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9. EMBODIED GEOMETRY

Signs and Gestures Used in the Deaf Mathematics Classroom – The Case of Symmetry

> By identifying the differences and similarities in the practices of those whose knowledge of the world is mediated through different sensory channels, we might not only become better able to respond to their particular needs, but also build more robust understandings of the relationships between experience and cognition more generally.
>
> (Healy, 2015, p. 289)

Research in the field of deaf studies shows that learning mathematics appears to be more difficult for deaf children than it is for those who can hear. Deaf students' basic math skills are found to lag several years on average behind those of hearing learners of same age (e.g., Kelly, Lang, & Pagliaro, 2003; Nunes, 2004; Pagliaro, 2006; Traxler, 2000). This is partly explained by a lack of informal mathematical knowledge typically gained by hearing children implicitly through everyday interactions in early childhood (Nunes & Moreno, 1998). Furthermore, deaf students struggle with reading, understanding and processing word problems (Hyde, Zevenbergen, & Power, 2003) since they have not had sensory access to the language in which the problems are written so that this language is a foreign language for them.

These previous studies mainly compare the learning *products* of deaf students with those of hearing students but rarely focus on the learning *processes*. If we assume that mathematical knowledge becomes shaped by processes of meaning making and that mathematical thinking is influenced by our interaction with the world, I suggest that it might be naïve to assume that the learning product will be the same for deaf students, considering the circumstances of learning are not. One major difference between social learning processes in regular and deaf classrooms concerns the modality of language, with spoken language being used in the first case and sign language in the latter, each with its specific characteristics.

Building on a Vygotskian approach, Healy (2015) claimed that the sensory channels by which we perceive information deeply influence the structure and process of thinking so that the substitution of the ear by the eye when interacting with others in the mathematics classroom may also influence what kind of mathematical knowledge is constructed. So, "rather than seeing difference as equated to a state of

R. Hunter et al. (Eds.), Mathematical Discourse that Breaks Barriers and Creates Space for Marginalized Learners, 171–193.

deficiency, difference can be treated as just that, difference" (Healy, 2015, p. 291). Taking this difference into account may help us get a better understanding of learning processes also more generally.

This chapter points out some of the differences in the way learning is experienced when sound is no longer a primary sensory channel and discusses possible consequences for the learning of mathematics in the deaf classroom. In doing so, it aims at drawing attention to the importance of taking a more thorough look at the specific situation that is faced by deaf learners (and their teachers), focusing on the influence of sign language as an important component of the process of mathematical meaning making in social interaction.

To approach this goal, theory gained from non-mathematics-specific studies on sign language will be introduced, namely the consideration of iconicity as one feature of sign languages that may influence conceptualization (Grote, 2013).

In this chapter, I present a case study from a fifth grade geometry classroom with all students as well as the teacher being deaf and communicating in German sign Language. I will draw on three examples to reconstruct how two 'mathematical signs'[1] develop to their use in the classroom together with the mathematical ideas they refer to and how this forms processes of iconization, that is processes in which iconic relationships between the signs and their respective referenced idea become established.

This investigation is especially important considering that there are rarely conventions about 'mathematical signs' to refer to a mathematical idea. They are often more or less idiosyncratic to the teacher, especially when it comes to more abstract concepts in upper grades. It is therefore important to shed light on the signs that are used, 'where they come from', and what might be implied by the iconicity between these signs and the mathematical idea.

Based on the analyses, I will discuss possible theoretical implications for the learning of mathematics within a theoretical framework that sees social, semiotic, and individual approaches to learning as being deeply intertwined, described in the next section.

LEARNING MATHEMATICS BETWEEN THE SOCIAL, THE SEMIOTIC, AND THE INDIVIDUAL

In the mathematics classroom, mathematical ideas and objects are mainly encountered and discussed in interaction among students and the teacher. Learning mathematics can therefore be considered a social phenomenon in which individuals co-construct mathematical meaning. But what influences this construction? One aspect may concern the semiotic nature of the social learning process, such that mathematical objects cannot be accessed directly but only mediated through (semiotic) signs (Seeger, 2006). These signs may be of spoken, written or gestural form, or may be multimodal in their nature and processed through different sensory channels