

THE GSP, AS A TECHNICAL-SYMBOLIC TOOL, MEDIATING BOTH GEOMETRIC CONCEPTUALIZATIONS AND COMMUNICATION

INTRODUCTION

The paper argues the Geometer's Sketchpad (GSP) could be envisaged as a technical-symbolic tool that facilitates the conceptual passage from *drawing* to *figure* (i.e., from the particular to the general) mediating, at the same time, the shared and consensual interaction between teacher and students, the indirect but intentional guidance of the teacher through tasks specially designed for the GSP, and students' conceptualizations of hierarchical inter-relationships between the structural elements of geometric figures to classify them according to certain essential attributes. The argument is extended with the analysis of an interview (from a sequence of interviews) of a pre-service teacher illustrating how and why this tool mediated his geometric thinking.

THE GSP AS A TECHNICAL-SYMBOLIC TOOL

Several researchers (among those Balacheff, 1993; Hoyles, 1996; Laborde, 2003, Mariotti, 2001; Jones, 2001) have argued that dynamic geometric environments are in fact mediational means. For Vygotsky, higher mental processes are generated *in* and *through* social and meaningful mediated activity. For him, the source of mediation is either in *a material tool*, in *a psychological tool*, or in *the behavior of another human being* (Vygotsky, 1986). The concepts of *tool* and *tool mediation* are central to the Vygotskian perspective for the analysis of conceptual development. For Vygotsky, material tools are directed to produce changes in the object(s) on which they are applied and although directed at natural objects they also have a reciprocal influence on the cognitive activity of the individual who uses them. In contrast, psychological tools is a system of symbolic artifacts (e.g., signs, symbols, texts, and graphic-symbolic devices) that helps individuals to master their own natural psychological functions of perception, memory, attention, and so on; that is, psychological tools direct the mind and behavior of the individual (Kozulin, 1998). The GSP, as a graphic device, can be considered as a tool with characteristics of both material and symbolic tools since it mediates the transformation of physical activity (e.g., the construction of drawings on the screen) into conceptualizing activity (e.g., abstracting geometric figures) and subordinating the former to the later.

One of the problems of geometry is that of determining *methods* for drawing instances of geometric figures with certain properties. These methods are called *constructions*. Paper-and-pencil constructions use geometric devices (straightedge and compass) while the GSP and other geometry computer environments use digital compass and some simple implemented constructions to aid in more complex constructions. The product of a construction by either method is called *drawing*. Different kinds of drawings (robust drawings and soft drawings) are widely mentioned in the literature of geometry dynamic environments (Healy, 2000; Laborde, 2001b; Laborde, Kynigos, Hollebrands, & Strässer, 2006): a *robust* drawing is a drawing that passes the dragging test otherwise it is a *soft drawing*. The GSP (through its dragging or animating capabilities) offers the means of constructing dynamic robust drawings and they have the potential of inducing learners to observe their variants and invariants attributes and in the process triggering the conceptualization of a *family* constituted by *all* robust drawings (actual or possible). This family is nothing else than a *geometric figure*. In this conceptualization, each drawing becomes an instance of a geometric figure instead of being confounded with the geometric figure itself. In other words, each robust drawing in the GSP constitutes itself as a perceptual engendering source of a geometric figure in the minds of the learners. It appears, then, that whether in paper-and-pencil or dynamic geometric environments it is important to consider the triad *construction-drawing-figure* differentiating and clustering together geometric elements that are intimately intertwined.

THE GSP AS A MEDIATIONAL TOOL

The GSP as a Tool Mediating the Passage from Construction to Drawing to Figure

Vygotsky points out that his principle from “action to thought” should be applied not only to the development of intelligence but also to the functioning of intelligence (Wertsch, 1985). This principle implies a considerable difference between learning *how to operate* with concepts and *becoming aware of* the structure of those concepts and their relations with other concepts or what Vygotsky (1986) calls the degree of generality of a concept. These notions of “how to operate with” and “becoming aware of” seem to be essential in any geometric environment whether static or dynamic. Arzac (1989) and Laborde (1993) brought to our attention the differentiation between *drawing* and *figure*. *Drawing* refers to material objects on sand, paper, or computer screens; in contrast, *figure* refers to a geometric theoretical object. Such a differentiation was first pointed out by Plato in Book VI of *The Republic*. He clearly says that geometers use material objects or drawings while in their minds they see only conceptual, immaterial objects.

I suppose you know that students of geometry, arithmetic, and so forth begin by taking for granted odd, and even, and the figures, and the usual figures, and the three kinds of angles, and things akin to these, in every branch of studies; they take them as granted and make them assumptions or postulates, and they think it unnecessary to give any further account of them to