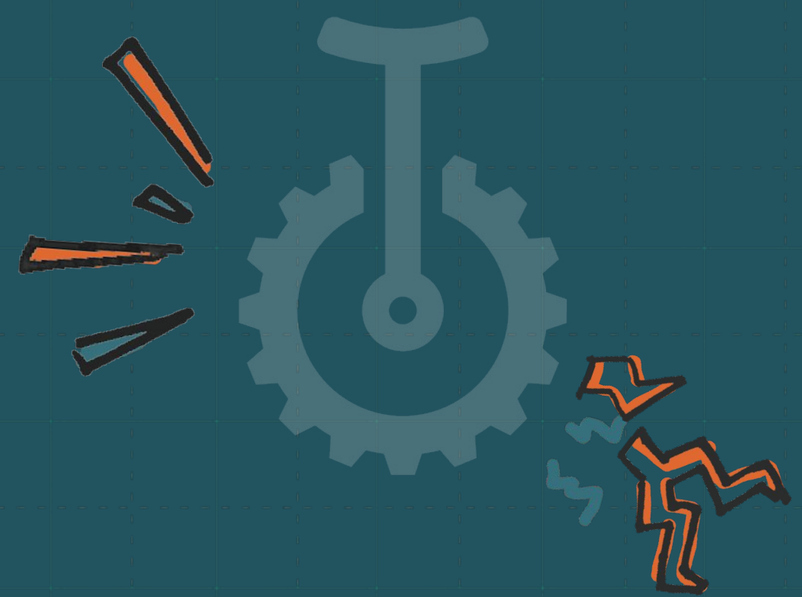
TWO BIT CIRCUS
FOUNDATION
· INVENTING INSPIRATION ·

SOHO IMPACT

BRICK PLAYBOOK

PARENT EDITION

PLEASE NOTE
We waive all responsibility for accidental violations of physics and/or eyebrow injuries.



Dear reader, inventor, and inspiring leader,

Whether you are a parent, an aunt or uncle, or a friend of the young makers and inventors who will work with our Bricks Project Book, I want to share our excitement and our cautions as we release this material to you.

Our goal is to spark curiosity in this next generation of learners. We attempt to do this through prompts, provocations, and challenges that inspire the young individual to want to know more, to search for what's out there, and to create new questions that will propel their interest and inventions.

We are supplying you with all the information we can in support of your effort to inspire your next generation of inventors and creators. Please, be cautious when you share the "how-to" portion of this book with them! Don't direct the process, support it. Even if you know what the child is about to do will fail. It isn't because we are trying to be difficult or mysterious or even proprietary, it is because we firmly believe that the value comes in the struggle to create. Failure is new information and the child will learn more from the experience than from our warning.

If you buy a child an expensive robotics kit they will learn to build a robot by following the instructions and will build what the creator of that kit designed. That will help develop "follow-the-instructions" employees for the future. There will be less need for that since the robots we are making will take on those jobs. However, if you supply random material and a few old motors and ask the child or children to build a robot, you will inspire them to become problem solvers. You will prompt critical and creative thinking. In doing this, you help build a muscle that will serve the child for the rest of their life.

Let's nurture a generation of children who can experiment and be comfortable with the failures that will be inherent in the creative process. Let's build a sense of "yes I can" solve that problem, build that contraption, and make my world better through trial and error. We want them to know that failure is the reality for all great inventors throughout history. Thankfully, those inventors knew that success was on the other side of well-considered failures. Patents come from this process. Let's encourage our children to see themselves as inventors and patent holders.

Thank you for taking this journey with us. And, please do share with us pictures and stories of your experience in this adventure!

Onward,

Dr. Leah Hanes
CEO
Two Bit Circus Foundation

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BRICK PLAYBOOK PARENT EDITION

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BRICK PLAYBOOK PARENT EDITION

Project 1

Build a Bar Chart

Objective: Child will be able to create a bar graph representing statistics.

Essential Question(s): How can we show trends and patterns in our community and/or environment?

Special Materials: Paper and pencil for recording data, sticky notes for labeling brick chart
Bricks Required: 16x16 plates, 1x1 and 2x2 bricks

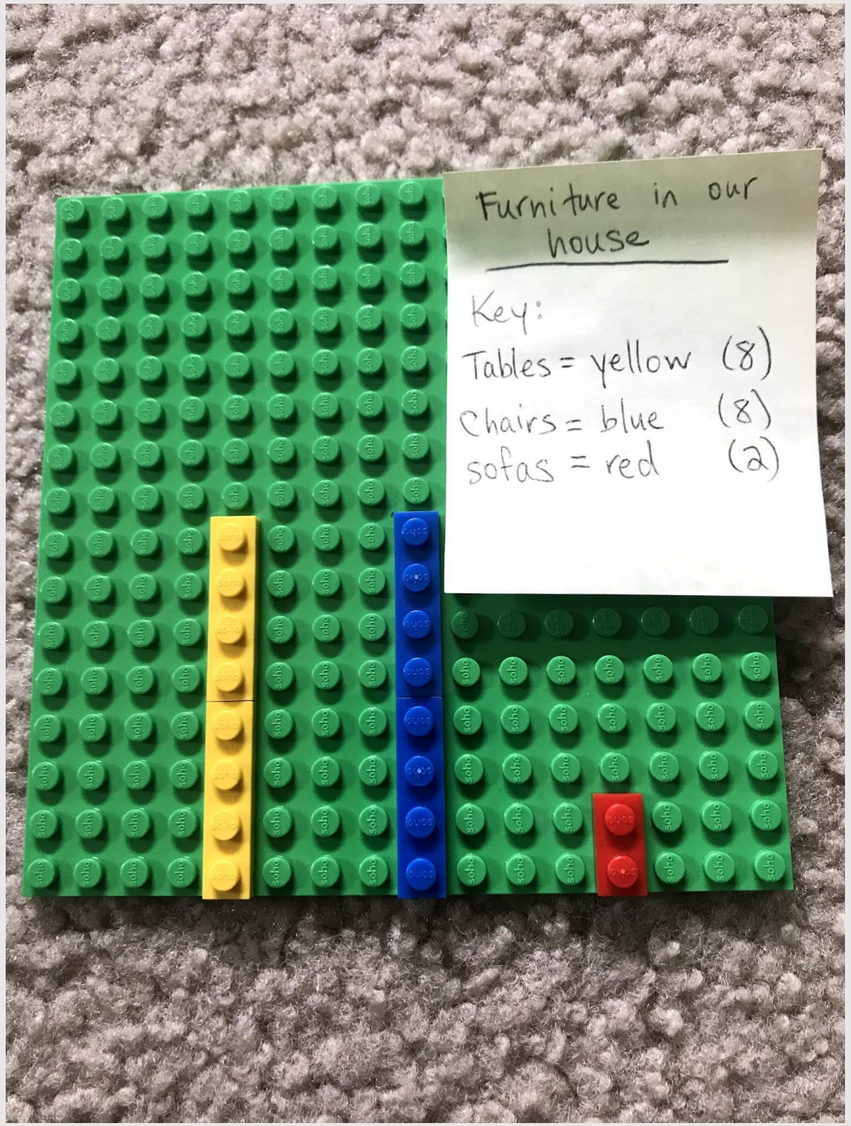
Project Structure:
Engage/Explore:

1. Begin by asking about patterns in the environment. “What sorts of things can you observe and count?”
    a. Ideas: hair color, types of furniture, anything that can be counted and categorized.
2. Explain how representing patterns visually makes comparing things easier.
    a. “How might we visually represent how many pens and pencils are in the container?”
        i. Tell child to count the pens and pencils and represent the respective numbers using a manipulative (SOHO bricks).
        ii. Child will create piles or lines of two different-colored 1x1 bricks to represent the numbers.
    b. “How do we know if the bricks are representing pens or pencils?”
        i. Child might suggest color differences or writing labels to identify which pile is which.

3. Provide child with 16x16 plates.
    a. Ask child how they might use their plate to organize the bricks which are representing pens and pencils to better keep track of them.
        i. Point out that there are many pens and pencils in the room, and ask what can be done to make the graph fit on the 16x16 plate.
            1. Child may suggest using a bigger brick, such as 2x2, to represent multiple items.
            2. Suggest using each 2x2 brick to represent five items, as counting by fives is easier; or to represent four items, so that each stud visualizes multiple items evenly.
            3. Allow time for child to arrange the bricks.
        ii. Facilitate child’s development towards a bar graph by encouraging organization.
            1. Ask: “How will we know which are representing pens and which are pencils?”
            2. Child should be labeling, creating a key, or both.
    b. Grab a small bundle of a third category of item, such as markers.
        i. Ask: “How might we add the number of items in the third category to our brick plate?”
        ii. Allow time for child to add additional bricks in a third color while facilitating their organization and tracking.

Explain/Explore:

1. Decide what to count from the list generated at the beginning of the Engage section.
2. Gather data using tally marks on paper or piles of SOHO bricks.
3. Encourage child to count three times to verify the accuracy of their data.
4. Child creates a bar graph using bricks. Graphs may be two- or three-dimensional. Child should label the axes of their chart.
5. Once child has completed their bar graphs:
    a. Have them generate at least two “how many more/less” questions for analyzing and interpreting their data.
    b. Child should then create an answer key on the back of their paper.



Project 2

Bricks Measure Up

Objective: Child will be able to create a ruler and measure everyday objects.

Essential Question(s): How do we measure things? What are units and why are they important?

Special Materials: Smallish, straight-edged objects to measure (books, crayon boxes, etc.)
Bricks Required: 2x8 plates, 2x1 and 2x2 bricks

Project Structure:
Engage/Explore:

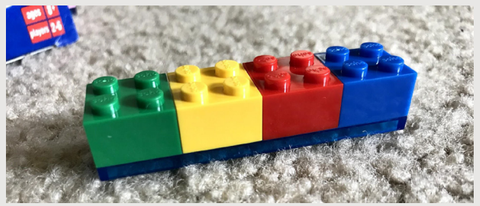
1. Prepare an assortment of SOHO Bricks for child.
2. Ask child if they know the length of an item of furniture in the room.
    a. Child may take a guess at the length and write it down.
    b. "I think it is _____ long."
3. Prompt child to find a way to measure the length of the item to find an answer.
    a. Use bricks as an easy and consistent measuring tool.
    b. Child may choose not to use bricks; any object will suffice as long as it is small enough to measure the item.
4. Allow child time to experiment with ways to measure their table.
    a. Serve as a facilitator for their measurement process.

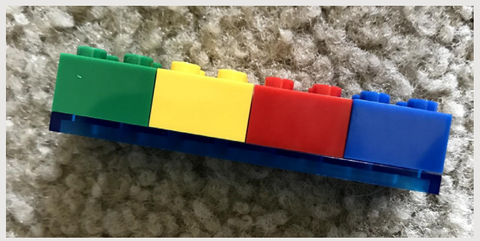
Explain:

1. Ask child to create a measurement tool (ruler) using the SOHO Bricks.
    a. Child can use 2x8 plates and different colored bricks(2x1 or 2x2) to scale their ruler to their liking.

Elaborate:

1. Child can now use their ruler to provide measurements for a plethora of things in the house or backyard.
2. Child can keep track of their measurements in a data table with measurements, written descriptions, and images.
3. Extension: Make new rulers, but with type of bricks that have not been used already, and measure again. Helpful for introducing the idea of feet and inches.
4. Child can use conventional units to complete measurement tasks.





Project 3

Decoding Area

Objective: Child will be able to find the area of an irregular shape using various methods (counting, breaking design into colors).
Essential Question(s): What strategies can we use to find the area of an irregular shape?

Special Materials: paper and pencil for recording data
Bricks Required: 16x16 plates, various bricks for "drawing" an image

Project Structure:
Engage/Explore:

1. Give child a 16x16 plate and additional bricks of various colors and sizes. Ask child to make a two-dimensional design using the bricks, which can be abstract or representational. You may wish to limit child to choosing three or four colors.

Explain/Explore:

1. Discuss the concept of area, talking about counting studs, or using the arrays found in rectangles. Demonstrate this using your own creation.
2. Child can find area in various ways, and should keep track of their data:
   a. Area of the whole image
   b. Area of the unused part of the 16x16 plate
   c. Area of each color they used
3. Encourage child to look for patterns in their creation. Do they tend to use the same brick size a few times? What colors do they use? etc.

Project 4

Define Your Perimeters

Objective: Child will be able to find the perimeter of rectangles.

Essential Question(s): What strategies can we use to find the area of an irregular shape? How do we find the perimeter of a rectangle?

Special Materials: Paper and pencil for recording data
Bricks Required: 16x16 plates, 1xN bricks for building the house

Project Structure:

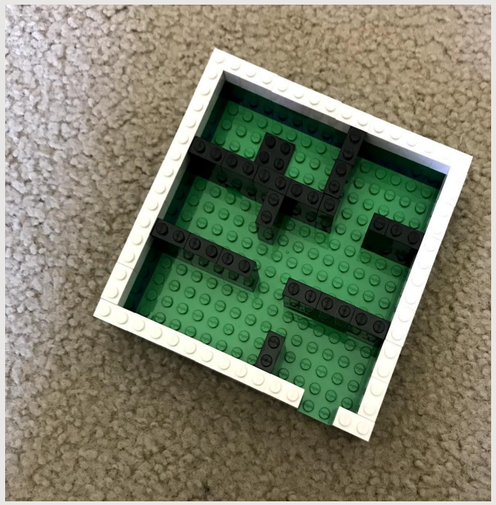
1. Give child a 16x16 plate and additional 1xN bricks for building a house. The house should include walls within the interior; gaps for windows and doors are optional. Child may furnish their houses with additional bricks (2xN-plus).
2. Ask child to make a list of the rooms and count the sides of each, measuring the area of each one by counting the wall studs.
3. Ask child to add up the areas of each room to find the total area of the house.
4. Child should use their lists to find the perimeter of each room. They should also find the perimeter of the whole house. It's OK for the house not to be perfectly square.

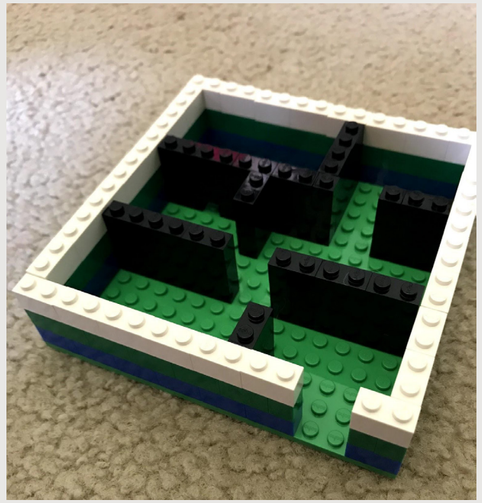
Engage/Explore:

1. Provide child with 16x16 plates to build a floor plan of a house or school.
2. Ask child to use different colored bricks for the interior and exterior walls.
3. Ask child a series of questions to determine, based on their floor plans:
    a. "How do you find the perimeter of each room?"
    b. "How might you determine the area of the entire structure?"
    c. "How did you find the area of each room?"
    d. "How did you find the area of the entire structure?"
4. You may find that the child counts the number of studs per wall as part of their measurements. Be sure to facilitate understanding of why width of walls should not be included.
5. Have child take measurements in SOHO studs.

Explain/Elaborate:

1. Provide child time to explain their answers to the perimeter and area questions above.
2. Child should discuss and articulate the ways in which they can determine complex areas.
    a. "Is there more than one way?"
    b. "Do you get the same answer when using multiple methods?"
3. Have child repeat the process using the metric system.





Project 5

The Brick Street Irregulars

Objective: Child will be able to find the area of an irregular shape.

Essential Question(s): What strategies can we use to find the area of an irregular shape?

Special Materials: Paper and pencil for recording data
Bricks Required: 16x16 plates, 2x2 bricks, 2xN plates, 2x2 clear blue tiles

Project Structure:
Engage/Explore:

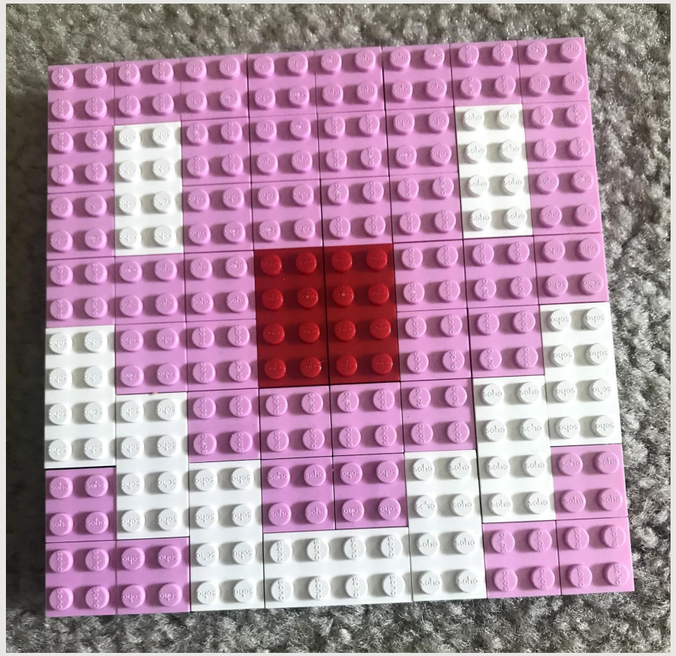
1. Show child a SOHO brick of your choosing and ask them to find the area of the brick using the SOHO studs as units.
    a. Provide time for child to solve the problem and facilitate their critical thinking.
    b. Pending their familiarity with area, you may have to do additional scaffolding.
2. Solve the problem as a team, exploring ways of determining the area by adding and multiplying the studs. Review the idea that multiplication is just a faster way of adding.
3. Ask child to design a 2-dimensional image of their choosing.
    a. Use no more than 3 colors of bricks.
    b. Bricks may not overlap.
4. Ask child, "how might we find the area of the entire 2-dimensional image?"
    a. Provide child time to brainstorm their approach to solving the challenge.
    b. Have child map out their strategies, for example:
        i. Counting each dimple independently.
        ii. Calculating the area of each color/type brick and multiplying by amount of bricks.

Explain

1. Have child execute their chosen strategy to determine the area of their image.
2. Child should keep track of their data in a table.
3. When they are finished, have the child reflect on their process for determining the area.
    a. What techniques did they use to determine the area?
    b. Was their method the simplest and most efficient way to determine area, or did they modify their strategy as they went?

