Math Buckets
Sorting and Patterning

Excerpts From Bridges in Mathematics
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Math Buckets: Sorting and Patterning
A Math Learning Center Publication

by Donna Burk & Allyn Snider
illustrated by Tyson Smith

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# Math Buckets: Sorting and Patterning

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Math Buckets  Sorting and Patterning
These activities are excerpts from Bridges in Mathematics, Grades 1 and 2. They are intended to enhance your use of the button, frog, and bug buckets, and may also be used as part of your sorting and patterning instruction for grades K–2.

The “You’ll need” list outlines supplies you need to gather in order to conduct the lessons. Deluxe Breakout contents are also listed; those who purchased an Economy Breakout will need to collect or make these items as well.

You’ll need  Deluxe Breakout includes
★ Unifix cubes  ★ Bug Sorting cards*
★ Button Sorting cards*
★ Frog Sorting cards*
★ bucket of buttons
★ bucket of frogs
★ bucket of bugs

*blackline versions of these materials are provided
Session A

PROBLEMS & INVESTIGATIONS

Button Detectives

Overview

The focus on sorting continues as children work first as a class and then in small groups to sort buttons in many different ways.

Skills

★ observing and describing likenesses and differences
★ sorting objects in a variety of ways

You'll need

★ bucket of buttons
★ 2 buttons you've selected from the bucket that are as different as they can be
★ paper tubs for distributing handfuls of buttons to small groups of students (Tubs should contain about 20–25 buttons each)
★ Button Sorting cards
★ Unifix cubes

Open the lesson by gathering children into a discussion circle. If you have a very large group, you might want to work at the overhead instead of on the floor. (Be sure to find two buttons among your collection that show some clear differences on the overhead.) In either case, display the two buttons you've selected from the button bucket. Ask children to talk with their neighbors about the likenesses and differences they can see, and then have individuals share their observations with the group.

Children One button is square. The other is round. The square one is black. The other one is clear. I have a square button like that on my coat. The buttons on my bathrobe are kind of square like that. My bathrobe has alphabet letters on it too. The little round button kind of goes in at the edges—it's a little bumpy. The big one has smooth edges. That big one has 4 holes. The other one only has 2 holes.

After they've had a chance to discuss the two buttons, distribute paper tubs of buttons to small groups of students. Give them a few minutes to play with the buttons and then ask that the students spread out all their buttons in front of themselves so they can see them clearly. Explain that you are going to display some cards that describe certain buttons, and you're going to ask chil-
dren to be detectives, hunting through their collections to find buttons that match the descriptions on the cards.

**Teacher**  Here comes the first card. Are you ready?

**Children**  What’s it say?
Round? That’s easy.
We’ve got this one and this one. We have some that look the same.
We have a whole bunch of round ones.

**Teacher**  Good job! Try this card.

**Children**  2 holes? That one’s easy too.
We have lots with 2 holes.
Do they have to look like the one on the card? We don’t have any like that.

**Teacher**  No, you don’t have to find buttons that match this one exactly.
You just have to find the buttons in your collection that have 2 holes.

**Children**  We have lots of those.
We have one just like the one on the card. It’s long and skinny.
Display six or seven more cards from your collection as children find buttons to match the descriptions. The idea is to give students some sorting practice as you introduce a collection of words and phrases that describe the buttons in your class collection. Finally, have children set their paper tubs of buttons behind them for a few minutes. Explain that you are going to introduce a sorting game that will be lots of fun and really stretch their brains.

After the buttons have been placed safely behind their owners’ backs so that they can focus on the activity at hand, ask the youngster on either side of you to help demonstrate. Take a small handful of buttons out of the button bucket and ask the class how you might sort them. Ideas will probably fly for a minute—by color: red, green, blue, yellow, silver; by size; by number of holes; and so on. Ask your two teammates which idea they want to try first, and work together to sort the handful of buttons in that way.

Explain to the rest of your students that they’ll be working in teams in just a few minutes. In order to get credit for each sorting idea, they’ll need to decide what to call each group of buttons, raise their hands together, and name each set as you come around and point to it. Explain further that each time a group finds a different way to sort their buttons, you’ll give them a Unifix cube as a “reward.”

Model this procedure with your little team, push the buttons back together, and go through the whole process once or twice more, using a different attribute—one suggested by the children—each time. When you think most of your students have the idea, send them out in teams of two or three, each with one of the paper tubs of buttons.

