

Teaching Mathematical Structure to Young Students

Summary: Some of the most fundamental mathematics understandings come from a sense of pattern and structure in numerical representatives. In an article for the *Mathematics Education Research Journal*, two professors discuss how teaching students explicitly to think about structure has been shown to significantly raise their math achievement.

Practical Applications

The authors, along with other researchers, have found that there are stages of development in students' understand of mathematical structure/patterns (by structure, they mean the concept that visual representations of numbers – pictures like an array or a clock face – follow a regular, predictable and unique order). I'll use their example of 1st grade students asked to draw 8 o'clock on a blank clock face. The stages are:

- Pre-structural stage: "Representations lack any evidence of numerical or spatial structure. Most examples show idiosyncratic features." *Example: A student draws a picture of a person using circles*
- Emergent stage: "Representations show some relevant elements of the given structure, but their numerical or spatial structure is not represented." *Example: A student draws a circle and fills it with random numbers; no clock hands are visible*
- Partial structural stage: "Representations show most relevant aspects of numerical or spatial structure, but the representation is incomplete." *Example: A student draws a circle and fills the edges with numbers from 1-12, but the numbers only take up half the circle and the clock hands don't distinguish between the hour hand and minute hand.*
- Stage of structural development: "Representations correctly integrate numerical and spatial structural features." *Example: A student correctly draws a clock and has the hour hand pointing to 8 and the minute hand pointing to 12.*

The authors note that there is ample evidence that students in the higher stages of development do better in math throughout their academic careers. They suggest the following:

- Teach students to recognize structure and pattern not just in separate lessons on patterns. Mathematical structure is everywhere, even as early as kindergarten – the structure of rectangular arrays, for example, can be used not just for counting (or later, multiplication) but to show students that it only works because there is a structure
- Provide students with tasks that let the students practice. Three possible tasks for young students are (more tasks can be found in the Teacher's Companion):
 - Draw a given time on a blank clock face
 - Complete a rectangular array that has only been partially gridded
 - Create a pyramid-structure with triangular dots (i.e. each row has one less)

Conclusion and Citation

Grasping the underpinnings of math structure from the earliest grades and have been shown to have a large effect on student's math achievement. Emerging research shows that, happily for teachers, this is an understanding that can be taught.

Mulligan, J. & Mitchelmore, M. "Awareness of Pattern and Structure in Early Mathematical Development." *Mathematics Education Research Journal*, 21.2 (2009), pp. 33-49. <http://tinyurl.com/3mby5t3> (free)