Elaborate

1. Ask child to repeat the process using a different method than the first time.
2. For an added challenge, ask child to determine the areas using metric units.



Project 6

Every Brick Tells a Story

Objective: Child will be able to create an imaginary object or creature out of bricks and use it as the basis of a narrative.

Essential Question(s): How do I use my imagination to create something new with limited supplies? How do I tell a story that moves the reader from the beginning to the end?

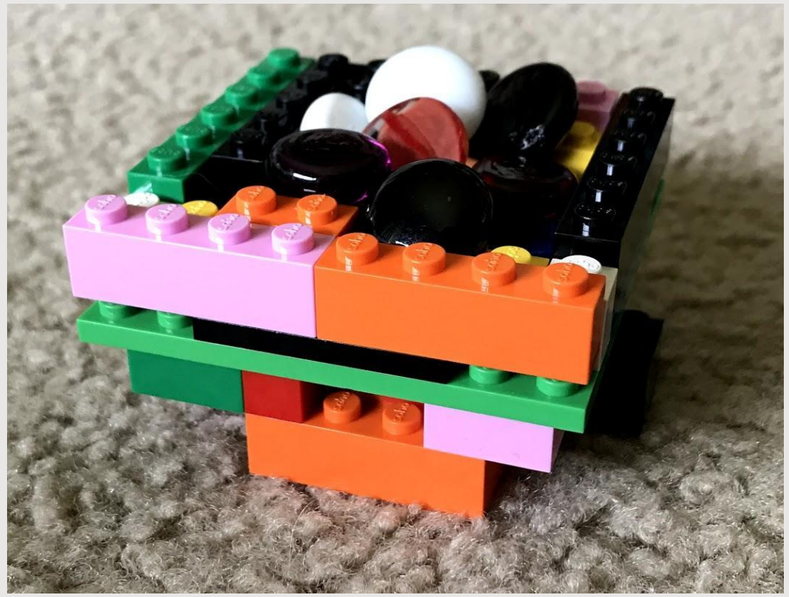
Special Materials: Paper and pencil.
Bricks Required: Any assortment

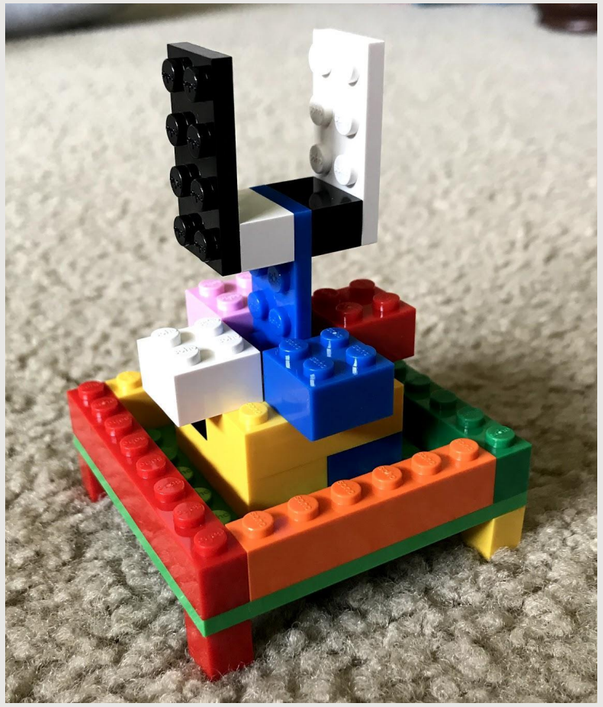
Project Structure:
Engage/Explore:

1. Hand out bricks, asking the child to create something with them: “Make something! Can you make a tool? A creature? What else can you make? Is there a top of the brick? Which side is up? How can you put them together in unexpected ways?”
    a. Emphasize that there isn’t necessarily a “top” or “bottom,” and that child should think about the texture they like, etc.
2. Allow time for child to build.

Explain/Elaborate:

1. When the child has finished building, ask: “What situation would this object be helpful in? Who uses it? If it’s a creature, what does it like to do?”
2. Ask child to plan their stories. How does their story begin? What’s the situation? Who are the characters? What choice does a character need to make? How does another character respond to the choice in words and actions?
3. Ask child to write the first draft of their stories. They may revise and publish as well as illustrate their story with a picture of their creation.





Project 7

Bricks... They're Multiplyin'

Objective: Child will understand the commutative property of multiplication.

Essential Question(s): How does multiplication work? Is there a direction, or can it be flipped around?

Special Materials: Paper and pencil for recording data.
Bricks Required: 16x16 plates, 2x2 or 1x1 bricks

Project Structure:
Engage/Explore:

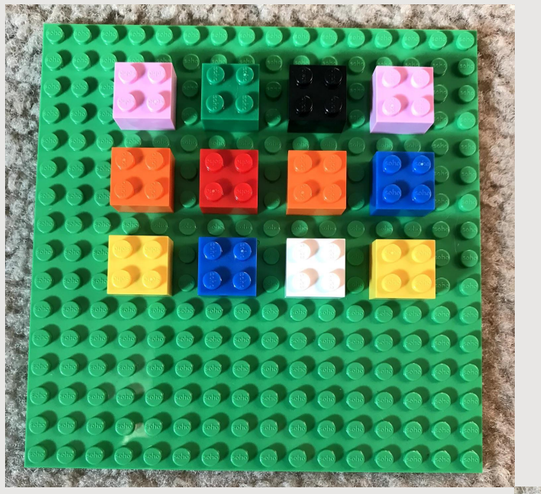
1. Distribute one 16x16 plate and 24 2x2 or 1x1 bricks.
2. Ask child to lay out a row of 4 bricks on the plate, then add 2 more equal rows.
3. Have child create a multiplication sentence based on their brick outlay.
4. Child then rotates their plates 90 degrees. Ask them to create a new multiplication sentence based on the new orientation.
5. Ask child to solve both multiplication sentences on a sheet of paper.

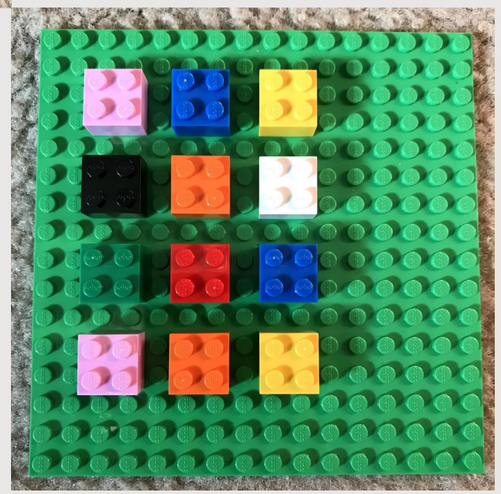
Explain:

1. Ask child: if they were to do the problems backwards, would they get the same answers? Why or why not?
2. Child should test their reasoning on a few problems and explain (commutative property).
3. Ask the child to lay out 1 more row of bricks (at this point it should be a row of 3 after the rotation). Then ask what the new multiplication sentence is (3x5).

Elaborate:

1. Have child create more arrays and share their multiplication sentences, rotating the 16x16 plate accordingly.
2. Challenge: Given 12, 18, or 24 bricks, how many multiplication sentences can you create? (This lays the groundwork for permutations and combinations in future years.)





Project 8

Divide a Build

Objective: Child will be able to understand the basics of division.

Essential Question(s): How can we better understand division of large groups of numbers?

Special Materials: None.
Bricks Required: 16x16 plates, plates of other sizes (not 1x1 or 1x2)

Project Structure:
Engage/Explore

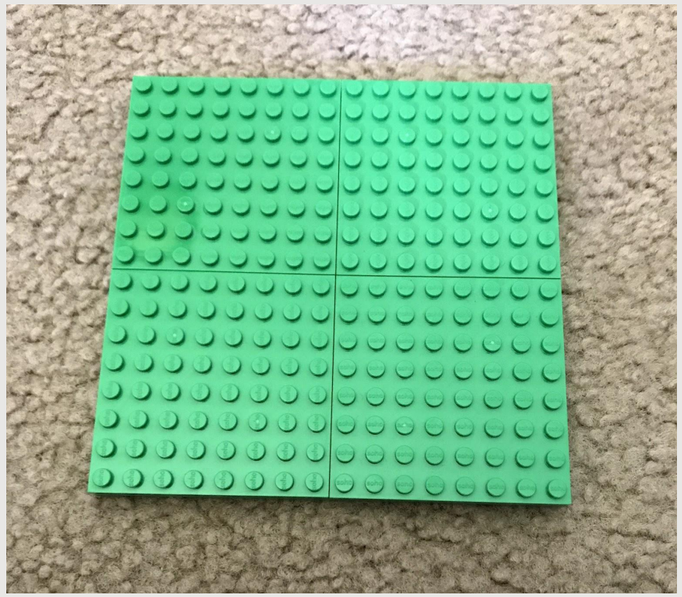
1. Ask child to use smaller plates to divide up a 16x16 plate by laying them next to each other and counting how many it takes to cover the whole plate.
2. Ask: "How many small plates did it take to divide the larger plate?" "Do you have any remainder or studs left over?"
3. Have child write out a division problem to reflect the model in front of them.

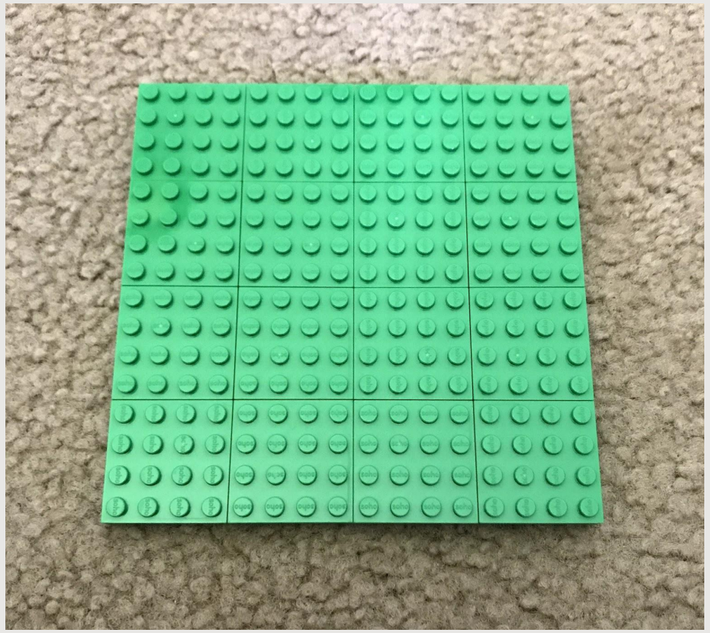
Explain

1. Ask child to repeat the process above using a different-sized brick to cover the plates
2. Have child model this division problem as well, and ask them how it differs from the previous one.
4. Child then calculates how many studs are on each plate, and writes a division sentence to show their math.
5. Have child compare their model to the written math problems to check their work

Elaborate

1. Provide child additional division practice problems on paper. They may choose to use SOHO bricks to support or check their work but it is not a necessity.





Project 9

Sort It Out

Objective: Child will be able to notice different ways of grouping items

Essential Question(s): How can we sort similar things? What aspects of objects are important?

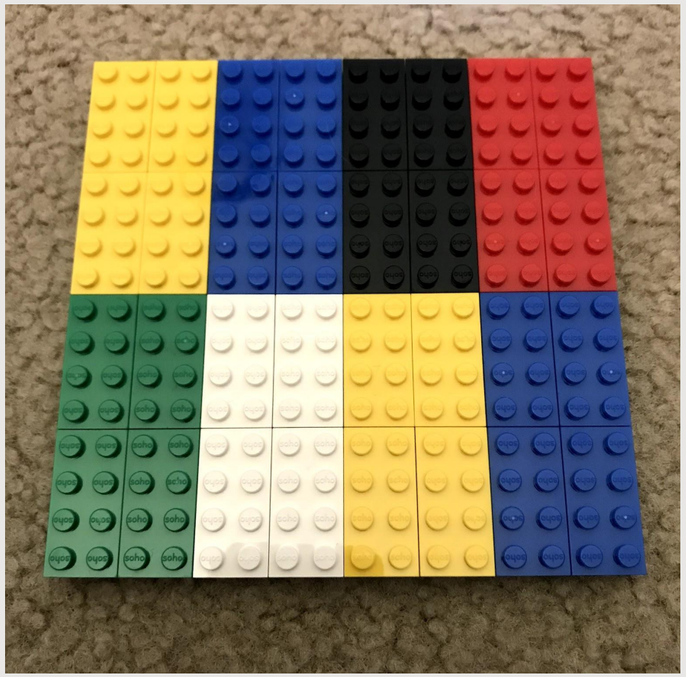
Special Materials: Bins for sorting bricks.
Bricks Required: All (or as many as need sorting)

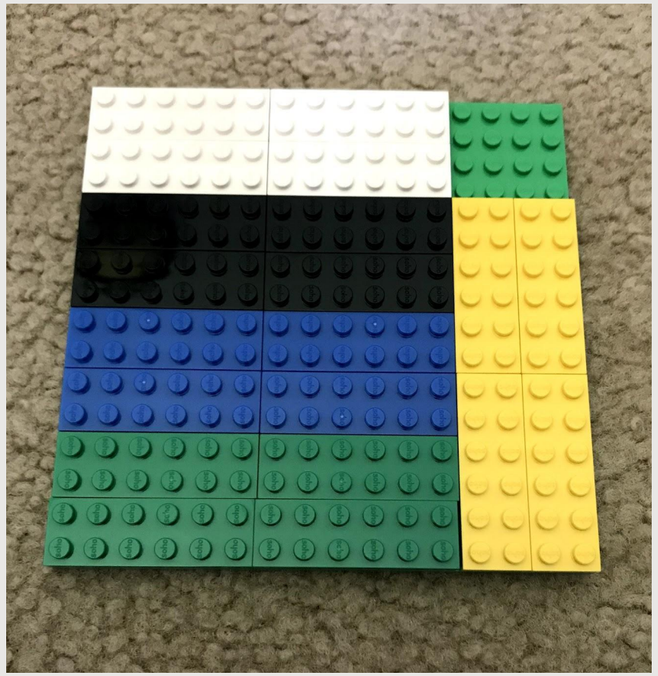
Project Structure:
Engage/Explain:

1. Begin by asking about patterns in the bricks. How can they be grouped? By size, by color, by general type (1xn bricks, 2xn bricks, plates, tiles)?
2. Start out with a small amount of bricks based on one feature only (color, size etc). Then work up to more bricks and features to be sorted.
3. Ask what is the best way to sort the bricks.
   a. Discussion may include:
      i. Sorting by color makes it easy to find all the parts of one color.
      ii. Sorting by size makes it easy to find the right shape for your creation.
      iii. Sorting by general type requires fewer containers but will involve more digging.
      iv. What should be done about parts where there aren't a lot of them, e.g., tiles?

Explore:

1. Agree upon categories and sort the bricks.





Project 10

Bricks In Fraction

Objective: Child will be able to visually represent equivalent fractions by overlapping different sizes of bricks.

Essential Question(s): How do fractions with different denominators relate to each other?

Special Materials: Paper and pencil for labeling.
Bricks Required: 16x16 plates; 1x2, 2x2, 2x4, 2x8, 1x3, 1x4, 1x6 bricks

Project Structure:
Engage/Explore

1. Have child lay out enough bricks to cover two rows of a 16x16 plate, using each type of brick (e.g., two 2x8 bricks and sixteen 1x2 bricks).
2. Ask child to place their plates on a sheet of paper and label each row: 1 whole, 2/2, 4/4, etc.
3. Ask child to find various equivalent fractions, such as 1/2 and 2/4.

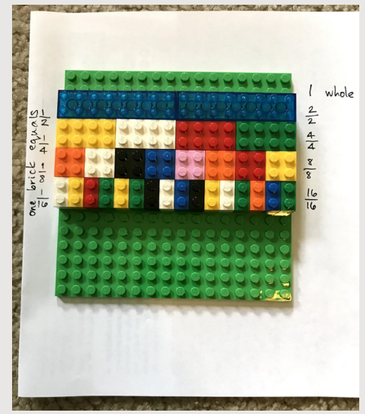
Explain

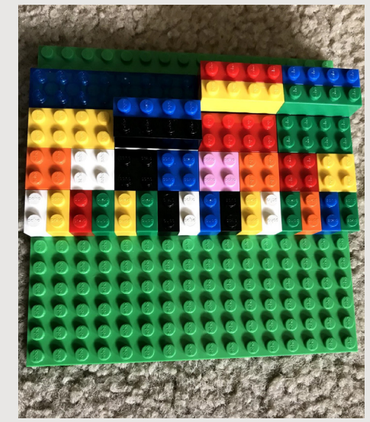
1. Ask child to solve a few addition and subtraction problems with common denominators.
2. Ask child to use their boards to show the pieces for their fractions.
3. Have child develop an explanation and reasoning for the correct addition/subtraction of the problems, using the bricks as evidence.

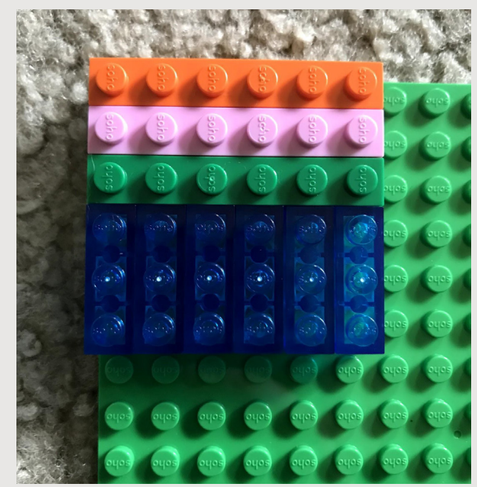
Elaborate

1. Challenge: Solve problems involving non-common denominators.
2. Child should demonstrate how they solved problems and found common denominators using the bricks.

From left to right: The model of comparing fractions; layering bricks to see equivalent (top row has four 1x4s on a 2x8 to show four eighths equal one half); comparing three 1x6 bricks to six 1x3 bricks.







Project 11

Mixed Bricks

Objective: Child will be able to add mixed fractions by physically regrouping.

Essential Question(s): How do you add mixed fractions?

