

Problem Solvers Activity SE 21: Building Together

CHILDREN ARE LEARNING...¹

Science Content:

- Designs can be conveyed through sketches, drawings, or physical models
- The shape of objects is related to how they are used
- Models (sketch/picture) are used to represent structures or objects

CHILDREN ARE DOING...

Science Practices:

- Make observations
- Develop and use models
- Construct, test, and design solutions

MATERIALS NEEDED:

Boxes of different sizes (mailing boxes, tissue boxes, shoe boxes, etc.)—at least 4-5 per child

Wooden or foam blocks—at least 20

Large chart paper and marker

Optional: Adult scissors, child-safe scissors, extra paper

Handout 1: Design Plan

PREPARATION:

- **For the ENGAGE activity:** Have **Handout 1** ready to share.
- **For the EXPAND and EXPLORE activity:** Place the boxes and blocks in a place with enough room for children to build a large structure. Have the chart paper and markers ready to create the design plan.
- **If possible:** It's ideal to block off an area of the room that is a dedicated space for building and design. In this area, children can revisit and revise their structures over time. This area should *not* be cleaned up daily like other areas of the classroom. The idea is to encourage the children to explore, create, improve and then start the engineering design cycle all over again!

¹ Adapted from the Next Generation Science Standards (kindergarten): <https://www.nextgenscience.org/>

JUST FOR TEACHERS: THE ENGINEERING DESIGN PROCESS

In this engineering activity, children will work through what is called the engineering design process. This process helps to guide the work of student-engineers through a three-step cycle until they have a design that works. This preschool engineering design process was developed by the Museum of Science in Boston, Massachusetts. The three steps include:

1. **Explore:** Find out more.
In this step, children explore materials and observe how they work and what they can do. This is the process of researching and collecting data! Teachers can focus children's observations by reminding them of the **goal** of their exploration.
2. **Create:** Try your idea.
In this step, children will decide **how to achieve the goal** of the activity. It's important not to emphasize the final product in this step. Instead, encourage children to "try an idea" and see if it works. Engineers often try many different approaches and fail many times before they are successful.
3. **Improve:** Make it better.
Teachers can help children reflect on what they have observed and learned so far, and then ask them how they could improve their design. Remember that children learn a lot from seeing others' work, so encourage them to observe their peers' designs as well as share their own work. In this step, you may see children utilize elements from their peers' designs. This isn't "cheating." This is how engineers share ideas to enhance their designs. Staying focused on the goal of this step—making it better—helps children continue to problem-solve improvements. Focusing on making it better also teaches children that mistakes or failures are simply part of being an engineer.

This content was adapted from the following source:

Davis, M. E., Cunningham, C. M., & Lachapelle, C. P. (2017). They can't spell "engineering" but they can do it: Designing an engineering curriculum for the preschool classroom. Zero to Three, 37(5), 4-12.

Activity Instructions

ENGAGE

Gather a small group of 4 children in a circle on the floor. (Note: Groups of 6 children work well if you are teaching 4-year-olds. Adjust materials as needed.)

EXPLAIN: Invite the children to share their experiences with building using questions like those below:

- Have you ever seen a building being built? What was happening? What machines or vehicles did you see? What were the workers doing?
- Do you like to build with blocks in the classroom? What are some things you've built with blocks?
- Has anyone heard the word 'engineering'? What do you think this word might mean?

EXPLAIN: Engineering is how we use math and science to design and build solutions to problems. You are all Problem Solvers in our class, and today we are going to solve problems and be engineers. Engineers are people who plan out—or design—and build things like machines, buildings, bridges, computers, and even toys!

ASK: What do you think this might be? What does it look like to you? (Show the children **Handout 1**. Give them a few minutes to look at it together.)

EXPLAIN: This is called a blueprint or a design plan. It is a plan for how a building will be built. A design plan helps engineers and workers know how to build something.

EXPLORE: Ask children about the design plan:

- What do you notice when you look at this design plan?
- What do you think the workers will build using this design plan?
- What do you see on this design plan? (Can anyone find a door? Any windows? How many... let's count.)
- Do you think it takes a long time or a short time to build a house? What makes you think that?
- Do you think a design plan is helpful to workers? What do you think workers do with the design plan?
- Has anyone seen construction workers building a house or a big office building? What did you see? (*Explain: The construction workers use a design plan to make sure they build the building correctly, so it is safe and is just right for the people who will be using it.*)

EXPLAIN: Today we are going to make a design plan and then we are going to work together to build our structure!

EXPAND

Move children to the area you have prepared with the boxes and blocks.

