The many sides of the moon.
Conception-to-scientific model evolution in teachers and children

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Child’s thought is based on CONCEPTIONS, explicative models abandoned by adults when recognized as incomplete, not structured or incoherent (Coquidé-Cantor & Giordan 2002, Roletto 1998).

As a matter of fact, adults select and USE MODELS, conceptions more organized, structured and stable than children’s (Hestenes 2006).
..., children and adults, ...

Looking for models they already know, adults often don’t recognize conceptions as continuous, individual, domain-specific learning processes of the children towards THEIR models (Karmiloff-Smith 1998, De Vecchi 1999).

Neglecting both their own and children’s conceptions, adults “modelize” children too…

... , children and teachers!

As adults, TEACHERS too have two consequent problems:

1) **if they drive pupils to forget their initial conceptions** about a topic, these remain latent and emerge later (Giordan, 2002);
2) **if they neglect their own conceptions**, they can accidentally transmit them to pupils (De Vecchi (1999).

Usual conceptions in pre-service kindergarten teachers:
• *science is the collection of facts, laws and formalized theories learnt at school*
• *we are too old to do science (that science)*
• *3-5 y/o children are too young to do science*
• *science is magic and fabulous for children, difficult for every/eone*

Our response: “To be close to the child” doesn’t mean at all to forget our own scientific culture, but to be always ready to catch child’s scientific thought, more subtle and powerful than we would often imagine...

• *The boat floats because it has the shape of the water (4 y/o)*
• *Seasons happens because it is the job of the World (4 y/o)*
• *The egg the chick was born, was made by the hen, the egg the chick is not, by the rooster (5 y/o)*
Starting problems for pre-service teachers

Everyone’s knowledge is the result of personal learning processes. A teacher has the privilege/must to recognize them in children.

Are they similar to ours?  
What are their start and final points?  
How can a teacher trigger them?
Our proposal

To let kindergarten pre-service teachers face these problems in science teaching:

**Method:**

1. Teachers choose a scientific theme
2. Collect and analyze children’s conceptions about it
3. Compare them with their own conceptions about it, *analyzed with the same criteria.*

**Objectives:**
- to appreciate children’s learning paths;
- to recognize at the same time adults’ own conceptions;
- to face the surprise/nuisance/fear induced by unsuited scientific knowledge;
- to inquiry into the conceptual knots responsible for the correct comprehension of a scientific model;
- to look for activities to help children discover autonomously cognitive conflicts inside what they believe to know, allowing their conceptions to evolve.
Themes chosen

The Moon’s “shape”  
Is it alive, doesn’t it?

Teachers motivation:
“It is close to the child!”
(why?)

Teachers motivation:
“I’m curious to know what they say!”
(even if me too, I have to think about it...)

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NPSE - Firenze 14-03-2013
Data collection and analysis

Why full or half moon?

- The sunlight
- Why full or half moon?

Who's on it?

- An octopus with tentacles!
- It's a head
- It's a ball

It's a rocket!

- It's a yellow planet

Other ideas

- The moon is stone and white
- Because I see it so
- Because the sun makes it white
- A side is white, a side is black

Color

- Grey
- Yellow

Features

- Black holes
- Black as the night
- At night
- Not always: it gets more and more little until it disappears

- It has a magic pulver inside, it makes it be up at night
- It changes its shape, its dimensions

Shapes

- Full
- "Broken"
- "Half full"

Because it fail and broke its head

It's not broken: it has two colors

When do you see it?

- At night: in the sky
- When we sleep
- In the morning: it goes away
- On the other side of the world, in Africa: where they still sleep
- During the day: it's visible with the sun
- During the day: it's awake

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NPSE - Firenze 14-03-2013
The Moon's "shape": children (12, 3-5 y/o)
Briefly

**CONCRETE MODELS** (fat, full, thin, real... Moon) for the wax/wane process:

1. wax/wane period: one night only;
2. distinct, fantastic modules (waxe: filled, made of...; wane: broken, eaten...);
3. one (geometric) process: a distant point grows drawing up, a circle breaks;
4. one “light” process: the Moon brings the night, it should do light, as a star or the Sun (it’s the Sun transformed or there’s the Sun inside);
5. the “dark side” is the shaded region, not the “back” (the Moon doesn’t spin).

**Overall MODEL**: analogy Sun/day/light as Moon/night/dark

- same circular shapes;
- same cyclic movements (same house under the mountains, but never meet);
- same “light” behavior.