Special Materials: Pencil and paper, dice for choosing numbers.
Bricks Required: Plates that are divisors of each other (i.e., 8x8s and 2x4s)

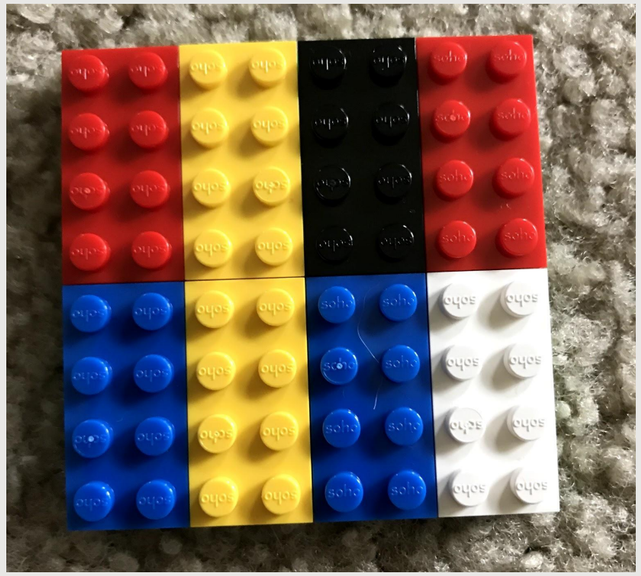
Project Structure:
Engage/Explain:

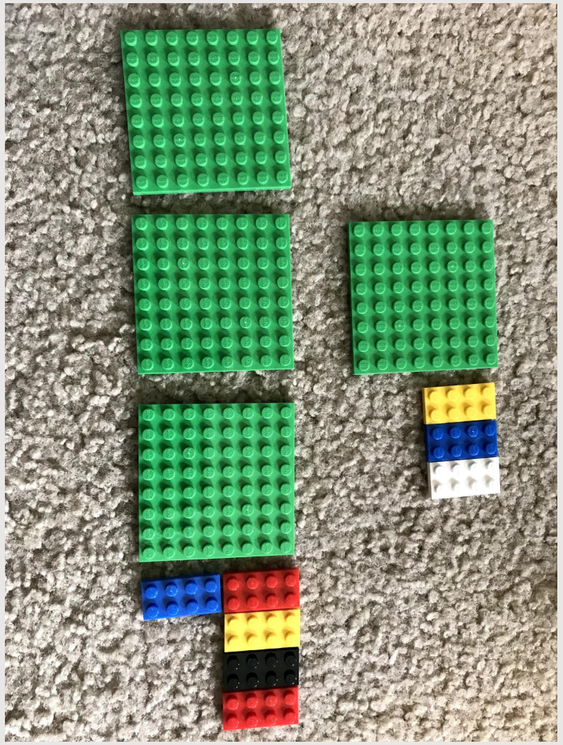
1. Ask child how to add fractions, reviewing adding the numerators but not the denominators.
2. Ask what child thinks about adding mixed fractions. How might they do it? How would they account for the whole numbers and fractions?
    a. Child may come up with the idea that they need to add the whole numbers and fractions separately.
    b. Child may come up with the idea that they may need to regroup the fractions if the fractions add up to more than a whole.

Explore:

1. Give child a die, a stack of 8x8 plates, and a handful of smaller plates.
    a. Have child practice adding mixed fractions with 8ths as the denominator.
    b. Ask child to use the die to roll numbers to add. First roll is the whole number, second roll is the numerator. Repeat for the whole number and numerator for the second portion of the equation (be writing down the equation). For example, if child rolls 6, 3, 2, 5, then the equation will be 6 ⅜ + 2 ⅝.
    c. Child then uses the 8x8 plates for the whole numbers and the 2x4 plates for the fractions. The 2x4s can be rearranged to make 8x8 squares.

Images, L-R: Adding together 3 ⅝ + 1 ⅜, then regrouping the fractions to equal one whole.





Project 12

Bricks By Design

Essential Question(s): How do you determine what features are necessary for a functional design?

Special Materials: Supplementary materials for extending the project, if desired.
Bricks Required: Plates, 1xn bricks, tiles

Engage/Explore:

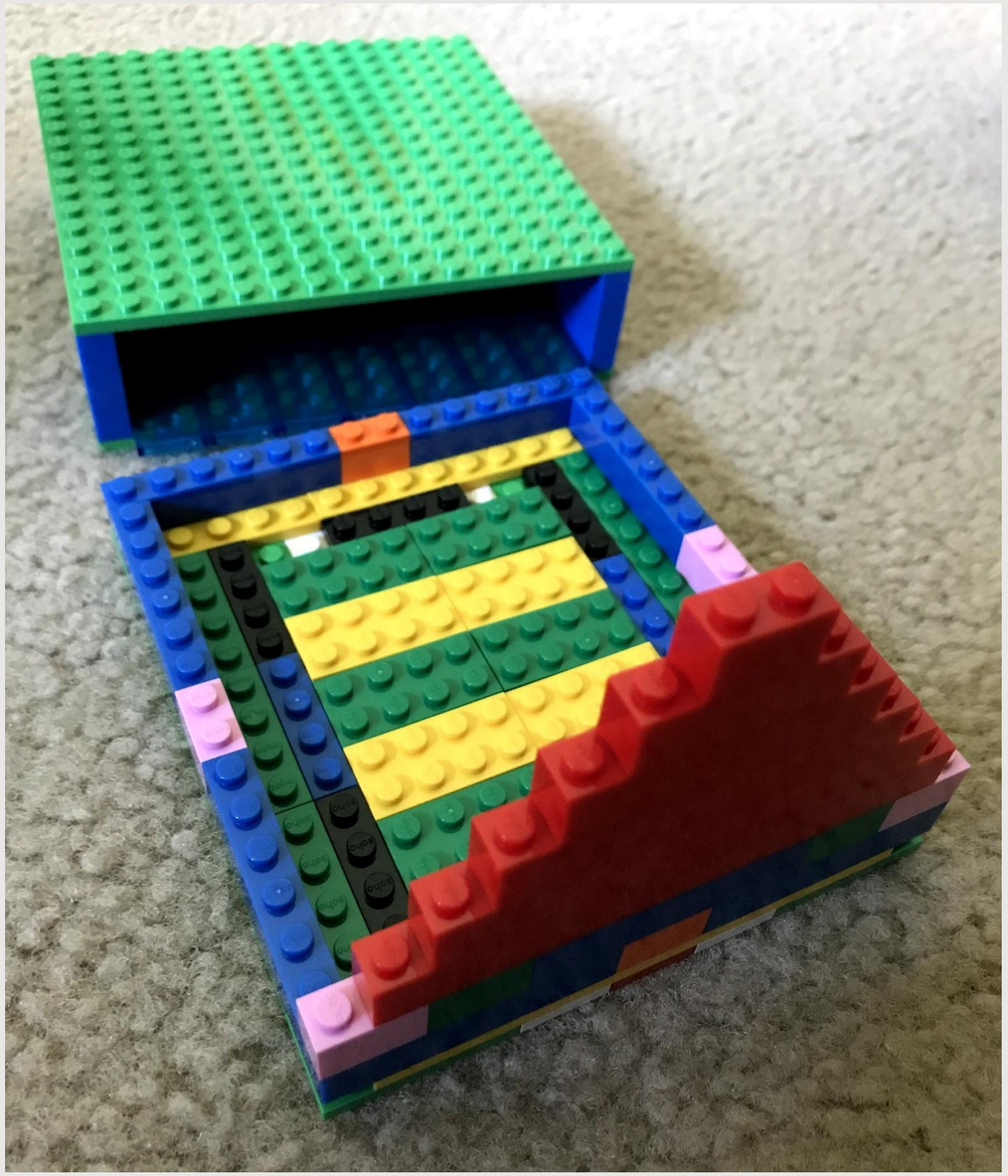
1. Ask what strategies child uses to keep their dresser organized. Have they noticed how the adults in their lives keep their dressers (or similar places) organized? Encourage child to think about using a caddy for that purpose.

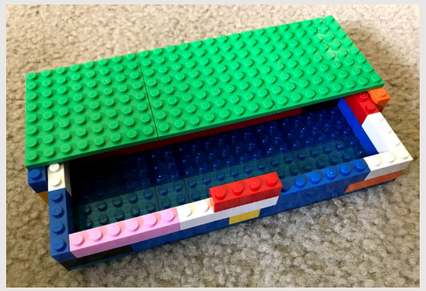
Explain/Explore:

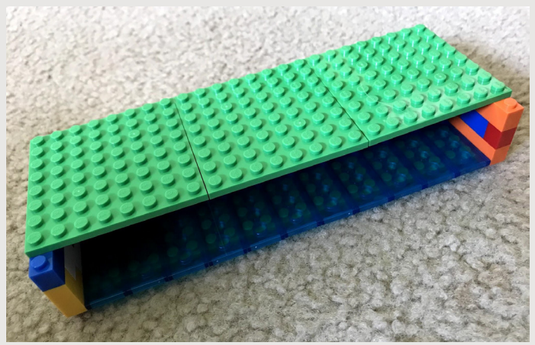
2. Ask child what kinds of objects go in a caddy and make a list.
   a. As the list is made, ask about attributes of the different objects (tall, short, wide, narrow).
   b. Ask child to make their own list of what they need to organize, which may not include everything on the list.
   c. Ask child to consider the attributes of their own lists.

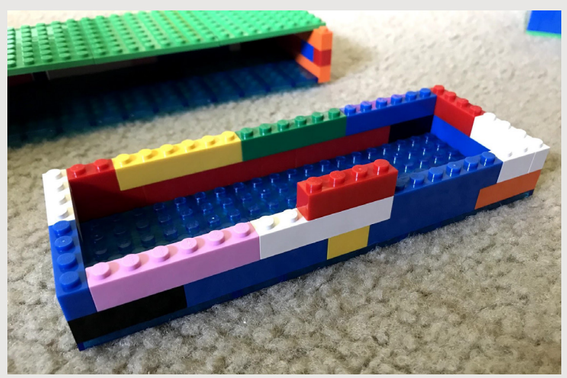
Elaborate:

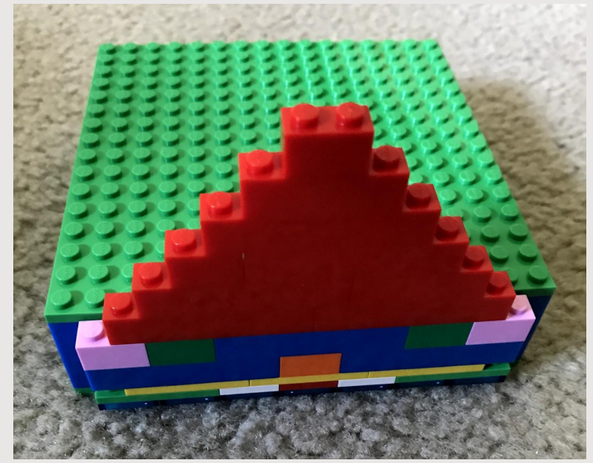
1. Have child plan their own caddies. They may want to begin with a rough sketch, or to outline with bricks on a plate, creating 2 or 3 different compartments. Child should be encouraged to try fitting the objects in before they get too far (for example, is the caddy the right size for an eraser? How tall does it need to be to keep pencils from falling out?)
2. Child then writes a paragraph explaining the features of their caddy and why they included them.

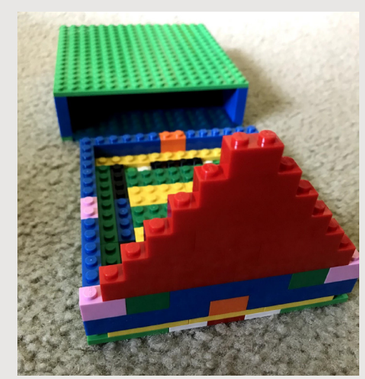












Project 13

It All Adds Up

Objective: Child will be able to add three numbers using objects and regrouping.

Essential Question(s): What strategies can you use to add multiple numbers together?

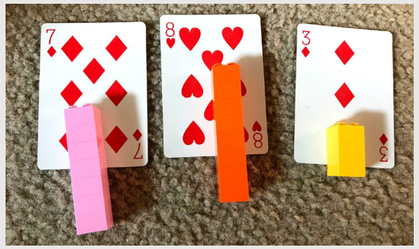
Special Materials: A deck of cards without the kings, queens, and jacks; pencil and paper.
Bricks Required: Each group of 3 students will need 9 2x2 bricks of three colors.

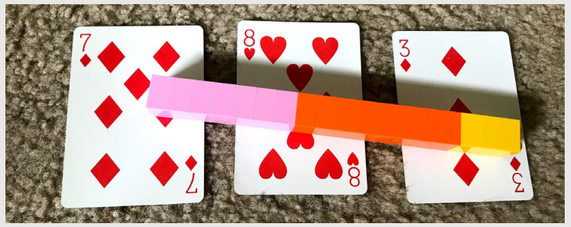
Project Structure:
Engage/Explain:

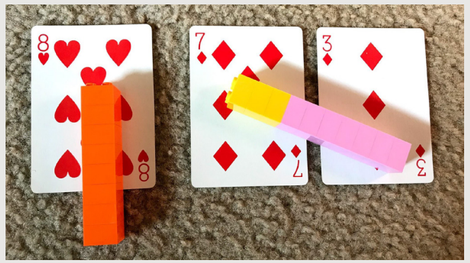
1. Point out that grouping them is a helpful way of adding things together, because you don't have to worry about a lot of numbers at once.
    a. Let the child know they will be practicing this today with playing cards and bricks.

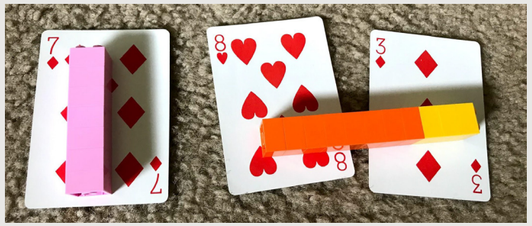
Explore/Elaborate:

1. Hand out bricks and a deck of cards (can be half a deck of cards or less, as long as it has at least one of every number but no kings, queens, or jacks).
2. Have child draw a card, then count out and stack together bricks of one color for the number on that card.
3. Next, child adds together two of the stacks by attaching them and counting. They should write down their work. Have them add the third stack and note that in their work as well.
4. Ask child to separate out the stacks again, and add the third number to one of the first two, again noting their work, followed by adding the remaining number. The idea is for them to see that they come up with the same number, no matter the order they add them in.
5. Child should write down how they do the grouping and then try it again adding two other stacks first. They should look for the times when two of the numbers add up to ten and add those first.
6. Have child repeat the exercise a few times.









Project 14

Interesting Groups

Objective: Child will understand the directionality of addition.

Essential Question(s): How can we use grouping to better understand addition?

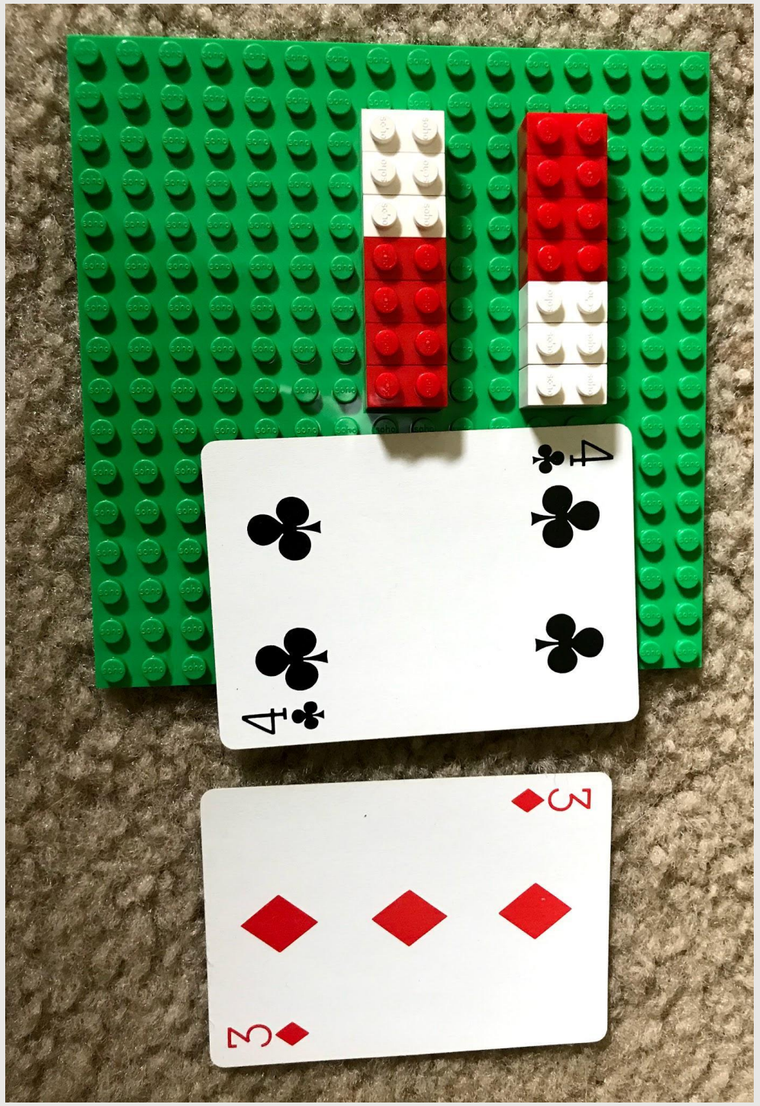
Special Materials: A deck of cards without the kings, queens, and jacks; pencil and paper.
Bricks Required: 9 1x2 bricks of two different colors, 16x16 plate

Project Structure:
Engage/Explain:

1. Prepare two kinds of small objects to count, perhaps pencils and crayons, and ask child how many objects there are all together.
    a. Lead the child in counting pencils and crayons, recording the results, and writing an addition sentence.
    b. Ask if the result would be different if the crayons were counted first; do so, writing a new addition sentence.
    c. Explains how addition does not change, even if done in a different order.

Explore:

1. Hand out cards to child (at least one each of denominations 1 through 9).
2. Child draws two cards from a deck, then uses two different colors of bricks to create groupings on the plate and record the equation on a piece of paper.
    a. Child then takes the same number of bricks in the same colors, but swaps them to create a new equation that yields the same result, recording the new equation.



