

# The incorporation of programming in mathematical education

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*The presentation will describe an ongoing design research study concerning the use of programming as a mathematical tool among students in Swedish upper secondary schools. During classroom interventions, students with no prior experience of using programming in school mathematics are observed trying to solve mathematical problems with the help of programming. The Instrumental Approach is used as a conceptual framework and the concept of instrumental genesis is intended to describe the process whereby students develop (inferred) mental schemes which together with the material artefact of a programming environment may act as an instrument in order to solve mathematical problems. During the presentation, results from the first intervention will be discussed.*

## **Background**

Programming has been given a more prominent role in education due to changed curricula in many countries. In 2017, the Swedish National Agency of Education revised the syllabus for mathematics in upper secondary school which led to the introduction of programming as a tool for mathematical problem solving in several courses. This research project has thus been influenced by the renewed acknowledgment of programming as a part of a so-called digital competence.

## **The Instrumental Approach**

As a mean to investigate the students' use of programming in mathematics, the Instrumental Approach is used as the conceptual framework. The Instrumental Approach describes the process whereby a subject uses an artefact, created by humans, in order to perform an action directed towards a given object (Verillon & Rabardel, 1995). To achieve the desired intention, the subject needs to develop mental schemes which enable the subject to use the artefact to complete a particular task. Vergnaud (1998) describes these schemes in terms of "invariant organizations of behavior for a certain class of situations" (p. 168) and together, the artefact and the schemes constitute a psychological *instrument* for the subject.

According to the Instrumental Approach, it is development of this instrument which enables the subject to use the artefact for a given purpose, through a process called instrumental genesis. In this research project, the instrumental genesis

concerns students' (the subjects) capacity to use programming and a programming environment (the artefact) in order to solve mathematical problems (the objects). Together with a detailed definition of schemes given by Vergnaud (1998), this theory is being used to analyze the work of students during classroom interventions.

## **Methodology**

The research project is built around teaching interventions and uses Design Research (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003) as a methodological approach. The interventions are designed by the researcher and this design includes both the design of tasks as well as the orchestration of the lesson. The latter is regarded as a possible tool to foster the instrumental genesis and is thus described as an instrumental orchestration (Guin & Trouche, 2002).

The interventions are conducted in Swedish upper secondary schools. During the interventions, students work in pairs on non-standard mathematical problems chosen to be amendable to solution through programming. Computer screens and the conversation of chosen pairs are recorded, and the written records and programming code generated by all students is collected. The students in the first intervention were, at the time of the intervention, taking a course in programming but had no prior experience of using programming in their mathematical courses. The primary focus was on how students used the programming environment as a tool to solve mathematical problems, on the assumption that their basic knowledge of programming might reduce the number of syntactical errors.

*The aims of the short presentation are to discuss the results of the first intervention study and to get valuable viewpoints regarding both the conceptual and analytic frameworks used in the study.*

## **References**

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