Qualitative Analysis of Children’s Learning of Programming in the Context of a Developing Culture of Open-Ended Project Work in a Primary School

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Abstract: Within the framework of the computer perceived as a medium for pupils to express and explore "theorems in action" (Vergnaud 1982), this chapter discusses how programming activity may encourage such a use of computer technology in the classroom. Our argumentation draws from longitudinal research experience set in the context of a Greek primary school where pupils' small-group project-work involving programming in Logo is being used by all the schools' teachers as a means to try out alternative and developing pedagogy. Here we qualitatively analyse an episode from the work of a group of 11 year-olds, highlighting their use of programming to plan and structure the solution to a problem, to express mathematical ideas which they found useful for its solution and to inductively form abstractions derived directly from concrete parts of their construction. We then discuss some emerging interrelated educational and technological aspects concerning this kind of learning environment, stressing its importance for qualitative development in the educational process, especially within centralised educational systems such as the one within which this project is taking place.

Keywords: Flexible learners, programming, expressing ideas, localized abstractions, inductive generalizations, qualitative analysis.

1 Introduction

In this chapter we argue for the value of learning environments where programming activity is an important element in using computers to express and
explore ideas and to form "theorems in action" (Vergnaud 1982). The argumentation is based on a longitudinal experience of the infusion of such activity in a Greek private primary school setting (Psychico College) within an educational system discouraging bottom-up pedagogical developments. From the outset of the project, seven years ago, the technology was used to set up a classroom organisation very different to the one conventionally practiced within the wider educational context; the pedagogy prescribed by the centralised Greek educational system tends to involve the teacher addressing the whole class at once, transmitting disembedded information, coaching the solution of exercises and testing the reproduction of that knowledge with little means to determine whether it was achieved by rote or not. The curriculum is to be followed accurately and until very recently it came in the form of a (unique) book approved by the Pedagogical Institute (Kontogianopoulos-Polydorides and Kynigos 1993). In the Psychico College project, the technology was used to qualitatively reform and develop learning and teaching processes, rather than to quantitatively optimise existing ones.

Pupils worked in groups of two or three, were encouraged to discuss ideas, negotiate how they would cooperate, persist on a problem and deal with it in depth, develop autonomy and responsibility towards themselves and their group peers, present and discuss the results of their projects (studies of related issues in school settings can be found in Hoyles et al 1992, Hoyles and Sutherland 1989). The computers were used as tools for the pupils to express and explore ideas in a process of alternating between qualitatively different methods of representation (Bruner 1974, Mason 1980). Computer feedback was used by the teachers to inject pupils' perceptions of error, as part of a learning process, rather than an irreparable judgement on past performance.

All pupils and their own teachers use this technology for one hour a week throughout the final four years of primary school (Kynigos 1992). Due to insurmountable constraints, the initial technology of Apple IIc's and conventional Apple Logo II have remained unchanged and the developing learning environment has not, at least explicitly, been integrated into the curriculum in a formal and systematic way. Nevertheless, the school project involved continuous but not intense teacher education, a Logo curriculum development and informal research into pupils' and teachers' strategies. More details of the project's outline, educational objectives, working structure, classroom setup and "taught" content can be found in (Kynigos 1989, 1991). Studies involving children's learning process can be found in Kynigos, (1991, 1992, 1992b, in press). A study into children's use of programming ideas is described in (Kynigos et al 1993).

2 Programming as an activity facilitating developing pedagogy

A considerable volume of research concerning children's learning of programming indicates that it is difficult and time consuming, even if the programming language used is tailor made for learning it (Noss and Hoyles 1992). Perceived as