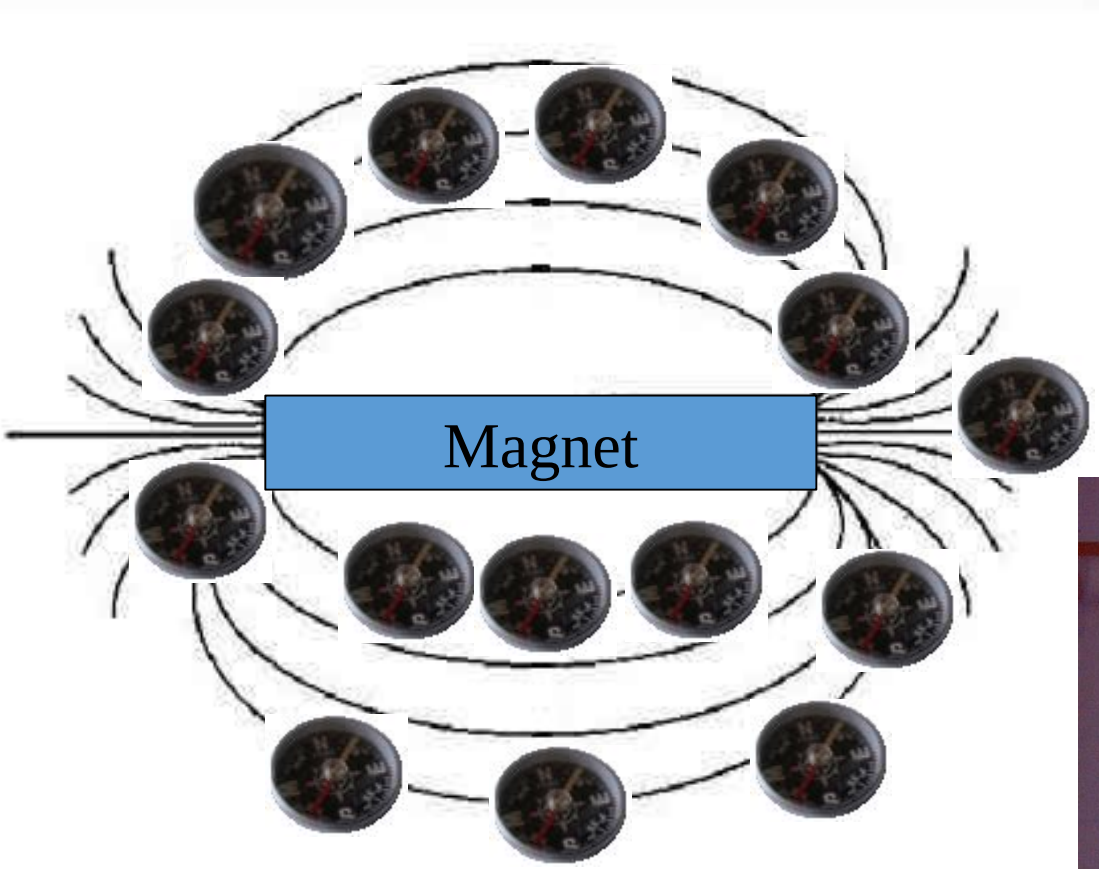
Before the experimentation: What type of and how many interactions would you expect to observe?
Experimentation: describe the behavior of the magnet when I approach it to each one of the following : ping pong ball, clip, another magnet, compass
After the experimentation: How many and what kind of behavior do you observe?
How do you categorize the compass?

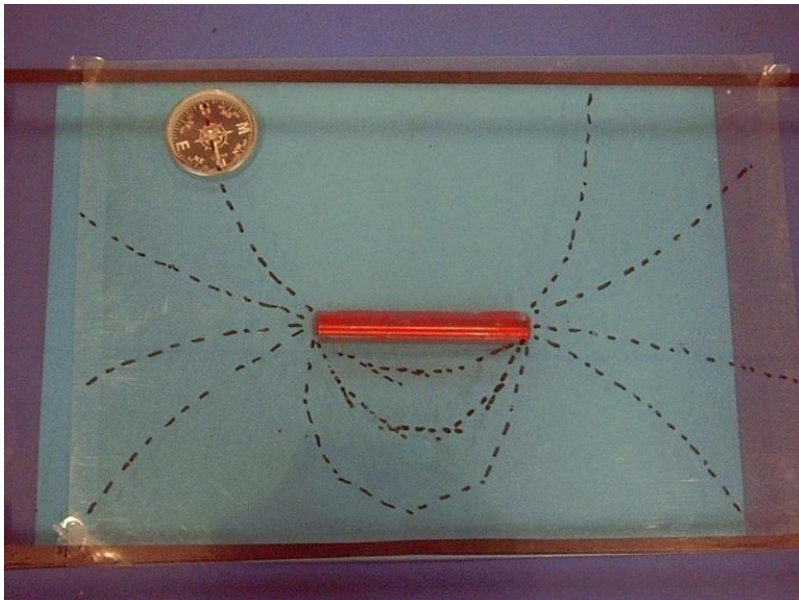
Research outcomes: 1) reasoning of students; 2) educational materials

EXAMPLES
The building of field lines

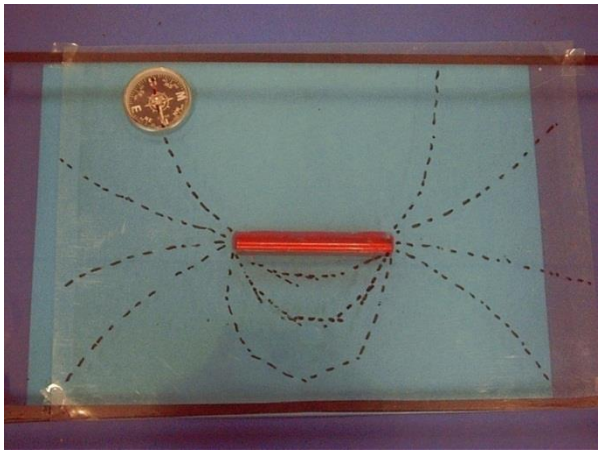
From the description of field lines emerge that

- there is no intersection between lines … they appear to be closed
- the distance between two lines is not constant



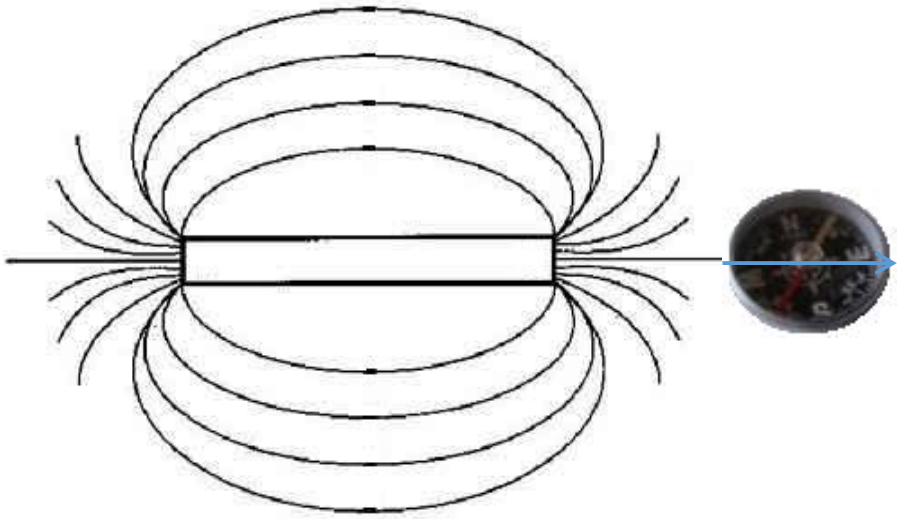


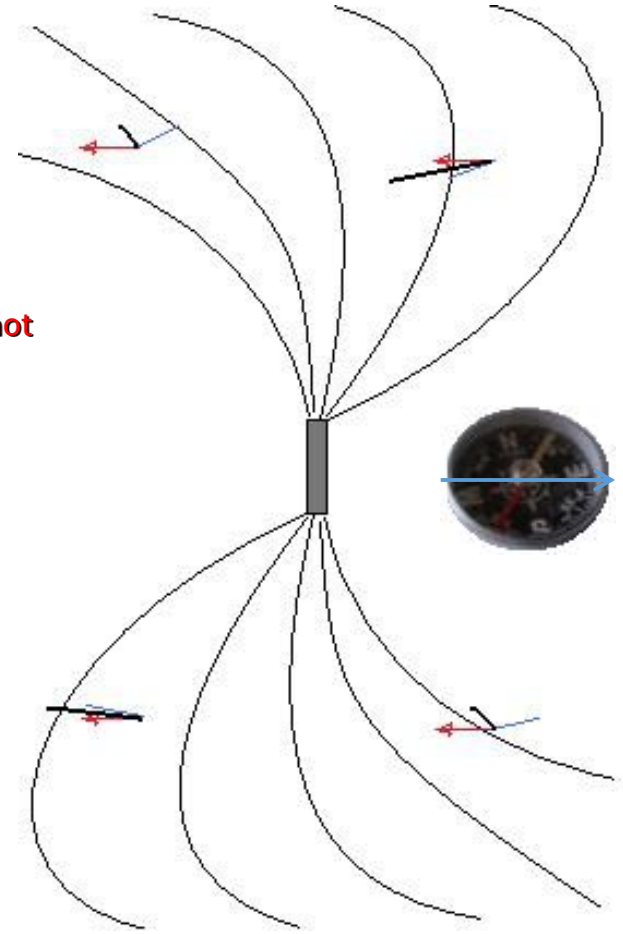
What about the nature of the property representing the needle of the compass orientation?



The change of the pattern with the magnet at 90°

create the first idea of a composition not scalar but … vectorial





Another crucial aspect is important in individuating the physics nature of B

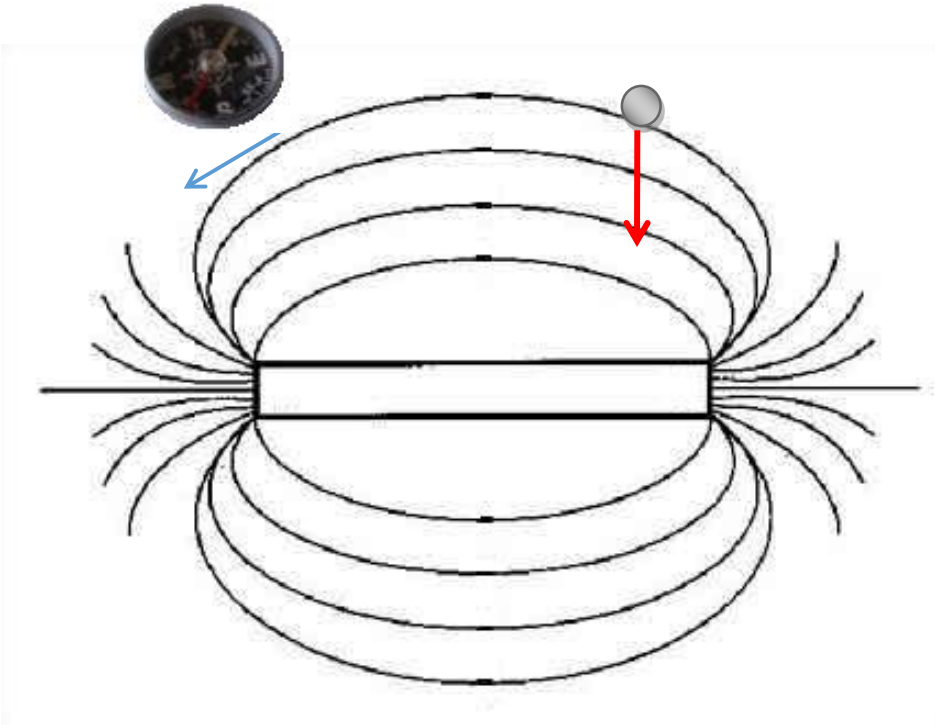
What about the nature of magnetic field?

magnetic field and acting force are different quantities

We know that B is a vector reperesenting a magnetic property in the space, orienting a needle of a compass

Is it a force?

