**Coding instruction**

* Assign themes that you feel appropriate to each episode (7 episodes in total, randomly selected from episodes that are meaningful and may reflect children’s spatial thinking)
* More than one theme can be applied to each episode

**List of themes**

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| **Theme** | **Definition** | **Example** |
| **Spatial Ways of Representation** | | |
| **Quantities-to-size mapping** | Children representing value differences in the numerical data they selected by varying the sizes (e.g. length, width, height, volume) of the tangible materials through measuring or estimation | “*And like, I did the biggest one for the biggest amount. And then I see, like the rest of the pom poms, how much smaller they need to be.”* |
| **Spatial ordinal arrangement** | Children highlighting ordinal relationships in the numerical data they selected by ordering and positioning materials spatially (e.g. from smallest to biggest, from highest to lowest) | *“Maybe from smallest to biggest, instead of biggest to smallest… Because maybe some people see it differently, that it’s more important to produce more or less.”* |
| **Proportional unitizing** | Children formulating the rules to allocate units of measurement to specific quantities of materials to set visual parameters | “*We just made a certain, uh, amount for like one hundred, a certain amount for ten, for one, and a certain amount for five.”* |
| **Constructing Spatial Understanding through Embodied Making** | | |
| **Generating ideas and concepts to give visual-spatial forms to data** | Children developing preliminary ideas and concepts about the forms or methods they can follow to physicalize data visually and spatially, either in their mind or at the onset of interaction with the materials | *“Look, so it's going to be like this, one whole pie, okay? Pie chart…If I wanted to know how much India uses, I could measure how, like, how much uses. I could just, like, into a fraction.”* |
| **Evaluating and adjusting the methods and materials used to physicalize data** | Children evalutaing and adjusting the size differences, unit values, spatial ordering, ways to arrange materials, or the two- or three-dimensionality of their physicalizations as they interact with the materials | “*This one has to be filled slightly more…and the plastic it has to be filled exactly the same.”* |
| **Identifying a (mis) match between ideas and crafting skills** | Children bringing their ideas to life through crafting with materials, or realizing that they had to give up or alter some ideas due to the lack of crafting skills | “*so I first thought to make a pyramid, a diorama thing. Something like a, like a 3D thing, yeah. Yeah, but then I thought that, like, it would take a lot of time, and I'm really not that good at making crafts.”* |
| **Considering others’ spatial perspectives** | Children envisioning how their physicalizations will look like when viewed by others from different angles or perspectives | “*We can stuff some paper underneath and then put this on top to make it looks like more full. Because in a box you can only see what’s on top.”* |

**Episodes to code:**

**\*All children’s names are fictive\***

1. *Teo: So I made this scale, which is representing the five biggest, uh, kilogram countries. USA is the biggest one with 812, Germany, 809 kilograms, and so on down. Um, and each stick, the USA stick is a whole stick, and with each country, which is less kg, it gets smaller each time, as you can see.*

*Researcher: If you could do it differently, would you change anything?* *Teo: Maybe from... smallest to biggest, instead of biggest to smallest.*

*Researcher: Why?*

*Teo: Because maybe some people see it differently, that it’s more important to produce more or less.*

*A group of paint brushes on a table

Description automatically generated*

1. *Shay: Look what I made. you pull it.. (showing the movable plates) So we could like, um, make a pie chart. We can put the information right here.*

*Otto: Um, how will we fit five countries on that? I'm confused, um, which paper is which. I don't even know which plate is which anymore.*

*Shay: Look, so it's going to be like this, one whole pie, okay? Pie chart. And then this is how much... I'm going to have this representing, for example, just give me a pencil, please. Like, this is how much waste India has, okay? If I wanted to know how much India uses, I could measure how, like, how much uses. I could just, like, into a fraction.*

*Otto: A fraction, yeah, yeah, that would work.*

*Shay: Yeah. Then we can color it in how much which country to have what.*

*A person holding a yellow plate

Description automatically generatedA person holding a paper plate

Description automatically generatedA person holding a paper plate

Description automatically generatedA paper plate with a piece of paper on it

Description automatically generated*

*Researcher: If you could do it differently, what would you do?*

*Shay: Uh, I would not represent it in percentages.*

*Researcher: So Instead, you would choose to?*

*Shay: I would have not made the plate.*

*Researcher: But what would you do instead if you were doing it a second time?*

*Shay: I would've made it, like, not, like, in percentages, definitely. And this time it was waste produced per person, if it wasn't, I would've stayed with this idea. And I would have also made it a whole, because there was a little bit left (on the plate) Yeah, because one estimation was wrong, I guess. It should have been to 25. Instead of 20.*

