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Spatial structuring in early years

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Theoretical framework

Spatial structuring, according to Battista (2008), “is the mental act of constructing an organization of form for an object or set of objects” (p.138). It consists in identifying components of shapes, establishing relationships among components into composites and establishing relationships between components, composites and the whole (Battista, 2012). Battista (2008) presents a different perspective on the development of geometric reasoning based on the idea of structuring. Spatial structuring is the first level of geometric reasoning and allows the students to understand the structures of shapes before geometric structuring, when students start to use geometric concepts.

In the early grades, constructions (composing and decomposing) and operations with shapes (geometric transformations) are special kinds of tasks that entail spatial structuring, allowing students to explore relationships among components and between components and the whole (NCTM, 2000).

According to Battista and Clements (1996), students’ spatial structuring is either local or global. Local structuring is related to the identification of components and a possible establishment of relationships among components, but students cannot yet relate components and the whole. In global structuring, students have a mental scheme for the object that enables them to establish relationships among components, composites and the whole. To a better understanding how spatial structuring is characterized, we referred to the work of Sarama and Clements (2009), related to composition and decomposition of 2D and 3D shapes, where they describe the levels of relationships students can establish among components. According to these authors, students progress along several levels: pre-composer (0-3 years old), piece assembler (4 years old), picture maker, simple decomposer and shape composer (5 years old), substitution composer and shape decomposer (6 years old), shape composite repeater and shape decomposer with imagery (7 years old) and shape composer using units of units and shape decomposer with units of units (8 years old). This progression concerning composing and decomposing also highlights a trajectory closely related to spatial structuring. In both cases, the students start by dealing with units, then they begin to establish relationships and form composites, and, in a final stage, they can deal with superunits and relate them with the whole.

Method

This study follows a design-based research approach, where, along two cycles of research, we aim to deepen our understanding of how students develop spatial structuring of 2D and 3D shapes and

how it is related to the learning context proposed for the learning experiment. Through this, we seek to contribute to a further understanding of students spatial structuring.

The results presented in this poster concern a preliminary study, developed during the learning experiment preparation phase. This study had the purpose of testing tasks and manipulatives adequacy and of gathering some information about strategies 1st grade students use to solve the tasks. We selected one task concerning 2D shapes and, for our analysis, we compare constructions and drawings using Battista and Clements' (1996) local and global structuring, with attention to location and orientation of components.

Results

The results of preliminary study, where students had to compose different two-dimensional constructions using four triangles, reveal that students show different levels of structuring, maybe influenced by the type of constructions and the type of components. Namely, triangles seem to present a higher level of difficulty for students, since the possibilities of combining several isosceles triangles are wider, influenced by their orientation and position.

During this preliminary study we also found differences between students' constructions using manipulatives and the drawings of their constructions. Drawing seems more demanding for students to perform, however, the search for relationships between constructions and drawings allow students to deepen their understanding about the relationships among components.

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