Let us consider the direction of starting motion of a still ball on a field line

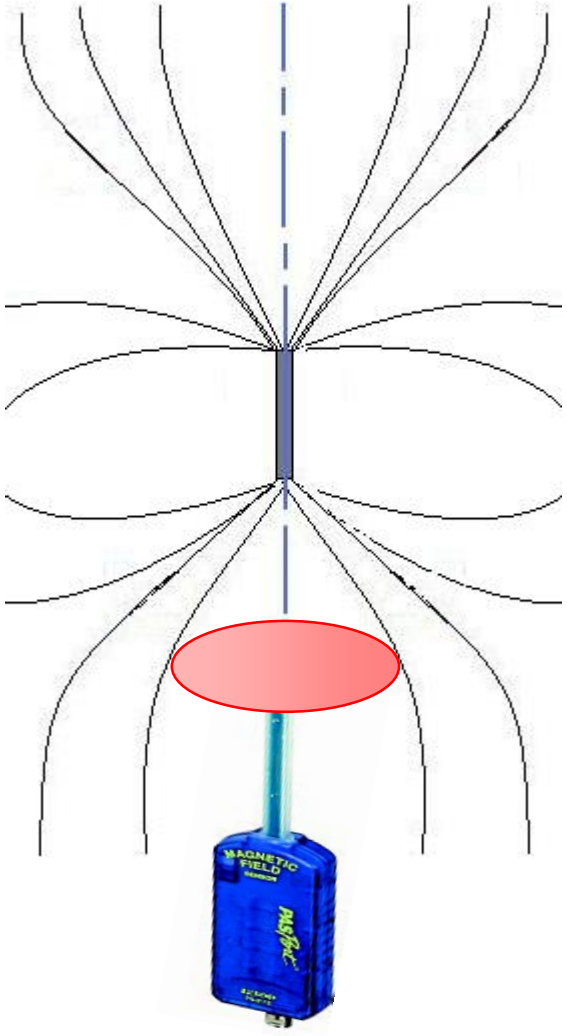


The idea of Flux

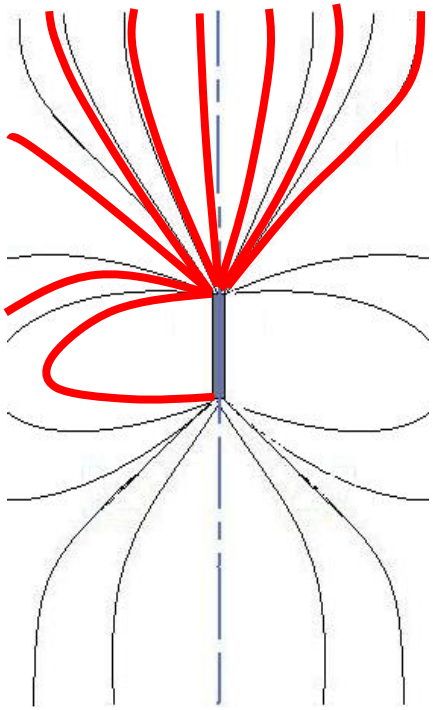
The field lines are distancing as the B intensity is decreasing!

Let us correlate:

- the measure of the intensity of the magnetic field and
- those of the area of the corresponding tube



B*S = const = Flux



Mapping the magnetic properties of the space with:

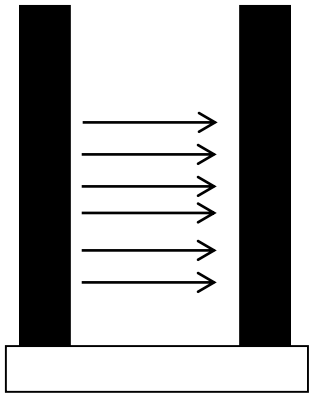
- Field lines
- Tube of flux

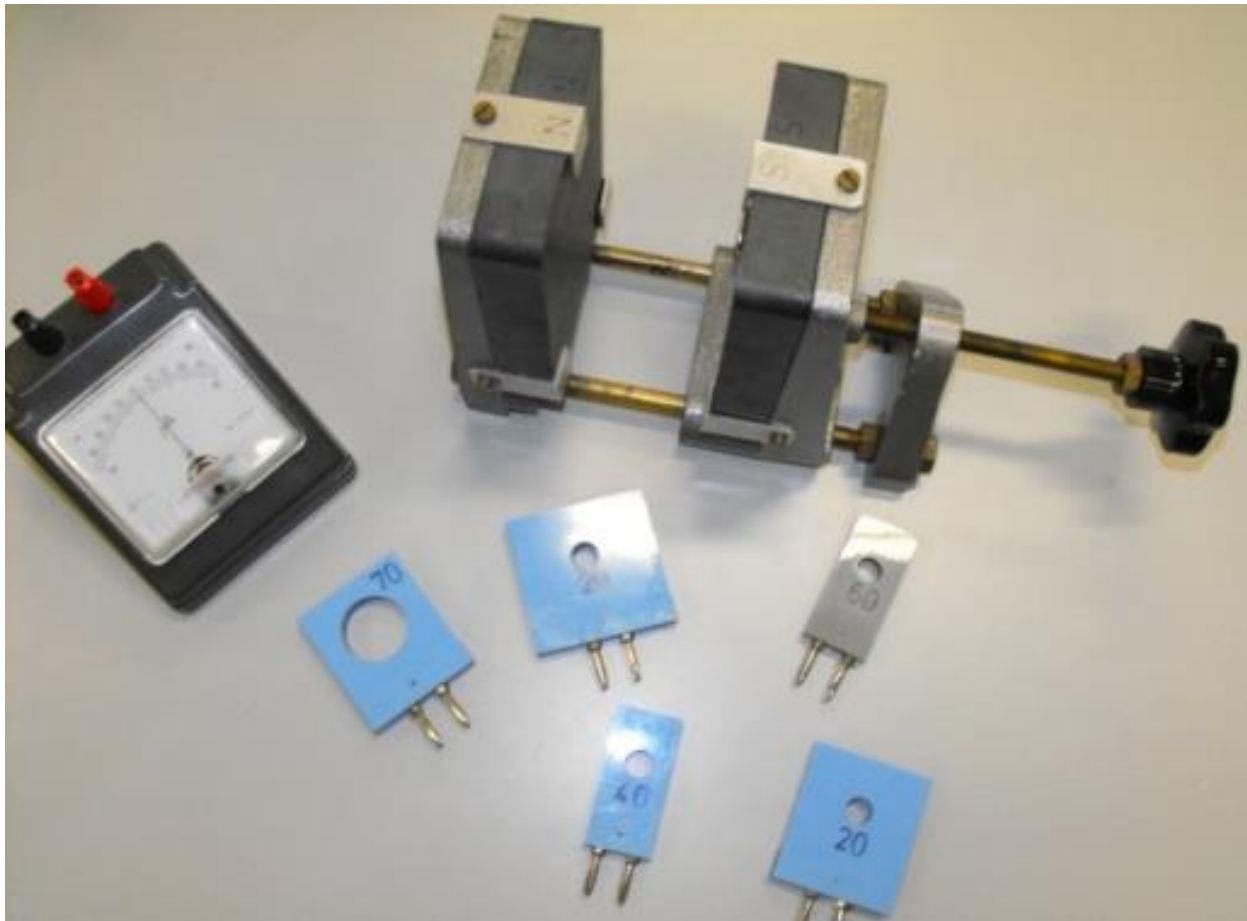
Exploration of the condition producing e-m induction

Experimental exploration

Interpreting it

having in mind flux tubes

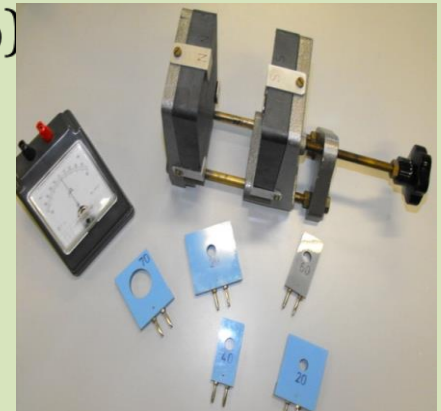




ACTIVITY P11

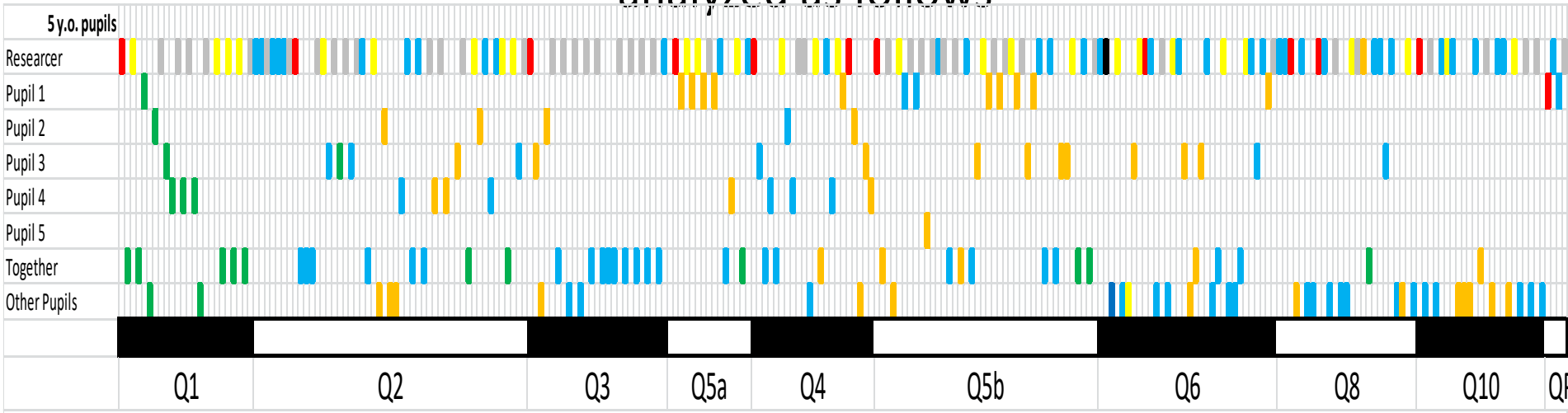
sample: 8 schools - 160 students – 10yo

Protocol steps	*Key question(s)*	Research Questions
11) E-M induction	**Q11** We have seen that a wire carrying an electric current generated a magnetic field. **Investigate** if is possible to achieve the reverse process: can you create an electric current using a coil and a magnetic field?	RQ Which are the way that pupils identify to produce electromagnetic induction? RQ How did the pupils conduct their explorations? RQ Which are the identified variables and parameters?
Naïve ideas	***After experiment and discussion***	
[electricity is produced by the battery. Students speak only in terms of source of energy and not on the process in which the current is product]	- *approaching and moving away a coil to a magnet produces a current* (75%) - *if we stop movement there are no more current* (70%) - *if we change the inclination of the coil or the speed of the movement the amount of current changes* (72%) -	- *rotating a coil near a magnet a current is produced* (65%) - *Current is produced when coil interrupt the field line of the magnet* (20%)



CLOE ACTIVITY

Audio-Video recording of discussions are analyzed as follows



Looking at the color of the intervention of 10yo pupils is evident how:

- simple answers disappear (color green)
- leaving space to the quotation of experimental situation (blue) and
- discussion/argumentation (orange).