Project 15

Not Just One Direction

Objective: Child will understand the directionality of addition and subtraction.

Essential Question(s): How can we use grouping to better understand addition and subtraction?

Special Materials: A deck of cards without the kings, queens, and jacks; pencil and paper
Bricks Required: 9 each of two different colors of 1x2 bricks, 9 clear 1x2 bricks and a 16x16 plate to stick them on

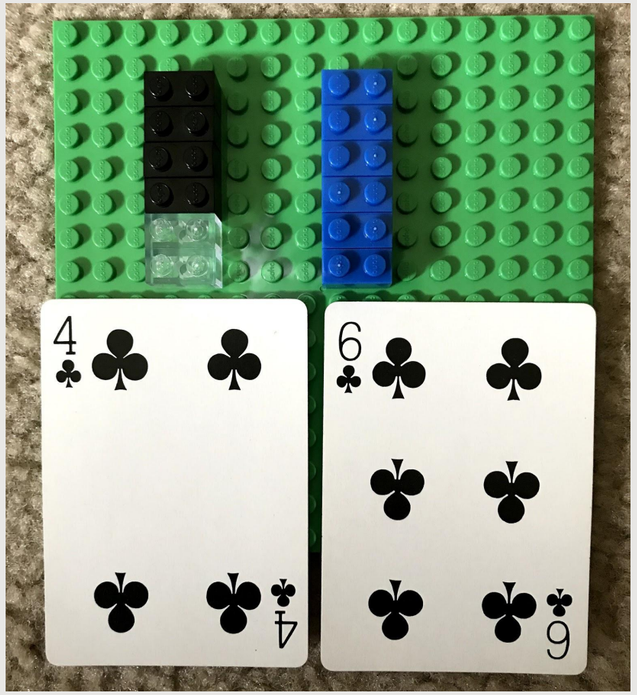
Project Structure:
Engage:

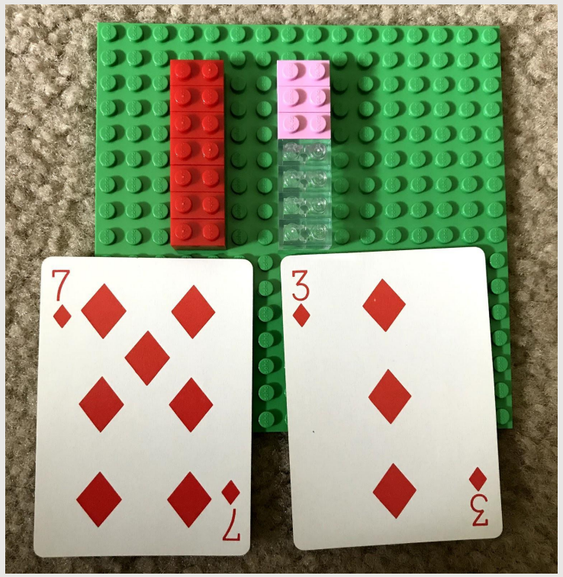
1. Ask child to explain how addition and subtraction are related.
    a. Answers may include that they are opposites.
2. Explain that addition can be used to help with subtraction and subtraction to help with addition.

Explore:

1. Hand out cards (at least one each of 1-9), a 16x16 plate, and bricks
2. Ask child to draw two cards and create an addition sentence with one number missing (card *x* + ___ = card *y*, where *y* is the larger number) out of bricks on the plate. Child should line up the bricks so it's easy to see where the blanks are.
    a. Child can use the clear bricks to help count how many are missing to fill in their equations and record them on paper.
    b. Child should repeat this process a few times.
3. Child then continues to draw cards, this time creating a subtraction sentence that focuses on the unknown addend, and recording their work.

Images, L-R: 4 + ? = 6, 7 - 3 = ? (and child asks, "What plus three equals seven?")





Project 16

Bricks Matter

Objective: Child will understand that matter is made up of parts of things and that those parts can be disassembled to make something new. Child will be able to describe how they created something and then built something new using the same parts.

Essential Question(s): How does matter combine to make something new? How can it break apart and be rebuilt?

Special Materials: Paper and pencil for writing
Bricks Required: A handful of random pieces

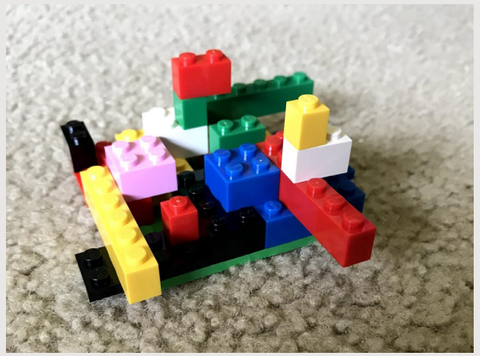
Project Structure:
Engage/Explore:

1. Ask child if they know what matter is. If they don't, explain that it is the scientific word for what everything is made of; and that some matter occurs naturally and some is manufactured.
2. Ask child if they can name some different types of matter, and then whether each type is natural or manufactured. Create a T-chart of the two types.

Explain/Explore:

1. Pass out about 20 or so bricks (a good handful, and can be fairly random) or a large pile, asking:
    a. What kind of matter (natural or manufactured) are the bricks?
    b. How do the bricks go together? Is there only one option, like a puzzle? (Answer: There are many ways to put them together, which is how matter works.)
    c. How do the bricks function if you make something flat? What about if you make something more three dimensional?
2. Ask child to build something with the 20 bricks.
    a. After building, child should write 3-4 sentences explaining what they built and how they chose their bricks. (Collect unused bricks while the child is writing.)
3. Child then takes apart their bricks, keeping the same pile, and builds something new.
    a. When completed, ask child to write 3-4 more sentences explaining how they used the same pieces to build something different.

Images: Right: converting a container to a one-eyed "quadripus" (because there weren't enough bricks for 8 legs)
Left: converting a guy coming out of a hole to a shadow of a tesseract



Project 17

New and Improved

Objective: Child will plan and build a second caddy.

Essential Question(s): How do we build something that works effectively? What questions do we need to ask? What observations do we need to make?

Special Materials: Objects for the caddy (from the child's own room), pencil and paper
Bricks Required: All

Project Structure:
Engage/Explore:

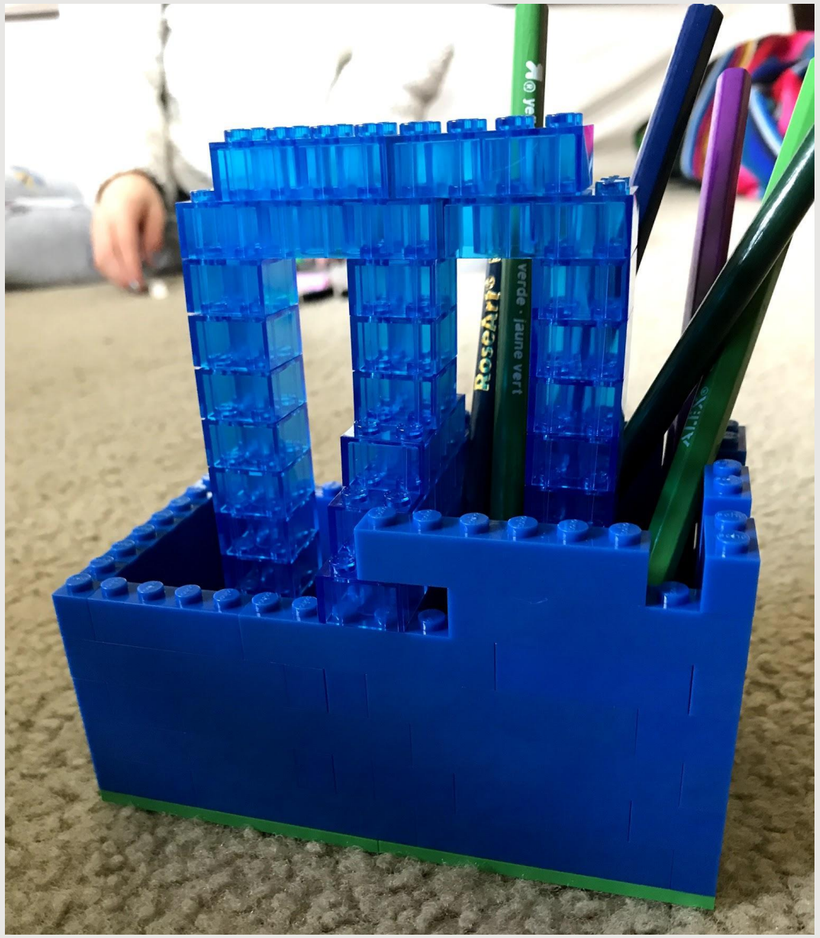
1. Ask what strategies child uses to keep organized. Have they noticed how the adults in their lives keep their desks (or similar places) organized? Encourage child to think about using a caddy for that purpose.

Explain/Explore:

2. Ask child what kinds of objects go in a desk caddy and make a list.
   a. As the list is made, ask about attributes of the different objects (tall, short, wide, narrow).
   b. Ask child to make their own list of what they need to organize, which may not include everything the list you just made.
   c. Ask child to consider the attributes of their own list.

Elaborate:

1. Have child plan their own desk caddy. They may want to begin with a rough sketch, or to outline with bricks on a plate, creating 2 or 3 different compartments. Child should be encouraged to try fitting the objects in before they get too far (for example, is the caddy the right size for an eraser? How tall does it need to be to keep pencils from falling out?)
2. Child then writes a paragraph explaining the features of their desk caddy and why they included them.



Project 18

Graph Track

Objective: Child will be able to represent data in a bar graph and use the data to make inferences about the data.

Essential Question(s): How can we gather data about similar things and compare it?

Special Materials: Pencil and paper and sticky notes for labeling the graph
Bricks Required: 16x16 plates, 1xn bricks

Engage/Explain:

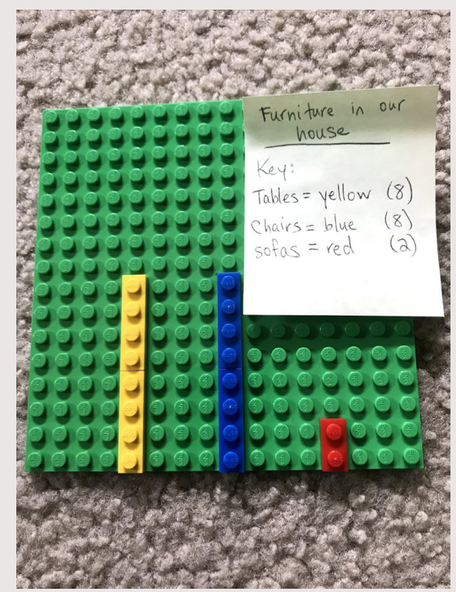
1. This project should be done with a group.
2. Begin by asking the children about things they like, looking for some broad categories such as after-school activities, cookies, reading.
    a. Choose a category and ask for more specifics: “Who likes chocolate chip cookies? Oatmeal?” Ask children to commit to one answer and create a table on collecting the data (how many prefer chocolate chip, how many prefer oatmeal, etc.).
    b. Ask comparing questions about the data, then about how children compared the data (addition or subtraction).
    c. Introduce bar graphs as a way to visually see differences in data, building a brick bar graph and reviewing labeling, units, etc.
        i. Asks additional questions about the data, asking children to group. “How many prefer a cookie that has chocolate?” for instance, would group together Oreos and chocolate chip.

Explore/Explain:

1. Ask children for ideas of two or three other things to count (hair color, favorite snack, etc.). Guide children to grouping categories (“fruit” instead of apples or grapes, etc).
    a. Make a table collecting the information.
2. In pairs, have children choose one of the data sets to visually represent using bricks.
    a. Ask children to build a bar chart, then label the axes.

Engage/Explain:

3. Ask children to compare their data and take notes using their bar chart:
    a. Which category has the most?
    b. Which category has the least?
    c. How many more in category A than category C?
    d. How many when two categories are combined?



Project 19

Create = Great

Objective: Child will be able to create something and explain the choices they made in its design.

Essential Question(s): What choices do we make when we're creative? Why is it important to explain those choices?

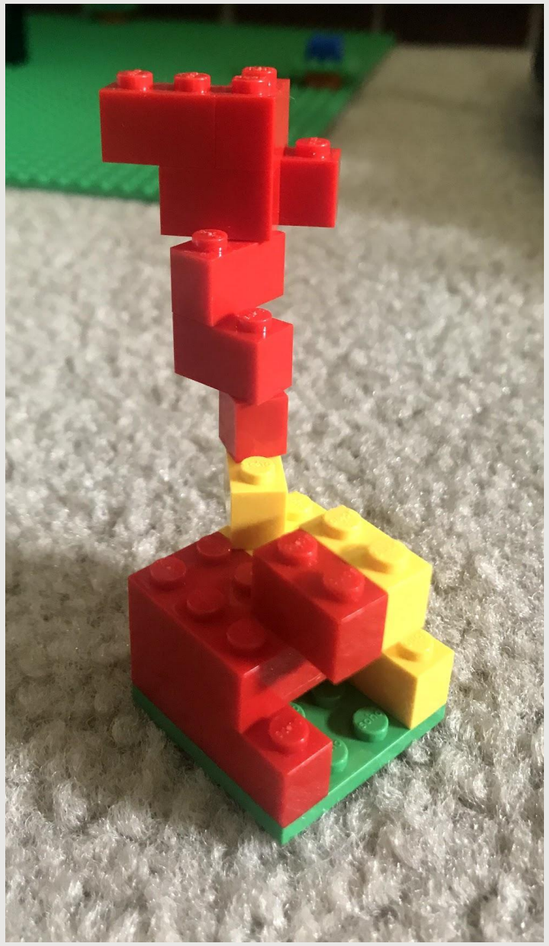
Special Materials: Pencil and paper
Bricks Required: All

Project Structure:
Engage/Explore/Explain:

1. Begin by asking child about times they've been "creative."
    a. Ask about what creativity is as well as how someone knows they've been "creative." (Try to get across the idea that creativity isn't just about making something "pretty," but rather something that's thoughtfully constructed, whatever its medium.)
2. Ask child to explain some of the times they've been creative and the choices they've made to achieve their desired results.

Explore

1. Child then builds something out of bricks. Hand out a relatively small pile of assorted bricks. This will result in child having some limits in executing their vision, which can in turn result in more creativity.
2. Once child has created something, ask them to write a story about it.



Project 20

Brick Blow-up

Objective: Child will understand that resizing something involves scaling through multiplication.

Essential Question(s): How do you make something bigger or smaller while maintaining its proportions?

Special Materials: Laptop and projector with an image in a word processing program
Bricks Required: 1x2 bricks, 2x4 bricks, 4x4 plates, 8x8 plates, 16x16 plates

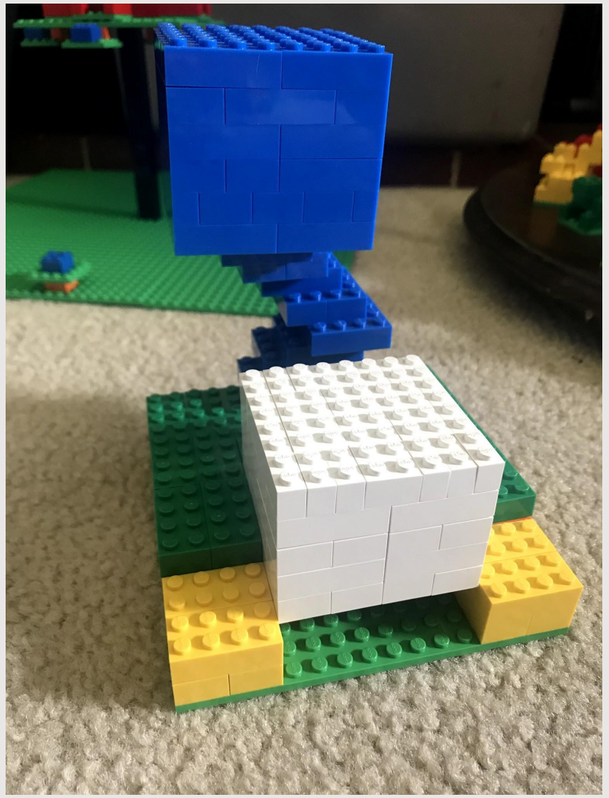
Project Structure:
Engage/Explain:

1. Ask if child has resized pictures before, and if so, how they've done it.
    a. Show a picture in a word processing program and ask what would happen if the sides or top and bottom were lengthened (it would distort the picture).
    b. Ask what happens when a corner is pulled out (it keeps the same scale). Connect the idea of scale to the idea of resizing, emphasizing that if you want to make something bigger or smaller, you need to make it bigger or smaller in all directions, not just one.

Explore/Explain:

1. Hand out 1x2 bricks and 4x4 plates and ask child to make a small creation, using 10-16 bricks. The base should be a foundation for the creation.

2. Once child has made the creation out of 1x2 bricks, pass out 8x8 plates and 2x4 bricks and ask if they know what is similar about the 1x2 and 2x4 bricks (and the 4x4 and 8x8 plates). Child may notice that they have similar proportions.
    a. Following the brick placement on their original design, child uses the 2x4 bricks in the same placement as the 1x2 bricks.
        i. Child can use the same quantity and placement of bricks on the horizontal access (2x4s are already doubled in that direction), but will need to double the height of the bricks.
    b. Ask child to notice that everything is doubled on their new model, both height and width.
        i. Challenge child to triple their original creation, asking what they will need to keep in mind (triple height and width of 1x2 bricks; be careful to multiply size correctly since there aren't any bricks that are three times the size of a 1x2).



Project 21

Run Brick Run

Objective: Child will understand how various forces work to amplify or impede movement.

Essential Question(s): What do you need to think about to build a marble run? What helps the marble go faster? What makes the marble get stuck?

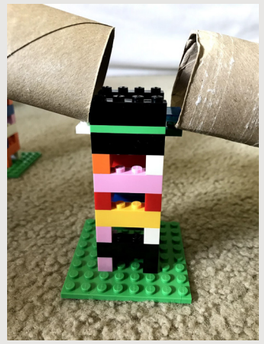
Special Materials: toilet paper tubes and marbles
Bricks Required: 8x8 plates, 4x4 plates, 2x4 plates, 2x4 tiles, 2x2 tiles, 2x2 plates, 1x4 bricks, 2x4 bricks

Project Structure:
Engage/Explain:

1. Ask child if they've ever played with a marble run before, or marbles in general.
    a. What makes a marble go?
    b. How does a marble steer?
    c. In a marble run, what sorts of things influence the marble?