Watch for the hands to go up, taking the opportunity to reinforce the idea that everyone in the team will have to put his or her hand up before you’ll came to see their work. If you ask that they all name the groups of buttons each time, they’ll work together better and there will be less likelihood that one or two children will take over. We usually reward each round of sorting a team does with a Unifix cube; children seem to like that concrete acknowledgment. The more competitive youngsters may be looking over their shoulders to see how many cubes the other groups are getting but, for the most part, the cubes seem to help focus efforts and keep children stretching for new ideas.
You will probably have to do a bit of teaching right on the spot, as some groups may come up with sorting methods that involve unrelated categories. (“See our buttons? We have the big ones here, the white ones over here, the pretty ones here, and the gold ones here.”) Take the opportunity to demonstrate and explain related categories quickly. (“This is great! I wonder if you could sort all your buttons by color next time. You already have the white ones here and all the gold ones in a different pile. What color is this button? Red? Great! How about putting all the red ones in another pile, and all the black ones here. That way, all your buttons will be sorted by color.”) You may have to repeat this sort of instruction several times with some of your groups. If it looks like an overwhelming majority of them don’t get it, you might pull your students back quickly and do more whole-group modeling; more than likely, some of them will already know what to do. Remember that there will be other opportunities to sort items soon.

At the end of the activity, collect all the cubes from around the tables, snap them together, and ask children to estimate and count how many sorting methods the entire group came up with. This acknowledges everyone’s incredible work and effort, without making it seem like it was a contest.
Session B

PROBLEMS & INVESTIGATIONS

Math Bucket Sorting

Overview
Using the game they learned last session, children continue to sort collections of objects in many different ways.

Skills
★ observing and describing likenesses and differences
★ sorting objects in a variety of ways

You'll need
★ small collections of math bucket items (Put several collections of 20–30 bugs into small ziplocks. Do the same with items from the other buckets so you wind up with 2–3 sacks of bugs, 2–3 sacks of buttons, and 2–3 sacks of frogs. Be sure that none of the collections has more than 30 items.)
★ Unifix cubes

Gather students into your discussion circle and explain that you are going to play the sorting game again today. This time, however, students will be able to sort bugs, frogs, or sea creatures instead of buttons if they choose. Take time to model the game with two helpers, using a sack of bugs or frogs, as the other children make suggestions.

Teacher  Wow! this is quite a collection of bugs. How shall we sort them?

Children  I see 3 spiders. I know! You could do spiders and not-spiders. Do the ones with wings!
But some have wings that you can’t see. 
Spiders—spiders don’t have wings. 
You could do the ones with wings you can see and ones where you can’t see them. 
Do spots and not spots! 
Could we do the ones that fly and the ones that don’t fly? 
Stingers! Look at that scorpion. Do the ones with stingers and the ones that don’t have stingers.

**Teacher** You have so many different ideas. I can tell that you learned a lot from the work we did earlier this month. Team? What do you say? Zanny? Matt?

**Zanny** Let’s do spots and not spots.

**Teacher** Is that okay with you, Matt?

**Matt** Sure.

Once children have seen the activity modeled once or twice, send them out to work in small groups, each one with a ziplock bag of frogs, bugs, buttons, or sea creatures. Remind them that in order to get credit for each sorting idea, they’ll need to decide what to call each group of objects, raise their hands together, and name the sets as you come around and point.

If it worked to reward groups with a Unifix cube for each new sorting idea last session, try it again today. Let children work for 10 to 15 minutes with their collections of items—long enough to get past the most obvious ideas and really begin looking for likenesses and differences. At the end of the activity, collect all the cubes from around the tables, snap them together, and ask children to estimate and count how many sorting methods the entire group generated.
Math Bucket Graphing

Overview
Now that children have had several opportunities to sort the math bucket items, they will create their own graphs by laying the actual items out on paper graphing mats and then drawing pictures of their results.

