

THE MANY SIDES OF THE MOON

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Abstract

Many pre-service kindergarten teachers think that 3-5 y/o children are too young to do science (seen as the collection of facts, laws and formalized theories learnt during their high school), so as they are too old to do the same. Given that “to be close to the child” doesn’t mean at all to forget our own scientific culture, but to be always ready to catch his/her scientific thought (more subtle and powerful than we would often imagine), a useful exercise for pre-service teachers is to let them collect, analyze and study children’s conceptions about a scientific theme, while they do the same with their own conceptions on the same theme. The comparison of the two sides of the coin let teachers recognize that they and their pupils are on the same road “toward science”, but only them could “come back” along it, wherever they are, to help children to “move forward” it together. We show two examples in which the representational reorganization between young teachers and their pupils is relevant.

1. Children’s thought, scientific knowledge and kindergarten teachers training

1.1 Children’s and in-training teachers’ conceptions of scientific topics

As stressed from Piaget on, the child’s thought is based on explicative models, usually named *conceptions*, abandoned by adults because incomplete, not structured or incoherent [1-6]. Adults often find conceptions hardly comprehensible, even if they too correlate informations coherently but not always pertinently, *building conceptions only more organized than children’s* [2-5]. Furthermore, considering only age-based, general development levels, adults don’t recognize continuous, individual, domain-specific learning processes [7], neglecting both their own and children’s conceptions [5,6]. As adults, teachers have two consequent problems: 1) if they drive pupils to forget their initial conceptions about the topic of study, these remain latent and emerge later [1-3]; 2) if they neglect their own conceptions, they can accidentally transmit them to pupils [5]. To let kindergarten teachers face these problems in science teaching, in training courses we make them collect and analyze children’s conceptions about a theme, comparing them with their own conceptions about the same theme, *analyzed with the same criteria*. This practice allows teachers to appreciate children’s learning paths, recognizing at the same time *their own* conceptions, facing the surprise/nuisance/fear induced by *their own* unsuited scientific knowledge. Inquiring into the conceptual knots responsible for the correct comprehension of a science model, teachers look therefore for “problem-activities” useful to help children to discover autonomously cognitive conflicts inside what they believe to know, allowing their conceptions to evolve [6].

2. Two examples: the “shape” of the Moon and the “problem of life”

2.1 Arguments and methods

To compare children’s and teachers’ conceptions, teachers have chosen two scientific themes: why the Moon “changes its shape”, and what is “alive” or not. The first one has been immediately considered *close to the child*, while a discussion about the second one highlighted teachers’ worries about science: to collect conceptions about both themes (from different children) they parted in two groups, but following a same conception of science, they would like to confirm: *science is magic and fabulous for children, difficult for every/one*. Teachers have been helped choosing strategies and materials to collect and analyze conceptions, stressing mistakes to strengthen their capacity to distinguish child’s

spontaneous though from ideas suggested by materials or questions used. In Fig. 1 the images used by a teacher as stimulus to collect conceptions about the Moon, via an open discussion with children, are shown together with a collective map to analyze the recorded debate [8]. In the map are evident both suggestions from materials (different Moon's colors or dimensions), and real spontaneous children thoughts ("broken" Moon, Sunlight, implicit relationship between night and Moon's motions respect to a probably fixed Earth).

