How do manipulatives influence students' understanding of fractions?

Lise Dausen and Pernille Ladegaard

VIA University College

TrygFonden

Research question

The aim of our project

- *How are students with mathematics difficulties supported or distracted in their reasoning by the use of concrete manipulatives compared to high performing students when comparing fractions?*

Theoretical background

(Bruner, 1966)

Aim to create an inclusive learning environment

CPA (Bruner, 1966)

Integrated

Results from the pilot project:

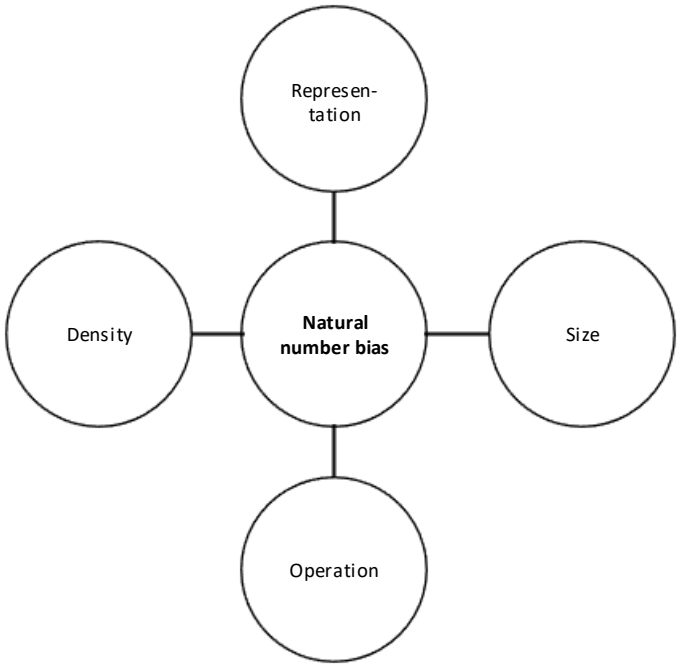
The teachers said that they also used concrete manipulatives before the TRACK project.

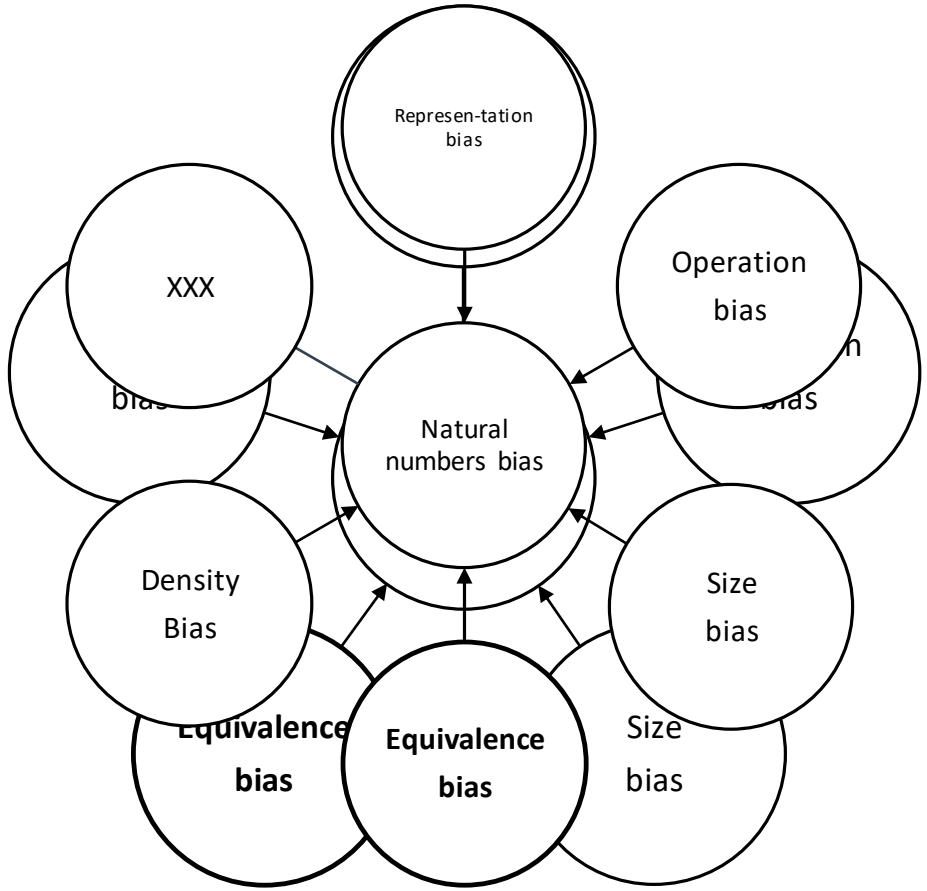
... but the teachers expressed that they lacked tools to create a connection between the concrete manipulatives and the abstract notation in the book.

