

COMBINING DYNAMIC MANIPULATION WITH FORMALISATION: MEANINGS CREATED AROUND THE CONCEPT OF CURVATURE

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Meaning-making processes based on the use of dynamic exploratory mathematical software in the classroom is attracting prolonged research interest (Noss & Hoyles, 1997). It is suggested that the enrichment of representation, functionality and feedback achieved with computer based learning environments could enable more focus on the ways by which medium resources within specially designed activities support the emergence of mathematical meanings. We report research aiming to explore how children construct meanings around the concept of curvature while working with software which combines symbolic notation (through a programming language) to construct geometrical figures with dynamic manipulation of variable values. "Turtleworld" enables constructions with variable Logo procedures and dynamic manipulation of these constructions using the "variation tool" (Kynigos et. al. 1997) to sequentially and continually change variable values. The students were engaged in trying to construct the arcs of bridges of different sizes and shapes. We investigated emerging meanings about the notions of curvature, arcs and angles and how these were constructed with the use of the variation tool. The analysis of pupil's interactions suggests that vivid interplay between symbolic and graphical representation was an integral part of the process by which they expressed "theorems" (Vergnaud, 1987) on length of arc, length of corresponding chord and the tilt of the arc as they were trying to create horizontal bridge arcs. Unexpected levels of abstraction emerged within these situations (Noss and Hoyles, 1996) and formalisation in quasi-algebraic terms became a means of thinking about and expressing relationships in a notational form. The dynamic manipulation and continuity effect of the variation tool facilitated pupil's spontaneous conceptions of arcs as well as their hypotheses drawn from pencil and paper calculations. Further research is suggested on the entanglement of symbolic expression in mathematical activity with dynamic manipulation software.

Noss, R. & Hoyles, C. (1996) *Windows on Mathematical Meanings*, Kluwer Academic Publishers, Dordrecht/Boston/London.

Noss, R. & Hoyles, C. (1997) The construction of mathematical meanings: Connecting the visual with the symbolic, *Educational Studies in Mathematics*, 33, 203-233.

Kynigos, C., Koutlis, M. & Hadzilacos, T. (1997) Mathematics with component oriented exploratory software, *International Journal of Computers for Mathematical Learning* 2: 229-250.

Vergnaud, G. (1987) About Constructivism, *Eleventh International Conference for the Psychology of Mathematics Education*, Dordrecht (pp. 43-54), Montreal.