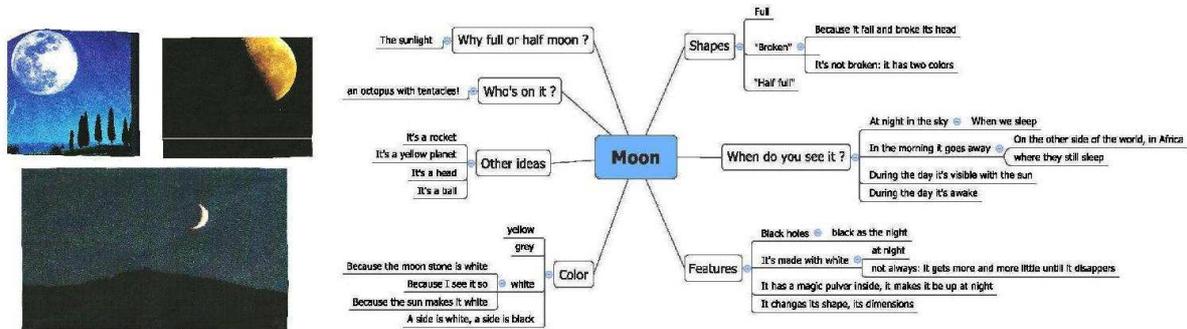


Fig. 1. Images and map to collect and analyze five 4-5 y/o children's ideas about the Moon's "shape".

Materials to collect conceptions about what is alive were more concrete (dolls, plants, objects), but in the maps suggestions and spontaneous thoughts appear still mixed: too many materials could reduce individual interviews to a list of "yes/no", while the use of puppets revealed a conscious distinction between existence, representation and live.

2.2 Children's and teachers' conceptions about "Moon's shape" and "life"

The "shape" of the Moon. In Fig. 2 the conceptions of twelve 3-6 y/o children on this theme are mapped. Many wonderful poeries have been resumed to allow analysis, but the deepest have been and will be left in *italic*. Children identify and name concretely (fat, full, thin, real...) several "Moon's shapes", motivating the wax/wane process with: 1) *fantastic modules*: the full Moon is filled with water and then breaks in half, or is made of cheese and is eaten by mice; 2) more rarely, *one process*, usually geometric: a distant point grows drawing up, or a circle breaks. There's a quite complete agreement about the wax/wane period (it happens in a night) and a quite complete confusion about the "dark side": for children it is the shaded region of Moon's face, concept correlated with their ideas about the Moon's visibility and "brightness". Coupling immediately the Moon with the night (*it brings the night*), children conclude that to be visible the Moon *should do* light, as a star or the Sun (*it's the Sun transformed or there's the Sun inside*). As a matter of fact, *the overall conception present in all children, coherent with tales and perception, is indeed the analogy Sun/day/light as Moon/night/dark*. Children focus their attention on the Sun/Moon circular shapes, their cyclic movements (usually they live in the same house under the mountains, but never meet), their "light" behavior, *neglecting the presence of Earth* (one child) *and the light/shadow behavior* (one child: *Moon changes Sun*). Briefly, these 3-6 y/o children should discover the light/shadow behavior, hypothesize the Sun/Moon movements *respect to the Earth*, hypothesize the relative Moon's lighting conditions.

In Fig. 3 a map analyzing the conceptions of twelve 18-30 y/o pre-service teachers is shown. Its structure is such as it could be *obtained from Fig.2 selecting and reorganizing children's conceptions within a Copernican frame* [7]. This result encouraged teachers because confirmed their perceptive model (no mathematic is needed) and the idea that the argument (not the model) was close to children. As they didn't find problems to express conceptions about the theme, they accepted easily their uncertainty too (does the Earth's inclination influence the phases? We see always the same face of the Moon: doesn't it spin?).

