On the Necessity of Multimodal Semiotic Approaches for the Analysis of Young Children's Mathematical Drawings

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Mathematics education research has classically considered several possible representations produced by students while engaging in mathematical activities: semiotic approaches have been developed to analyse students' products and interactions. The analysis of students' products becomes particularly challenging when they are so young and written language is not available as means of expression for them. Researchers in the field of early years mathematics are discussing theoretical frameworks and methods for addressing the complexity of communication of mathematical ideas (e.g., Maj-Tatsis et al., 2023).

Drawings have often been used as means for understanding children's representation of mathematical ideas. They can depict the context of mathematical activity (characters, objects, etc.) together with dynamic, pictographic, iconic, written, and symbolic marks (e.g., arrows, letters, numerals, etc.) (Carruthers & Worthington, 2006). Some researchers use drawings solely as a data source, but we believe that this might result as misleading and we argue that methodologically, multimodal approaches are preferrable. With the term 'multimodality' we are referring to the full range of means of representation which are observable in the mathematics class (or in kindergarten) including gesture, speech, bodily movements, writing, gazes, and tone of voice (Arzarello et al., 2009).

Graphical representations of mathematical ideas can serve to communicate the process of problem solving to others, but also to oneself. The different components of a drawing not only represent the process of reasoning, but they are part of it together with other means of representation. All of these must be considered to fully understand the child's mathematical ideas, and this could only be realised by taking into consideration both how the different means of representation evolve along time (diachronic analysis) and how they are related (synchronic analysis). We suggest Arzarello et al.'s (2009) semiotic bundle is suitable construct. A semiotic bundle is a system of signs produced by one or more interacting subjects while solving a problem and/or discussing a mathematical question. It is a bundle in the sense that different signs (speech, gestures, drawings) are produced and modified during time, but they are not separated: they are bundled and evolve together over time. Data taken from the study presented in (Downton & Maffia, 2023) supports us in showing that, in the case of children representing division word-problems, a multimodal semiotic approach allows to discern different strategies of problem solving, while the analysis of solely the final product would point to more similarities than differences.

References

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