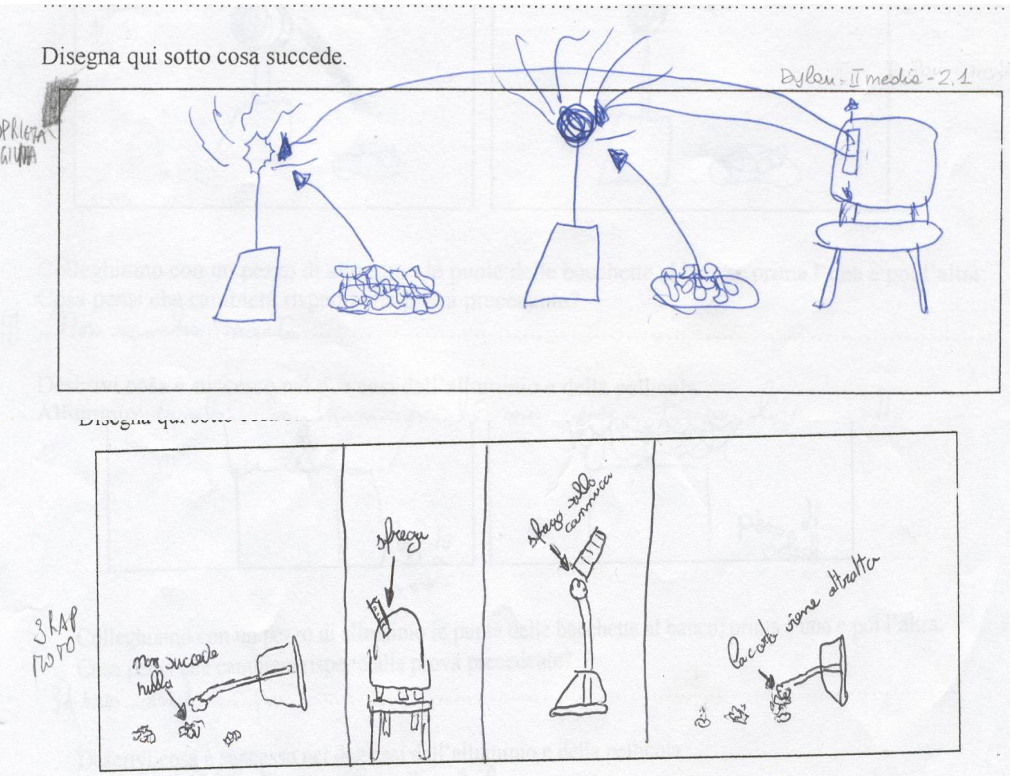
The time spent on the different situations and the number of interventions depends by the situation, as well as the spectra of interpretations.

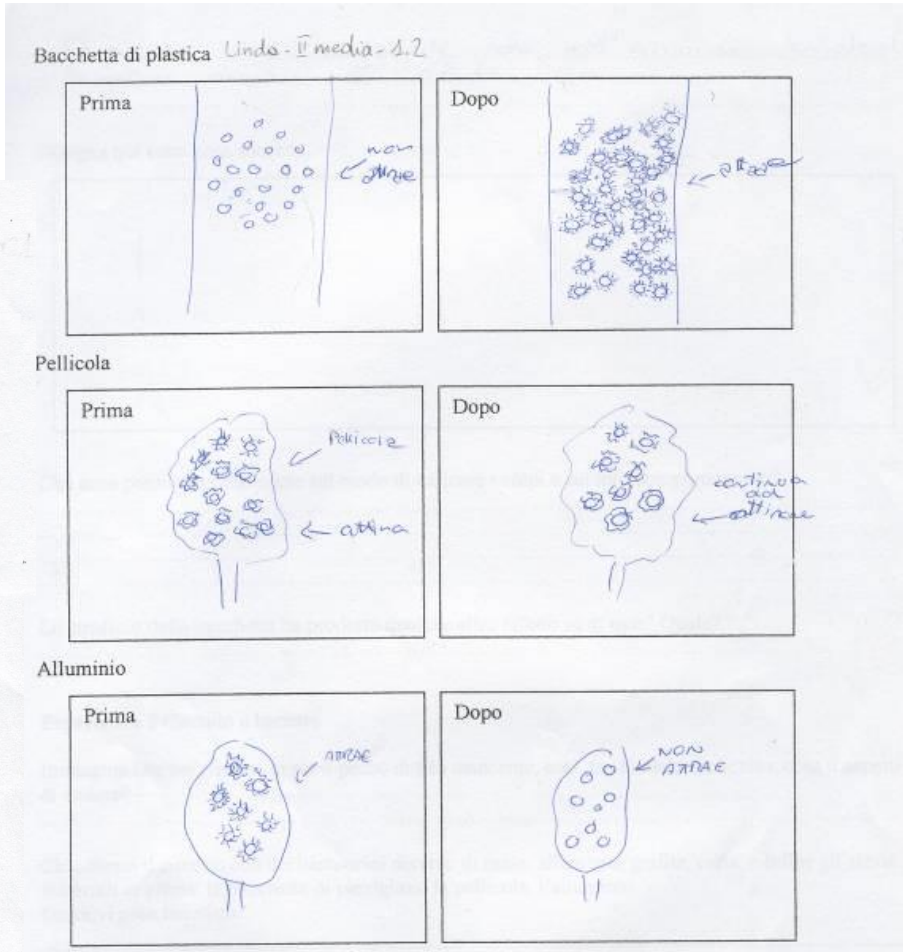
	key question
	promotion further discussion
	introduce / refers to situations
	waiting for further answer
	answer
	discussion

Group of students case study of a videorecorded discussion

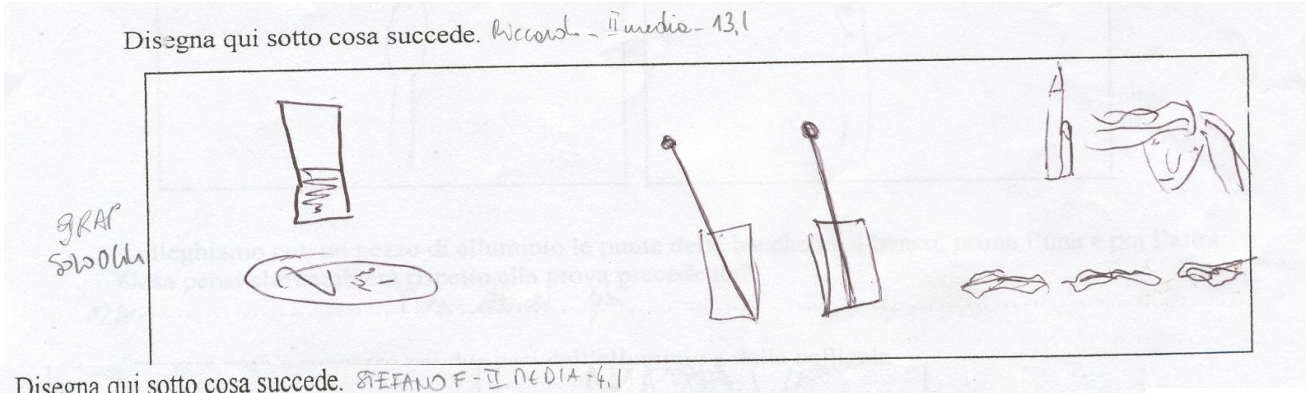
Looking to learners' reasonings in developing formal thinking

