

A Conceptual Classification of Mathematical Symbols: Encompassing a Student's Stroke Order of Mathematical Symbols in Semiotic Resources by Unpacking Written Signs

Daiki Urayama

Hiroshima University

d-urayama@hiroshima-u.ac.jp

A wide variety of modalities (e.g., Edwards & Robutti, 2014) exist in classrooms, including discursive, embodied, and material signs and artifacts, each with different affordances, offering different possibilities for students' actions. For instance, since students think and do mathematics by "drawing" mathematical symbols using writing tools, drawing these integrated symbols reflects the result of selecting the most significant and rational affordances of these modalities in line with their mathematical thinking.

The significance of symbolic processes for mathematics education lies in the use of symbols, which is ubiquitous in the field of mathematics. Semiotics has the potential to be a powerful theoretical lens for studying diverse topics in mathematics education research (Presmeg et al., 2018), and Duval's cognitive semiotics (e.g., Duval, 2006), a leading study of the relationships between symbols and cognition, uses the concept of the registers of semiotic representations in relation to semantics. However, insufficient research results have been obtained on the pragmatic aspects of symbolic use specific to students' drawings, which are subjective cognitive actions performed by students.

The cognitive action of drawing acted upon from a specific modality is therefore considered to be selective and subject-dependent. From this viewpoint, it can be hypothesized that the student's cognitive structure is represented in their drawing. In this study, the discussion will initially focus on a conceptual classification of mathematical symbols, such as sigma and integral, in terms of the conceptual structures of them as well as a potential stroke order that can come into play when students solve mathematical tasks. Additionally, a stroke order can be regarded as one of the semiotic resources and results in a construct of a system of signs, the semiotic bundle (Radford & Sabena, 2015), that is used as a methodological tool to analyze students' interpretations.

References

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