Explore/Explain:

1. Work together with your child to build a marble run. You can build a tower of varying heights according to the pictures below (alternating 1x4s).
    a. Lead child in making the top connectors and corner turns (a 2x4 and 2x2 tile down the center of a 4x4 plate with corresponding plates underneath to create the grooves for the toilet paper rolls, framed by 1x4 bricks to keep the marble centered; corner turns are similar but on 8x8 plates).
2. Child can put the towers together in groups, line them up and connect them with toilet paper tubes and start testing their work. Questions to consider:
    a. How far does the marble go?
    b. Why does it get stuck where it does?
    c. What happens when you change the order of the towers?
    d. If there's a marble of a different size, how does that impact things?
    e. What's the minimum height difference necessary to make the marble go?



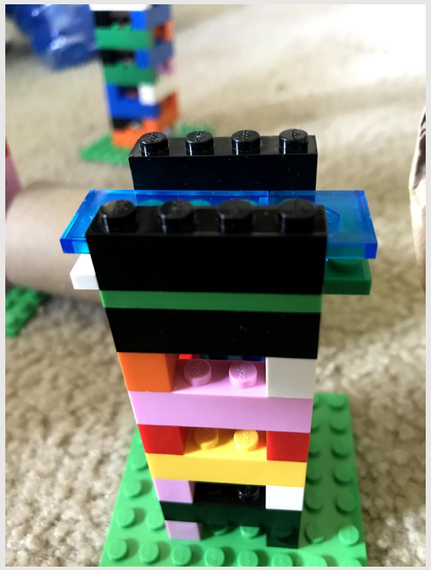
Project 22

Control Towers

Objective: Child will design a marble run for multiple marbles at various stages to see how force impacts the movement of the marbles.

Essential Question(s): How might the speed of an object relate to the energy transferred to another object?

Special Materials: toilet paper tubes and marbles, Newton's cradle (if possible; video would do)
Bricks Required: 8x8 plates, 4x4 plates, 2x4 plates, 2x4 tiles, 2x2 tiles, 2x2 plates, 1x4 bricks, 2x4 bricks



Project Structure:
Engage:

1. Ask if child has played with a "Newton's cradle" (the physics toy with a row of metal balls hanging from a rod).
    a. Ask what happens with the metal balls. Child will probably point out that the center balls stay still while the outer balls bounce.
    b. Point out that the energy from the outside balls is transferred through the inside balls.
    c. Ask what child thinks may happen if you pull the ball out more or less.
        i. Child may answer that the end ball will bounce further if the first ball is pulled out more, or less if the first ball is pulled not as far.

Explain/Explore:

1. Explain that they will use the same ideas from the Newton's cradle to move marbles through a marble run.
2. Work together with your child to build a marble run. You can build a tower of varying heights according to the pictures below (alternating 1x4s).
    a. Lead your child in making the top connectors and corner turns (a 2x4 and 2x2 tile down the center of a 4x4 plate with corresponding plates underneath to create the grooves for the toilet paper rolls, framed by 1x4 bricks to keep the marble centered. Corner turns are similar but on 8x8 plates).
    b. The goal is to move three marbles through the marble run, with the first marble released at the top and hitting two additional marbles in succession (each previous marble stops when it hits the next one).
3. You can put towers together in groups, line them up and connect them with toilet paper tubes and start testing.
    a. Child should:
        i. Try a few towers together to see how marbles move, especially around corners.
        ii. Adjust the height of the towers to see how that impacts speed.

Project 23

Top Brick

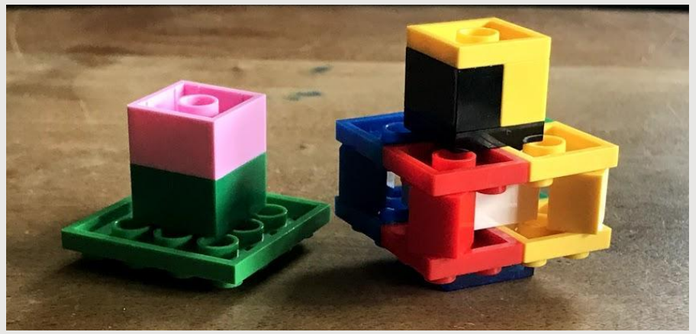
Objective: Child will understand how placement and weight affect the motion of an object.

Essential Question(s): How does the placement of design components affect the spinning speed of a top?

Special Materials: A regular top for opening demonstration, a shallow box for spinning (although desks work well, too, these don't spin that far)
Bricks Required: 2x2 tiles, 4x4 plates, various bricks and plates

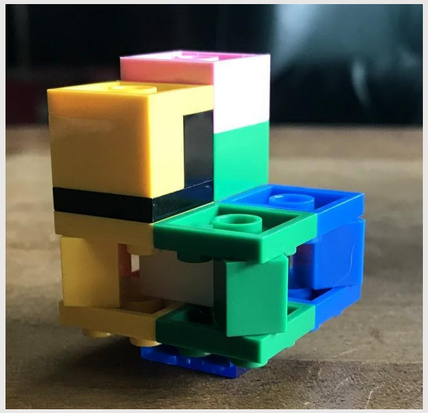
Project Structure:
Engage/Explain:

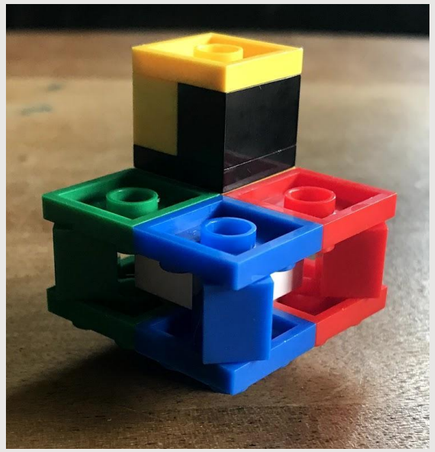
1. Spin a top and ask child about its motion.
    a. Child should notice how vertical it is at the beginning, and how it begins to wobble when it slows down.
2. Ask child to notice the shape of the top: its handle, pointy bottom, and roundness. You may also want to point out its symmetry if child is familiar with the concept, and also mention what would happen if there were more weight in one place or another.



Explore:

1. Show child the rudiments of building a brick top:
    a. Friction needs to be reduced on the bottom, so this will be built "upside down" or "studs on the bottom"
    b. A 2x2 tile centered on a 4x4 plate will create the base of the top.
    c. The top needs something to grip to give it a good spin.
2. Have child begin building their top, aiming to get one that spins well. Things to experiment with:
    a. Weight: How many bricks should the handle have? Should it be wide or narrow? Tall or short?
    b. Body: Should it be made of plates or bricks? Should it have gaps or be solid?
    c. Bottom: Should the tile be right against the plate or should there be a plate or brick adding height?
3. Once child is satisfied with their design, ask them to experiment with moving parts around or adding weight in an unbalanced manner. Some ideas:
    a. Move the handle to one corner or side;
    b. Make the handle wider.
4. Child should prepare a data table, perform multiple trials, and record data on their varying prototypes.
5. Child can also have contests to see which top spins the longest, using their "best" top designs based on their recorded data.





Project 24

Unidentified Objects

Objective: Child will understand that materials have a variety of properties and that these can be used separately or together to identify them.

Essential Question(s): What are some attributes of bricks? How can we think about attributes of other materials by understanding these bricks?

Special Materials: Something to sort bricks into
Bricks Required: All

Project Structure:
Engage/Explain:

1. Ask child about some properties of items in the house.
    a. Encourage child to describe features of household objects. Perhaps there are squishy couch cushions, bookshelves, shiny counters, etc.
2. Explain that all matter and materials have various properties that scientists use to classify them, such as hardness, thermal conductivity, solubility.

Explore:

1. Ask child about the various properties of SOHO bricks.
    a. Child may point out color, size, type (brick, plate, tile).
    b. Ask about the functionality of these properties: Color is for design, type is for purpose, etc.
2. Ask child how they would rank these classifications in order of significance. For example, is it more important to sort by type or by color?
3. Make a list on the board with child's input about the agreed-upon categories for sorting (for example, by size and type but not by color--so all the 2x2 bricks would go together).
4. Ask child to sort the bricks.

Elaborate:

1. After sorting the bricks, connect the brick properties more closely to materials: powders, metals, etc.
    .

Project 25

State of the Brick

Objective: Child will understand the basics of conservation of matter.

Essential Question(s): What happens when matter changes? Is anything lost? Does its weight change?

Special Materials: a scale and/or a laser thermometer, pencil and paper for notes
Bricks Required: 6x8 plates; 1x2, 1x4, & 1x6 bricks

Project Structure:
Engage/Explain:

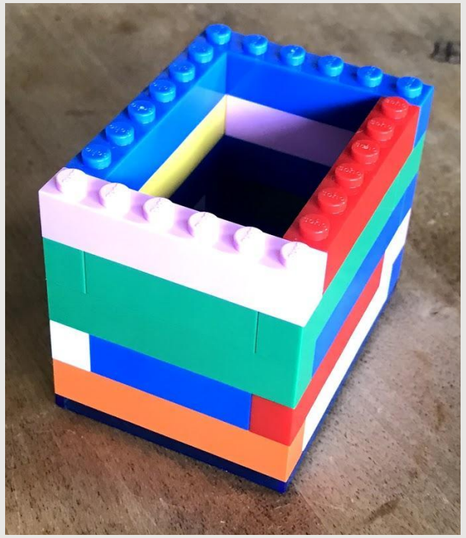
1. Ask child what they know regarding what happens when matter is heated or cooled or mixed together.
    a. Child may already be familiar with water breaking a jar when it's frozen (cooled) or the chemical reaction of baking soda and vinegar.
2. Explain that the total weight of the matter never changes in any of these situations.

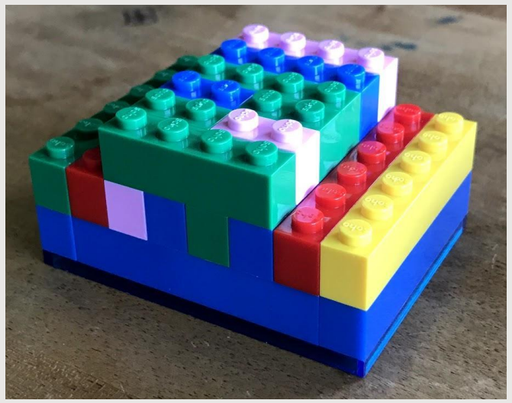
Explore:

1. Explain that child will see how that works today by building with bricks representing the molecules.
2. Give child plates and bricks to build a hollow box.
    a. Size is not too important, but probably no more than five bricks high;
    b. The walls should not have any gaps or holes.
3. When child is finished, ask them about the properties of the box.
    a. Child should weigh, measure, and take the temperature of their creation, taking notes on all the measurements.
4. Child then disassembles their box and reassembles it into a different-shaped box, still with no gaps.
    a. Child weighs, measures, and takes the temperature again. Child should notice that the only measurement that changed significantly is the size.
5. Child then puts their box in ice water and the sun, and then takes the temperature and weighs it again, taking notes on all the measurements.

Elaborate:

1. Ask child how rebuilding the box is similar to what happens with water when it turns to steam and then condenses back to water.
    a. Extend the idea to other types of materials as well.





Project 26

A Roll of the Brick

Objective: Child will be able to use bricks for beginning fraction multiplication.

Essential Question(s): When multiplying whole numbers by a fraction, how can we visualize the mathematics?

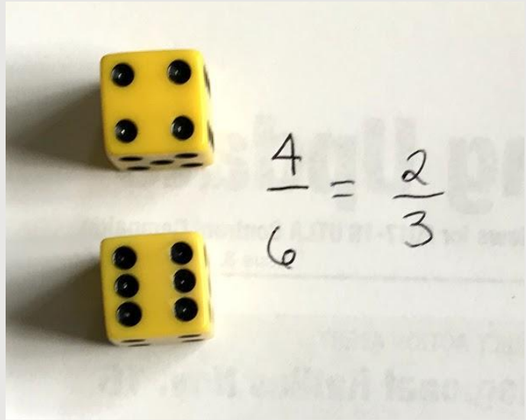
Special Materials: dice, pencil and paper
Bricks Required: 1x2 or 2x2 bricks, 16x16 plates

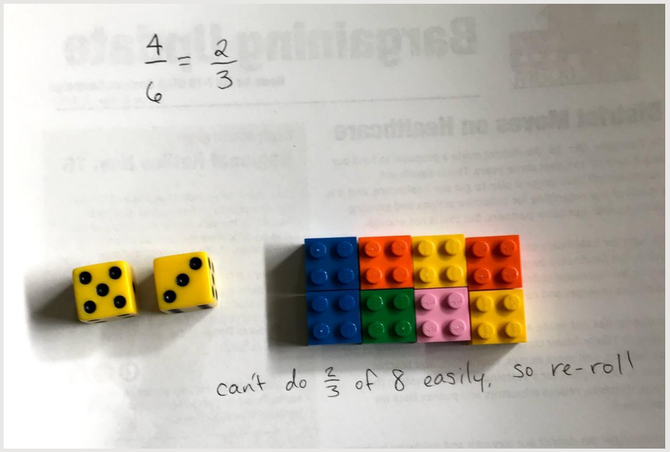
Project Structure:
Engage/Explain:

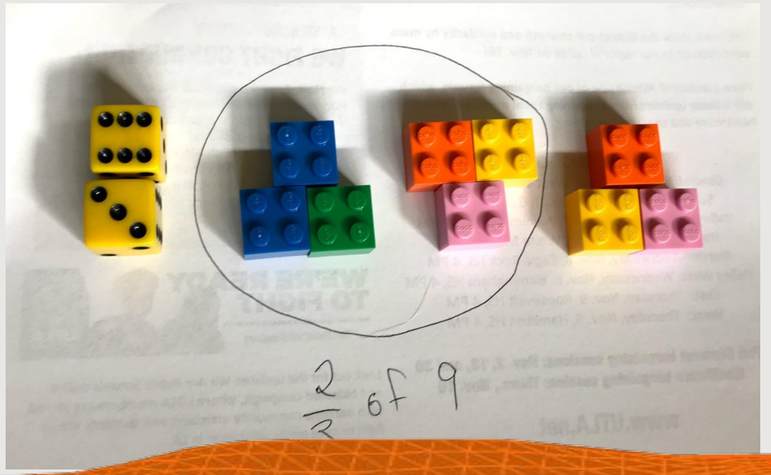
1. Front-load fraction multiplication concepts.

Explore:

1. Give child a handful of bricks, a 16x16 plate, and a pair of dice.
2. Child rolls the dice to make a fraction, with smaller number on top, then notes it on their paper. If the fraction needs reducing, child should do so.
3. Child rolls the dice again, add sthe dice together to determine the whole number, and counts out that many bricks.
4. Ask child to multiply their fraction by the whole number, using the bricks to create groups according to the denominator of the fraction (e.g., if the fraction is ⅘, child divides the bricks into five equal groups). If the bricks can't be divided evenly by the denominator, the dice should be rolled again to get a new multiplicand.







Project 27

Greater Than One

Objective: Child will be able to use bricks for beginning fraction multiplication.

Essential Question(s): When multiplying whole numbers by a fraction, how can we visualize the mathematics?

Special Materials: Dice, pencil and paper
Bricks Required: 1x2 bricks in three colors, 16x16 plates

Project Structure:
Engage/Explain:

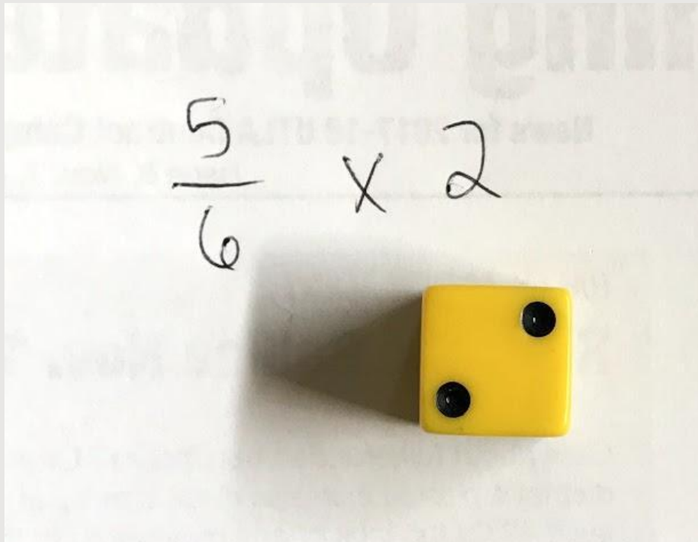
1. Front-load fraction multiplication concepts.

Explore:

1. Give child a handful of bricks, a 16x16 plate, and a pair of dice.
2. Child rolls both dice to make a fraction multiplier, smaller number on top, then notes it on their paper.
3. Child rolls one die to determine the whole number multiplicand.
4. Child counts out 1x2 bricks to create their fraction: *x* number of color A for the numerator and then enough of color B to make the total for the denominator.
5. Child continues counting out fractions until they have as many as the multiplicand, then counts how many of color A they have total.
6. Child then groups as many of color C as color A, according to the denominator, to find the result of their multiplication sentence; they should reduce if necessary.

Elaborate:

1. Ask child to create an explanation on how they are multiplying and visualizing the fractions so they can teach the process to others.
2. Child should also explain the effects of multiplying by a number greater than 1 vs. less than.



Project 28

The Shadow Knows

Objective: Child will measure the movement of the sun through measuring the movement of shadows.
Essential Question(s): How can we track the sun's movement?