- Role of macro-micro representation
- Electrical phenomena

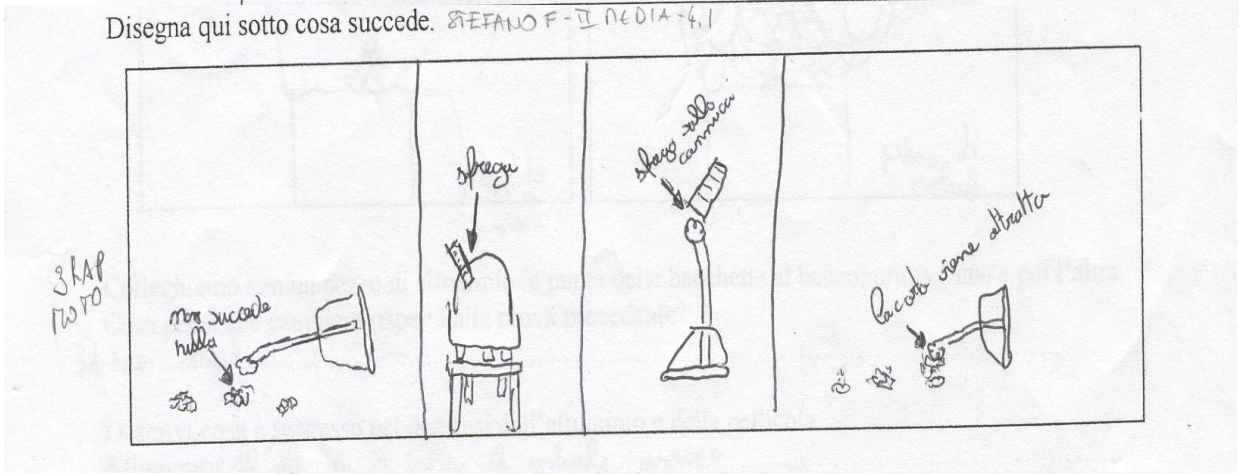




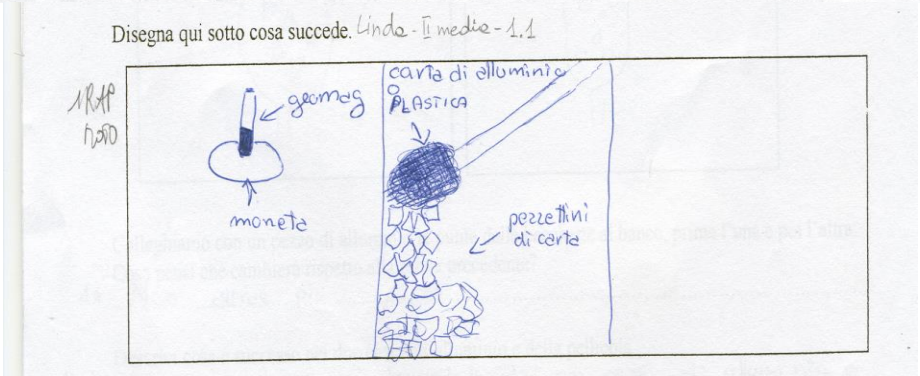
Different kind of representation



A. Exposition of used materials



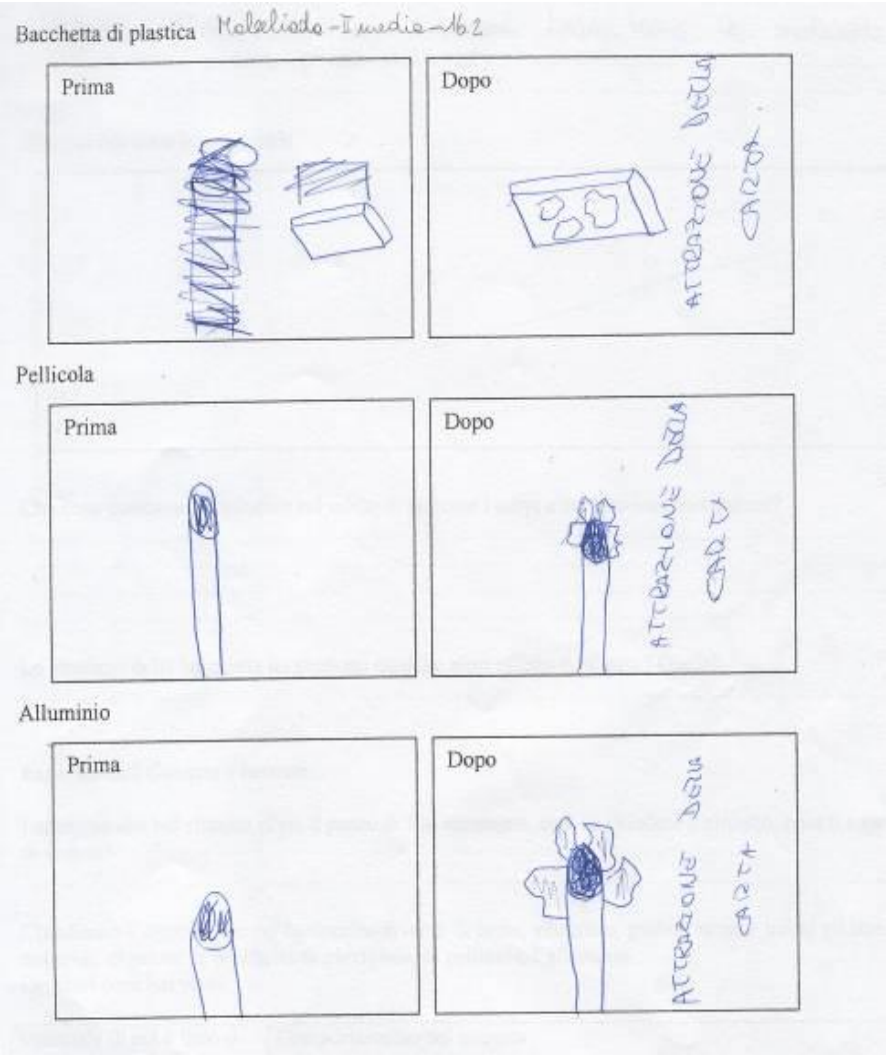
B. Story telling



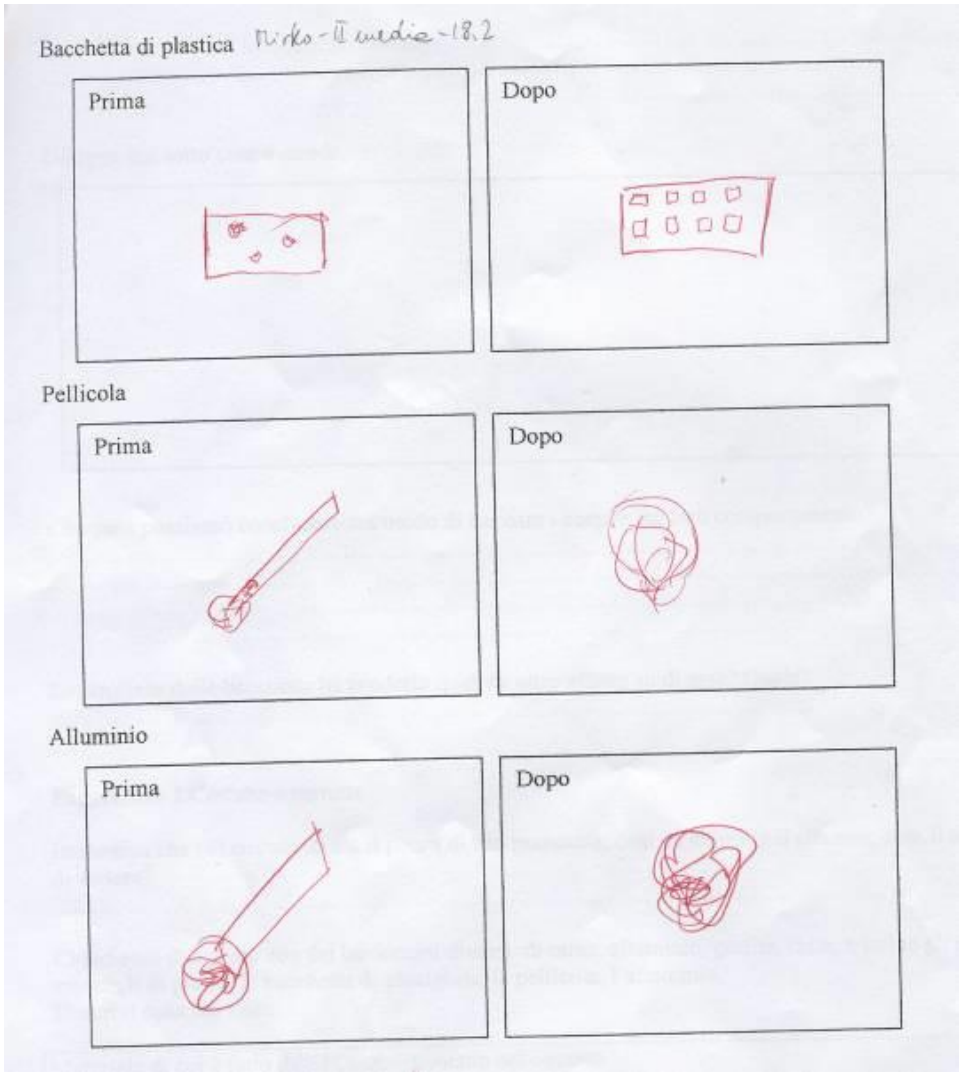
C. Characterisation and explanation of selected parts

type 1: Chance in the status of the system

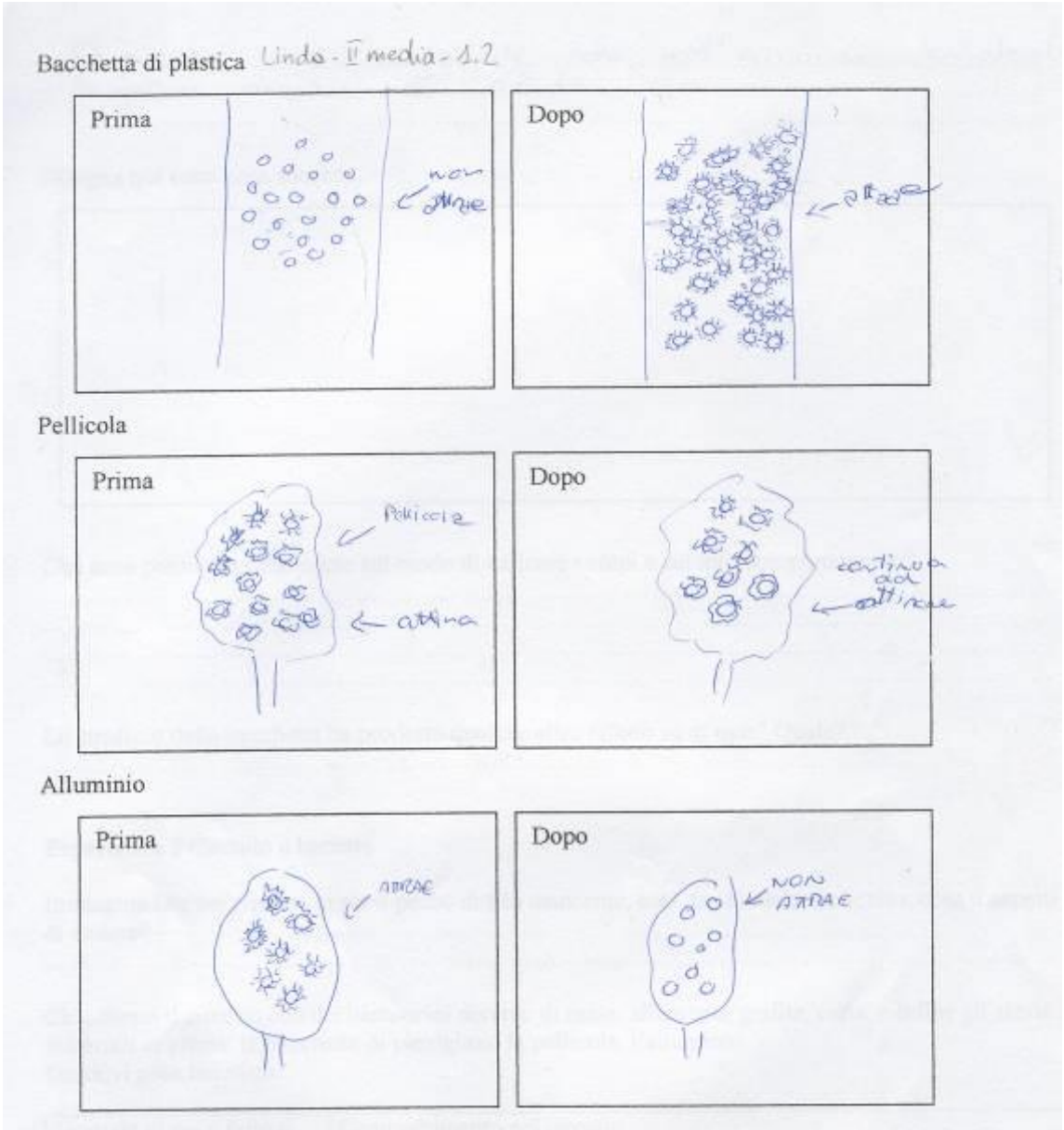
B1:Materiale indistinto che quando c'è attrazione si intensifica o non cambia



B2. Materiale indistinto che quando c'è attrazione si intensifica e particelle che aumentano e si ordinano



Type 2
Activation of internal parts of the system



Change in the structure of the internal parts

Bacchetta di plastica

Prima

Dopo

Pellicola

Prima

Dopo

Alluminio

Prima

Dopo

Bacchetta di plastica

Prima

Dopo

Pellicola

Prima

Dopo

Alluminio

Prima

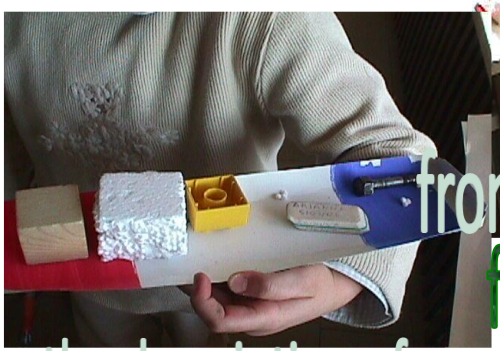
Dopo

Exploration activities with children

First steps in thermal phenomena

UNITÀ DI RICERCA
IN
DIDATTICA DELLA FISICA

from thermal sensations



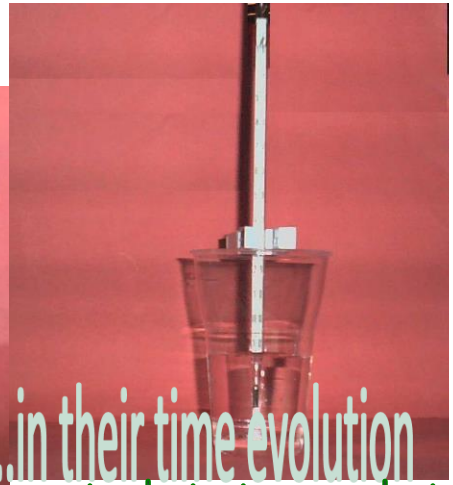
from thermal sensations

to its representation

to its representation

to the description of common phenomena

to the description of common phenomena



...in their time evolution

...in their time evolution

Sensors as an extension of senses for the exploration of thermal states and processes

…if I put my hand here… I feel

…it's cold!

