

From the concept of negative numbers to the use of the minus sign: The model of ‘negativity’ or the negatives reviewed in the light of socio-cultural approaches

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Our presentation takes place in the context of mathematics education, and more specifically in the domain of elementary algebra. The starting point of the study that will be presented was to understand seventh and eighth-grade students’ difficulties with the negative numbers revealed by some researches. Why do so many students not solve with success the equations with a negative solution? Why do they commit a lot of errors in reducing polynomials when one negative is present?

In order to answer these questions, it seemed important to us to explore the historico-epistemological origin of the negative numbers. Until now, many researches which addressed negative numbers focused on the idea of concept. They searched in the history of these numbers the explanations of the current students’ difficulties. In this context, the obstacles raised by a negative solution of an equation, for example, were often pointed out in the literature.

If we cannot deny that historico-epistemological arguments about the concept of integer gave some answers to the problems raised by these numbers, we think that it could be useful to consider socio-cultural approaches based on Vygotsky’s principles, to enlarge our understanding of that issue. In Vygotsky’s theory, the primary focus of study is the sign and no more the concept. It implies the idea that signs and meanings co-emerge. If we examine the negative numbers from this point of view, we can say that, on the one hand, the main symbolic characteristic of negative numbers is the presence of the minus sign, and on the other hand, the ways this sign will be used by the learners will be interrelated with the meaning they will attribute to it. These theoretical reflections led to question the origin of the difficulties with negative numbers from the point of view of the use of the minus sign, and no more from that of the concept of integer. Indeed, if we examine the minus sign in an expression like $3 + 6x - 2$, what is this sign used for? Only for forming a negative number? Or also for indicating that 2 has to be subtracted from 3? Or from an algebraic point of view, does it mean that you have to take the opposite of 2? The multiple uses of the minus sign, often implicit in the teaching of algebra, lead the students to make many errors due to confusions in its use.

In order to show the different uses of the minus sign in elementary algebra, we elaborated the model of ‘negativity’, which considers more widely the problems raised by the negatives in focusing the issue on several uses of the minus and no more restrictively on the negative numbers only.

In this presentation, we propose to report the evolution of our theoretical reflections from negative numbers to the model of ‘negativity’. We will illustrate them with examples coming from results of an empirical study.