Special Materials: Paper and colored pencils, masking tape, paper or poster board
Bricks Required: 8x8 plates, 2xN bricks

Project Structure:
Engage:

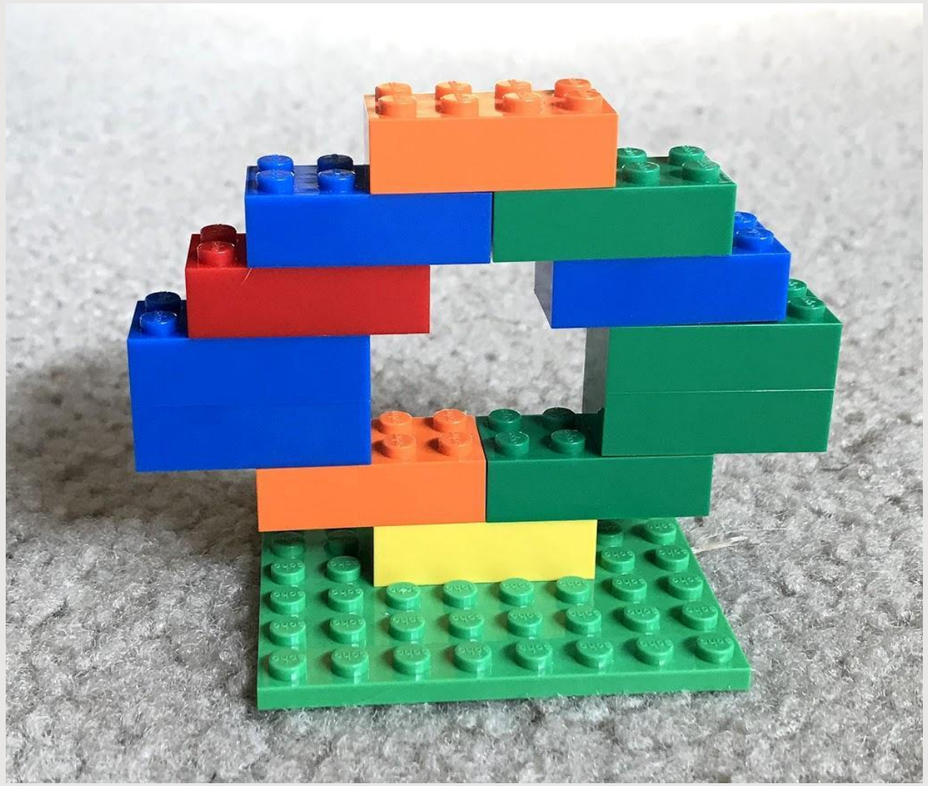
1. Ask child to observe the length of their shadow while they are outside; ask them to notice if it is the same length at all times, and to think about why that is.
2. Ask child about the movement of the Earth and the Sun, and how we can tell what is moving.
3. Have child provide a brief explanation of how they think the movement of the Earth/Sun systems affect their shadows.

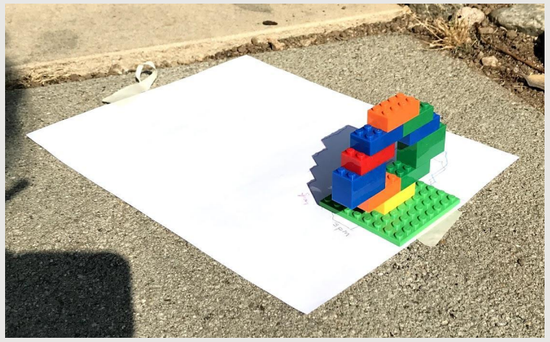
Explore:

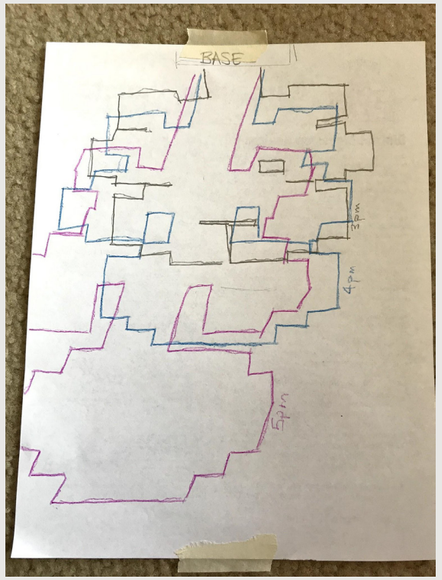
1. Have child build a tall-ish creation (2xN bricks are most ideal for stability reasons) on an 8x8 plate.
2. Set out the creation on a piece of paper or poster board taped to the ground in the sun. Have child trace the base of the creation to help with placement if it gets bumped, then trace the shadow, and write down the time next to the top of the shadow.
3. Periodically, child should return and trace the shadows, noting the time and taking a measurement. It's helpful to use a different colored pencil each time.
    a. Child should keep track of the time and shadow length in a data table.
4. At the end of the day, child measures each shadow from the base of the creation to the top of the shadow, then makes a table of their data, noting the time and length for each measurement taken.
    a. Child may also want to re-trace their shadow to create a clearer line (it's tricky to trace on the ground).

Explain/Elaborate:

1. Child should plot their data in an x-y coordinate plane.
2. Ask child to draw conclusions from their data:
    a. What direction is the Earth spinning? i.e., which direction is the Sun appearing to move?
    b. The Earth spins counterclockwise, causing the Sun to appear to move east-to-west.
    c. How can this motion be seen in the night sky?
    d. What effects do the time of day and year have on the lengths of the shadows?
        i. You may opt to collect data in fall, winter, and spring, and culminate the project in spring, comparing all three sets of data.



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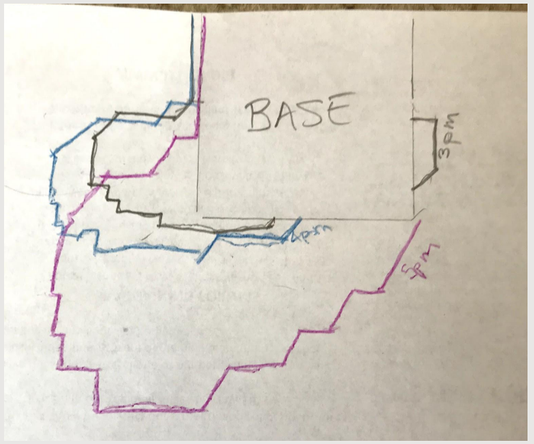
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Project 29

Plane Dealings

Objective: Child will be able to graph points on a coordinate plane based on the data they collect.

Essential Question(s): How can graphs help us see change using two different measurements?

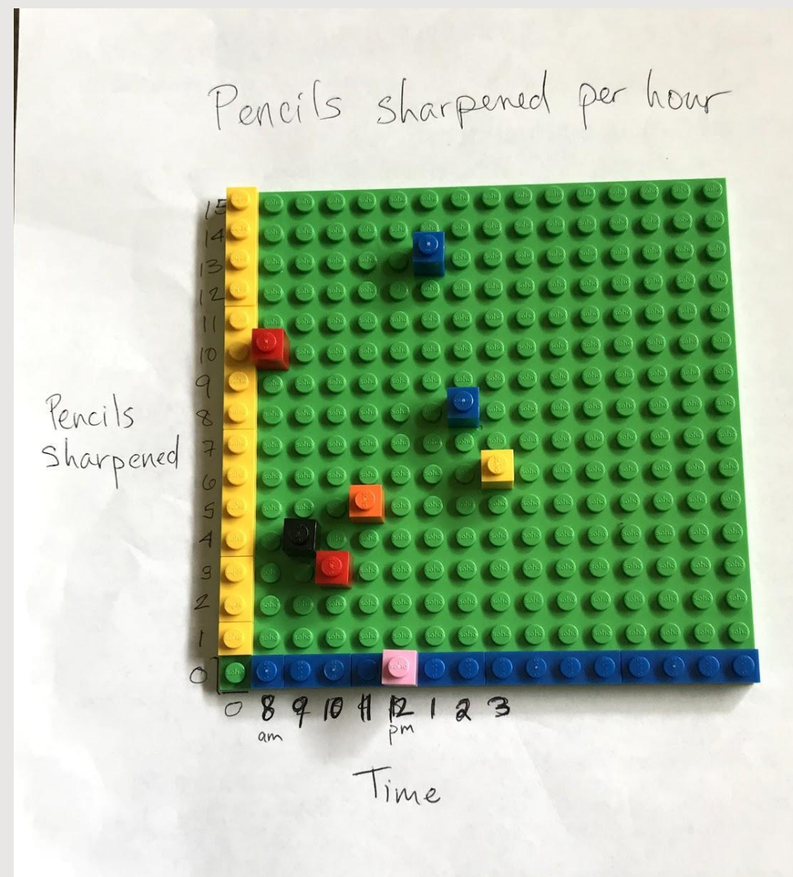
Special Materials: Pencil and paper
Bricks Required: 16x16 plate, 1x1 bricks, 1xn plates

Project Structure:
Engage/Explain:

1. Begin by asking child about the weather today.
    a. Is it warm or cool? Has there been any rain? What about yesterday and the day before? Do they know what it's supposed to be like tomorrow or later this week?
2. Ask child if the weather has been moving in a certain direction: Has it been getting progressively warmer or cooler, or has it been different every day?
    a. Explain that it can be helpful to visually represent data to see the changes in relation to each other.
    b. Sketch a first quadrant on the board, then ask child to look up the weather and plot the temperatures with date as the *x*-axis and temperature as the *y*-axis.

Explore/Elaborate:

1. Ask child what else could be measured this way.
2. Child gathers their data, then creates a first-quadrant graph and plots their data using 1x1 bricks. Child should be sure to label their axes and the chart.
3. Have child share what they have plotted and if they can make any inferences from this data.



Project 30

Pump Up the Volumes

Objective: Child will understand that volume is how you measure the amount of space something takes up.

Essential Question(s): How do we measure how much space something takes up?

Special Materials: pencil and paper
Bricks Required: 16x16 or 8x8 plate, 2xN bricks

Project Structure:
Engage/Explain:

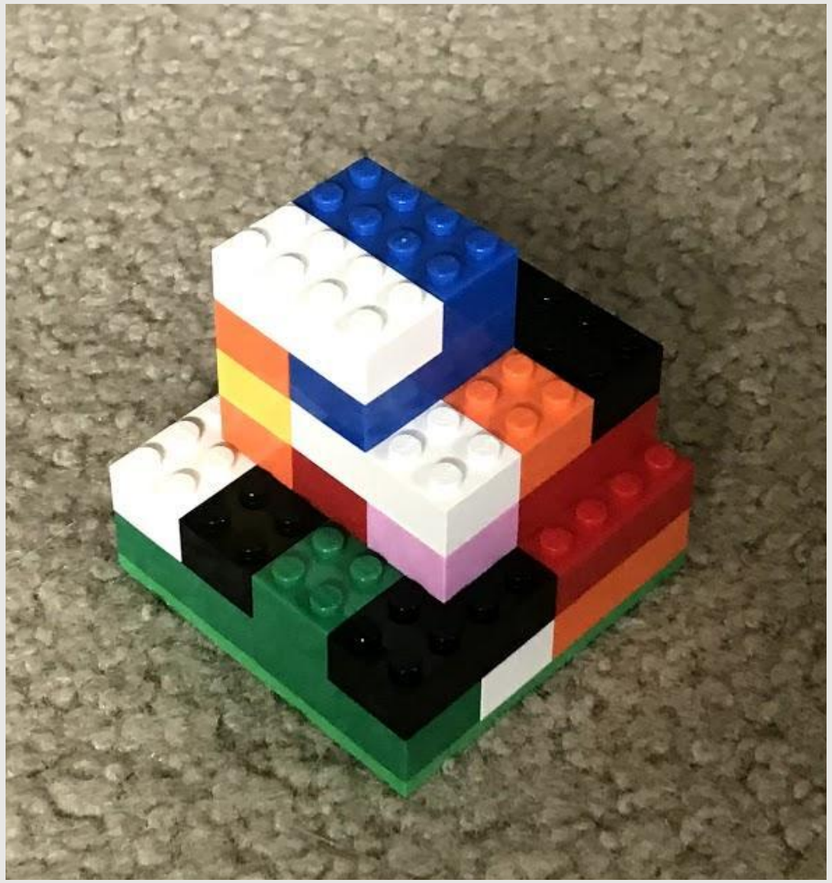
1. Hold up a rectangular object of some sort (a ream of paper, a deck of cards, a book) and ask child how to measure it.
    a. Child may recommend using a ruler. Ask what parts of the object should be measured. Child's answers will vary.
    b. Explain that child has already found the area of flat things, but that something like a book or deck of cards takes up space and that we measure that space through finding an object's volume.
    c. Measure the object to find its volume.

Explore:

1. Have child build a rectangular structure and find its volume.
    a. Child could be restricted to just 2x2 and 2x4 bricks; total bricks might then be counted to find the volume (noting that 2x4 bricks would count as two bricks). Unit of measure would be "bricks."
    b. Child could build with any bricks and use the number of studs on each layer to find the volume. Unit of measure would be "cubic studs."
    c. The example has three sections: 8 on the top layer, 18 on the middle layer, and 32 on the bottom layer, yielding 58 cubic units.

Explain/Elaborate

1. Task child with finding the volume of quadrilateral containers (like a small cardboard box).
2. Have child devise an explanation on how they plan to measure the volume of the container.
    a. Some possible methods are:
        i. Using the SOHO bricks to fill the container;
        ii. Counting the brick units;
        iii. Using a ruler to measure the 3 dimensions.
3. Have child perform their method to determine the volume of the box.



Project 31

The Building Bricks of Life

Objective: Child will be able to develop models of living things and their needs to live using SOHO Bricks as a modeling aid.

Essential Question(s): What do living things need to survive? Where do they live and why? How do they use natural resources?

Special Materials: pen/pencil and paper, markers or colored pencils; cards with living things' names
Bricks Required: All

Project Structure:
Engage:

1. Provide child with a piece of paper, markers and a pencil for drawing.
2. Provide child with a card (at random) with a living thing's name.
    a. Ask child to draw a picture of the living thing and its home (natural environment), including things they would need to live.
    b. Provide child with facilitating questions to support their art:
        i. What does your living thing need to eat to live?
        ii. Does the living thing have a special home?
        iii. What do you imagine would be in the living thing's home?

Explore/Explain:

1. Provide SOHO Bricks to build their living thing and its home.
2. Provide child the opportunity to write about their living thing:
    a. What is it?
    b. What does it need to live?
    c. What does its home look like and why?
3. It is okay at this time if child is not sure what living things are or what they need to live, or to know much about their natural environment.

Explain/Elaborate

1. Provide child with a piece of paper, markers and a pencil for drawing.
2. Provide child a new living thing card at random.
3. Have child draw the living thing and its home.
4. Child can then use SOHO Bricks to build the living thing and its home.
5. Ask child to write a few sentences about their living thing and its home.
    a. Identify the living thing.
    b. Where does it live and why does it live there?
    c. Child explains their model.
6. If desired, go a step further and have child identify living things that work together or support one another in an ecosystem.
    a. Have child connect living things that have similar needs or that support one another (i.e food chains/webs).
    b. Child can construct ecosystems and explore living and nonliving things' relations within their natural habitat.
        i. i.e. plants need sun, water, air to live—bees need the air from plants, warmth from the sun, water and flower nectar and pollen from plants to live.

Project 32

Building Out Of The Box

Objective: Child will be able to use SOHO Bricks as manipulatives to help in answering questions using equations and inequalities as they solve and check for an unknown variable.

Essential Question(s): How might we solve for an unknown quantity?
Special Materials: Small boxes.
Bricks Required: All

Project Structure:
Engage/Explain:

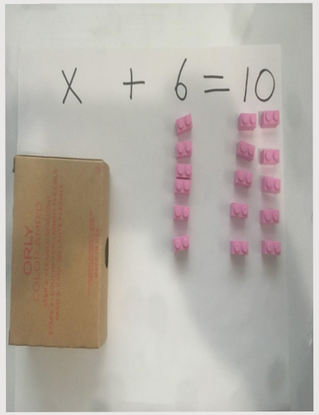
1. Present a box filled with an unknown amount of bricks by shaking it up and down so it makes noise.
2. Tell child that there is an unknown number of SOHO Bricks in this box. Their task today is to solve for how many bricks are in this box, and to explain in detail how they got the answer. Winning answers may receive bonus points or any other reward.
3. Provide child with a math expression that can be used to solve the amount of bricks in the box. For example, place 4 bricks in the box and provide the expression $x + 6 = 10$.
4. There are a number of ways that child may solve this problem. Most may use mental math to determine that x is 4.

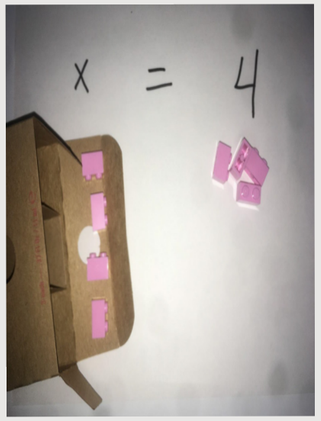
Explore:

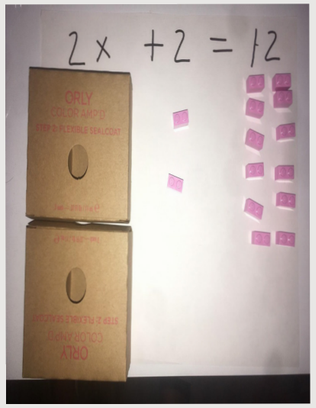
1. Now that child knows the answer is 4, ask them to clarify how they got the answer.
2. Facilitate child's responses to get them to reason that mentally, they are removing the 6 from both sides to isolate the x.
3. Together with the child, set up the algebraic expression using SOHO bricks and "balance" board. Demonstrate with manipulatives the removal of 6 (the unbalance), and the removal of 6 from 10 to rebalance and to identify $x = 4$.
4. Open the box to show child that there are indeed 4 bricks.

Explain/Elaborate:

1. Set up and label stations with unknown boxes of bricks and loose bricks to mirror expressions around the room.
2. Have child rotate to each station to solve their problems.
3. After all stations are completed, share out by modeling each station and reveal the correct number of bricks. Child should check their work and ask clarifying questions where needed.
4. Follow up this activity with scaffolding to performing the steps with mathematics only and provide additional practice problems.







Project 33

Monster Brick Rally

Objective: Child will create SOHO Brick monsters of their own design and will compare their features using ratios.

Essential Question: How might we use mathematics to describe and compare the relationships between different things?

Special Materials: Pen/pencil and paper, markers or colored pencils
Bricks Required: All

Engage/Explain:

1. Tell child that today they will be using SOHO bricks to engage in creative play by designing Brick Monsters of their choosing.
2. Ask child to take out a sheet of paper and begin designing what they would like their monster to look like.
    a. Remind them to think about the monster's features:
        i. How many eyes will it have? Arms, feet, tails, tentacles, claws, etc.
        ii. Child can make notes of their features on the side.
    b. Child ought to draw their creation.