Freddo come quando c'è la neve

Mi piace il freddo

C'è il freddo

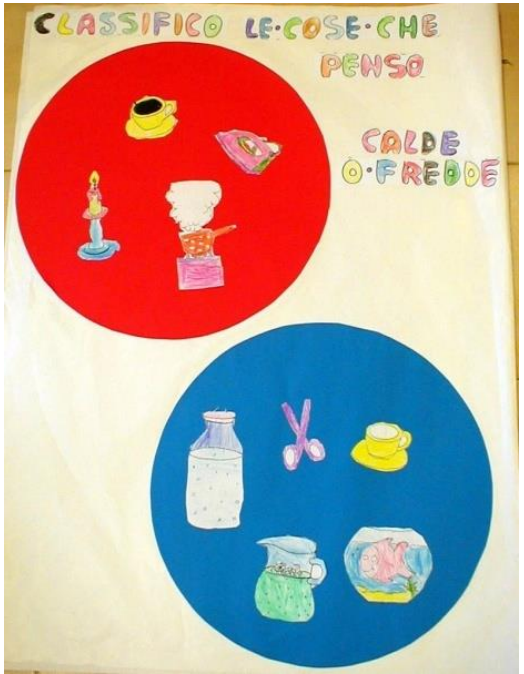
C'è il ghiaccio , così è freddo

La manina sente freddo, è la neve

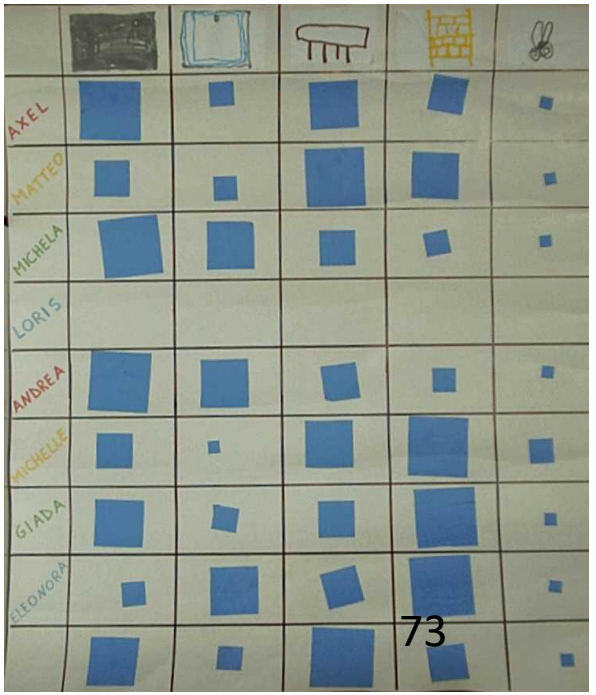
…it's hot!

Exploration of thermal sensation in kindergarden

Ordinamento effettuato dai bimbi della Scuola dell'infanzia di Terenzano (Udine) - Insegnante Adriana Odorico.

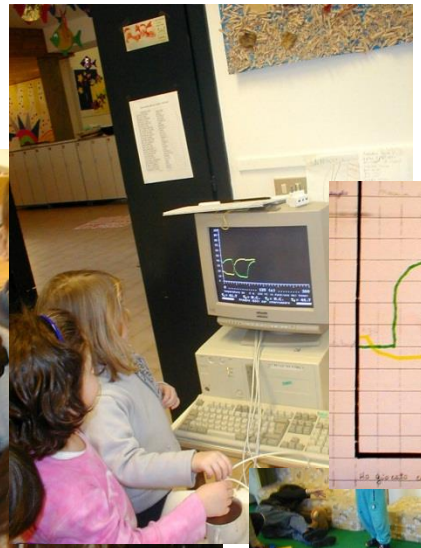
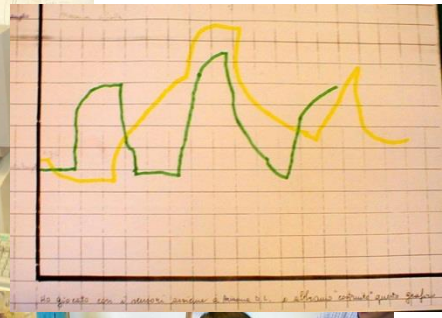


… and its formalization



Kindergarden
Playing with sensors



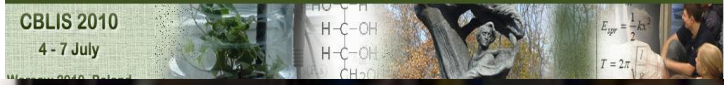






Exploration of thermal interactions by means of computer on-line sensors and its formal visualisation

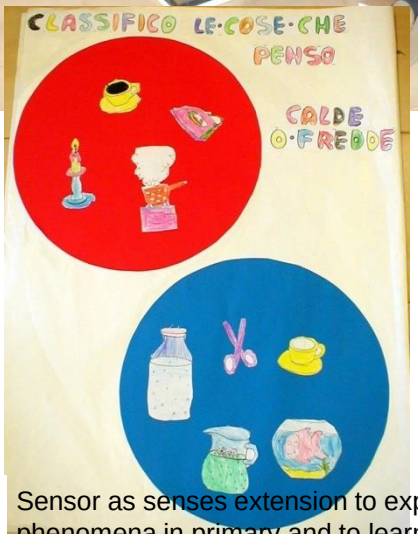
… and the adventure become more interesting

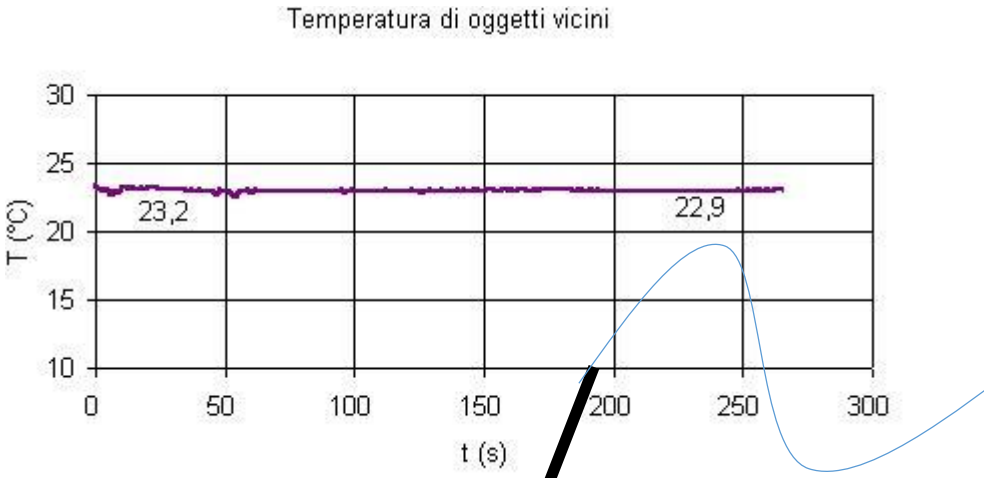
Teromocrono: thermal sensors as extension of senses



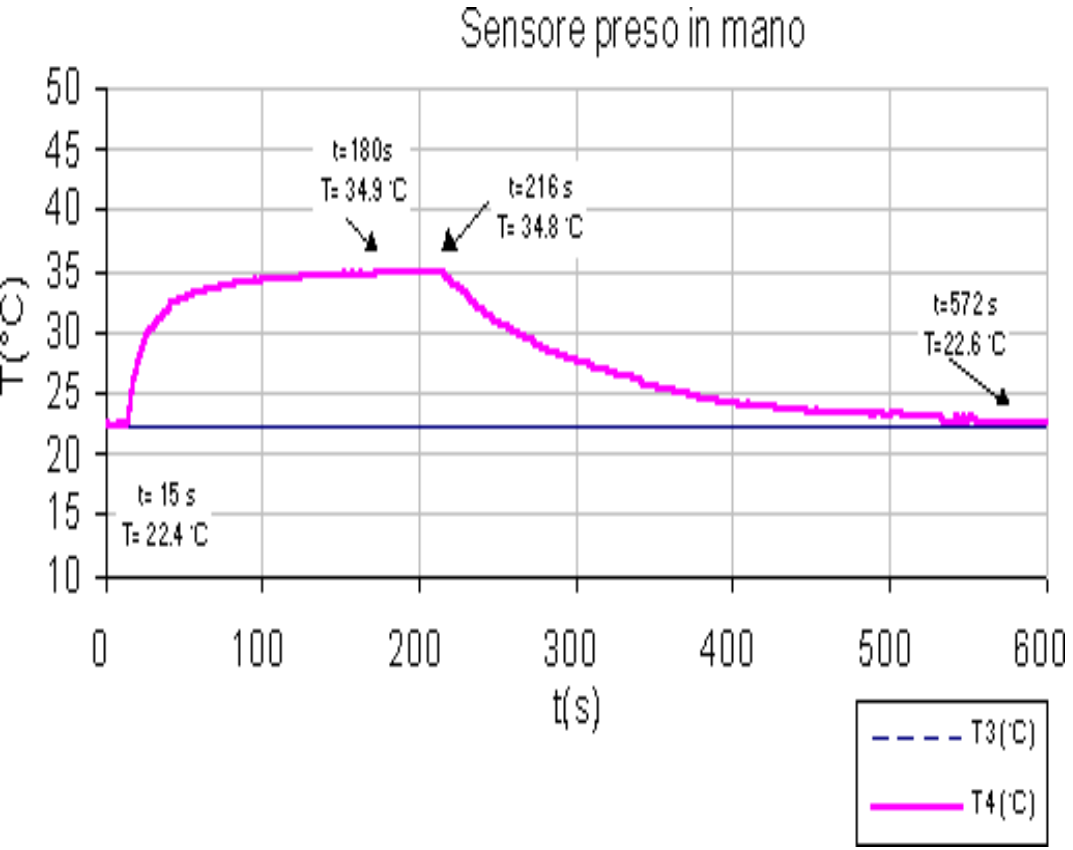
CBLIS 2010
4 - 7 July
Warsaw 2010, Poland
9th International Conference on Computer Based Learning in Science

The exploration by tactile sensation of thermal properties of systems is extended using on line sensors.

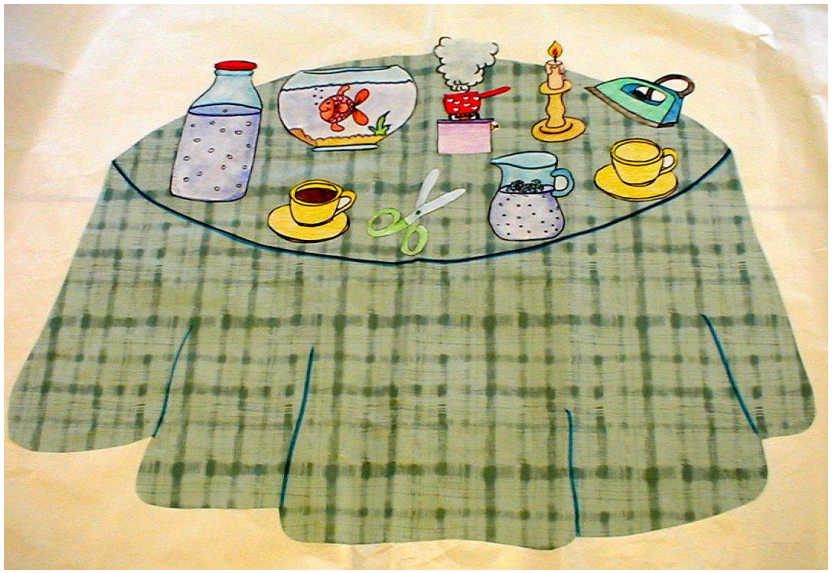




The real time graphs observed by pupils are linked with the processes realized by pupils themselves for instance heating by their hands a sensor or putting in contact different systems.



temperature of the various objects /systems…
and compare temperature with thermal sensation