Skills
★ sorting
★ creating and interpreting 2-column real graphs
★ drawing to represent data

You’ll need
★ small collections of math bucket items (Use the ziplock bags of bugs, frogs, and buttons you put together for Session B. For this lesson, you’ll need a bag of 20–30 items for every 2 children in your room.)
★ Math Bucket Sorting cards—bugs, frogs, and buttons (Split each set into 3 or 4 smaller sets, depending on the number of children in your classroom. Just put sets of 5–6 sorting cards right into the ziplocks along with their corresponding math bucket items.)
★ Graphing Mats (Blackline 1, run several copies for each pair of children. If you think it might be difficult for children to lay the papers end to end and keep them together, tape them before the lesson to create long mats like the one shown on the left.)
★ drawing paper, crayons, and pencils

Gather children into a discussion circle and explain that today, they are going to work in partners to create their own graphs about the math buckets items. After choosing a bag of items and sorting cards, they’ll dump their items out and have a good look at them. Then they’ll choose two sorting cards from their collection, find the items that match the descriptions on the cards, and work together to lay them out on their paper graphing mats. Finally, they’ll each create a picture of their results. You’ll want to model the entire procedure at least once before sending children out to work with their partners.
Teacher  Today, we're going to make graphs about some of our math bucket items. You'll be able to choose the bugs, frogs, or buttons.

Children  I want the bugs—they're my best!
 I like the frogs.
 Not me—I like buttons the best.
 What's a graph?

Teacher  Good question. What is a graph, anyway?

Anna  A graph is what tells you more.

Will  I remember! We made a graph of sea creatures. We found out that dolphins had more than turtles.

Teacher  Sure! And do you remember the class graph we made to show which number filled up the column first in our spinner game, Which Numeral Will Win?

Stephanie  Yeah! It was funny how the 2 got the most.

Teacher  Well, what you're going to do today is work with a partner and a collection of math bucket items to make a graph. I'm going to show you how to do this activity, but I need one of you to help me. Lauren? Okay! Which of these sacks shall we use?

Lauren  Let's use the frogs.

Teacher  Okay, and we'll need a little set of the Frog Sorting cards as well. Let's put all of our frogs out in the middle of the circle so everyone can have a look.

Children  Wow! Look at all those little guys!
 I like the green ones.
 I like those blue ones with the spots.
 I like the ones that look like leopards.
**Teacher**  Let's have a look at the sorting cards that came in this bag of frogs now. Ready? Let's read the descriptions together.

![Sorting cards](image)

**Teacher**  Hmmm... Which 2 cards shall we use to sort and graph our frogs?

**Lauren**  Let's use the ones that say “green” and “sitting.”

**Teacher**  Okay. Do you think we have more green frogs in our collection or more frogs that are sitting?

**Children**  Green frogs!
There are way more green frogs—1, 2, 3, 4, 5, 6, 7, 8!
There aren’t so many that are sitting.

**Teacher**  Let’s put the green frogs on one side of our paper graphing mat and the sitting frogs on the other so we can get a really good look at this. Lauren, will you help me arrange our frogs?
Children Hey, look! There are more green frogs.
Lots more!
All the frogs that are sitting are brown.
What about the rest of the frogs?
They’re not green!
And they’re not sitting! They can’t go on the graph.

Teacher This is really interesting. How many more green frogs are there than sitting frogs?

Children 8! There are 8 more green frogs.

Teacher Well, it’s true that there are 8 green frogs, but there are also 4 sitting frogs. How many extra green ones are there?

Children 8!
No, 4! There are 4 extra green ones.

Although most of your students will readily tell you which group has more, they may not be able to explain how many more, or how many fewer just yet. They will have many more opportunities to read and interpret graphs this year, so don’t belabor it right now. The final step in your demonstration will be to explain that children need to make pictures of their results in order to share them with classmates. We recommend that you have children invent their own ways of showing the data, both to get a sense of their abilities to organize data at this point in the year, and also because students’ own methods of representing information are more meaningful to them right now than formal graphs.

If you are careful to explain the drawing task without modeling it, you may see a range of responses. Many students will draw each item. Some will invent some kind of coding system, and a few might draw their own version of the graph itself. Children can be encouraged to use their sorting cards to help spell the words they need to label their work.
Once you have modeled the task, quickly review all the steps with your students and then send them out to work in partners. Each pair of children will need one sack of math bucket items, five or six sorting cards, and several paper graphing mats (either separate or taped together). You might want to distribute drawing paper, pencils, and crayons as children finish setting up their graphs and explaining them to you.
Session D

PROBLEMS & INVESTIGATIONS

Math Bucket Sorting  Venn Diagrams

Overview
Students use sorting cards to sort collections of items from the math buckets. Because they’ll be sorting by unrelated categories sometimes, such as “large” and “4 holes,” they will use a 2-circle Venn diagram to define their sets visually.

