English Abstract

Mathematics is characterised by the use of the symbolic language. Symbols are used for developing, storing and communicating mathematical knowledge (Steinbring, 2006). Formulas are built from symbols, and they express features of objects that can be abstract or concrete; for instance, there are formulas for determining the area under a curve and for determining the volume of a solid.

In upper secondary school formulas occur in almost every topic, and they are a useful tool for generalising mathematical results, making them applicable in various contexts. This quality of formulas is part of the problem: "[...] that multiple meanings are comprised within the same expression or can be derived by transforming it – is what simultaneously blurs the sense of it (Arzarello, Bazzini, & Chiappini, 2002).

The objective of this dissertation is to investigate how students in upper secondary school understand symbols and formulas thereby also shedding light on the reasons that hinder this understanding. In the investigation, a semiotic approach is applied.

The study begins with an examination of the instructional practice around the transition from lower to upper secondary school. Pivoting on the use of symbols, the instruction students has experienced in lower secondary school and how they are met in upper secondary are characterised. The result shows a noticeable gap from a context- to a concept-based instruction. On this background, the students' encounter with the mathematical symbolic language can be characterised.

The findings of the dissertation rest on three consecutive classifications. The first is an identification of the roles symbols can play in mathematics in general and in school-mathematics in particular. The second is an operative characterisation of mathematic understanding. 'Understanding' takes on many meanings, but in the study of how students understand symbols and formulas there is a need to put forward a characterisation which makes it possible to compare and contrast various types of understanding. The third and final classification is the major finding of the dissertation. From a teaching experiment, eight different kinds of 'understanding formulas' are advanced. In order to be a "proficient formula user" students must possess all of them and be able to combine and shift between them. By employing the various understandings to describe students' handling of formulas, it becomes apparent *if*, *how* and not the least *why* students are *not* always capable of dealing with formulas in developing mathematical knowledge, including solving tasks. It is noticeable how a single understanding, at certain times, can dominate other understandings and preventing them from using their full potential.

A main component in the teaching experiment is the use of concrete materials. The findings of the dissertation suggest that concrete materials can scaffold students' work with formulas, especially setting them up. In some cases, the use of concrete materials leads to a disadvantageous dominance of a particular understanding, resulting in the concrete materials acting as a hindrance for learning.