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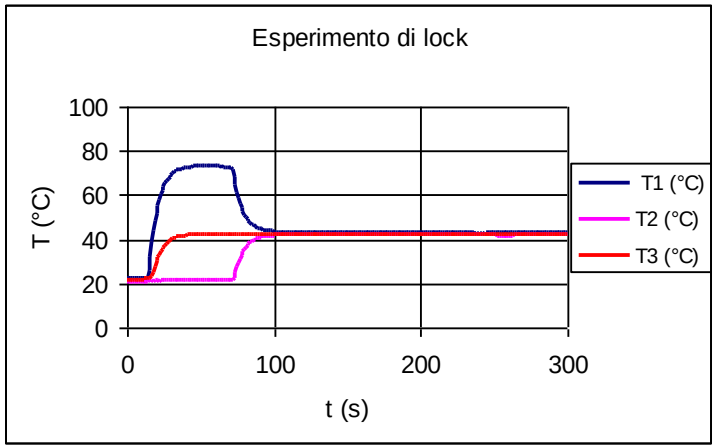
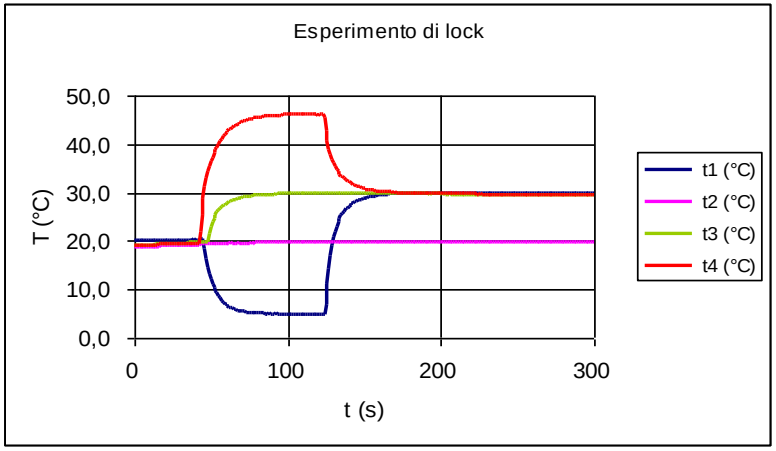
from exploration to the measure with sensors





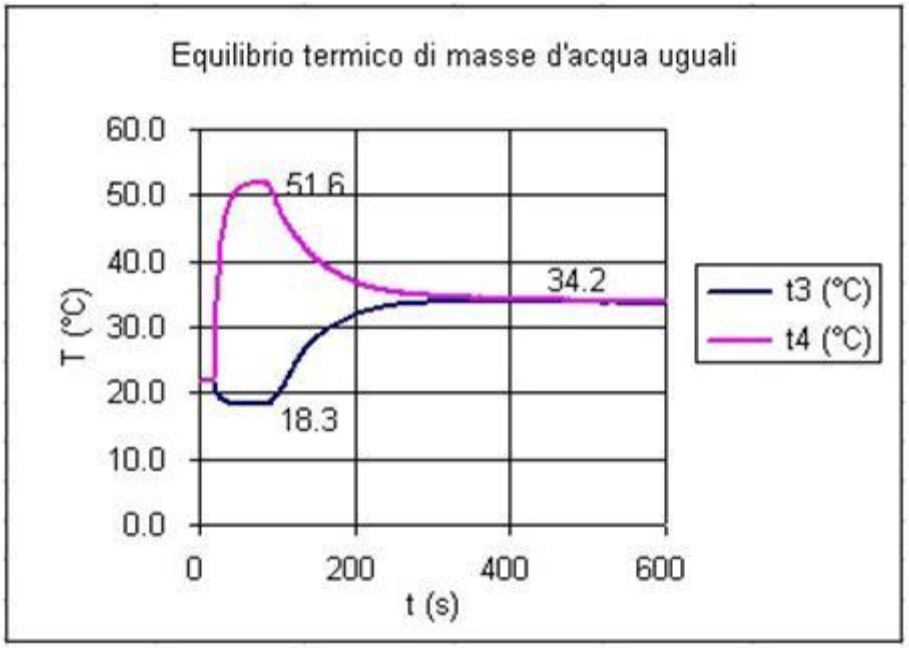
First steps in thermal phenomena

Exploring the thermal interaction between equal masses of water

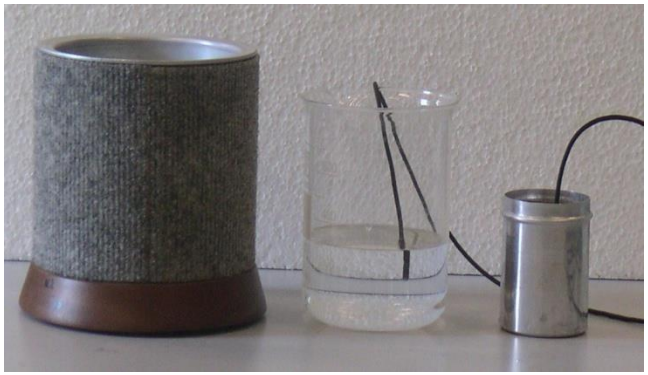
… and the adventure continues…

In the field of thermal phenomena on-line sensors allow a phenomenological exploration based on a thermodynamic approach to the thermal processes.

To thermodynamic approach……

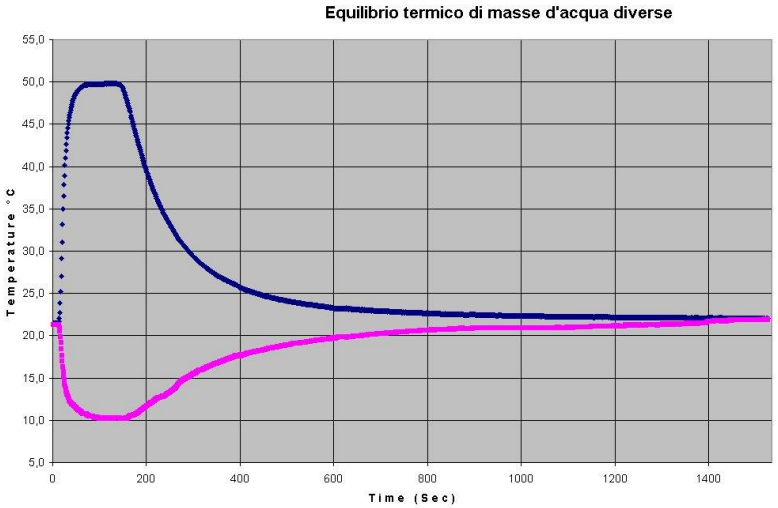


Examples of measures – two different masses of water



In the alluminium conteiner: 150 g at 49,8 °C

In the glass beker 300 g at 10,2 °C



The two systems interact thermically reacing a common equilibrium temperature Te.

Te is given by the weight average of the initial temperatures of the two masses of water

Fourier law of thermal equilibrium

The equilibrium temperature is 24.1 °C

11,9 g is the equivalent water mass of the container

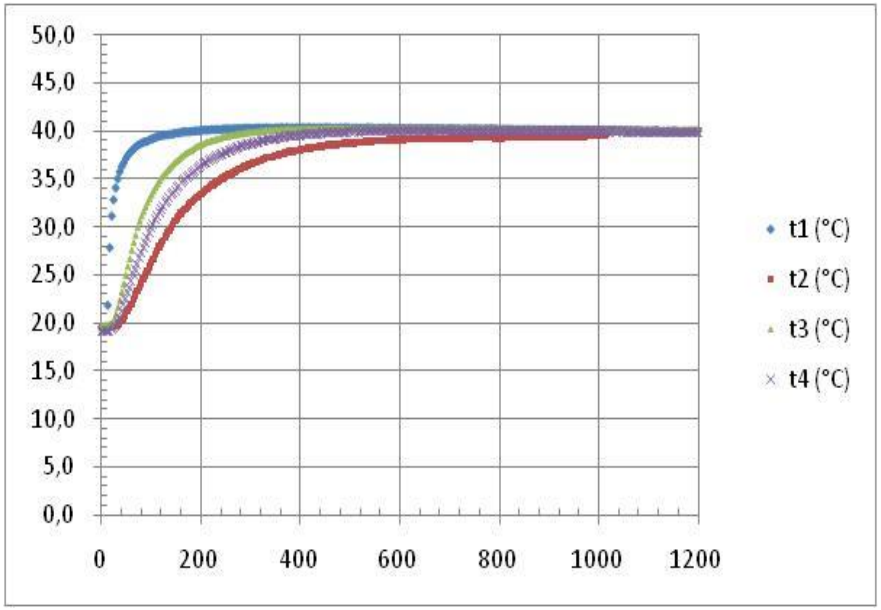
Examples of measures – mass role or time response of the sensors

Four sensors are covered with different masses of alluminium
(0, 2, 4 and 10g =0,3,6, 15 sheets)

and putted in a big mass of warmer water (isothermic).

The dependence of the time to reach equilibrium on the mass of alluminium allows to understand the meaning of time of response of a system and to calculate It.

It is possible to study the exponential law to reach equilibrium.



