STUDYING THE TEACHING/LEARNING OF ALGORITHMS AT UPPER SECONDARY LEVEL: FIRST STEPS

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Algorithm, Algorithm Workspaces, Modelling competencies, Programming, Simulation.

SUMMARY OF ONGOING RESEARCH WORK

Our work focuses on the teaching/learning of algorithms in a mathematics course. The design and construction of algorithms by students is located within a more general framework of modelling approaches in mathematics. The first steps in this work include: **1.** Initial questions **2.** A specification of the knowledge at stake **3.** The elaboration of a theoretical framework taking into account general frameworks in math education and in computer science education, as well as frameworks related to modelling **4.** The preparation of a didactical engineering **5.** A projected study of students' modelling competencies.

Initial questions

According to the new French upper secondary curriculum in mathematics, teaching algorithmic should help to give sense to a number of studied concepts. The questions are: **1.** How teaching can go beyond this objective so that algorithmic becomes a learning object? **2.** How working on algorithm can be considered as a modelling task?

The knowledge at stake

1. The conception and execution of algorithm. **2.** The concept of algorithm: as a "tool", as an "object". **3.** A program is considered as a procedure (Input-Output), a function (Data-Results). **4.** The "Algorithmic Workspaces". **5.** The modelling competencies.

Theoretical frameworks

At first our theoretical framework is based on dialectic "tool-object" (Douady, 1984), a transposition of "Geometrical Workspaces" (GW) (Houdement and Kuzniak, 2003, 2006) to "Algorithmic Workspaces" (AW). Further, we will use the description of the levels of modelling competencies (Henning and Keune, 2007). In this approach, an algorithm will be seen as a model of a real world situation. This transposition GW to AW makes possible to start by thinking the interactions between objects, artifacts and paradigms when analysing tasks, and helps to analyse the respective positions of students and teachers, under influence of curricula. We propose to structure the AW into a network of components: **1.** sets of objects; **2.** artifacts "programmable"; **3.** a set of theoretical ideas that help to create and justify algorithms on the objects for execution by the artifacts. The paradigms algorithmic allow to interpret the contents of the components and to define their functions on three levels to algorithms:

Level I: an intuitive approach of algorithms of real life situations. At this level, for instance, the algorithm's effectiveness follows naturally from its description.

Level II: a "natural" axiomatic of algorithms. Effectiveness of the algorithm used, its efficiency and complexity are questioned. The algorithm can become an object.

Level III: formal treatment of algorithms (e.g. Turing machines).

At all three levels, just like in geometry, representations of algorithms involve specific registers (Duval, 2006) with conversions and treatments.

Preparation of a didactical engineering

The method is based on the idea of a didactical engineering (Artigue, 1992): the conception and the execution of a part of a curriculum. In a framework of modelling approach in mathematics, a random process' simulation tasks is analysed. For instance we consider a random phenomenon based on number of births within a family that stop either: – after the birth of the first son – after the family has four children. We expect from the students that they can implement and understand simulation with diverse instrumental choices and representations of randomness. It will be implemented with three $11^{th}/12^{th}$ grade classes.

Projected study of students' modelling competencies when building algorithms.

In a modelling approach, the student is confronted with the following challenges:

- describe the various steps between the observation of reality and the construction of the mathematical model developed;
- move to the simulation, and then write, in natural language, one (or more) algorithm (s) the model obtained, and the simulation defined;
- encode the algorithm(s) obtained for use in machine language;
- do relevant interpretation of the results obtained.

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