EXPLAIN: Wow, Problem Solvers, let's look at the boxes and blocks we are going to build with today! Why don't you take a few minutes to explore these and think about what you might want to build together? (*Give children about 5-10 minutes for free play. After the children have explored, bring them back together to talk.*)

ASK: Let's create a plan for what we want to build. Does anyone have ideas about the kind of structure we can build today? (*Encourage the group to talk about their ideas.*)

ASK: Help children create a design plan using the questions below. Draw/document children's decisions using the chart paper and marker.

- What do we want our structure to look like? What is on the bottom—boxes or blocks?
- How many boxes/blocks should we put down first?
- What goes on top of those boxes/blocks?
- Should our structure be tall or short?
- How tall will our structure be? (*Draw the blocks/boxes stacked in rows or columns.*)
- Should we make a skinny house (*show with hands*) or a wide house (*show with hands*)?
- How much of the carpet should our structure cover? Show me how big you want it to be.
- Should we use boxes or blocks here? How many should we use?
- Will our structure have a door? Where will it be?
- Will the structure have windows? Where will they be?

STEM TIP

As children are exploring the various boxes you've gathered, it is a great opportunity to use math vocabulary – like cube or rectangular prism when talking about 3D shapes or square and rectangle when talking about the flat sides of the boxes

STEM TIP

Note that many of the questions you'll use in this design discussion give children an opportunity to use important math skills like counting, spatial skills (*on top of, next to, behind*), and measurement skills (*tall, short, etc.*). This is a great example of how all STEM skills work together!

NOTE: If you are working with younger children, they may not fully understand the idea of creating a model (the drawing/design plan) and then building based on the plan. If that is the case with your students:

- You can flip the activity and begin building first. Invite a child to choose a box to begin. When the child places that block, draw it on the page. When the next child chooses and places their block in the structure, draw that on the page. Continue, so children can see how their choices/structure is being reflected in the design plan. This can help make the connection clear between the plan and the structure being built.
- Another option is that you take the lead with developing the design plan. Keep this first plan very simple (perhaps 2 boxes on the first “floor” and 2 on top). Draw the plan and engage children in making simple choices (“should we use big boxes or small boxes on the first level?”). Build this plan first.
- If children are still engaged, take the initial creation apart and begin again. With a fresh piece of chart paper, develop a new design plan—reflecting children’s choices and ideas now that they have had some experience with the activity.

REVIEW: When you are done with the design plan, pause and review it with children. Ask children to look at the plan and tell you about what they decided to build.

DISCUSS: Discuss safety rules if needed (like – keeping the structure no taller than children, sharing materials). For older children approaching age four, you might ask: What do you think are some rules that can help us be safe while we build together?

TRANSITION: Are you ready to be engineers? Let’s use our plan to build our structure!

EXPLORE

TRY IT: Hang the design plan where the children can see. Transferring information from a symbolic document (like a visual plan) to 3-dimensional objects (like blocks or boxes) is very difficult for young children and they may need help.

IMPLEMENT: Help children begin building by asking questions like:

- Okay, engineers, let’s look at the plan. Where do you think we should start building?
- What do you think we should build first on the plan?
- What do we need to build the bottom level of our structure? Let’s check the plan!
- Who would like to find 3 boxes to put on the floor, like we see in our plan?
- I need our engineers to help. Let’s look: What comes next in our plan?
- What do we need to make our structure look like the plan?
- *If you see errors:* Let’s check our plan. (*Show children the plan:*) Our plan has 3 boxes at the bottom, then 3 boxes on top of that. Let’s count how many boxes we have in our structure to make sure we’re following the plan!

STEM TIP

Point to each box as you count it. This practice models one to one correspondence for children, or the idea that each object in a set is counted only once.

When you are done counting, observe the total amount: “1, 2, 3. There are 3 boxes in our design.” This practice emphasizes cardinality, or the idea that the total quantity in a set is the last number counted.

NOTE: If the design plan includes doors or windows, teachers have two choices. You can cut a door or window in boxes for the children. Or, children can cut a door/window out of construction paper and tape it to the structure. Older children with scissor skills can also help with the second option as well.

OBSERVE: The teacher's role during this part of the activity is to observe the children as they build in order to support their learning.

- Younger children may need help working together, particularly support around turn-taking.
- As children are building, you may need to provide some behavior supports to help the group work together. For example, you might want to encourage children to take turns getting a block and placing it, before the next child adds to the structure.
- All preschoolers may need help in organizing themselves to begin; encourage them to start in one area (at the bottom) and build the structure from there. A good question to ask might be: *What is stopping us from building the top part of the structure first?*
- All preschoolers will need assistance in translating the written plan to the 3-dimensional materials – remember that this is a very challenging skill for young children. Teachers help when they continue to use the plan as a tool and make connections between the plan and the materials.

