# Students’ talk about mathematical symbols

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This presentation addresses natural language (for example Swedish) which is central to students’ understanding of mathematical symbols. In the presented study, we focus on how students use natural language when talking about the meaning of mathematical symbols, and whether there are differences related to how familiar the symbols are. We look at two dimensions of how students talk, first on how explicit the students describe the meaning of a symbol. The second is what type of meaning is presented. This is work in progress, where we after several pilot studies have decided on methods for data collection and analysis. At the time for the conference, we plan to have carried out our main data collection and analysis. In the talk we will present preliminary results together with empirical data.

## Introduction

Many students have problems learning the symbolic language of mathematics (Carraher & Schliemann, 2007). Research shows that the natural language (for example Swedish) is central to students’ meaningful understanding of mathematical symbols. In this study, we analyze students talk about symbols to investigate relations between natural language and the symbolic language in their communication. Thus, we focus on relational understanding (Skemp, 1976), that is, students’ ability to, for example, describe the meaning of a symbol.

This ongoing study is a part of a larger project on the role of natural language when students learn the symbolic language of mathematics. In previous studies of textbooks, we have shown how symbols and natural language are connected (Hultdin et al., 2023) and how the meaning of symbols and symbol expressions is created using natural language. The next step is to understand more about students’ meaning making of symbols by analysing how they are using natural language when talking about the meaning of mathematical symbols.

The aim of the study is to gain knowledge on how students talk about the meaning of mathematical symbols using natural language, and whether there are differences related to how familiar the symbols are. To address the aim, we will answer the following research questions:

1. How explicit are students when talking about the meaning of mathematical symbols?
2. What type of phrases are students using when talking about the meaning of mathematical symbols?
3. What differences related to familiarity of symbols can be found?

The analysis in the study will focus on two dimensions. The first is when students are saying something about a symbol that more or less explicitly describes the (possible or potential) meaning of the symbol. Here it is the level of explicitness we analyse. The second dimension focuses on how the meaning is presented, if it is as a phrase with a noun, an adjective or a verb, which will characterize the type of referent for a symbol.

In this stage, we have carried out several pilot studies to clarify central aspects of the data collection and analysis procedure. For the data collection, we have looked at what school years to include, how to present the symbols or symbol expressions, what symbols to include, what type of questions to ask, and if students should be alone or in pairs. The following conclusions were drawn from the pilot studies:

School years We will interview students in school years 3, 6 and 9. This will make it possible to answer research question 3, the familiarity of symbols.

Symbols The symbols used in the study will range from well-known to not yet encountered in the mathematics classroom. The following five symbol expressions will be presented in the interviews:
3 + 5 = 8, 20% of 50kr is 10kr, $\sqrt{ 36 }=6$, $omkretsen=π∙diametern$ och $\sum\_{i=1}^{4}i=10$. The first two expressions will be given to all students, the third and fourth to students in school year 6 and 9, and the fifth only to students in year 9.

Questions The questions to the students will be restricted to “tell us about this”, “tell us more”, and “what about this” (pointing at a specific symbol, including the numbers). We will also use the question “You have a friend who doesn’t know about this. How would you explain it?”

Students We will interview students one by one. In the pilot studies, no extra information was found when students were interviewed in pairs.

We have also tried out the analysis procedure. When the students were asked to talk about a symbol expression, two researchers separately identified the object of analysis in each phrase. The object was the specific expression where the students specify a referent to the symbol. This meaning was then coded in the two dimensions, first on explicitness of the meaning of the symbol, and second on how the symbol was presented.

We plan to have carried out the main data collection and started the analysis before the conference. At the conference we plan to present preliminary results from the main study together with examples from the empirical data.

## References

Schliemann, A., & Carraher, D. (2007). Understanding and Supporting Children’s Mathematical Learning Lives. *Extending Learning*, 24.

Skemp, R. R. (1976). Relational understanding and instrumental understanding. *Mathematics Teaching, 77*, 20-26. [doi.org/10.5951/MTMS.12.2.0088](https://doi.org/10.5951/MTMS.12.2.0088)

Hultdin, U. W., Bergqvist, E., Bergqvist, T., Vingsle, L, & Österholm, M. (2023). Applying a new framework of connections between mathematical symbols and natural language, *The Journal of Mathematical Behavior, 72*, 101097. [doi.org/10.1016/j.jmathb.2023.101097](https://doi.org/10.1016/j.jmathb.2023.101097)