Published In Helen L. Chick, Jill L. Vincent (Eds.), *Proceedings of the 29th Conference of the International Group for the Psychology of Mathematics Education*, University of Melbourne, Australia, Vol. 1, pp. 143-145.

Why do gestures matter?
Gestures as semiotic means of objectification

Luis Radford
Université Laurentienne
Canada

One of the most intriguing aspects of gestures is that in such varied contexts as face-to-face communication, talking over the phone, and even thinking alone, we all make gestures but we still do not know why. Explanatory models have been proposed by neuro-psychology, information process theories, etc. Our problem here is narrower. We are interested in understanding the role of gestures in the mathematics classroom. However, before going further, we should ask: why do gestures matter? Contemporary forms of knowledge representation are challenging the cognitive primacy with which the written tradition has been endowed since the emergence of printing in the 15th century. The audio and kinesthetic dimensions of oral communication of the pre-print era –dimensions which were replaced by the visual and linear order of the written text– are nowadays viewed with a revived and rejuvenated cognitive interest. Current studies on gestures and perceptual-motor activity belong to this stream.

Now, the way in which each one of us, as mathematics educators, may understand the role of gestures is naturally linked to the theoretical framework underpinning our research. From the semiotic-cultural approach that I have been advocating (Radford, 1998, 2003a), gestures are part of those means that allow the students to objectify knowledge –that is, to become aware of conceptual aspects that, because of their own generality, cannot be fully indicated in the realm of the concrete. In a previous article I have called those means *semiotic means of objectification* (Radford, 2003b). In addition to gestures, they include signs, graphs, formulas, tables, drawings, words, calculators, rules, and so on.

Our answer to the question: "Why do gestures matter?" can then be formulated as follows. Gestures matter because, in learning settings, they fulfill an important function: they are important elements in the students' processes of knowledge objectification. Gestures help the students to make their intentions apparent, to notice abstract mathematical relationships and to become aware of conceptual aspects of mathematical objects.

However, considered in isolation, gestures have –generally speaking– a limited objectifying scope. We have tried again and again the following experiment: we have turned off the volume of many of the hundreds of hours of our video-taped lessons and, even though we *see* the students making gestures and carrying out actions, our understanding of the interaction is very limited. The same can be said of other semiotic systems. Thus, we have also turned off the image and, even though we *hear* the discussion, our understanding of the interaction is again very restricted. We have also stopped both the sound and the image and limited ourselves to *reading* what the students *wrote*, and the result has been as poor as in the previous cases. The reason behind the poor understanding of the students' interaction that results from isolating one or more semiotic systems present in learning is that knowledge objectification is a multi-semiotic

mediated activity. It unfolds in a dialectical interplay of diverse semiotic systems. Each semiotic system has a range of possibilities and limitations to express meaning. The conceptuality of mathematical objects cannot be reduced to one of them, not at least in the course of learning, for mathematical meaning is forged out of the interplay of various semiotic systems.

Semiotic Nodes

The theoretical construct of *semiotic node* (Radford *et al*. 2003) is an attempt to theorize the interplay of semiotic systems in knowledge objectification. A *semiotic node* is a piece of the students' semiotic activity where action and diverse signs (e.g. gesture, word, formula) work together to achieve knowledge objectification. Since knowledge objectification is a process of becoming aware of certain conceptual states of affairs, semiotic nodes are associated with the progressive course of becoming conscious of something. They are associated with layers of objectification.

Let us illustrate these ideas through a story-problem given to a Grade 10 class. In the story-problem two children, Mireille and Nicolas, walk in opposite directions, as shown in Figure 1. The students were asked to sketch a graph of the relationship between the elapsed time and the remaining distance between the children.

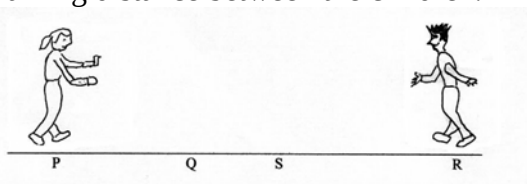

Figure 1. Mireille walks from P to Q. Nicolas walks from R to S.