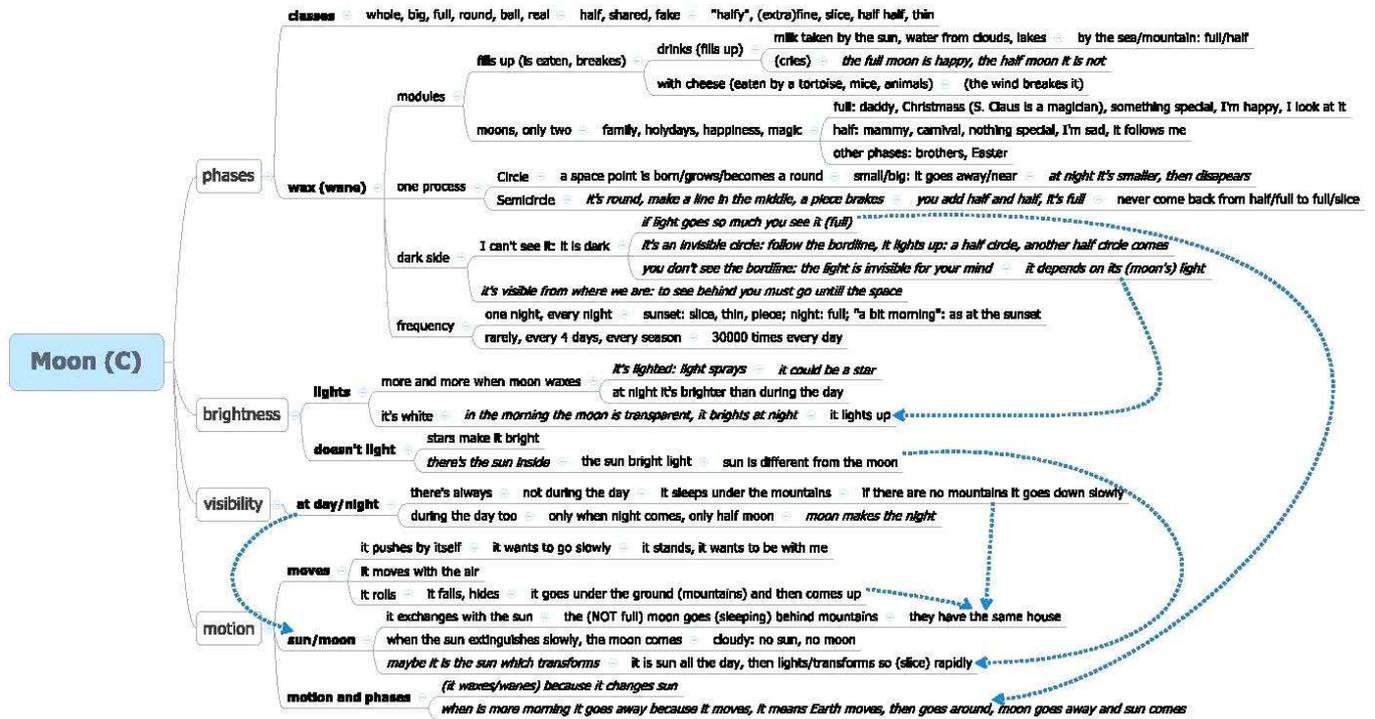


Fig. 2. Children's conceptions about the "shape" of the Moon: synthesis from 12 children, 3-6 y/o.