Explore:

1. Provide time for child to use SOHO Bricks and to design their monsters.
    a. Set a time limit for your child to build so they stay on task.
    b. Adjust this time as you see fit.
2. Ask child to create a table of features for their SOHO Monsters.
    a. Tabulate features by name and quantity.
3. Consider getting involved by building a SOHO Monster as well.

Explain:

1. Provide child with the definition of a ratio:
    a. A ratio expresses a relationship between two quantities.
2. Ask child to look at your SOHO Monster and write down a ratio of features from your monster.
3. Have child share ratios that they came up with.
    a. This may be a struggle at first as they may not quite know what you are asking them.
    b. Facilitate the feedback they give you to work towards an example of a ratio from your monster.
    c. Once the first one is done, child will be able to generate others more quickly.
    d. Through child-generated examples, help facilitate the use of language and written forms to express ratios.
4. Ask child to look at their monsters and generate and write down as many ratios as they can think of.

Project 34

Bricks Are A Factor

Objective: Child will be able to construct a fluid multiplication table to determine all of the whole number factored pairs for numbers and identify them as prime or composite numbers

Essential Question: How might we determine all the factored pairs for a number 1-100?

Special Materials: None
Bricks Required: Bricks of all the same sizes for a group of students.

Project Structure:
Engage/Explain:

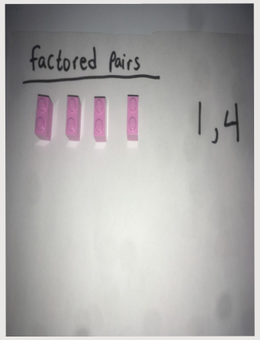
1. Provide child with a simple composite number like 4.
2. Ask child for the whole number factors for the number 4.
3. Child should begin trying to figure this out, but they will be confused by the term “factor.”
4. Tell child that you will quietly (without speaking) model for them how to find the whole numbered factors for 4. Ask child not to shout out while you are solving the factors—even if they know the answers.
   a. Demonstrate using bricks by lining up 4 bricks in 1 row. These are the first two factors (4, 1).
   b. Write them down.
   c. Proceed to move the bricks to make additional rows with even amounts (2 bricks, 2 rows).
   d. 3rd trial will give 1 brick 4 rows; the factors have just repeated.
5. Once complete, circle the 4 whole factors (1,4,2).

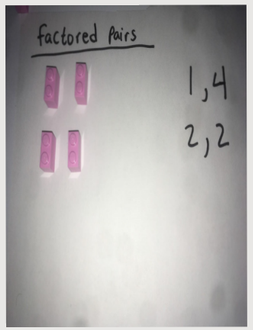
Explore:

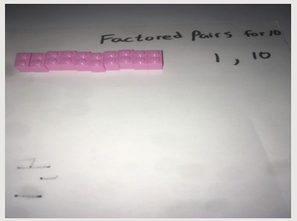
1. Provide child with another number from 2-10 and ask them to use the bricks to determine all of the factors.
2. Repeat this process and facilitate child’s work as they solve the numbers 2-10.
3. Question child as to why some numbers have factors, and others only are factored by themselves and 1.
4. Discuss composite and prime numbers.
5. Child should also catch on that factors are just multiplication of numbers.

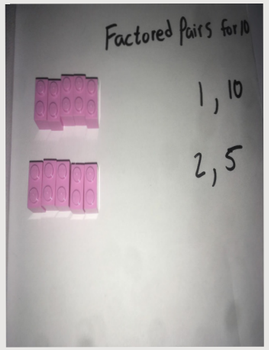
Explain/Elaborate:

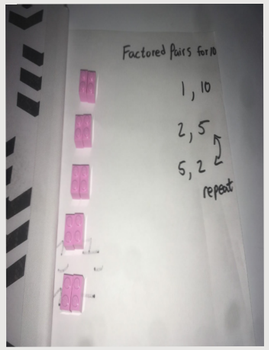
1. Ask child to find all the factors for numbers 1-100, and to identify them as composite or prime numbers.
2. Child may choose to abandon the manipulative table for finding factors and do them mentally.
3. Facilitate child to double check their factors.











Project 35

Hold The (Number) Line

Objective: Child will be able to determine a way to represent numbers going different directions using + and - numbers.

Essential Question: How might we represent directions Left/Right, Up/Down, North/South, East/West using only numbers?

Project Structure:
Engage/Explain

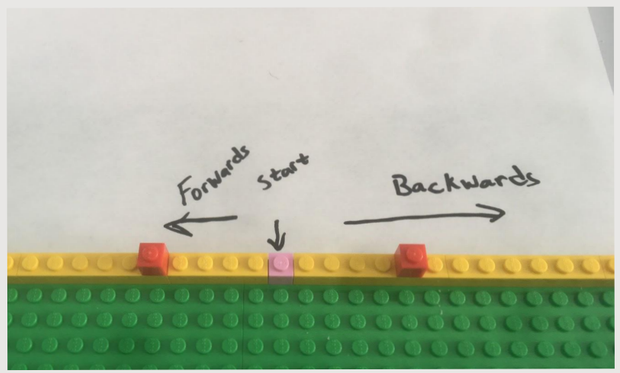
1. Stand approximately in the middle of the room to start the project. From standing, ask child to count your steps as you walk.
2. Begin to walk towards the front of the room, slowly exaggerating each step to make them easy to count. Child should be counting out loud.
3. Write the number of steps down so it is easy to remember.
4. Repeat the process with the same number of steps, but towards the back of the room. Write it down.
5. Ask child: How might we differentiate the difference between the two walks?

Explore

1. Ask child to create lines to represent the two different directions of the walk, identifying the starting point with different color SOHO bricks.
   a. Child ought to be designing a line of bricks where 0 is a different color than the rest.
   b. They should be marking on the line the correct number of steps “forward” and the correct number of steps”backwards.
2. Ask child how we might use this line to identify the number of steps and direction with just mathematical notation—rather than by saying “forward” or “backwards.”
   a. Give child time to develop their comprehension and share ideas. The hope is to get them to use +/- as replacements for direction words.
   b. It may be helpful to facilitate child’s ideas by using the expression “opposite” direction when talking about the difference between forwards and backwards.
3. Have child explain their concepts and how +/- may be used to represent opposite directions.
4. Have child make attempts at making number lines with varying scales for same and different scenarios.

Explain/Elaborate

1. Provide child with scenarios to practice using the number line. Scenarios may be related to walking, temperature changes, climbing up/down a ladder, gaining or losing money, and so on.
2. Have child write an explanation of how the number line works, and how opposite numbers may be used to solve a wide variety of real-world problems.
3. Have child write out an explanation of the importance of scale and how it may be changed.



Project 36

Why Coordinate?

Objective: Child will be able to plot and draw polygons on a coordinate plane given a set of vertices. They will be able to determine side lengths using their graphs

Essential Question: How might we represent polygons and measure sides using coordinate planes?

Special Materials: None
Bricks Required: 1x bricks of various sizes**;** two brick plates

Project Structure:
Engage/Explain

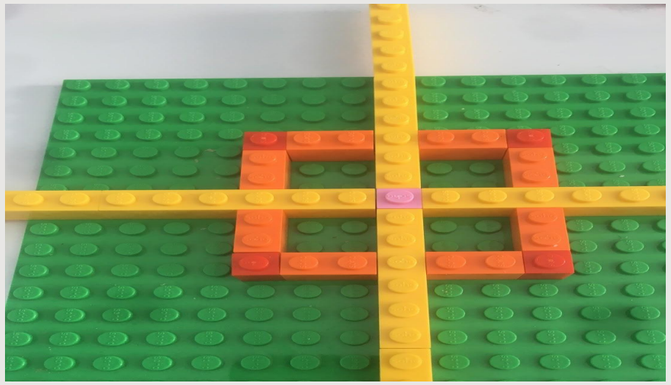
1. Have child create a coordinate plane using SOHO Bricks.
2. Provide them a set of vertices to represent a square: (-3,3) (3,3) (3,-3) (-3,-3)
3. Ask child to identify the polygon shape they see.
    a. If child has trouble visualising the shape, they may connect the lines from point to point using a different color brick.

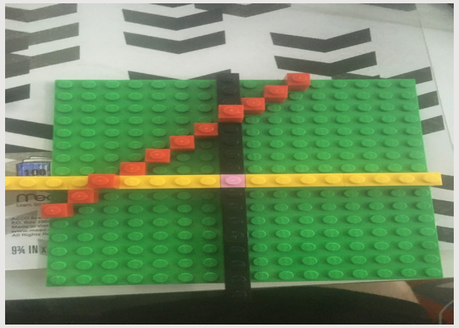
Explore

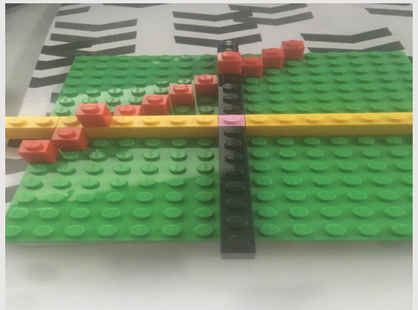
1. Ask child to determine the length of the side and explain how they got their answer.
    a. Most children will probably count the studs to determine their answers; be careful to facilitate thinking on counting so they arrive at the correct answers.
2. Ask child if they can devise a “formula” for determining the correct length using the coordinates.
    a. Provide time for child to explore various formulas of their creation, always checking the correct answer to see if they match.
    b. The equation they should arrive at is the absolute difference between the two coordinates (i.e. |x2-x1|).

Explain/Elaborate

1. Provide child additional paper practice problems to determine polygon shapes and length of sides.







Project 37

The Plots Thicken

Objective: Child will be able to practice plotting points on a coordinate plane.

Essential Question: How might we plot points in a coordinate plane?

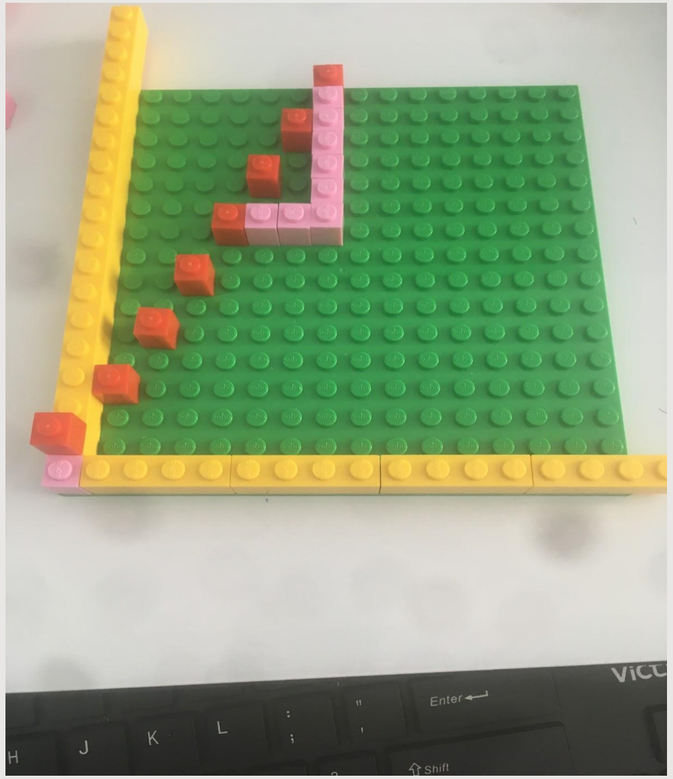
Special Materials: None
Bricks Required: 1x bricks of various sizes; two brick plates

Project Structure:
Engage/Explain:

1. Ask child to create a horizontal number line extending in both - and + directions. Ask that the zero be a different color brick.
    a. Have child practice plotting numbers along this number line (a skill they should already have).
    b. Monitor child and check for misconceptions.
2. Have child create a vertical number line using the same zero point and extending in both - and + directions.
    a. Child will have created an *x-y* coordinate system.
3. Have child practice plotting on the horizontal and vertical axes separately to make sure they are able to identify each axis. You may choose to refer to these as vertical/horizontal, up-down/left-right, or as *x* and *y*.
4. Once child gets the hang of things, provide them coordinates in pairs (*x,y*).
    a. As child plots each point, circulate and check for and correct misconceptions.

Explore:

1. Have child clear their graph of any previous points.
2. Provide child a set of coordinates:
    a. (2,2) (-2,2) (2,-2) (-2,-2)
3. Ask child to plot these points and reflect upon them.
    a. What is different about them?
    b. What happens to the point when a negative is added?
4. Have child converse with you about coordinates, quadrants and signs.
5. Have child translate their work onto conventional graph paper, with proper labels and coordinates and quadrants labeled.
6. Provide additional problems on brick graph and paper graph, slowly scaffolding away from the brick graph.



Project 38

In the *mx*

Objective: Child will use similar triangles to determine slope and interpret unit rates as slopes.

Essential Question: How might we use triangles to determine the rate of change?

Special Materials: None
Bricks Required: 1x bricks of various sizes; two brick plates

Project Structure:
Engage/Explain:

1. Provide child with an equation of a line that they can easily graph using SOHO Bricks. For example, $y = (2/1)\,x + 1$. Child should graph by plugging in values for x and determining the y coordinate.
2. Ask child to reflect upon the equation and the graph.
   a. "Looking at your graph, where does the line cross the y axis?"
   b. "Looking at your equation, how might you be able to tell where it crossed the y axis?"
   c. "Do you think the equation will always tell you where the line will cross the y axis? Why or why not?"
   d. "Does the equation tell us anything else about the graph?"
      i. Facilitate child to think about the "*mx*" portion of the equation. How is it represented in the graph?

   a. Through observation and exploration, child may discover that each point increases in the y direction by 2 units while the x increases by 1 unit, and that this is the visible component in front of the x.

Explore:

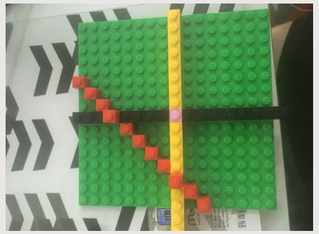
1. Ask child to provide an explanation of how they know that the x and y coordinates move 2/1 every time.
2. Ask child to prove that this works if they do not count from one point to another. In other words, can they skip points and still get the same results?
   a. Child may elect to use bricks to construct triangles from any two points;
   b. Child may not see at first that their results are the same.
3. Work with child to demonstrate that similar triangles will always result in the same ratio of 2/1 for this line. This is called the *slope* or the *rate of change*.
4. See if child can construct an equation to determine the slope.
5. Discuss the slope formula.
   a. How does this fit our understanding of rate of change and our similar triangles?

Explain/Elaborate:

1. Provide child additional problems to determine the rate of change for each problem and the y intercept.
2. Child may do these on graph paper and sketch triangles to show the ratio of the rate of change (slope).

Further Elaboration (The SOHO Stack):

1. In this activity, child will have an opportunity to blend science and math by performing a SOHO Brick stack.
2. Take turns with your child stacking as many bricks as they as you can in a given time allotment: 1 second, 2 seconds, 3 seconds, etc. Each attempt should be repeated at least 3 times and the average taken.
3. Child then plots their own data, determines the line of best fit, finds the slope of their line using similar triangles, and determines which had the fastest rate of brick-stacking.



Project 39

When Bricks Collide

Objective: Child will be able to investigate system of equations to find their solutions using SOHO Brick graphs.

Essential Question: How might we identify solutions to a set of equations using graphs?

Special Materials: None
Bricks Required: 1x bricks of various sizes; 2 brick plates

Project Structure:
Engage/Explain:

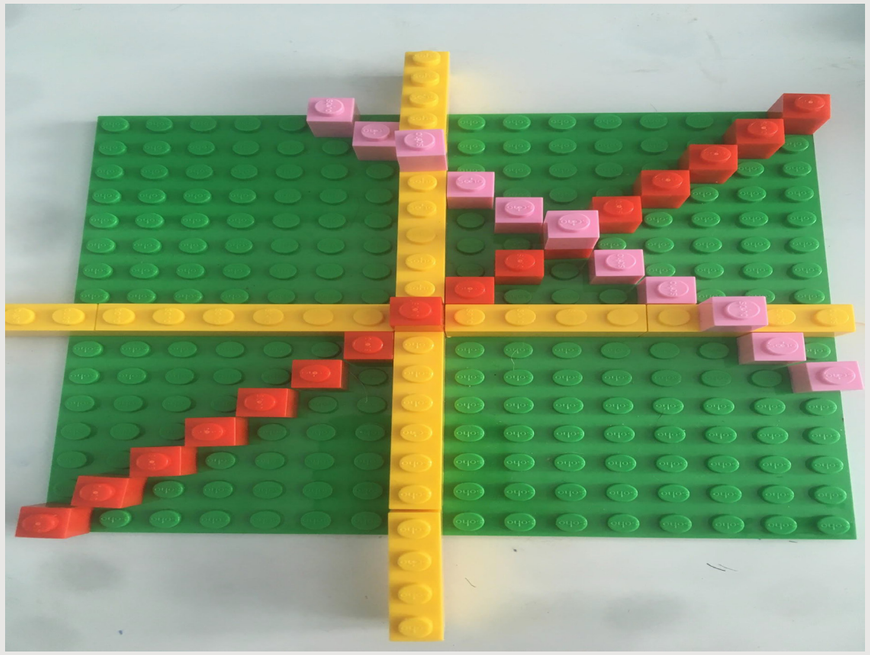
1. Have child graph a set of equations using SOHO Bricks.
2. Ask child a series of questions about the graphs and review:
   a. What is the *y*-intercept of each graph?
   b. What are the slopes of each graph?
   c. Do the graphs intersect at all? Where? How do you know they intersect?
   d. What does it mean to have two lines intersect?
3. Have child clearly identify and label the coordinates of intersection.

Explore:

1. Have child solve the system of equations they graphed, using algebra:
   a. This can be done via a method of their choosing and should be supported and scaffolded.
2. Have child compare their solution from their equation to the intercept.
   a. Ask child to explain what they see and what it means for the graph: mainly, that the solution to the equations is always the point of intersection between the two lines.

