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Hands-On Activities for 3-D Spatial Skills (Part 1)

Sheryl Sorby, Ph.D. • November 2007

Topic: Encouraging Girls in Math and Science
Practice: Teaching Spatial Skills

Highlights

- Spatial skills are those parts of your brain that enable you to visualize what something looks like if you rotate it in space.
- In order to develop 3-D spatial skills, one of the things that has been found effective is helping students learn how to sketch 3-D objects on a 2-D piece of paper.
- Teaching students this skill can be done by having them draw an isometric view of an object on isometric grid paper. Repetition is very helpful in allowing the students to grasp the concept.

About the Interviewee

Dr. Sheryl Sorby is currently serving as a Program Director within the Division of Undergraduate Education at the National Science Foundation. She is a Professor of Civil and Environmental Engineering at Michigan Technological University. Dr. Sorby is the former Associate Dean for Academic Programs and the former Department Chair of Engineering Fundamentals at Michigan Tech. Her research interests include graphics and visualization. She was the recipient of the Betty Vetter research award through the Women in Engineering Program Advocates Network (WEPAN) for her work in improving the success of women engineering students. She has also been a leader in developing first-year engineering and the Enterprise program at Michigan Tech. She is the author of numerous publications and several textbooks. Dr. Sorby currently serves as an Associate Editor for ASEE's new online journal, *Advances in Engineering Education*.

Full Transcript

Spatial skills are those parts of your brain that enable you to visualize what something looks like if you rotate it in space or, if you're standing someplace, what something looks like over there, or imagine the path you're going to go down as you're traveling somewhere. Spatial skills are part of your—what Gardner calls, your "intelligences," are your spatial skills, and they enable you to maneuver within the world around you.

In order to develop 3-D spatial skills, one of the things that we found to be very effective is helping students to learn how to sketch 3-D objects on a 2-D piece of paper. One of the techniques that is used is an isometric drawing. If you look at this picture here, you can see that this is just a 3-D object in any kind of orientation. An isometric drawing though, is a special type of drawing that shows an object as if you are looking down a diagonal of a cube.

So this picture here, then, shows what that isometric view of this particular objects looks like. Because now, you're looking straight down the diagonal of that cube. So, one of the things we work with in developing spatial skills is helping students to be able to draw an isometric view of an object.

Now to draw an isometric view, we kind of cheat a little bit. We use isometric dot paper or isometric grid paper. And the isometric dot paper and grid paper are related to each other. I've found that the dot paper works a little bit better for my purposes. But basically the dots are in straight lines and they go that way, that way, and then vertically. And if you were to draw lines from these, all these angles meet at 120 degrees, or the lines meet at 120 degrees, which is where it comes, the word "iso" comes from, which is the Greek meaning the same. So all the angles are the same, they're all 120 degrees.

So how do we draw, then, an isometric drawing using dot paper? Well, one of the other things that we do is we use blocks like this that I have in my hand. These are snap cubes, and they are easily available through lots of different places in math manipulatives. And we use these to help us build our buildings. But the one thing that we tell the students to make sure about is that they don't sketch all of the individual blocks. They just sketch the outlines. So where you have two surfaces intersecting is where you draw a line. You don't outline all the blocks. Now, we use a coded plan to define what a building will look like. So here is a coded plan: it has a two, a three, a one, a one and a one. So the numbers on the coded plan are telling you how high the building is at that particular location.

So right here, the building is two squares high, here is three squares high, and all of these are just a single block. So the first thing you would have students do is build this particular object. So if you start, I've got two blocks here. So that corresponds to that area. Now I'm going to put in three blocks, so now I've got the two blocks here and the three blocks here. I need three single blocks in those three locations. And so this is my completed building, then. And you'll see that it's got two blocks high here. It's three here; it's one here; it's one here, and it's one here. So this building then matches this coded plan.

Now when you have a coded plan, you need to define which angle you're looking at the building from. In this particular example, we're going to look at this from this corner here labeled X. So if this block, if this building is located here, we're going to imagine looking at it down like this, which means that the building actually looks like this because we're looking at it from that X corner. And this, then, is the isometric sketch of what that building looks like from that corner. So this, we call the X corner view and this is the isometric sketch of this particular building made out of blocks. Now a building can have more than one—has more than one corner view. It actually has four corner views. So here we've got a new coded plan. This is the particular building for that: two, three, one and one, and you'll see that the corner views are W, X, Z and Y. And if you look at it from the W view, it looks like this. If you look at it from the X view it looks like this. If you look at it from the Y view, it looks like this. And if you look at it from the Z corner, it looks like this.

So we have the students, then—we give them a coded plan and we say we want a sketch of the W view or the Z view, or you know, whatever the problem is. But they have to then—typically they would build this building out of the blocks and sketch what that looks like from the corner that you specify.

Now when sketching the object, the easiest way to do this is to think about sketching in one surface at a time as shown here. So you sketch in this first surface, then the second surface, then you keep going.

Now what I'd like to do is demonstrate what this looks like—what some of the problems we've used look like for this particular type of activity. So here we have an object. This is a multiple choice type of problem, and here we have a coded plan. It's two, one, two, two, one, one. If you build that particular building…it looks like that. Now a lot of times we don't let the student build the object with the blocks, but sometimes we do. And then the question is, "Of all of these objects shown here, which one is a view—one of the corner views of this particular object?"

Well, if you look at you can see that the correct answer to this problem is A and you're actually looking at it from this corner, right?

Now, to sketch the object is a little more difficult for the students, and it's also actually probably one of the more beneficial parts of the spatial skills development. So, what you would normally do is have the student build this coded plan. So this is a three, two, one and then all those one spaces there. So if I build this object…it looks like this. I've got a height of three, a height of one, a height of two, a height of one, a height of one and a height of one. This is my object that I have defined in my coded plan right here.

Now, it says here to, "Sketch the indicated corner view." So this particular view, I'm looking at from X, which means I'm going to look at the object from this direction and sketch what it looks like from that direction. So the way that you do this normally would be to start with the edge that's closest to you. In this case that's the edge right here on the object. So I would draw that. That edge has a height of the vertical edge and it's got a height of one. So I sketch that line in there.

Now, I want to pick one of the receding surfaces from that edge. So here's a surface that's going back towards the left. It's one unit high, and it's two units deep. So if I start at my edge I've drawn, go back two units, and one unit high, and that is what that surface looks like on isometric sketch paper.

Now I've got this surface right here, kind of an upside down, T-shaped surface, and that is going back from my original edge to the right. So if I want to sketch this, it goes back three, it goes up one, in one, back up one, and then making the T shape. So I'm going to go from the bottom. I'm going to go over three units, go up one, in one, and then make the T shape.

So that is what that particular surface looks like in the isometric sketch. Now I can add in all the other surfaces. I've got this small vertical surface. I've got this small horizontal surface. Now I've got this part here sticking up one from there. So if I got up one, and then I've got a top surface, and I ran out of dots – but that's okay. That goes down by two and across, and this goes down by two again and across that front like that.

So that, then, is what the isometric view of this particular object looks like. You can see that we normally have students practice several of these problems because it's practice, practice, practice. The more you do the better you get at doing the sketches. But this seems to help students develop their 3-D spatial skills – being able to take a 3-D object and translate that into a 2-D image on a sheet of paper.