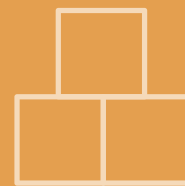


Math Materials Guidance: Summary Brief on Manipulatives



This brief summarizes some of the key points about manipulatives discussed in the *Science of Teaching Materials Guidance for Numeracy Programs*. The full two-part Materials Guidance will be available on the Science of Teaching website: scienceofteaching.site

Why are manipulatives important?

Using different representations, and especially beginning with concrete representations, helps children understand mathematical concepts. Research has shown that using concrete materials in the math classroom can have positive outcomes on learning. Using concrete and pictorial representations to introduce and build a concept, and then moving to the abstract, helps ensure that children can understand and apply the abstract concepts.

Manipulatives are concrete materials that can be moved and touched. They include counters, fingers, place value sticks, and geometric shapes (cutouts). Using manipulatives helps children make sense of math concepts that would otherwise be abstract to them. In the early primary grades, children should usually work first with manipulatives when learning a new topic. This prepares them to work next with pictorial materials and finally abstract symbols. In the example shown in Figure 1, the children first work with counters to see how they can put two groups of blocks together and figure out how many they have altogether. Using concrete materials can also interest and engage students and responds to key principles of Universal Design for Learning.

Definitions

Abstract

A mathematical concept represented through symbols (e.g., the addition sentence $4 + 2 = 6$)

Concrete

A mathematical concept represented using physical objects (e.g., counters)

Domain

An area of study in a curriculum (e.g., number sense, operations, measurement)

Manipulatives

Physical materials that can be moved and touched, such as counters

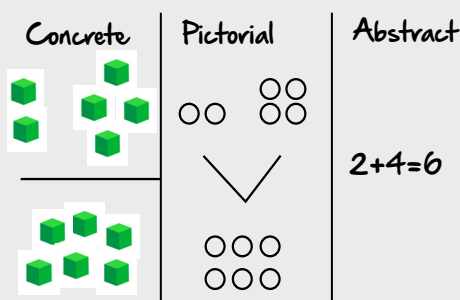
Pictorial

A mathematical concept represented through a picture, drawing, or figure

Representation

A mathematical concept or idea shown through symbols (abstract), drawings (pictorial), or objects (concrete)

FIGURE 1



How should manipulatives be used in the classroom?

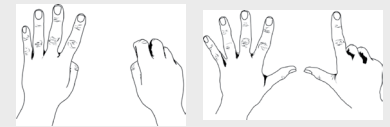
When using manipulatives as representations, teachers should:

- Use multiple representations to reinforce the concept and allow for multiple strategies. Figure 2 shows multiple representations that can help students understand simple addition strategies.
- Show and explain the concept clearly using the concrete or pictorial representations.

FIGURE 2



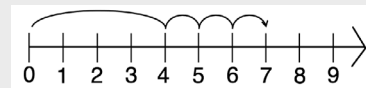
"1, 2, 3, 4, 5, 6, 7"



"4 ... 5, 6, 7"

What is 3 more than 4?

Start at 4 and count on 3:



Pitfall: If learners see the teacher using the manipulatives as just a series of steps – they can follow the steps without understanding the concept.

- Give learners ample opportunity to use the manipulatives themselves
- Move learners from concrete or pictorial to abstract, by:
 - » using manipulatives when introducing new concepts
 - » explicitly linking concrete/pictorial/abstract to help learners bridge. Figure 3 shows how a teacher in Madagascar made explicit linkages between concrete, pictorial, and abstract representations.
 - » ensuring learners move on to abstract as they master skills



Pitfall: If learners continue use to concrete or pictorial strategies for basic skills, without moving on to abstract, they will make more mistakes and struggle more when trying to solve more advanced problems.

How should appropriate manipulatives be selected?

Select materials that are:

- **Conceptually appropriate:** can be used to show the concept accurately and is effective in teaching the math topic at the level required.
- **Contextually appropriate:** appropriate for the local context in terms of its accessibility in the local environment and its applicability to the local curriculum.

In Figure 4, The sticks and bundles are more conceptually appropriate for teaching this concept because they clearly show, and children can easily understand, that ten sticks can be bundled together to make a 10. While you could tell young children that a white disk means 1 and a red disk means 10, this does not show the concept clearly and is likely to be confusing to them. While the "base-10 blocks" are conceptually appropriate, they may be too expensive or difficult to procure/make for some contexts.

FIGURE 3

The teacher says ▶

Here are 3 seeds (showing seeds to learners). Here are 3 more. If I put these seeds together, how many are there?

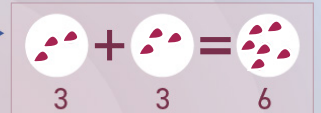
Learner answers ▶

6 seeds.

Teacher draws on board ▶



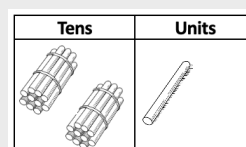
Then teacher writes and says ▶



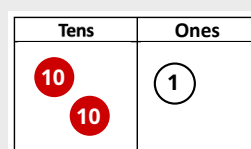
To show we are putting the seeds together, we insert the symbol +, and to show the result, we write =

FIGURE 4.

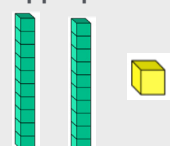
Appropriate:



Not conceptually appropriate:



May not be contextually appropriate:



A manipulatives “package” should be:

- A small selection of materials that are affordable or easy for teachers to create
- Easy to store, carry, and use throughout the year
- Useful for multiple topics/skills



Pitfall: Sometimes teachers are given a large set of manipulatives, but they have difficulty selecting which ones are appropriate for which skills and may have difficulty managing all of them.

The minimum recommended set of essential concrete and pictorial materials is as follows:

CONCEPTS	CONCRETE MATERIALS	PICTORIAL MATERIALS
Counting/Number recognition and simple operations	1 concrete material (such as counters)	2-3 materials (e.g. images of counters, hundreds chart, number line)
Place value and operations	1 concrete material (e.g. sticks and bundles or base-ten blocks)	2-3 materials (e.g. place value chart, 10-frames, hundreds chart)
Fractions		Fraction strips
Measurement	Ruler	
Geometry		Geometric shapes

What do teachers need to know?

To use materials effectively in lesson activities, teachers should be trained, and supported, to:

Select appropriate materials for the math topic and activity
Identify how many materials are needed
Prepare materials for themselves and students
Manage distribution and collection of materials
Model correct usage of the materials
Clearly show and explain math concepts to students using the materials
Guide and monitor students' use of the materials
Plan for the storage and reuse of materials