EXPERIMENTS

...to experiments

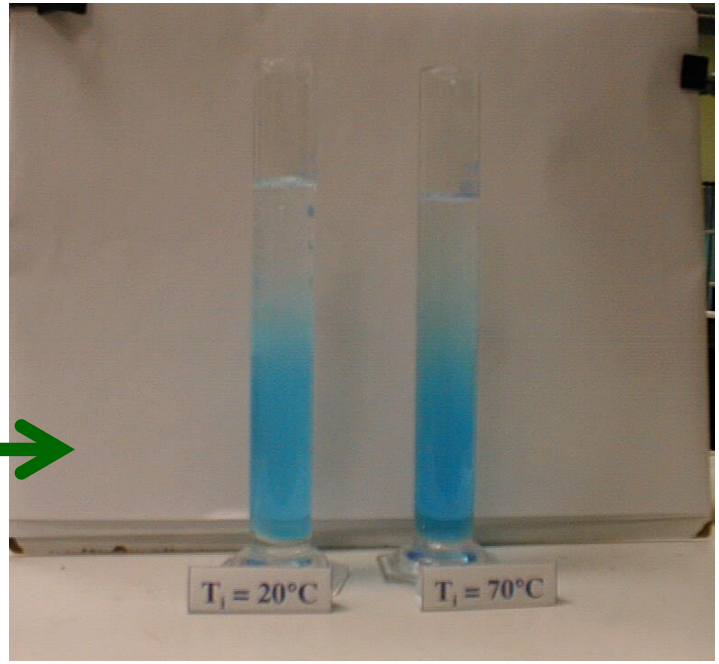
...to experiments

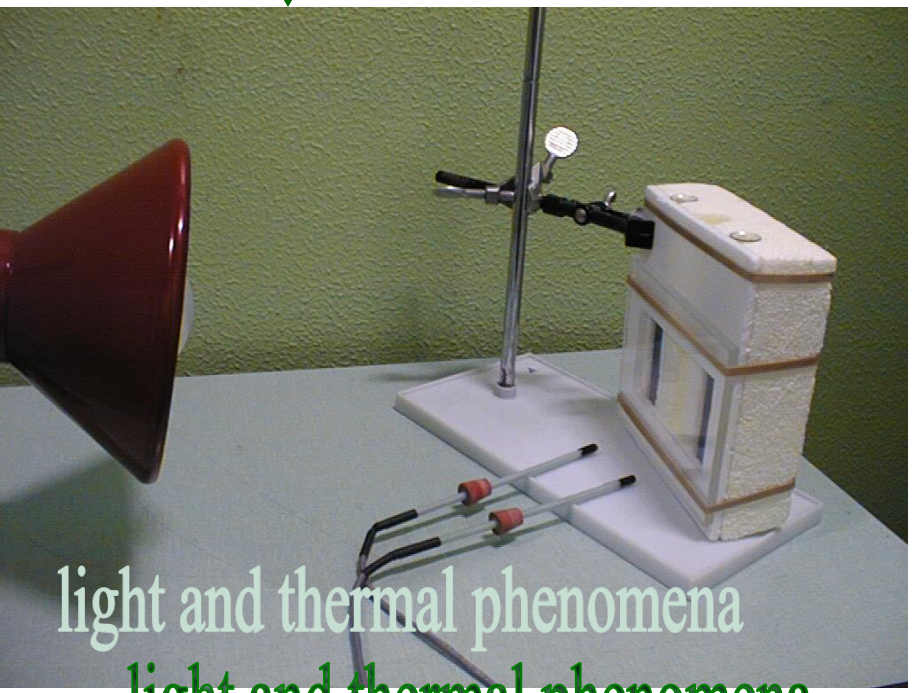
with light

with light

on diffusion

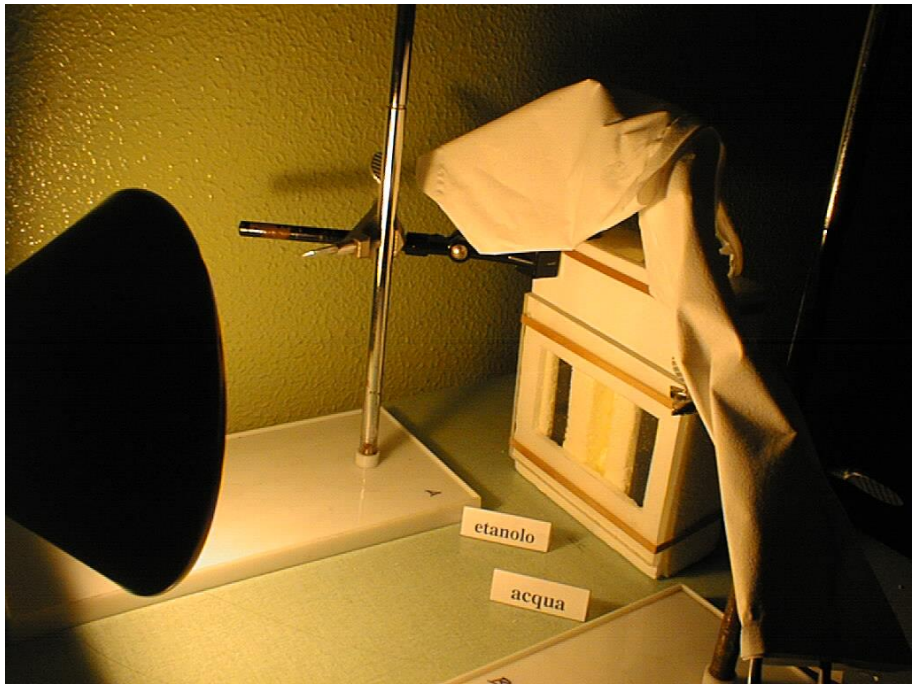
on diffusion



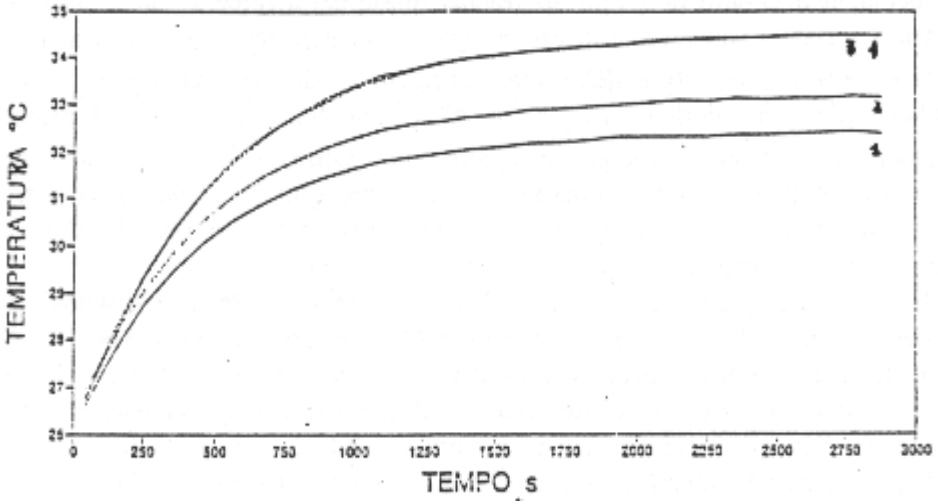


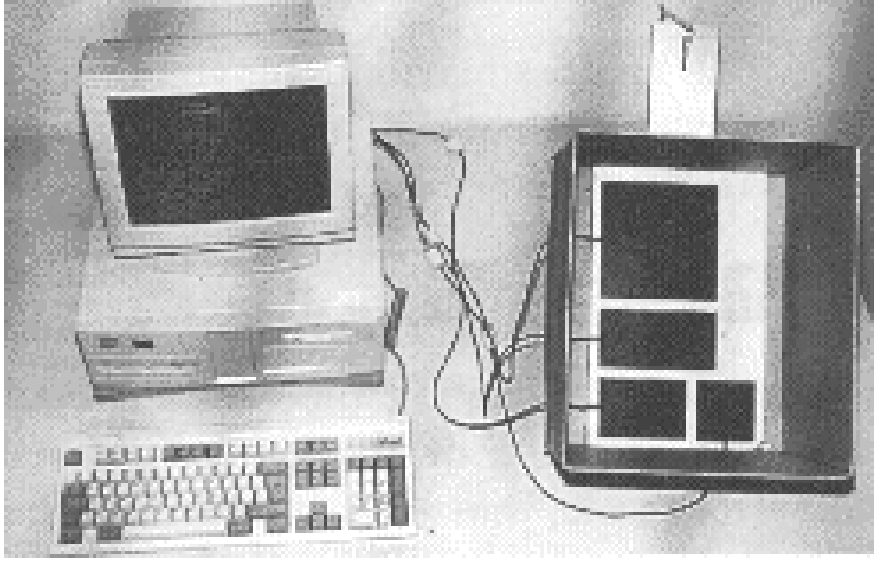
light and thermal phenomena

light and thermal phenomena



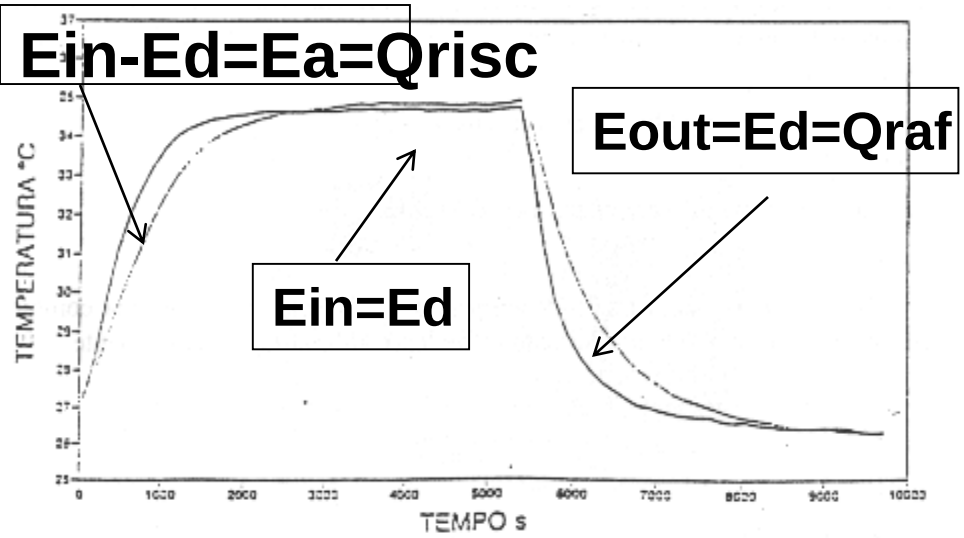
The absorption of light and the greenhouse effect





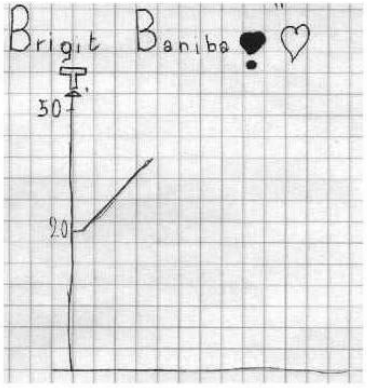
The temperature of equilibrium of lighted slabs of the same thickness depends on the amount of surface exposed

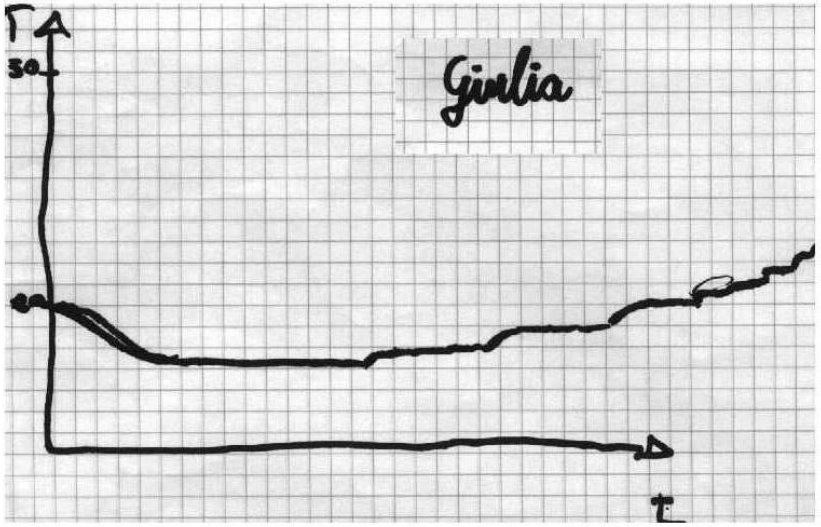
Slabs with the same surface and different thickness reach the same temperature in different times.

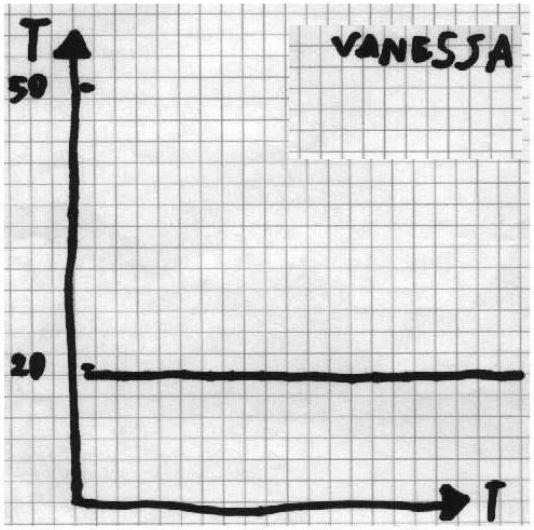


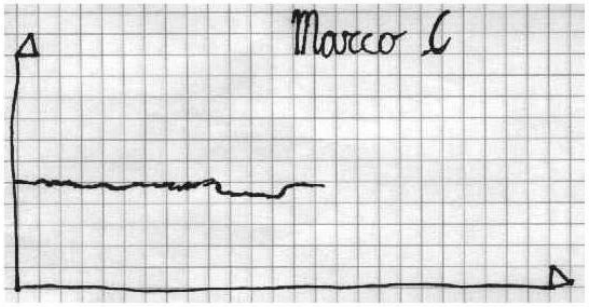
Calculation of the solar constant

Previsions by pupils: 8 years old (S. Giovanni di Casarsa)









