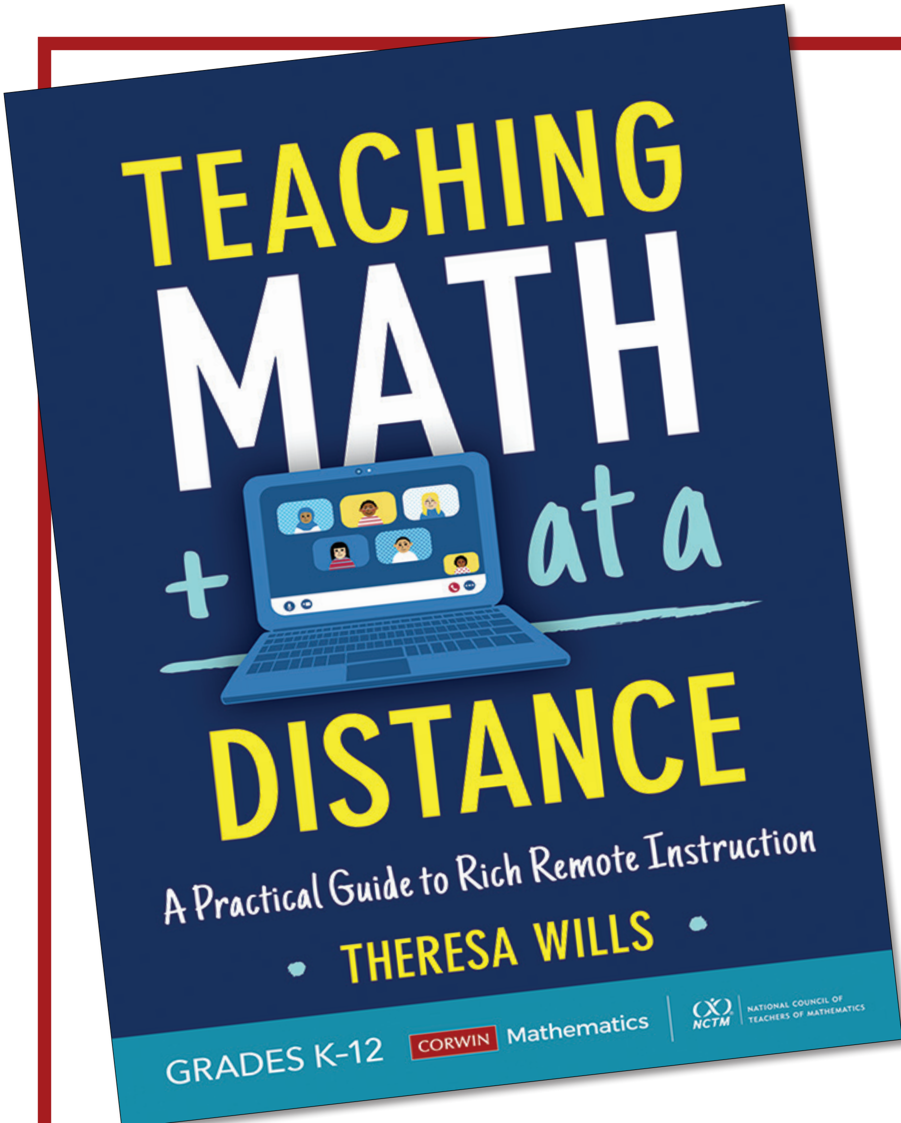

Thank you

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Planning for Virtual Manipulatives

Manipulatives: Any physical or virtual objects or materials that students can move around in order to help them learn mathematical concepts

Virtual manipulatives describe any virtual tool that you change, stack, connect, group, drag, spin, or otherwise move to model mathematical ideas. Some of these tools are direct replacements of physical manipulatives from the classroom such as spinners, dice, cards, snap cubes, and pattern blocks.

FINDING VIRTUAL MANIPULATIVES

Begin your search with familiar manipulatives that you have used in a face-to-face classroom. For example, a web search for base-ten blocks will result in dozens of applications, web-based tools, and downloadable programs that all use base-ten blocks. Once you become comfortable searching for manipulatives that you are familiar with, you can make broader searches for other manipulatives, such as two-colored counters, linking cubes, fraction bars, or algebra tiles. It can also be helpful to use synonyms for virtual manipulatives such as *interactive, modify, online, web-based, drag and drop, activity,* and *game.*

Your students might be assigned identical school computers, or they might use a variety of personal devices such as a PC, Mac, Chromebook, iPad, Kindle, or even a cell phone. It can be daunting, expensive, and impractical to ensure that the virtual manipulative is available on all devices. I recommend beginning with a choice of three different websites that all offer base-ten blocks. Much as you would give your students general exploration time before using physical base-ten blocks in a face-to-face classroom, you should do this online as well and learn who can and cannot access different apps. Maintaining a list of student devices can also be useful.

