# Effects of manipulatives in interventions with children with mathematics learning disabilities: A systematic review

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## Introduction

- Manipulatives (e.g., blocks, plastic chips) often used in elementary grades to illustrate mathematical concepts.
- Increasingly popular with students with Mathematics Learning Disabilities (MLD).
- Small- to medium-sized effects relative to instruction with written symbols alone (Carbonneau, Marley, and Selig, 2013).
- Little is known about the effects of manipulatives in the MLD population, nor the instructional conditions under which any effects are optimized.

## Aim

- To review research on the effectiveness of instructional interventions delivered with manipulatives on the learning of children with MLD.

## Method

- PRISMA Statement (Moher et al., 2009).
- Criteria for inclusion: The studies 1) were conducted with participants who struggle with mathematics; 2) reported primary data; 3) assessed the effectiveness of an intervention delivered with manipulatives, whether administered individually, in small groups or in the whole class; and 4) focused on improving performance regardless of mathematical domain.
- Language: English or French.
- No limitations on publication date.

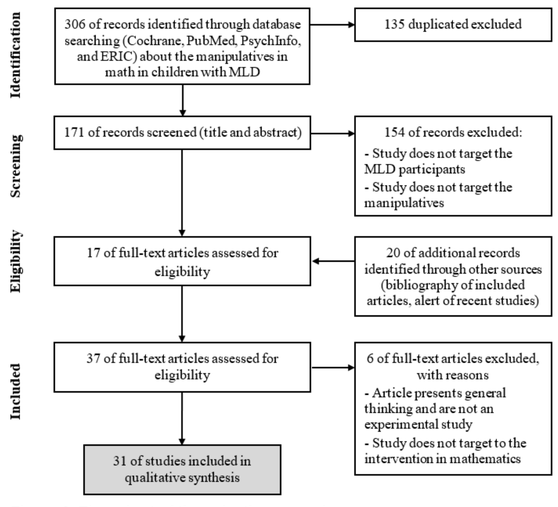


**Figure 1. Flow chart of the selection procedure**

## Results

- **Agreement** between 2 coders: Cohen's k of 0.763 (87.5%) for the methodological assessment and Cohen's k of 0.795 (90.3%) for the robustness assessment.
- **Characteristics of studies**: 2308 children, with 1205 children with M(L)D.

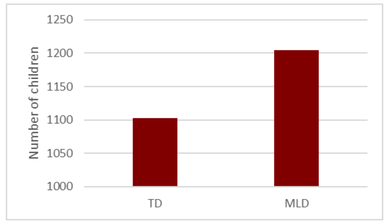


**Figure 2. Group of participants**

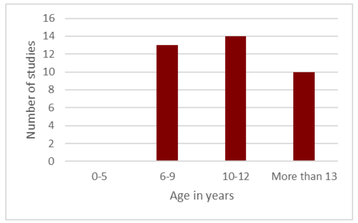


**Figure 3. Age of MLD participants**

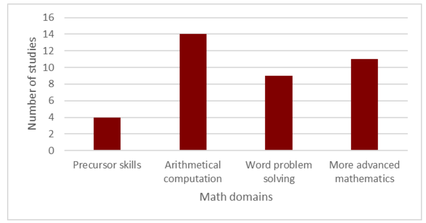


**Figure 4. Math domains**

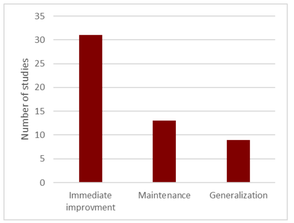


**Figure 5. Number of studies according to the measured effect**

- **Manipulative Type**
  - **Virtual manipulatives**: 2 studies
  - **Concrete materials**: 29 studies (e.g., Cuisenaire rods, Rekenrek, Geoboard, base-ten blocks, plastic counters).
- **Effectiveness**
  - **Immediate learning**: 18 studies used inferential statistics; 14 studies reported descriptive statistics.
  - **Maintenance**: 4 studies used inferential statistics; 9 studies reported descriptive statistics; maintenance from a few days to 11 weeks of follow-up.
  - **Transfer**: 9 studies; 1 showed no transfer, 1 showed a transfer in interest and confidence in mathematics, and 7 showed a transfer in problem solving.

- **Methodological assessment** (Downs & Black, 1998)

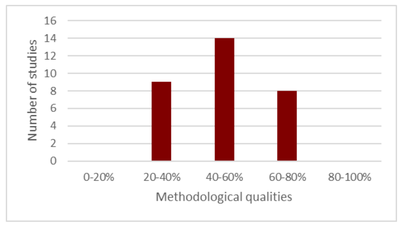


**Figure 6. Methodological quality**

- **Robustness assessment** (Ebbels, 2017)

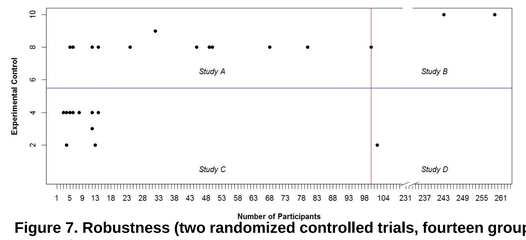


**Figure 7. Robustness (two randomized controlled trials, fourteen group studies, fifteen multiple case studies, and no single-subject study)**

## Discussion

- Interventions using manipulatives with MLD children effective for a variety of mathematical outcomes (e.g., conceptual understanding, computational fluency, problem solving) in the contexts of whole number arithmetic, fractions, algebra, and geometry.
- Heterogeneity in the way child and instructional variables (e.g., grade/age, duration of intervention, instructional environments) influenced intervention outcomes.
- Lack of excellent quality and robust studies.
- Perspectives of research:
  - Effect of manipulative type and characteristics?
  - Role of general cognitive abilities of (MLD) children in effect of manipulatives?

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