The promises and problems of a semiotic approach to mathematics, the history of mathematics and mathematics education
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The Semiotic Bundle: a tool for a broader analysis of teaching and learning processes

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Plan METTIAMO?

1. The problem of genesis of signs
2. A “broad” semiotic approach: the Semiotic Bundle
Overview

1. The problem of genesis of signs
2. A broad semiotic approach: the Semiotic Bundle
3. ...
Our research problem: the genesis of signs
What happens in classroom?

a variety of **resources** activated by students and teacher to do mathematics:

- words (orally or in written form);
- extra-linguistic modes of expression (gestures, gazes, ...);
- different types of inscriptions (sketches, graphs, formulas ...);
- different instruments (from the straightedge to the most sophisticated ICT devices);...
a variety of resources activated by students and teacher to do mathematics:

- words (orally or in written form);
- extra-linguistic modes of expression (gestures, glances, ...);
- different types of inscriptions (drawings, sketches, graphs, symbols, ...);
- different instruments (from the pencil to the most sophisticated ICT devices)
HYP: All such resources intervene in the teaching-learning process in a *multimodal* way.

The hypothesis and the term stem from recent studies in Neuroscience, suggesting that the sensory-motor system of the brain is multimodal rather than modular, that is

"the modalities of action and perception are integrated at the level of the sensory-motor system and not via higher association areas“

(Gallese & Lakoff, 2005, p. 459)
HYP:
All such resources intervene in the teaching-learning process in a *multimodal* way.

Transposed in educational context, the paradigm of “multimodality” sees learning as requiring the essential activation of different cognitive-semiotics components, involving the *wholeness* of the subject in a very profound way.

In particular, perceptuo-motor and embodied activities—bodily actions, gestures, manipulation of materials or artefacts, acts of drawing, rhythms—come to play a role, even with respect to what is called “abstract reasoning” and has such a great part in mathematics.
HYP:
Signs, which mediate the relation between our thinking and the world, are culturally created and socially embedded.

Furthermore, learning in school setting entails an intrinsic social component, that we have to take into account.
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The semiotic lens is particularly suitable to focus the multimodal aspects of mathematics learning, and allows us to consider both its cognitive and didactic dimensions.
But to accomplish a semiotic analysis in a multimodal perspective, a broader notion of semiotic system is necessary.

In fact the classical semiotic approaches, placing strong limitations upon the structure of the semiotic systems they consider, may result too narrow for interpreting the complexity of didactical phenomena in the classroom.
We need a system that encompasses also the “open” sets of “signs” (e.g. sketches, drawings, gestures), which are:

- holistic
- idiosyncratic
- ...
We need a semiotic lens, which can give account of all the varieties of semiotic processes that happen in the classroom.

A new theoretical structure that enlarges the classical notion of semiotic system, to include also more embodied resources, and the use of artefacts:

*the Semiotic Bundle*
The Semiotic Bundle

(i) a collection of *semiotic sets*;

(ii) a set of *relationships* between the sets of the bundle.
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(ii) a set of *relationships* between the sets of the bundle.

- semiotic systems (e.g. algebraic symbols);
- gestures and idiosyncratic modes of expression;
- the use of artefacts.
The Semiotic Bundle

E.g.: the speech-gesture enactment.
It has deeply studied in Psychology, and a deep unity between them has been generally advocated (see the studies by McNeill’s and Goldin-Meadow’s groups).

A semiotic bundle is to be intended not as a juxtaposition of semiotic sets, rather as a unitary system, whose components are distinguished for sake of analysis.
(A consonant perspective: Goodwin in his ethnographic-linguistic studies on situated human interactions).
The Semiotic Bundle

Our research problem can thus be formulated in the following terms:

What are the relationships within the Semiotic Bundle, and how does it evolve, in the context of the genesis of signs in students?

Let us enter into it through some examples.
Manca parte 2
The semiotic game of the teacher
Conclusions
conclusions
Learning can be seen as students’ personal appropriation of the signs’ meaning, fostered by social interactions, under the coaching of the teacher.

From a functional point of view, gestures and idiosyncratic signs within the Semiotic Bundle (and their relationships with the other signs in the Bundle) can act as “personal signs” (in the sense of Leont’ev), supporting the genesis of signs in the students.
As a consequence, they can be a powerful mediating tool supporting the evolution towards the institutional signs.

However, personal signs may not be able to support the transition to the institutional ones and to the sharing of common treatment rules (culturally and socially established):

the mediation of the teacher becomes hence crucial, and this may take place in the Bundle through a semiotic game.
The teacher’s semiotic game

The semiotic game of the teacher can start from students’ gestures and use the right words to support their transition to the scientific meaning:

it may therefore constitute an important strategy in the process of appropriation of the culturally shared meaning of signs.
The teacher’s semiotic game

On the one hand, it allows the teacher to tune with students’ languages, and conversely it allows students to achieve resonance with the teacher’s languages and, through them, with the institutional knowledge.
In order that such opportunities can be concretely realized, the teacher must be aware of the role that multimodality and semiotic games can play in communicating and in the production of knowledge.

Awareness is necessary for designing the conditions that foster positive learning experiences and for adapting the intervention techniques to the specific didactic activity.
The teacher can use two types of analysis of the semiotic bundle for designing her/his didactic interventions:

- Synchronic analysis
- Diachronic analysis
Diachronic analysis at a small scale lets the teacher see whether there is an evolution in the students’ productions towards the institutional signs and practices.

Synchronic analysis allows the teacher to accomplish her/his semiotic mediation, using the different components active in the Semiotic Bundle.
Considering larger scales, diachronic analysis allows the teacher (and the researcher) to study the evolution of the semiotic resources and practices in the classroom within different Semiotic Bundles. For example, we have used diachronic analysis to analyse students’ actions, productions and communications while facing the multifaceted notion of derivative.
Our findings point out that the teaching-learning of mathematics develops along a border, with interchanges between personal signs (and practices) activated by the students (including gestures) and institutional signs (and practices) introduced into the classroom by the teacher.
The synchronic and diachronic analysis highlight the modalities and rhythms of such back and forth processes within the varieties of Semiotic Bundles that are activated and produced in the classroom.
The promises and problems of a semiotic approach

nuove domande che emergono dal sem game
The promises and problems of a semiotic approach

Legame con Semiotic Mediation di Mariotti