The eight Mathematical Practices are a critical part of students' mathematics learning. Mathematical Practice Notes are included throughout the unit to indicate opportunities for engaging students in these practices. Each unit focuses specifically on two Mathematical Practices.

In this unit, the highlighted practices are MP4, Model with mathematics, and MP5, Use appropriate tools strategically. This essay describes each of these practices and provides examples from the unit of how to engage Grade 5 students in them.

MP4 Model with mathematics.

When given a problem in a contextual situation, mathematically proficient students at the elementary grades can identify the mathematical elements of a situation and create a mathematical model that shows those mathematical elements and relationships among them. The mathematical model might be represented in one or more of the following ways: numbers and symbols, geometric figures, pictures or physical objects used to abstract the mathematical elements of the situation, or a mathematical diagram such as a number line, a table, or a graph, or students might use more than one of these to help them interpret the situation. . . .

Mathematically proficient students are able to identify important quantities in a contextual situation and use mathematical models to show the relationships of those quantities, particularly in multistep problems or problems involving more than one variable. . . .

Mathematically proficient students use their model to analyze the relationships and draw conclusions. They interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

As students model situations with mathematics, they are choosing tools appropriately (MP5). As they decontextualize the situation and represent it mathematically, they are also reasoning abstractly (MP2).

(Illustrative Mathematics, *Standards for Mathematical Practice: Commentary and Elaborations for K–5*)

In this unit, students have many opportunities to use mathematics to model real-world problems. In particular, they use mathematical tools, including geometric shapes and volume formulas, to determine the volume of a variety of boxes and of their classroom. Modeling the volume of real objects with cubes helps students visualize the structure of a rectangular prism and the relationship of its volume to its linear dimensions. At first, students use boxes that have dimensions that allow them to be filled exactly with connecting cubes. Later, when determining the volume of the classroom in cubic meters, they of course cannot fill it up with cubic meters. Rather, they have to develop a model for determining the volume. In creating their model, they have to make decisions about what the best model is. For example, they may have to estimate some parts of the classroom dimensions or approximate the actual shape of the classroom as a rectangular prism or some combination of rectangular prisms.

Consider the following discussion. In Session 2.3, the teacher has noticed a few problems that are coming up for many of the pairs as they attempt to determine the volume of the classroom in cubic meters. The teacher decides to pull the class together to share some of these common issues.

Zachary: We were going to measure the length and the width and the height and multiply them, like in the formula. We got 9 meters for this length, but Yumiko and Hana were measuring the other side of the room, which should be the same, but it wasn't. So we all measured again, and it was still different. Then Hana realized that the other side really is shorter because there's that place where the wall comes in—like, the corner is cut off.

Hana: It's like if there were a closet, but there's no closet. It's just kind of cut out of the room.

Zachary: Yeah, so our class isn't really a rectangular prism. It's a rectangular prism with a corner cut off. So can we still just multiply?

Teacher: What do you think we should do? We want to get the best measurement we can in cubic meters.

Olivia: We could figure out how much that closet part is and subtract it.

Walter: That would be hard.

Yumiko: [excited] Yeah, yeah. We could do it. We just have to measure the length and the width of where the wall comes in. We already know the height because it's the same as the classroom. Then we just subtract that part at the end.

Nora: But the indented part is really small. It's like only about 15 centimeters wide. I bet it's only a couple cubic meters altogether if you like cut it apart and put it into cubic meters.

Teacher: Why does that matter that it's really small?

Nora: Because you could just kind of ignore it. We'll be really close if we do length times width times height.

Teacher: We have two solutions. And it might depend on our purpose for measuring. If we needed to know exactly the volume of air in the room . . .

Renaldo: Like it was a space ship and we want to know how much air we have . . .

Teacher: Right, then what you're calling the closet might matter. But if we just need a pretty close estimate—like if you're buying an air conditioner for a room, you have to know about how big the room is, but it doesn't have to be exact—then maybe you could ignore that part.

Joshua: But we have another problem. Everybody pretty much got 10 meters and 45 centimeters for the other length, but we can't squoosh cubic meters into a space that's only 45 centimeters.

Charles: It's kind of like the closet problem.

Rachel: I thought you said we were rounding to the nearest meter. So we just rounded it down to 10 meters. Then we can multiply.

Teacher: Yes, I did say you should round to the nearest meter, but, Joshua, why were you thinking that 45 centimeters is important to think about?

Joshua: It's almost half a meter. If we round down we'd be missing a lot of volume.

Renaldo: Like I was saying about the space ship. You'd really want to know if you have that extra air.

Rachel: We could think of it as $10\frac{1}{2}$ meters, that's pretty close.

Cecilia: We could think of the classroom in two pieces, like find the volume of the part that's 10 meters wide and then find the part that's $\frac{1}{2}$ meter wide and then add them together. It's two rectangular prisms put together.

Teacher: If some of you want to try what Joshua, Rachel, and Cecilia are suggesting, why don't you go ahead. Others of you might decide to stick with rounding to the nearest meter. Later, we can compare how different the results are and think about when that might matter and when it might not matter.

As students make these decisions, they are determining how they can use mathematics to model the volume of the classroom. There are several kinds of modeling activities going on. First, students are picturing how they can fill the classroom with cubic units. Second, they are applying the volume formula for rectangular prisms. Third, they have to figure out how to approximate the classroom as a rectangular prism or as a combination of rectangular prisms. Through these activities, students are visualizing the real-world object, the classroom, in terms of geometric shapes for which they can find the volume. Through discussing the problems they confront as they make their measurements, students are coming to understand that their calculations are a *model* of the volume of the classroom, that different measurement decisions lead to different models, and that different models might be valid and useful for different purposes.

The following chart shows where Mathematical Practice Notes specifically address MP4 and when that mathematical practice is assessed.

MP4 Model with mathematics.

SESSION	MPN	ASSESSMENT CHECKLIST
1.1	●	
1.4	●	
1.6	●	
1.7		●
1.8	●	●
2.2	●	

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