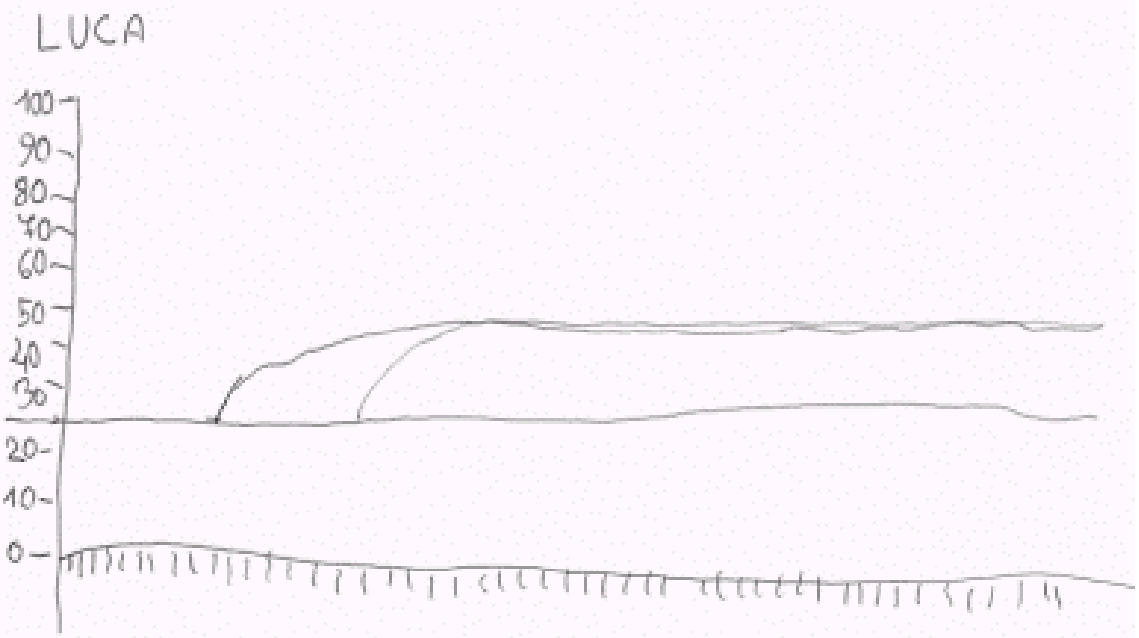


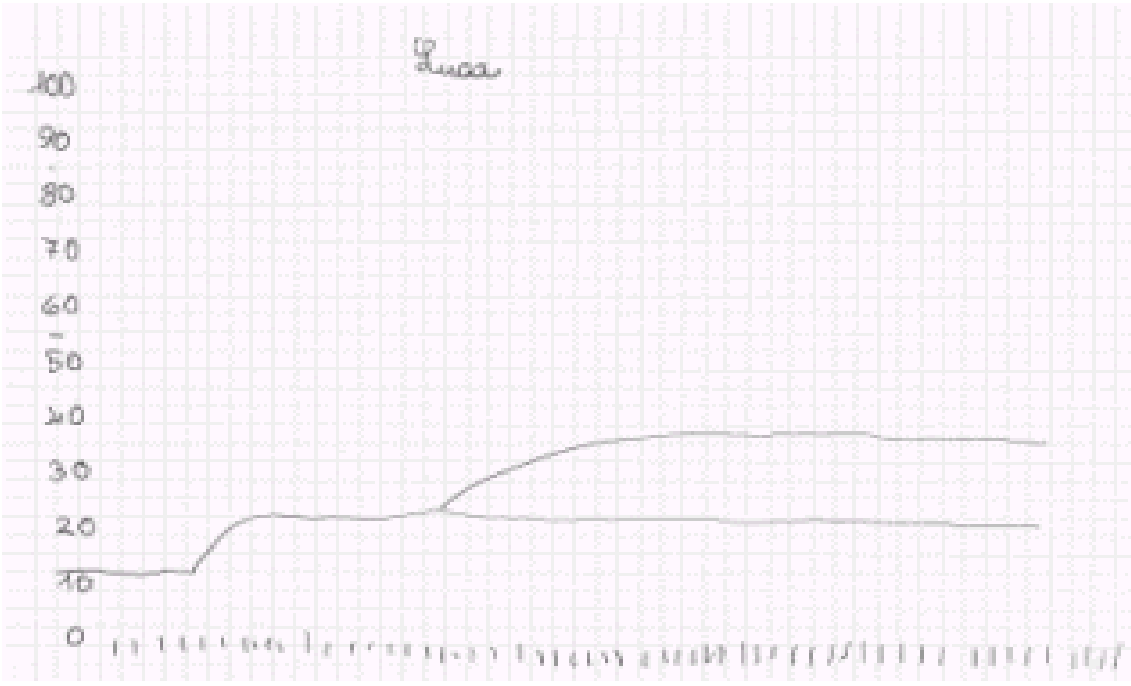
Figura 1 - Luca 8 years old pupil - febbrai

Note

the temperature scale

The grafical evolution of temperture in time

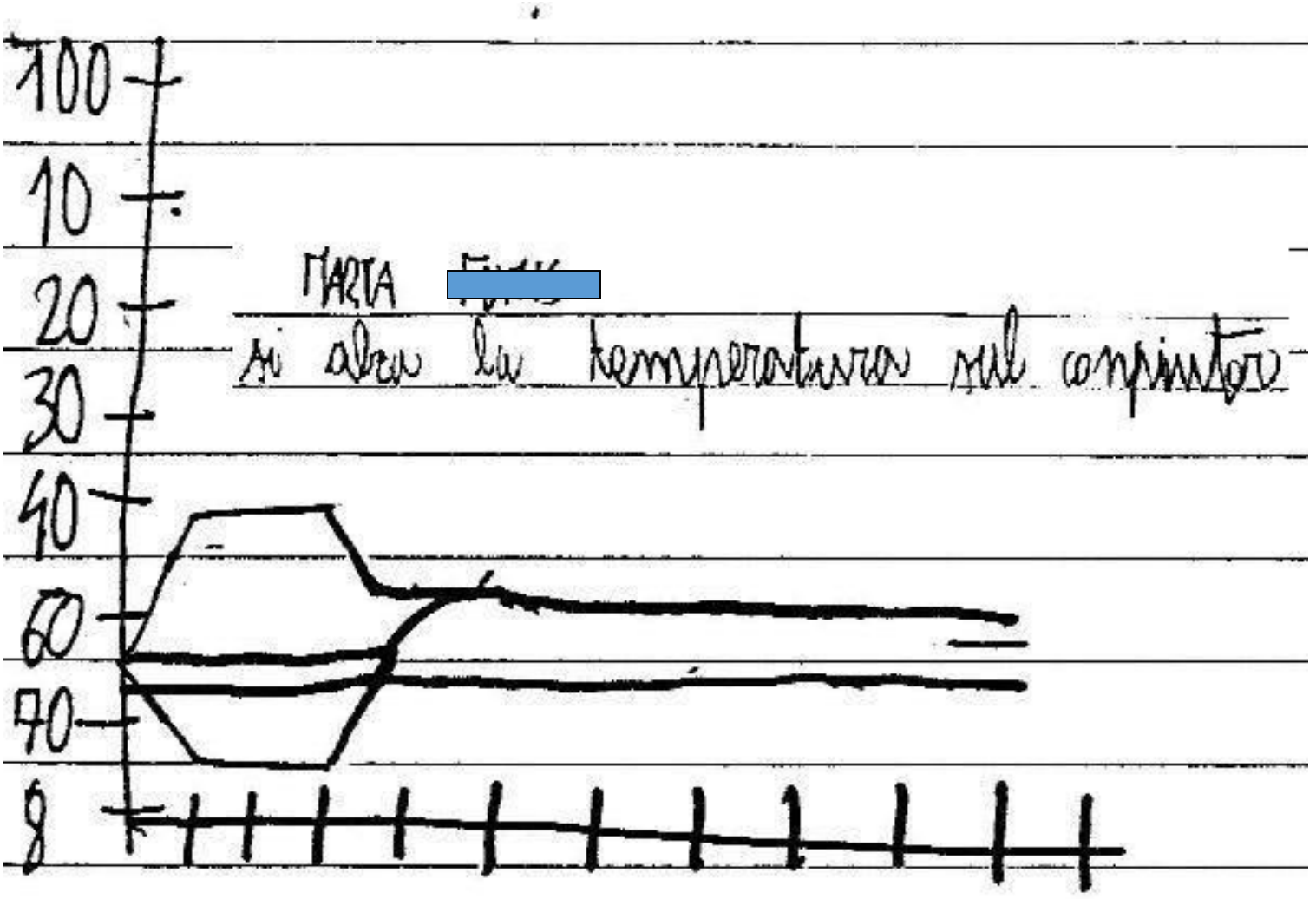
Figura 1 - Luca 8 years old pupil - febbraio 2002



The temperatures rapresented are correct

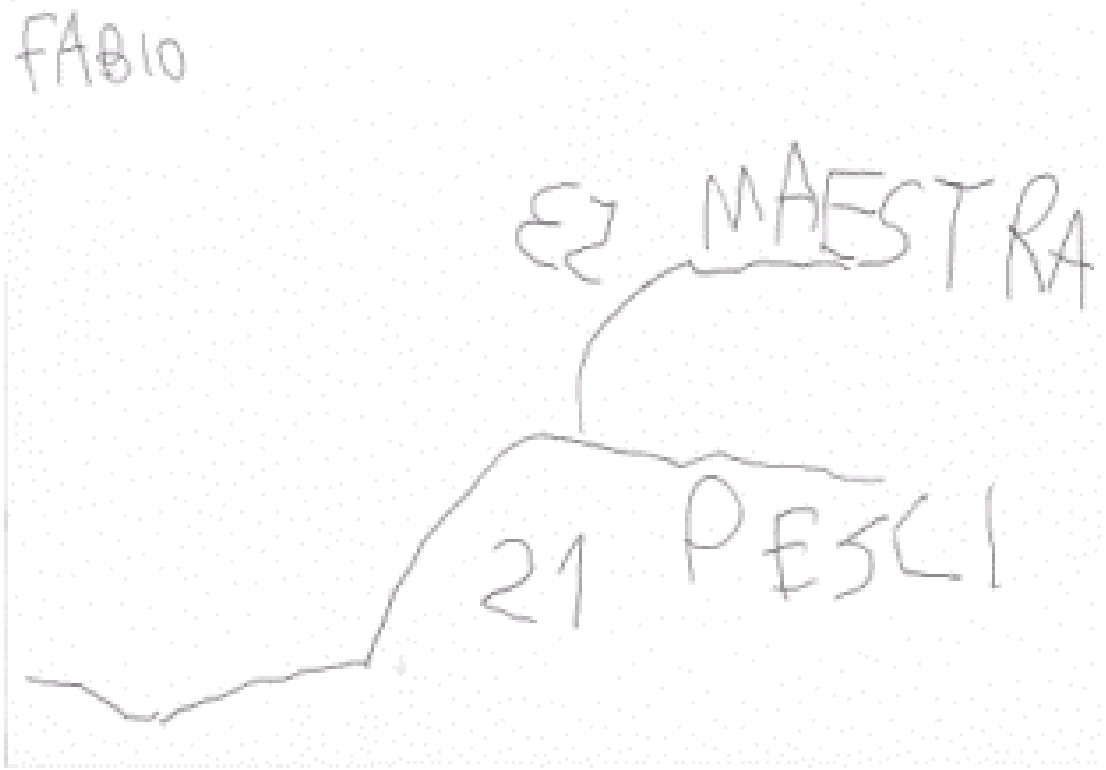
The temperature curve is rigorous

Marta: 3 elem. Fogliano-Redipuglia



*Fabio : **3 years old** ricognize that the following **temperatures are constant and different** :*

- *table*
- *fish bacin*
- *teacher hand*



Researches carried out

Confirm how

-> the operativity (pratical and conceptual) [hands-on & minds-on] produced the involvment of the learners with the interpretative problem, Activate resources and cognitive skills, that help to separate the descriptive and interpretative plans

-> the integration of classroom work with activities in others context and with different students' groups

- **Motivate to the exploration**
- **Stimulale the planning skills - projectuality**
- **Activate the attention for the comparison between hypotesis and data**

BASIC PROBLEMS in content research
Common sense ideas and reasoning

- From previous researches emerge the need to:
  - Identify **strategic angles** and **critical details** (Viennot, 1994)
  - Study **spontaneous dynamical paths of reasoning** looking to a cluster of answers describing **way of thinking** (Michelini 2010).
  - Find new approaches to physics (Viennot, 1994; 2003; McDermott, 1993-2006; Michelini 2010).

In our intervention modules

Intellectual challanges and **experimental activities**

are offered to study:

- **Student reasonings paths and**
- **conceptual referents in students' knowledge foundation**
- **The connection between**

Everyday experience ⟺ Scientific learning

We stop here:
- to play with materials available
- to discuss how to implement in MoocLab

strategies, methods and examples for CLOE Labs

THANK YOU FOR ATTENTION

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