SELECTING VIRTUAL MANIPULATIVES

There are advantages to both the teacher selecting the manipulative and the student selecting the manipulative to use in solving a problem. When the teacher selects the manipulative, there is less time spent on web searches, ensuring that it is appropriate to use for the particular problem and that it can be used on a variety of devices. However, when students locate the manipulative, it can enhance their digital citizenship skills and increase the rigor of the problem-solving activity. Students would need to consider the type of manipulative that they want to use, summarize the name or application in the web search, and finally learn the manipulative as they apply it to the problem. In either case, purposeful planning will result in a more predictable classroom implementation.

When teaching younger students to use virtual manipulatives, you should have some that they use on a regular basis, but do not limit them to only those tools. The skill of being able to search for something on the web is important for young children too. Many five-year-olds use the microphone on tablets to search for their favorite shows on Kids YouTube. This real-world example is evidence that young kids are ready to search and evaluate information for their needs, but this digital literacy and application to academics does not happen overnight. Sometimes offering early finishers the challenge of searching for another tool (perhaps name some but don't link them) is a great way to maintain engagement and infuse digital literacy.

Evaluating for Instructional Purpose

You will soon find that some virtual manipulatives are better than others, and that the definition of better depends on the mathematical goal. When evaluating a manipulative for instructional purposes, it is important to consider how students will use it, how it is related to the mathematical goal, and how it is used to build conceptual or procedural understanding. A good virtual manipulative is one that is user-friendly, is accessible, is related to the mathematical goal, and supports connections to conceptual and procedural understanding.

USER-FRIENDLINESS AND ACCESSIBILITY

Student usability and accessibility is important to consider as you balance the time it takes to learn and manipulate the virtual tool. Determine if it is intuitive and invites students to interact without extensive knowledge of the tool. Assess the dexterity needs and hand–eye coordination and compare that with the developmental levels of your students. You might even ask some students to try them out. With proper planning, you can ensure that your choice results in smooth implementation.

One facet of user-friendliness is to consider if and how students will collaborate while using the virtual manipulatives. Some manipulatives, especially third-party manipulatives, require students to interact independently and then insert a screenshot of their finished model to the group recording space. Other manipulatives can be manipulated together in the small group. Consider how you want your students to discuss and connect each other's models while collaborating.

APPLICATION TO MATHEMATICAL GOALS AND STUDENT LEARNING

Finding the right virtual manipulative requires the right application to the mathematical goal. I personally have a few favorite tools that I use in almost every problem-solving situation, but not everyone sees how to use them in different problems. It is important to try out the manipulative with the problems that you assigned to ensure that the manipulative helps students to understand the mathematics goal of the lesson.

The purpose of a virtual manipulative is to build conceptual and procedural understanding, but beware of apps that do too much of the thinking or manipulating for the student, thus robbing them of the chance to reason. Look for virtual manipulatives that help you scaffold the learning without removing the problem solving. For example, if you are teaching a lesson on geometry and the fundamental lesson defines squares as a subset of rectangles, then you don't want the app to simply draw a square. Rather, tools such as Geogebra will require students to code the square to maintain right angles and congruent sides. Similarly, if students are learning about regrouping and trading tens and ones using base-ten blocks, the app should allow for students to determine when to group and break apart and not do it automatically, so that the students can apply their conceptual understanding.

Integrating Physical and Virtual Tools

There are a variety of tools available to support student understanding by manipulating objects as they generalize the mathematics. When teaching in an online math class, it can be tempting to only consider virtual tools and manipulatives, but attention should also be spent on the physical objects that students can still use and access from around the house. Just about anything can become a manipulative, such as cereal, spaghetti, beans, paper clips, buttons, and bottle caps. Another physical tool is traditional paper and pencil for recording algorithms and drawings. There is still a place for these tools, and they should still be included in the online class. Teachers can establish norms that make these tools visible to the rest of the class so that they can be integrated in whole-group discussions. Figure 3.1 provides some examples of mathematical concepts and common physical manipulatives that can be used to support student learning and are easily found at home.

Figure 3.1

Common Manipulatives Around the House

Place Value	• Pennies, dimes, and dollars • Cereal and spaghetti • LEGO bricks • Paper clips • Beads and string
Computation and Operations	• Buttons • Beans • Beads • Bottle caps
Building Arrays	• Cheez-it® crackers • LEGO bricks
Fractions	• Egg cartons • Muffin trays • Toys with different attributes (Shopkins, small dolls, marbles, Nerf cartridges, and blocks or LEGO bricks of various shapes and colors)
Measurement	• Rice, sand, and water to fill containers • String • Measuring tape • Measuring cups • Paper clips, cubes, or other equal-sized objects (nonstandard measurement)
Probability	• Dice • Paper clip spinners • Coins • Game pieces • Cards