Chapter 51
Students' Experiences Composing and Decomposing Two-Dimensional Shapes in First and Second Grade Mathematics Classrooms

Drew Polly
University of North Carolina at Charlotte, USA

Trisha Hill
Kannapolis City Schools, USA

Tabitha Vuljanic
Kannapolis City Schools, USA

ABSTRACT

The composing and decomposing of geometric shapes is a building block in children's development of geometry and spatial reasoning. The Common Core State Standards in Mathematics focus and emphasize the need for students to build composite shapes from smaller shapes and break a geometric shape into smaller shapes. This chapter presents findings from an exploratory study that examined both teachers' and students' experiences working with shape puzzles. Inductive qualitative analysis of field notes and student work samples indicated that shape puzzles provided opportunities for students to develop a deeper understanding of spatial reasoning. In certain subgroups of students, the vocabulary terms related to students' work revealed a disconnection between students' work and their oral explanations of their processes. Implications for professional development and classroom implementation in light of the Common Core State Standards are shared.

OVERVIEW

The Importance of Composing and Decomposing Shapes

Students' understanding of ways to compose (build) and decompose (break apart) geometric shapes is a foundational building block to students' understanding of geometric shapes. Researchers have spent time looking to explore and develop the research base related to children's geometric and spatial reasoning. Within that area, research has cited the significant work of children learning about composing and decomposing shapes (Clements, Sarama, Batista, & Swaminathan, 1996; Clements, Swaminathan, Hannibal, & Sarama, 1999).

Clements and Sarama (2007) write the following about composing and decomposing shapes:

The ability to describe, use and visualize the effects of composing and decomposing geometric regions is significant in that the concepts and actions of creating and then iterating units and higher order units in the context of mlconstructing patterns, measuring, and computing are established bases for mathematical understanding and analysis. (p. 512)

Decomposing and composing geometric shapes is a critical component of geometric understanding (Clements & Sarama, 2000). The task of putting smaller shapes to form a larger shape and vice versa requires students to understand the basic features of shapes as well as how different shapes relate to each other (Clements & Sarama, 2000). Further, research states that:

"The ability to describe, use, and visualize the effects of composing nad decomposing geometric regions is significant in that the concepts and actions of creating and then iterating units and higher-order unit in the context of constructing patterns, measuring, and computing are established bases for mathematical understanding and

analysis. Additionally, there is suggestive evidence that this type of composition corresponds with, and may support, children's ability to compose and decompose numbers (Common Core Progressions Writing Team, 2012, p. 3)."

The mathematical work involved in composing and decomposing two-dimensional shapes helps to build a foundation for later work related to the properties of geometric shapes.

According to the authors of the Common Core Geometry Progressions Document, "Composing and decomposing requires and thus builds experience with properties such as having equal lengths or equal angles (Common Core Progressions Writing Team, 2012, p. 4)."

According to the van Heile levels of geometric understanding, students' experiences composing and decomposing two-dimensional shapes provides opportunities for students' to develop a stronger sense about the properties of shapes, which is the distinguishing factor between elementary school children at Level 0, Visualization, where they only can identify shapes, and Level 1, Analysis, where students are able to associate shapes with specific properties, such as the number and types of sides, the number and types of angles, and other characteristics. Most children in Grades K-3 function at Level 0, Visualization, and need rich experiences in order to support their development of geometric understanding. In his textbook, van de Walle (2003, p. 353) stated, "Children need to freely explore how shapes fit together to form larger shapes and how larger shapes can be made of smaller shapes."

Composing and Decomposing Shapes in the Standards

In the United States Common Core State Standards in Mathematics ([CCSSM]; CCSSI, 2011), the authors call for students to successfully compose and decompose two-dimensional shapes in each Grade from Kindergarten through Second Grade. This study took place during the first year before

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