Theoretical background

Natural number bias

Whole number bias/natural number bias





Ni and Zhou (2005);
Van Hoof, Vandewalle, et al. (2015)

Method

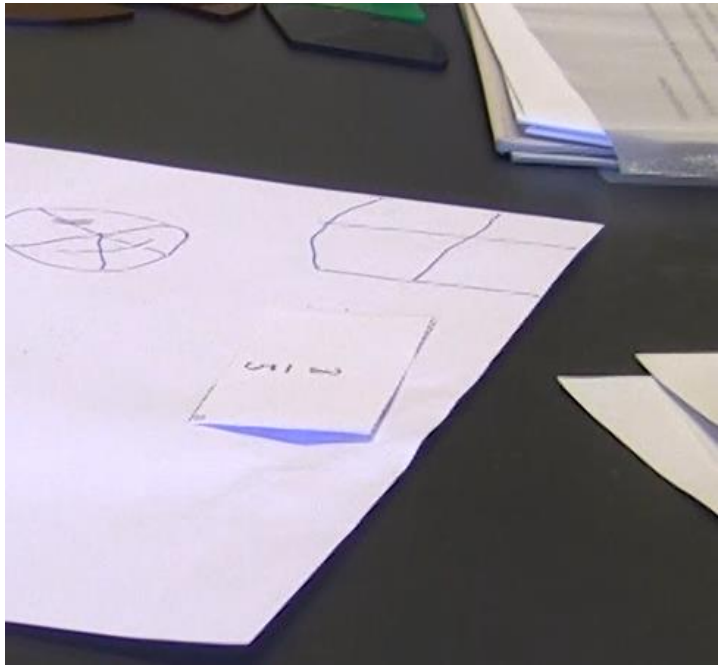
Natural number bias

Method

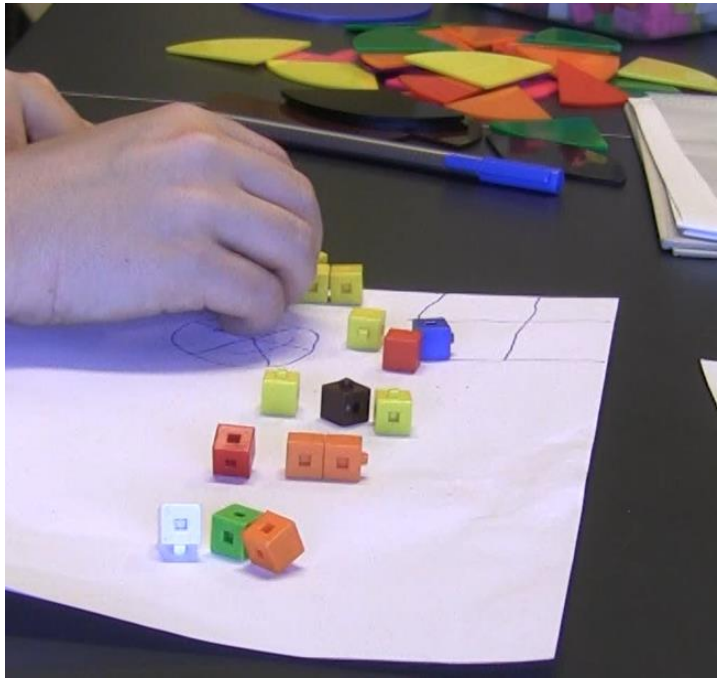
- 10 semistructured interviews times two
- Participants were four grade students (9 years 3 months to 10 years 7 months) from two classes from the same school.
- Teacher selected three high performing students, four students with difficulties and three average performing students
- Interview guide developed from the Rationale Number Project (Behr et al. 1980)
- Ethical consideration.