Supported by the students' previous experience, one of the Grade 10 students, Claudine, proposed a compelling –although incorrect– argument: the graph, she suggested, is something like an "S". Ron did not agree, but could not counter Claudine's argument. He claimed that the graph should be something like a decreasing curve, although the details were still unclear for him. In an attempt to better understand the details, he deployed a series of arguments and gestures that were intended not only for his group-mates but for him as well. Here is an excerpt of the discussion:

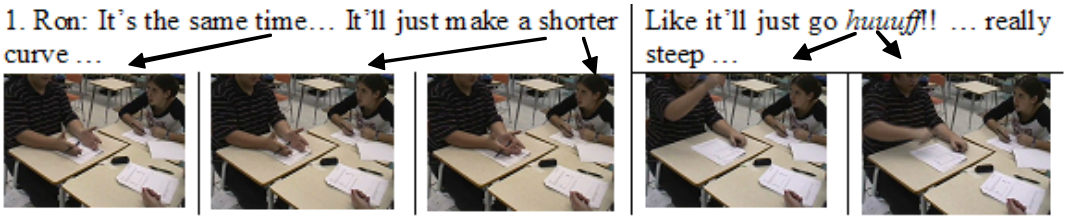

Figure 2. Pictures 1 to 5. Some gestures made by Ron while uttering sentence 1.

To objectify the relationship between distance and time, in the first picture, Ron put his hands one on each one of the students of the story-problem as drawn in the activity sheet. Insofar as the hands stand for something else, they become signs. But in opposition to written signs, which are unavoidably confined to the limits of the paper, hands can move in time and space. Capitalizing on this possibility, to make *apparent* the fact that the distance decreased, Ron moved his hands in opposite directions (pictures 2 and 3). In pictures 4 and 5 he made a vertical gesture sketching the graph time vs. distance, right

after have finished the sentence. Three seconds later, remarking that Claudine was not convinced, he started his explanation again. Uttering the first sentence led him to better understand the mathematical relationship, so in the second attempt he was able to produce a more coherent discourse and to better co-ordinate gesture and word. Here, he reached a clearer layer of knowledge objectification.

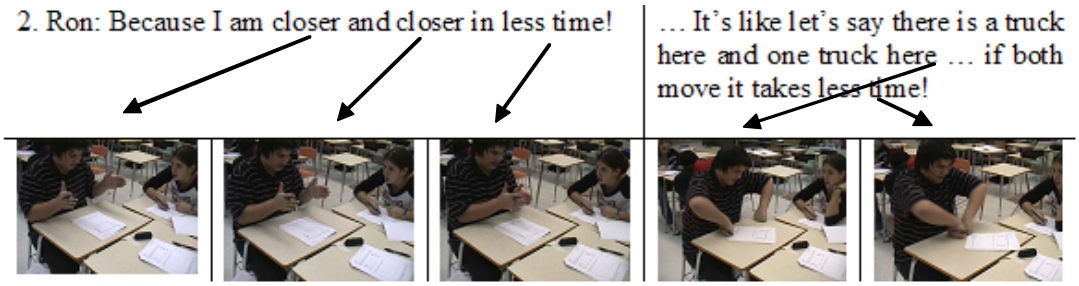

Figure 3. Pictures 6 to 10. Two more arguments intended to objectify the relationship between space and time.

Pictures 6 to 8 show gestures similar to those in Figure 2, except that now they are made in the air and Ron talks in the first person. In pictures 9 and 10 a familiar situation is invoked (the motion of two trucks). There is, however, another more fundamental aspect that has to be stressed. While in sentence 1, time remained essentially implicit (it was mentioned to emphasize the fact that the children started walking at the same time), in sentence 2, time became an explicit object of reference. Time, however, was not indicated through gestures. It was indicated with words. Even if both are semiotic means of objectification, gestures and words dealt with different aspects of the students' mathematical experience.

In each of the previous cases, the different co-ordination of words and gestures constitutes a distinct semiotic node reflecting different layers of knowledge objectification. One of the research problems that my collaborators and I are currently investigating is related to the theoretical and practical characterization of layers of knowledge objectification. As we saw, gestures play an important role therein. But this role, we suggest, can only be understood if gestures are examined in the larger context of the dialectical interplay of the diverse semiotic systems mobilized by teachers and students in the classroom.

Acknowledgment: This paper is a result of a research program funded by the Social Sciences and Humanities Research Council of Canada (SSHRC/CRSH).

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