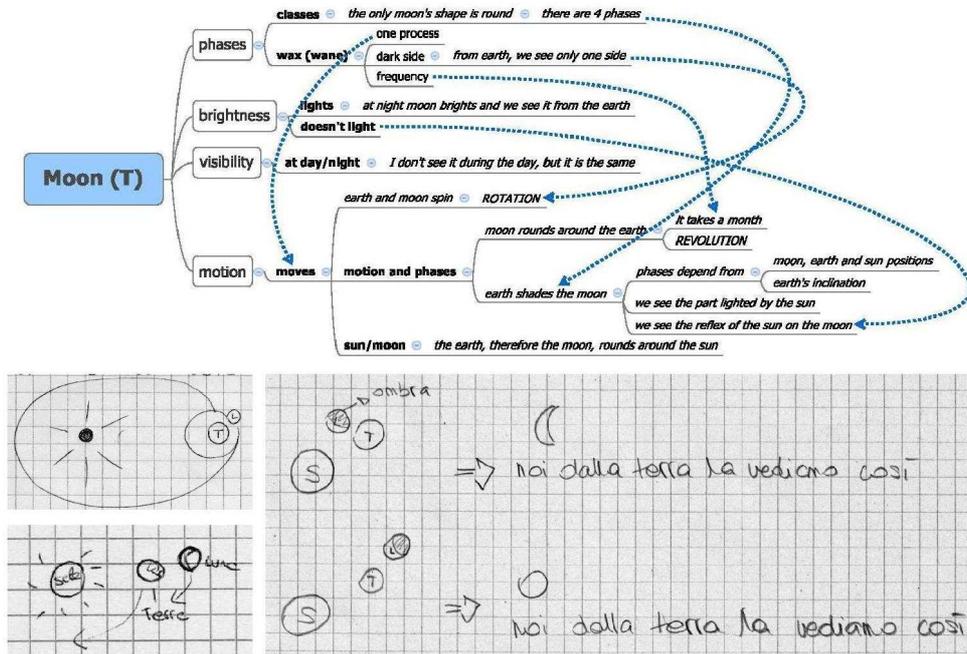


Fig. 3. Synthesis of 24 pre-service teachers' ideas, and some drawing, about the "Moon's shape".

The "problem of life". In Fig. 4 the conceptions of twelve 3-6 y/o children about what is "alive" are analyzed. Briefly: 1) alive/not alive are quite symmetrical: brackets indicate "not alive". Following approximately answers' frequencies, "alive" is what eats, drinks, moves, talks, breathes and grows; less frequently it stands, and has human features (eyes, mouth); rarely, it is born and breeds. "Not alive" is principally what doesn't eat, drink, move, talk, grow, has human features. 2) A lot of "not alive" things became alive by perceptive analogies about nutrition, movements, sound, space: cars drinks and moves, objects make noise as

animals cries, a bicycle *stands* as us. 3) Children distinguish temporal from dimensional growth, matching them in cycles (plant, animal life). 4) Cycle identification or extension by analogy has huge implications [9]: linked to the evolution of children's time perception, it seems to help in the representational redescription [7] of the whole world, not only of individual systems (*the world, it is sufficient a seed grows, then humans too can live*). 5) 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. cannot comes back in a cycle). A third alternative seems therefore constructed: stones, whales, are *too strong, big, hard* to die: *they stay always*.