High performing students

Show the size by drawing



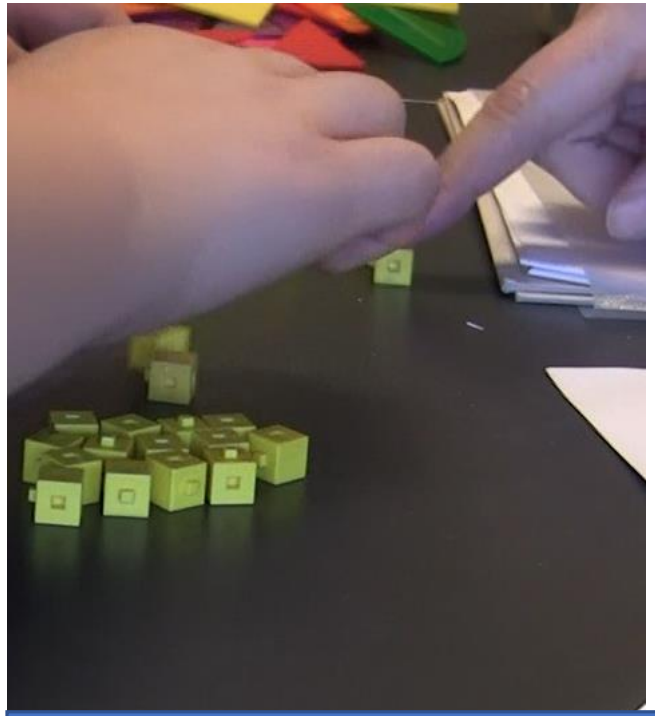
By concrete materials



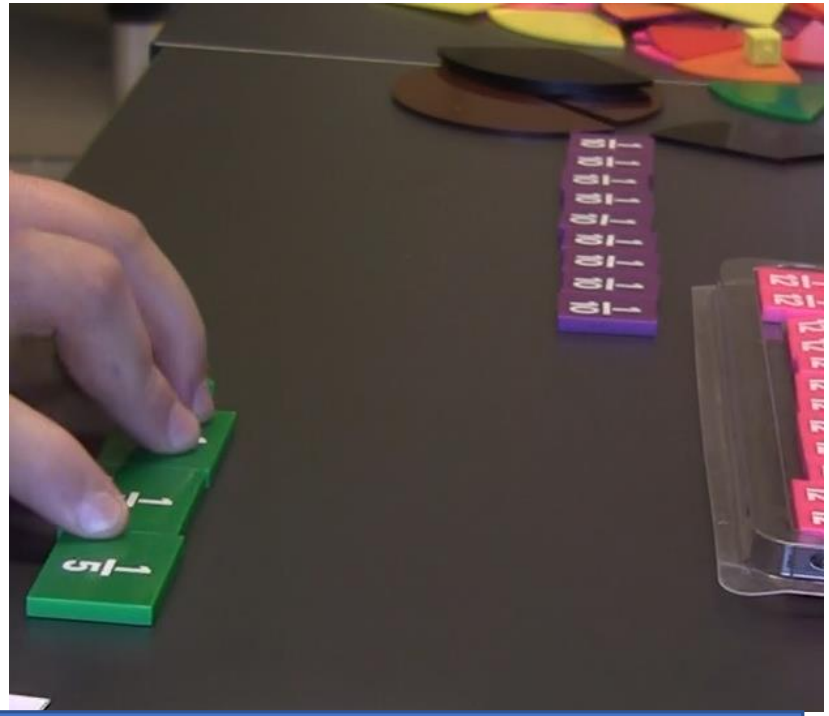
By the numbers

Low performing students

Using centicubes
3/5 as 8



Using block bricks 3/5



First interview one week

Still using block bricks

Interview by the end of the fraction intervention (6 weeks)

Findings

- The students having mathematical difficulties showed a tendency to whole number bias when they were asked to compare the magnitude of two fractions. The bias means, that when the students were given the fractions 1/4 and 1/5 to compare, they would identify 1/5 as bigger as they related to their knowledge about natural numbers where five is bigger than four. They were then asked to explain why 1/5 was bigger. During the interview, their reasonings were based on the manipulatives and showed that their misconception about the size of the symbol representations was contradicted by their reasoning while using the manipulatives.

- Our preliminary result showed that the manipulatives supported them to overcome their whole number bias connected to the *representation aspect*, meaning that they developed an understanding of the fact that the numerator and denominator were a part of a whole relation and not separate numbers. At the same time, the students showed that the solving process stayed at the same level of abstraction during the interview and very little progress were found. In other words, their reasoning was connected to each task and, when they were asked to compare two new fractions, they did not use their experience from previous tasks.

Reference

- Behr, M. J., Lesh, R., Post, T. R., & Silver, E. A. (1983). Rational-number concepts. In R. Lesh & M. Landau (Eds.), *Acquisition of Mathematics Concepts and Processes* (91–125). Academic Press.
- Bruner, J. S. (1966). *Toward a theory of instruction*. Belkapp Press.
- Ni, Y., & Zhou, Y.-D. (2005). Teaching and learning fraction and rational numbers: The origins and implications of whole number bias. *Educational Psychologist, 40(*1), 27–52.
- Van Hoof, J., Vandewalle, J., Verschaffel, L., & Van Dooren, W. (2015). In search for the natural number bias in secondary school students' interpretation of the effect of arithmetical operations. *Learning and Instruction, 37*, 30–38.

Paper strip task

Paper strip task

$\frac{3}{8} + \frac{1}{4} = ?$

$\frac{6}{8} - \frac{1}{2} = ?$

$\frac{1}{4} + ? = \frac{7}{8}$

$\frac{1}{4} \cdot 5 = ?$

Paper strip task

- Difference in the use of manipulatives.
- Focus on the process of folding
- Representations of numbers beside the manipulatives.
- Simultaneous representations