You'll need
★ the math buckets—buttons, frogs, and bugs (Every 3–4 children in your class will need a collection of objects. You may want to divide the items from each bucket into 2 ziplocks for this activity.)
★ Venn Diagram Sorting Mats (Blackline 2, 1 copy for each group of 3–4 children)
★ Math Bucket Sorting cards
★ Unifix cubes

Skills
★ creating and analyzing Venn diagrams
★ sorting objects by related and unrelated categories

Gather your students in a discussion circle. Explain that they’re going to start in the same groups they were in yesterday, and that they’ll be using the math buckets to do a different kind of sorting activity today. With two children as your volunteer “team,” demonstrate the following:

1. Get the button bucket and the corresponding set of sorting cards. With the two children helping you, lay the cards out on the floor one by one, reading them as you go.

2. Open the button bucket and take out a small handful of buttons—no more than 30.

3. Shuffle the button sorting cards thoroughly and then turn them face down. Let each of your two volunteers pick one. Have these children read their cards to the group and then lay each card beside one of the sorting circles on your mat.

4. Work with your two volunteer teammates to sort the handful of buttons according to the two cards. You’ll probably end up with four groups of buttons—one group inside each circle, one group that shares both attributes, and a fourth group that has neither.
Explain to the children that once their group has gotten this far, they need to raise their hands. When they do, you’ll come around to look at what they’ve done, award them a Unifix cube for their work, and ask them to push their objects back together, pick two more sorting cards, and repeat the process.

After demonstrating the process once or twice, send your students out to work in the same groups they did yesterday. You might even want to have them start with the same math buckets they used yesterday, and then after 5 or 10 minutes, trade buckets and cards with another group. Remind them that they’re to shuffle the cards thoroughly and pick two at random each time they sort. Also, they’re not to use any more than 30 items from their math buckets. Be aware that some children might have trouble with the idea of intersecting sets. You might have do a little more teaching as you circulate, showing them that sometimes objects fit into both categories and can be placed on the mat in the spot where the two circles come together, and sometimes some of the objects don’t fit in either category and have to be left off the mat entirely.

After another 10 minutes or so with new buckets, you might want to end the activity by having the groups leave their final sorts arranged carefully on the mats. The two sorting cards they used for this final sort should be laid face-down next to the correct circles. The remaining cards should be put away inside the math buckets so they don’t confuse anyone. Children can then circulate singly or in pairs to guess how each group has sorted its objects. When they think they have it, they can peek at the sorting cards to check. This step is optional, but it’s lots of fun and really requires some good thinking.
Math Bucket Mystery Patterns

This Work Place Basket will need
★ the math buckets—buttons, frogs, and bugs
★ a set of sorting cards for each math bucket

Skills
★ sorting and patterning objects in a variety of ways
★ analyzing likenesses and differences
★ making generalizations

To Work
1. Take a handful of items from one of the math buckets. Find a way to sort them other than by color, and then line them up in a pattern. You can either think of your own way to sort the items or use the sorting cards for that bucket to help. Here’s an example. These buttons have been sorted by the number of holes and then patterned accordingly.

![Buttons patterned by number of holes]

Teacher  This arrangement does not look much like a pattern unless you really study it carefully, and that’s what you want to create—something tricky.

2. After you’ve made a mystery pattern, find a friend to come figure it out.

Instructional Considerations for Math Bucket Mystery Patterns
Following the Math Bucket Sorting lessons presented in Sessions A, B and D, this Work Place encourages students to combine their sorting and patterning skills. The idea is to set up a pattern that isn’t obvious at first glance using items from one of the buckets. If you sort by attributes other than color, size, or shape, this is quite possible to do. Here’s an example:
In order to decipher the pattern, you have to figure out what’s alike and what’s different from button to button. (This pattern is ridged, non-ridged, ridged, non-ridged, and so on.)

Second graders really seem to delight in the idea of making patterns that are “mysterious” enough to stump their teachers and friends. They will often persevere at this Work Place for quite a long time, setting up pattern after pattern, each a little trickier than the one before.