Explain/Elaborate:

1. Provide child with systems that do not have points of intersection, such as parallel lines.
2. Have child graph and see they do not intersect. Ask them the questions from the “Engage” section above.
3. Ask child to use observation to develop a way to determine if lines will have a solution or a point of intersection.



Project 40

What Are The Chances?

Objective: Child will develop an understanding that a probability of an event occurring will always be a fraction or a percentage between 0 and 1 through experimentation and reasoning.

Essential Question: What is the probability of an event occurring?

Special Materials: Brown lunch bags
Bricks Required: Brick plates, 1x to make the borders, any size bricks to keep a tally, and a separate quantity of bricks to put in the brown bag

Project Structure:
Engage/Explain:

1. Select two different colors of bricks.
2. Ask child, "If I place these two bricks in a paper bag and ask you to select a brick, what is the likelihood that you will select _____-colored brick?"
    a. Give child a chance to think about the question and give a response.
    b. Encourage child to not only give the answer, but provide supporting reasoning for their answer.
3. Tell child that you will now put one brick of a 3rd color into the bag.
    a. Repeat the question above;
    b. Allow them time to respond with reasoning.
4. Child should write the probability in terms of a fraction: ½ and ⅓.
5. Child may use a number line (0-1) to help identify fractions and their magnitude.
6. Repeat the process if desired by adding a 4th and then 5th color.

Explore:

1. Ask child what happens to the probability of selecting a specific color as additional colors are added.
    a. Are the chances of selecting that color getting larger or smaller?
    b. Will the chances of selecting a certain color ever be certain?
2. Have child brainstorm around these questions and share their conclusions and reasoning.

Explain/Elaborate

1. Tell child that in each case above, their odds of selecting a brick were decreasing, and at most they had a 50-50 chance of selecting a specific brick color.
2. Task child with finding a way to increase their odds of selecting a specific color from the bag.
3. Allow child time and additional bricks to develop a model of ways they may increase their odds of selecting a specific brick color.
    a. Have child provide reasoning and examples of their model, to show that it provides an increase in the probability of a certain color being selected.
4. Child's responses should include adding more of the same brick color to generate higher probabilities for those colors.
5. Child may run into difficulty in developing fractions, as the numerators and denominators change. Facilitate sound reasoning on a case-by-case basis.

Project 41

Probable. Cause?

Objective: Child will explore probability with bricks in the real world and compare its theoretical outcome over time.

Essential Question: Does the theoretical probability of an outcome guarantee its outcome in the real world? What factors affect the theoretical outcome matching that in the real world?

Special Materials: Brown lunch bags
Bricks Required: Brick plates, child-selected bricks for tally if they so choose, and a separate quantity of bricks to put in the brown bag

Project Structure:
Engage/Explain:

1. Have child select at least 3 different-colored bricks; they should select differing amounts per color (but no more than 10 each).
2. Have child record the theoretical probability of selecting each color before placing the bricks in the bag.
3. Have child develop a method of recording the brick selection:
    a. A table with tally marks.
    b. A brick-based table to keep track of their selections (make sure child does not use the bricks they pull from the bag for their table as this will change the odds in the bag).
    c. Any other valid option.
4. Have child perform the activity ~10 times.

Explore:

1. Have child reflect on their data:
    a. Did the results match the theoretical probability? Why or why not?
    b. Is probability a guarantee of the results?
    c. How might we get closer to the theoretical probability in the real world?
2. After child reflects on their data and these questions, discuss that theoretical probability does not guarantee an outcome; rather, it states that an event is more likely to occur.
3. By increasing the amount of trials of the selection, the real-world results should move closer to the expected theoretical outcome.

Explain/Elaborate

1. Have child test the validity of the assumption that more trials move the real-world results closer to the theoretical outcome.
2. Child should experiment by doing their bricks selection in 10-selection intervals, and compare the outcomes to the theoretical ones.
3. Have child reflect on the process and perform additional trials.

Project 42

Vector-y is Ours

Objective: Child will be able to use SOHO Bricks as manipulatives to add and subtract vectors.

Essential Question: How might we add and subtract vectors of varying directions?

Special Materials: None
Bricks Required: 1x1 bricks of different colors

Project Structure:
Engage/Explain:

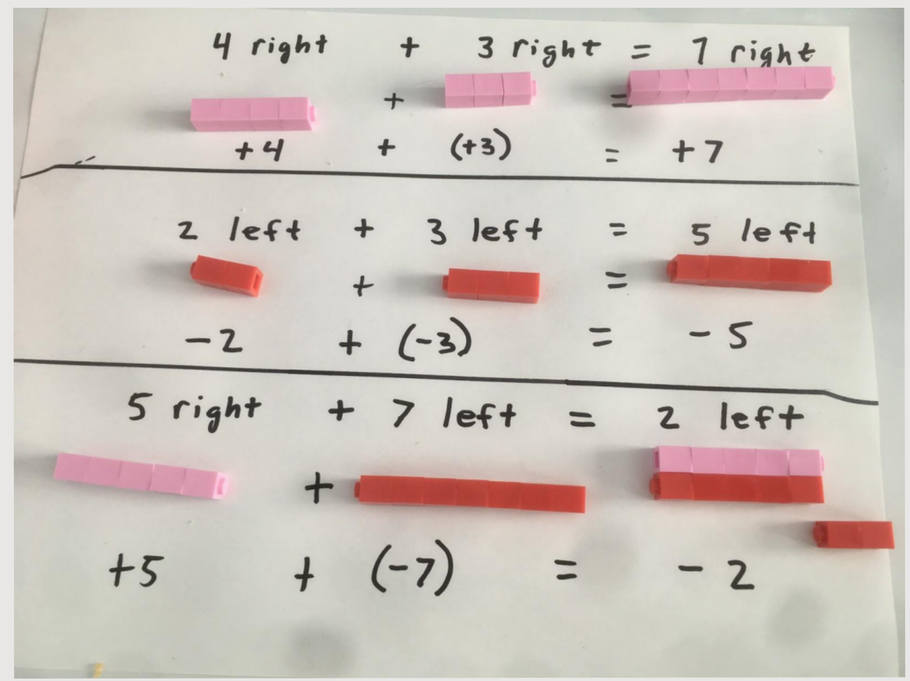
1. Provide child with 1x1 SOHO bricks in various colors.
2. Ask child to construct several vectors of various magnitude and direction ("4 bricks to the right" "7 bricks to the left").
3. Ask child to solve several vector addition problems using their bricks to model the vector additions (it is a good idea to start with same-direction vectors and then proceed to opposite-direction vectors).
4. Have child write brief explanations of how their vector addition problems work. This is to provide a better understanding of vector math in their own words.

Explore:

1. Provide more rigorous problems to child by giving them horizontal and vertical vector problems that can be modeled on graph paper.
2. Ask child to develop a method for determining how to add these vectors together.
3. Work with child on developing the parallelogram rule and using tip-to-tail methods of lining up vectors.
4. Child should practice solving problems visually, as well as numerically.

Explain/Elaborate

1. Provide child with problem sets to practice adding and subtracting a series of vector problems that can be solved numerically and with graphing.
2. Child should also demonstrate graphically how vectors $a+b = b+a$.



Project 43

SOHO Bingo

Project Structure:

Engage/Explain:

1. This is a simple and fun build and can be used as an interactive game to check understanding or test review.
2. Construct the Bingo Boards using SOHO Bricks. The board size can be scaled up or down by adding or subtracting brick plates. Choose board size for child.
3. Have child cut and place answer cards in each rectangle of the board. These answer cards will vary based on subject, content, and grade level.
4. Ask questions and child will respond quietly by placing a brick in the correct box. 1st connecting line, or whole plate wins!

Card Designs

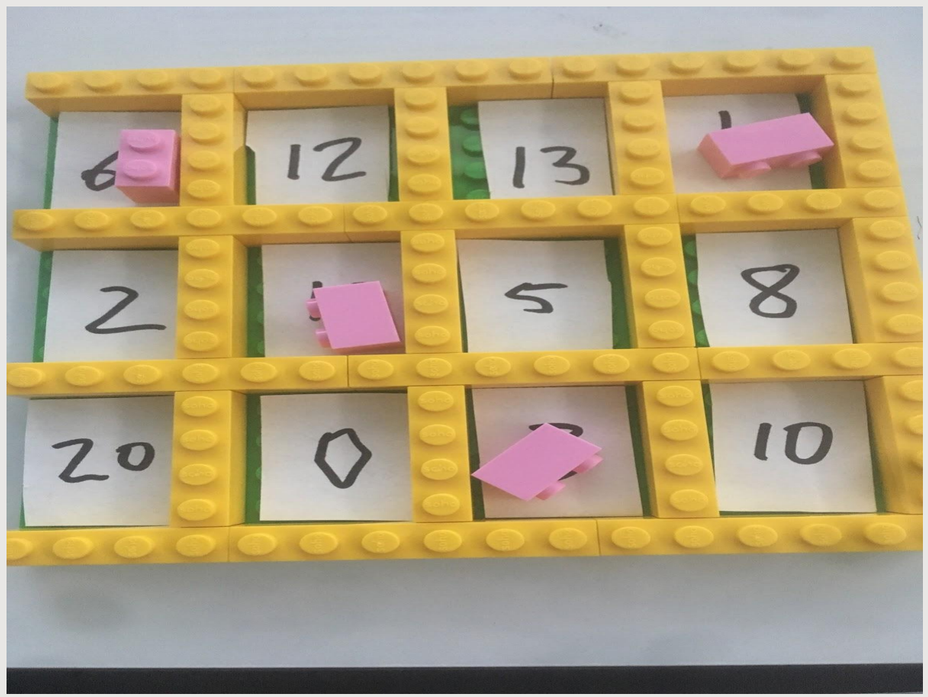
Front Side:

- **Challenge activity**
- **Creative design for background(maybe 2BCF logo shadow)**

Back Side:

- **2BCF and/or SOHO logos**
- **2BCF color themes**

Card #	Challenge Activity
1	Build a tree
2	Build something that would fly
3	Build a rocket ship
4	Make a pattern with bricks
5	Build a number “8”
6	Build your favorite fruit
7	Build your favorite vegetable
8	Build something using only 7 bricks
9	Build a dinosaur
10	Build a small table
11	Build your favorite animal
12	Build a number four
13	Build a flower
14	Build a bird
15	Build an ant
16	Build a spider
17	Build something using 10 bricks
18	Build the first letter of your name
19	Build a ladder
20	Build a person
21	Build a surfboard
22	Build a crab
23	Build your favorite superhero
24	Build a turtle
25	Build a bat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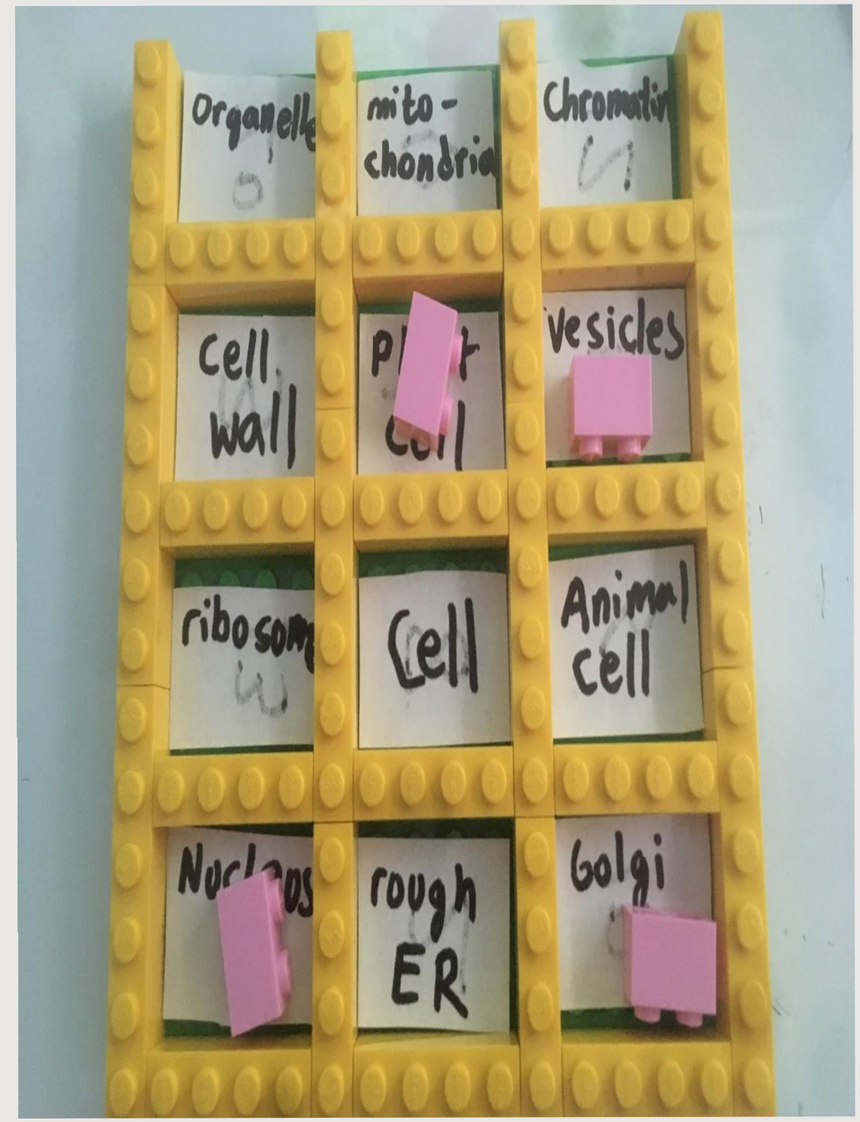
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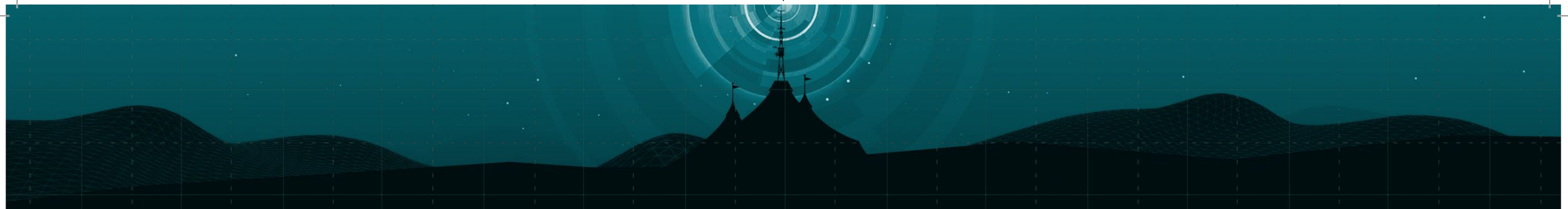

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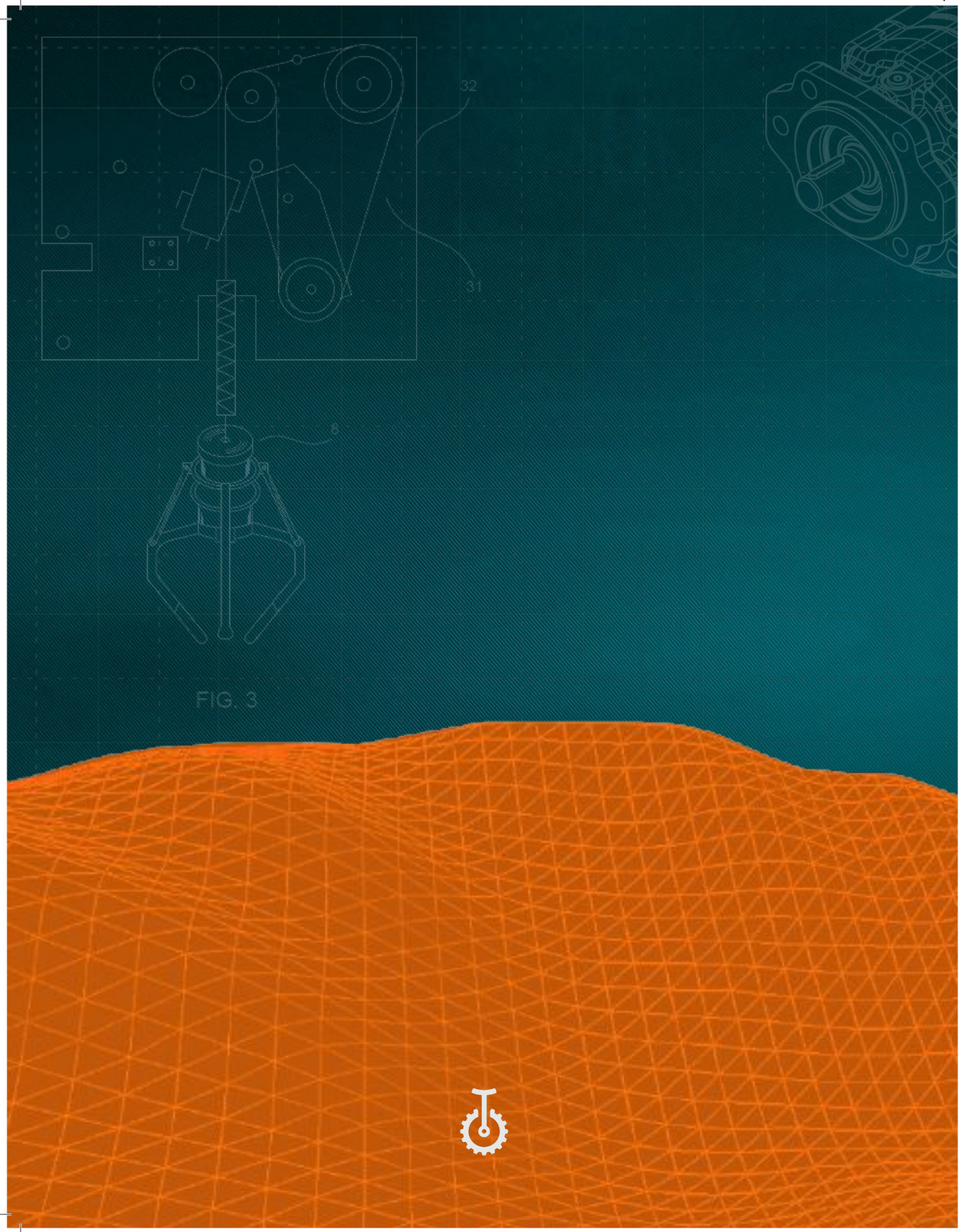
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FIG. 3