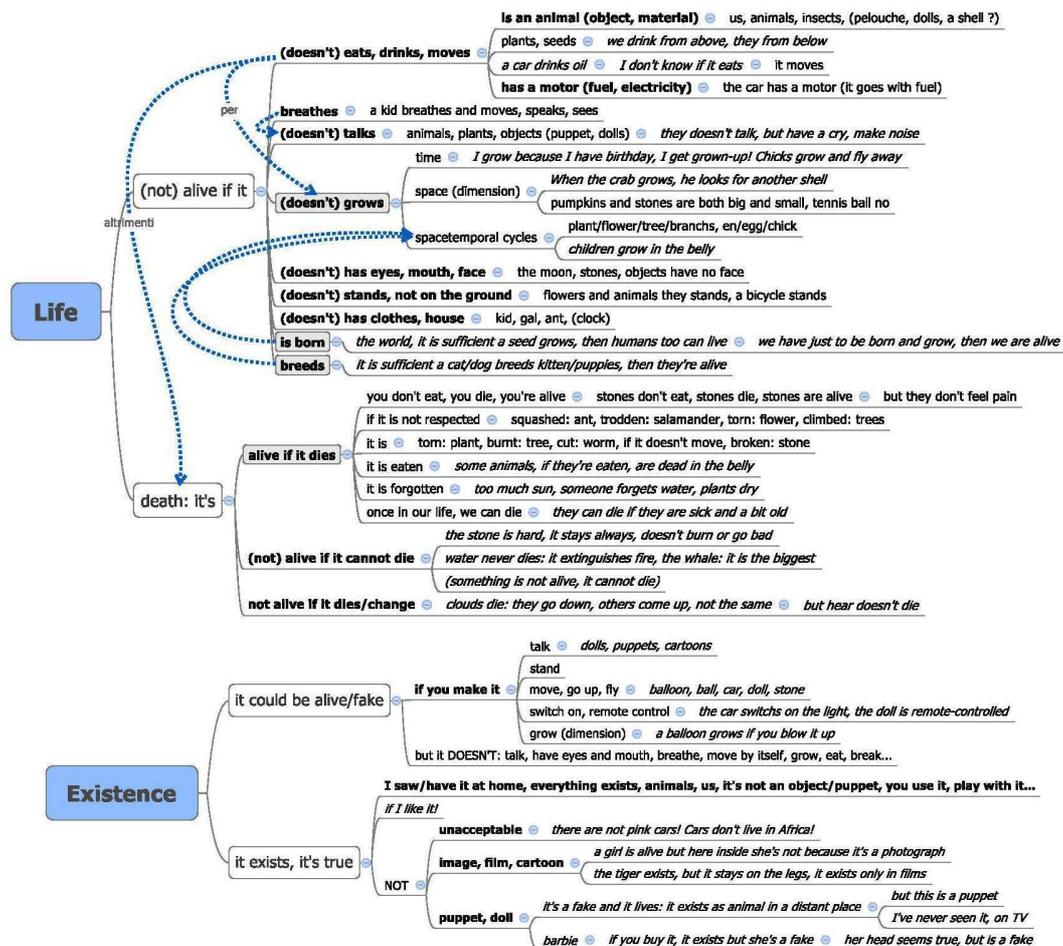


Fig. 4. Children's (and teachers'...) conceptions about what is "alive" and what is not

Finally, children recognize the problem of 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. This conception, stimulated by the materials used by the teachers, could be linked to a child's experience in a "magic" technological world: the car, out of child's control, is alive, while a puppet, remote-controlled by her/him, it is not. This crucial point introduce children to *reality modeling*. In front of a puppet representing an animal or a child, children need to change their representation of "alive", moving from concrete to abstract. Excluded *taste choices* (*there are no pink cars!*) two levels appears: 1) at first the "life" problem becomes an "existence" one: the question changes, and the child answers taking into account her/his experience: *it is true, I have a dog at home*; 2) subsequently, a symbol identifying a class can be 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.

Teacher's conceptions about "alive or not" evidence *the* problem in teacher training. In Fig. 5 some representative teachers' conceptions are shown: "alive is what was born, grows, breeds and dies". It needs food, air, light and water. A plant is as a man.

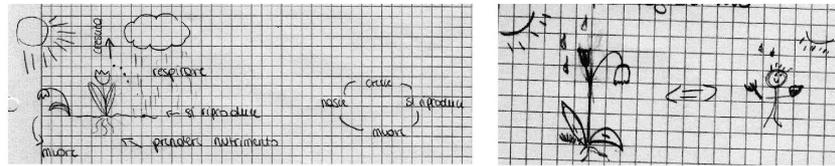


Fig. 5. Some teacher's conceptions about what is "alive": representative examples.

This model doesn't seem to be of much use for teacher's work: *children know it already* (it's reported in Fig. 4, grey rectangles), *even if in an unstable form, so that if teachers don't extend their own model, they could transmit it "freezing" children's ideas*. Following [10], a system is "alive" if it organizes itself, has a metabolism, reproduces and evolves. While teachers didn't talk about organization and evolution, children reflect *still* about what *growth* means, *still* ask themselves what a life-cycle is, and focus *always* their attention on what enter in and goes out from their bodies. Of course, they don't talk, respectively, about organization or entropy, individual/species evolution and metabolism. But their teachers should do. Obviously, this result didn't encourage teachers at all: initially they were worried and astonished. Nevertheless, the comparison with the previous, favorite case (Moon's shape), made them reflect on the difference between knowledge transmission and to be ready to trigger and receive the representations of children, helping them to reorganize them together.

2. Conclusions

In this work we discussed two comparisons between children's and teachers' conceptions about a scientific topic, done during kindergarten teachers pre-service training. In the first case (Moon's "shape"), teachers' ideas were "ahead" with respect to children's: a perceptive and non-formal model made they feel secure and able to *teach* children, recognizing their thought development directions; in the second one (what is "alive" and what is 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.

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