We demonstrate the activity by taking a handful of items from one of the buckets, sorting carefully for the ones that match in color, setting up an absolutely obvious pattern, and telling them that if they were a year or two younger, we’d think such a pattern was a brilliant creation. Then we look through the sorting cards for the collection with which we’re working. When we hit on a card or two that helps us sort in a less obvious way (say, shanks and ridges for the buttons), we use the idea to create a pattern that doesn’t look much like a pattern unless carefully analyzed. This brief demonstration is enough to get most students started. Those who don’t understand at first often “catch on” by watching their classmates for a bit.
Venn Diagram Sorting Mat
Bug Sorting Cards

Make 2 copies, each on different colored cardstock. Color. Cut apart on thin lines. Laminate.

<table>
<thead>
<tr>
<th>Bug</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Green Insect" /></td>
<td>green</td>
</tr>
<tr>
<td><img src="image2" alt="Not Green Insect" /></td>
<td>not green</td>
</tr>
<tr>
<td><img src="image3" alt="Purple Insect" /></td>
<td>purple</td>
</tr>
<tr>
<td><img src="image4" alt="Not Purple Insect" /></td>
<td>not purple</td>
</tr>
<tr>
<td><img src="image5" alt="Red Insect" /></td>
<td>red</td>
</tr>
<tr>
<td><img src="image6" alt="Long Insect" /></td>
<td>long</td>
</tr>
<tr>
<td><img src="image7" alt="Short Insect" /></td>
<td>short</td>
</tr>
<tr>
<td><img src="image8" alt="Wings Visible" /></td>
<td>wings you can see</td>
</tr>
<tr>
<td><img src="image9" alt="Wings Hidden" /></td>
<td>wings you can’t see</td>
</tr>
</tbody>
</table>

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Bug Sorting Cards

Make 2 copies, each on different colored cardstock. Color. Cut apart on thin lines. Laminate.

- 8 legs
- 6 legs
- spiders

- insects
- spots
- no spots

- beetles
- crawl only
- crawl & fly
Button Sorting Cards

Make 2 copies, each on different colored cardstock. Color, cut apart on thin lines, laminate.

<table>
<thead>
<tr>
<th>Plastic</th>
<th>Round</th>
<th>Not Round</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ridged</td>
<td>Not Ridged</td>
<td>Bumpy</td>
</tr>
<tr>
<td>Designs</td>
<td>Transparent (can see through it)</td>
<td>Opaque (can't see through it)</td>
</tr>
</tbody>
</table>
### Button Sorting Cards

<table>
<thead>
<tr>
<th>White</th>
<th>Brown</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="White Button" /></td>
<td><img src="image" alt="Brown Button" /></td>
<td><img src="image" alt="Red Button" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Black</th>
<th>2 Holes</th>
<th>4 Holes</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Black Button" /></td>
<td><img src="image" alt="2-Hole Button" /></td>
<td><img src="image" alt="4-Hole Button" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1 Hole</th>
<th>Shanks</th>
<th>Metal</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="1-Hole Button" /></td>
<td><img src="image" alt="Shank Button" /></td>
<td><img src="image" alt="Metal Button" /></td>
</tr>
</tbody>
</table>

Make 2 copies, each on different colored cardstock. Color. Cut apart on thin lines. Laminate.
<table>
<thead>
<tr>
<th>Frog Sortong Cards</th>
<th>Make 2 copies, each on different colored cardstock. Color. Cut apart on thin lines. Laminate.</th>
</tr>
</thead>
<tbody>
<tr>
<td>frog</td>
<td>brown</td>
</tr>
<tr>
<td>frog</td>
<td>more than 2 colors</td>
</tr>
<tr>
<td>frog</td>
<td>spots</td>
</tr>
<tr>
<td>frog</td>
<td>not green</td>
</tr>
<tr>
<td>frog</td>
<td>2 colors</td>
</tr>
<tr>
<td>frog</td>
<td>no stripes</td>
</tr>
<tr>
<td>frog</td>
<td>green</td>
</tr>
<tr>
<td>frog</td>
<td>red</td>
</tr>
<tr>
<td>frog</td>
<td>stripes</td>
</tr>
</tbody>
</table>
Frog Sorting Cards

Make 2 copies, each on different colored cardstock. Color. Cut apart on thin lines. Laminate.

- bumpy skin
- crawling
- spots that aren’t black
- smooth skin
- legs in
- black spots
- no spots
- stripes and spots
- sitting