*No Earth or light/shadow behavior considered* (only one child: Moon changes Sun).

These 3-6 y/o children are good 1500 scientist: they could discover the light/shadow behavior, hypothesize the Sun/Moon movements *respect to the Earth*, hypothesize the relative Moon’s lighting conditions.
This map could be obtained selecting/reorganizing children’s one within a Copernican frame. Teachers encouraged by a perceptive model (no mathematic is needed) close to the children. No problems to accept uncertainty (does the Earth’s inclination influence the phases? We see always the same face: doesn’t it spin?).
Starting problems for pre-service teachers

Moon’s “shape”

Children/Teachers: different learning processes, initial/final points

- C: SEVERAL unstable conceptions; T: ONE stable model;
- selection of mental images, concepts, relationships, variables, parameters, languages;
- from analogic to logic reasoning (I see the Moon as a Sun/ I see that the Moon is not the Sun).
“Alive or not”: 24 teachers (20-30 y/o), 12 children (3-5 y/o)
CONCRETE MODELS of a living system:

1) alive: (f) eats, drinks, moves, talks, breathes and grows; (s) stands, has human features (eyes, mouth); (r) is born and breeds;

2) not alive: doesn’t eat, drink, move, talk, grow, has human features (symmetry);

3) not alive things become alive by perceptive analogies about nutrition, movements, sound, space (cars drinks and moves, objects make noise as animals cries, a bicycle stands as us);

4) distinct temporal/dimensional growth, matched in cycles (plant/animal life);

5) cycles identification/extension by analogy is linked to time perception. The contrast between periodical models of life (cyclic time) and the irreversibility of death (linear time), makes children stumble on a dilemma: something alive can die, but something which dies cannot live (i.e. come back in a cycle).

6) third alternative: alive is strong, big, hard to die: stones and whales they stay always.

Overall conception: alive is born, grows, breeds (rare) and die (at least one time…). Life perception is linked to time modelling.
There’s something more!

Materials used to collect conceptions
Children recognize the *representation* of life: something “not alive”, as a puppet, *could be made* talking or moving, it *could be alive*, but it *seems alive*, it is a fake.

Children *model reality*. In front of a puppet representing an animal or a child, children can change their representation of “alive”, moving from concrete to abstract.

1) “life” becomes “existence”: the child answers taking into account her/his experience: *it is true, I have a dog at home*;

2) a symbol identifying a class can be then recognized: *this is not a dog, it is a puppet, (but) the dog is alive*. The puppet-dog is a symbol: it exists as a model of a dog, and a model of a dog is not alive, as a real dog is...
The challenge…

Teachers: “alive is what was born, grows, breeds and dies”. It needs food, air, light and water. A plant is as a man.

This model is not enough for teacher’s work:

• children know it already, even if in an incomplete/unstable form;
• “alive”: it organizes itself, has a metabolism, reproduces, evolves (Boncinelli 2001);
• teachers didn’t talk about organization and evolution;
• children didn’t talk about organization too: BUT they reflect still about what growth means;
• children didn’t talk about evolution too: BUT they still ask themselves what a life-cycle is;
• children didn’t talk about metabolism: BUT they focus always on what enter in and goes out from their bodies.

Teachers should reinforce and extend their model, without “freezing” children’s ideas.

A BIG CHALLENGE FOR ALL
Starting problems for pre-service teachers

Children/Teachers: quite similar learning processes, initial=final points:

- C: SEVERAL unstable conceptions; T: ONLY ONE model;
- Quite similar mental images, concepts, relationships, variables, parameters, languages;
- Analogic reasoning (I see the mas as a plant).
Conclusion

We showed two comparisons between children’s and kindergarten pre-service teachers’ conceptions about scientific topics:

- Moon’s “shape”: teachers’ ideas were “ahead” with respect to children’s: a perceptive, non-formal model made they feel secure and able to teach children, recognizing their thought development directions;

- “alive” or not: children’s and teachers’ conceptions were quite similar, because of the complexity of the theme. These results allowed a deep reflection about children’s conceptions evolution vs. “official” models transmission in science teaching.

This comparison made teachers aware to extend their scientific knowledge to be always ready to trigger and receive children’s representations, helping them to reorganize them together.
This year, in Tessin...

There are no rivers, without MOUNTAINS.
(The Nile...???)
Bibliography