

The role of materiality in the teaching-learning of mathematics between 4 and 6 years

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Epistemological framework

This research fits into a double epistemological framework:

- The didactics of mathematics** (Dias, 2017): the teaching-learning of mathematics consists of several fields such as numeration, geometry, measures, problem solving in each of these fields.
- The Vygotskian socio-historical and semiotic perspective on development** (Vygotsky, 1934/1997) and its extension, the Pragmatics of the Object (Moro & Rodríguez, 2005) which highlights the importance of the object and its use and associated semiotic mediation deployed by the adult for the baby's psychological development.

Aim of research

When they build their mathematical skills, pupils have the semiotic means relating to the knowledge of the objects and their uses at their disposal, as well as gestures and their meanings (Moro & Rodríguez, 2005), which overall characterizes **materiality**.

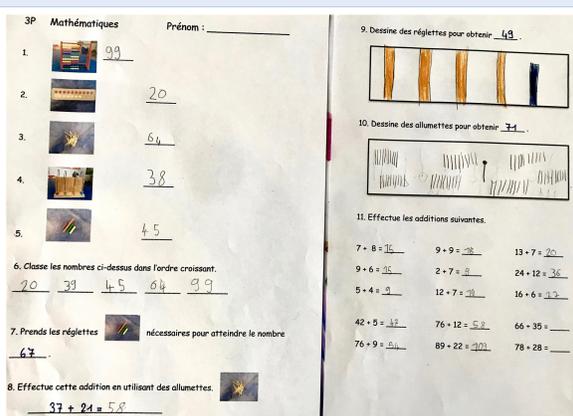
This research reveals that the first skills related to materiality (space, objects and the corporeality) are **a resource for the teaching and learning mathematics** as well as **an indication of the psychological development of the pupil**.

Methodology

- A longitudinal case study:** 2 years, 4-5 and 5-6 year old pupils
 - 8 class sessions (4/year) recorded on video
 - 1 self confrontation interview of the teacher
- Double macro/micro genetic analysis** using appropriate tools:
 - synopsis for the sessions
 - photograms for the remarkable events in terms of materiality

5-6 year old pupils 8th class session

Photograph that shows the articulation between objects (rods, abacuses, matches and so on), diagrams, mathematical writing.



The teaching-learning of mathematics for pupils aged 4 to 6 requires **the progressive articulation of symbolic systems** that goes from **oral materiality** (space, objects, corporeality, oral language) to **written materiality**: the mathematical writing.

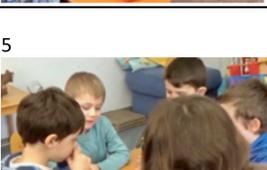
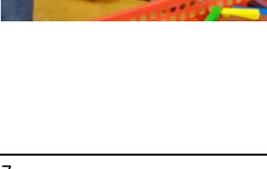
Conclusion: first results

- The oral materiality (space, objects, corporeality, oral language) allows pupils to progressively access to abstraction.
- Sensory perception is fundamental.
- Pupils are confronted with several symbolic systems before accessing mathematical symbolic writing.
- Forms of the materiality change depending
 - on which field of mathematics is concerned,
 - on how the pupils' learning achievements are progressing.

References :

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 Moro, C., & Rodríguez, C. (2005). *L'objet et la construction de son usage chez le bébé*. Berne : Peter Lang.
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| PHOTOGRAM – 4-5 year old pupils – 3 rd class session THE RATIO BETWEEN THE NUMBER 7 AND THE NUMBER 1 | | | |
|--|--|---|---|
| Spatial and material organization | | | |
| The pupils and the teacher are grouped around the table with a collective material. | | A basket of Cuisenaire rods |  |
| Images | Speech | Action | Semiotic analysis |
|  | T: here we said we had how much QU you remember ↑ QU: er | T takes the black rod whose value is 7 units (7 beige rods) and shows it to the whole group for several seconds. | Ostension to show the black rod to talk about in order to focus pupils' attention on this rod |
|  | T: you do not remember here how much ↑ // can it help you to look at other rods ↑ or not QU: er | T puts the black rod on the table. | Moving the black rod and the basket of rods invites the pupil to handle. |
|  | T: so look if you want to watch with other rods that's how much QU: er | T pushes the basket of Cuisenaire rods and the black rod towards QU. QU waits. | These gestures maintain the didactic reticence. |
|  | T: do you know how much that makes ↑ QU: one | T takes a unit cube (a beige rod whose value is 1 unit) in the basket and shows it to QU. | Ostension to show the beige rod to talk about in order to focus pupils' attention on this rod |
|  | T: then you put it here next | T puts the beige rod against the black rod. | This gesture initiates the handling to be done: putting the beige rod against the black one allows to compare visually their values. |
|  | T: how much will you be able to put ↑ ///// continue / you can ask if you want | QU looks at T and does not answer. Then he takes 4 beige rods in the basket and puts them along the black rod. He takes again several beige rods in the basket. He aligns the 7 beige rods against the black rod. | Material realization, organization of objects in space and visual mode to understand the ratio: - between the black rod and the beige rod - between the number 7 and the number 1 |
|  | T: very well then how many cubes are there ↑ | YA makes pointings on the beige rods (but his hand remains at a distance from the rods) and simultaneously counts in his head | Articulation of several semiotic tools to enumerate and count the beige rods: - the object rod - the dynamic pointings - the oral word number |
|  | T: you can count them / you can count the small cubes QU: one two three four five six seven | QU makes pointings on the beige rods (but his hand remains at a short distance from the rods). He simultaneously counts aloud. | Articulation of several semiotic tools to enumerate and count the beige rods: - the object rod - the oral word number - the dynamic pointings |
|  | T: seven / so that's how much ↑ QU: seven T: the black rod is worth seven | T makes a pointing on the black rod. | Pointing to focus pupils' attention on this rod |