1. *Pim: And after when I was done with all the balloons, I just thought to myself. Oh, well, I guess I could also make any like a stand that's like this. Yeah. That's standing upwards on the table. Mm-hmm. . And then I noticed that it wouldn't, it wouldn't just fit all of them and it wouldn't be high enough. So I noticed I could just flip my stand over and it would fit perfectly on the wall.*

A person holding a balloon

Description automatically generatedA person pointing at balloons on a string

Description automatically generatedA child holding a slingshot

Description automatically generatedA group of balloons in a classroom

Description automatically generated

1. *Researcher: Before even starting making this thing, do you have an image in your mind, like, how am I going to make it? and how is it different from your imagination?*

*Ashe: Yeah. It was really different because, I imagined of having like, using beads, and lay them down like in art forms.*

*(Ashe gestured to show how the plan was to make number five with the beads)*

*Researcher: So would you say previously you were thinking of, like a 2D representation*

*Ashe: Yeah, 2D, yeah. And I didn't have an idea back then, that’s like, kinda, good. And then I thought it would be really bad of presenting beads, which, which roll out. So then I had an idea of representing, like, you know, a graph with boxes, like, uh, say, like, 28% this, uh, uh, Like before, twenty eight and nine, thirty percent this, this year. (gesturing a bar graph) Like something like that, so. Like, I tried to evaluate, like, the graph, and I came out, and then I realized that I can use Legos as, like, pieces to represent, like, the height of the piece, and also, like, if there are small pieces, they represent zero. And that's why I thought that people, uh, will understand the height and the block number of it.*

A group of colorful objects on a table

Description automatically generatedA person's hands playing with lego blocks

Description automatically generated

1. *Lia: I have an idea, so for compost and food we can fill it up until halfway or something (putting the pom poms in the cup to explain the idea) say this is the recycling thing. And fill it up that much. Like, really little, for five percent. Then, say, for this one (compost), we fill it almost halfway. And then, for say, um, plastic. Say we don't have enough of glass. We can stuff some paper underneath and then put this on top to make it looks like more full. Because in a box you can only see what’s on top.*

*Zoie: Oh and we can put a mark on the front to say how much of it is inside, but you could also look inside to see like how full it is. So...*

*Lia: So, yeah. And we need some more cups. So we need five cups. So then we could just write, uh, plastic waste, and then fourteen percent, and then plastic.*

*Zoie: So then, um, how much we fill the plastic?*

*Lia: We have to fill exactly the same as the paper.*

*Zoie: What if, to make, say, the plastic higher, we can put this on top here, and then we put the lid… (they did not have enough plastic lid, but they thought of filling something else inside frist to show that there is some volume of plastic) And then we can fill that. It's full of plastic. So wait, but is this 14% about?*

*Lia: This one has to be filled slightly more…(% for plastic and % for paper) So the plastic it has to be filled exactly the same.*

*Zoie: That looks kind of the same.*

*Lia: Yeah, that's fine, that's fine. Although, this has to be more than this… The tin is 5%...*

*Zoie: So, this is 10% compared to 5%. That's about half.*

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*Lia: Yeah, I think. Look, I had this fun experiment. Let's dump them all into one and see if that makes exactly a full cup. A full hundred percent. I don’t think it will because I think it’s a bit too much. That makes about a full 100%.*

*Zoie: It’s a bit over, right?*

*Lia: Okay, I’m taking out one of each just to make it slightly smaller.*



1. *Beau: So, I made with my partner, like, this design to show how much waste ISD produces and which type, which type of waste ISD produces the most… So it's the bigger they are, the more trash. So like, this is really small, the 10% of the trash is of glass. 14% of the paper, cardboard slash paper. Plastic is also 14%. Compostable waste is a whole 43%. And I guess Compostable Waste was made out of quite a lot of things. Also the pom poms sizes weren't enough, so we decided to put multiple pom poms in the balloon to represent the compostable. So, you have to read to get the exact percentage, but you know which type of trash is more than this type of trash if you just look.*

*Paper plates with different colored objects on them

Description automatically generated*

1. *Zen: So, like, we need to make, one hundred kilograms equals one centimeter.*

*Eli: I'm gonna go look if there's a better format.*

*Researcher: You measured it with the ruler?*

*Eli: No, like, we did like an equation, like, for each hundred kilograms, we times it by, like, three. Otherwise, India would be too small to, like show. So, so this is...three centimeters.*

*Researcher: Why did you decide to times it by three?*

*Zen: Because, if you times it by two, it still would be, say India, it still would be small.*

*Eli: We're just gonna like, uh, write, then, we're just gonna put it in like a paper. Like a, like a line chart, like this.*

*Zen: Yeah, and then we're gonna place them like this.*

A paper with colorful worms on it

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