REVIEW: When children complete the structure, ask: *Does our building structure look like our design plan? Do we need to change anything in our structure or our design plan to make them look the same?*

DISCUSS: Refer to the design plan and talk through what you see: *The plan has 3 rows of boxes stacked on top of each other. Let's look at our structure and count the boxes there.*

Don't emphasize errors—instead, make an observation and ask children how to solve the problem: *Hmm, our plan had one box on top (point on the plan) but our structure has 3 boxes on top (point to the structure). What can we do to make our structure look like the plan?* Encourage children to review the plan/structure and make changes as needed.

REFLECT

To close the activity, bring the children back together. Use a reflective question/s - like those below - to prompt children's thinking about engineering and design plans.

- What do you remember about the word engineering?
- What did you discover about engineering today? What does engineering mean to you?
- Tell me about our design plan. What did we do with our plan? (How did we use our plan?)
- What is the same about our plan and our structure? (How is our structure like the plan we made?)
- Is there anything different about our plan and our structure? What is it? (How is the structure different than the plan we made?)
- Did the plan help us while we were building? How was it helpful?

SUMMARIZE: Today we learned about engineering and design plans. Engineers work to construct many different things, but they also do a lot of problem solving. Design plans help engineers to create a plan before they begin constructing.

Individualizing the Activity

Make it more challenging:

- Have children use a wider variety of blocks and boxes. Different sizes and materials will challenge their building skills.
- Make two groups of 2-3 children each. Have each group create their own plan and build different structures.
- Allow each child in the group to create a design plan. Let children vote on the plan they want to build first.

Make it less challenging:

- Use just one type of material (blocks or boxes).
- Keep design plans simple—for example, a two-story structure with two boxes on the bottom and two on the top.
- The least challenging option is to provide children with a prepared design plan of a simple structure you believe they can construct. After that experience, you might have them create their own design plan with you.

MAKING CONNECTIONS ACROSS THE DAY:

- Keep a clipboard, paper, and pencils/crayons in the block area to encourage children to create their own design plans.
- On community walks, point out construction that may be taking place. Ask children to predict what the workers might be building. If there is a picture of the new structure posted, make comparisons between the plan and the current structure.
- Create a “building snack” with children. Draw a simple plan/photo of 2 stacked crackers and an apple slice on top (or change to reflect whatever you are serving). See if children can create this building snack based on your design plan. Give children a chance to create their own building snack and see if their friends at the table can build it on their plates.
- Use the idea of “planning before doing” in all classroom activities. For example, as you are gathering art supplies, you might say: “I need a plan. Let me make a list. I need 6 paintbrushes and a pad of paper. Let’s be sure I have everything on my plan.”

Song: *I Am An Engineer*

Materials Needed: Any materials that can be used to build a pretend house: chairs, big boxes, pillows, cushions, blankets or big towels, etc.

Directions: While the music plays, help children decide what materials to use and make a fort or pretend house together! (Motions to model are included below if that works better.)

I am an engineer.	(Point to self)
I like to make designs.	(Nod head)
And when I've planned it out	(Point to head)
I'll build a house so fine!	(Make the shape of walls and roof with hands)

How will we build the walls?	(Model walls with hand motion)
Where will the windows be?	(Pretend to look out the windows, hand to forehead)
Let's place a door in front and a	(Pretend to turn a doorknob)
Roof with a brick chimney.	(Pretend to look up high to the roof)

(Interlude-spoken)

Hey engineers! Time to design your house!	(Decide what to use, and start building)
What things can you use to build it?	
Some chairs or boxes? Some cushions or pillows? Some blankets or big towels?	
You can do it when you Think it, plan it, draw it, build it!	

(Interlude-sung)

Plan it, draw it, build it!	(Sing along while you build!)
Plan it, draw it, build it!	
Plan it, draw it, build it!	
Plan it, draw it, build it!	

Verse 2

Then when we've built our house	(Sit inside the house/fort if possible)
Cozy inside we'll be.	(Give self a hug)
Sharing some special times	(Palms up, gesture to everyone)
With friends and family.	

I am an engineer.	(Point to self)
I like to make designs.	(Nod head)
And when I've planned it out	(Point to head)
I'll build a house so fine!	(Make the shape of walls and roof with hands)

Making Literacy Connections

Share the following book with children as an opportunity to deepen their understanding of design and construction.

Suggested Book: *Building a House* by Byron Barton.

AS YOU READ:

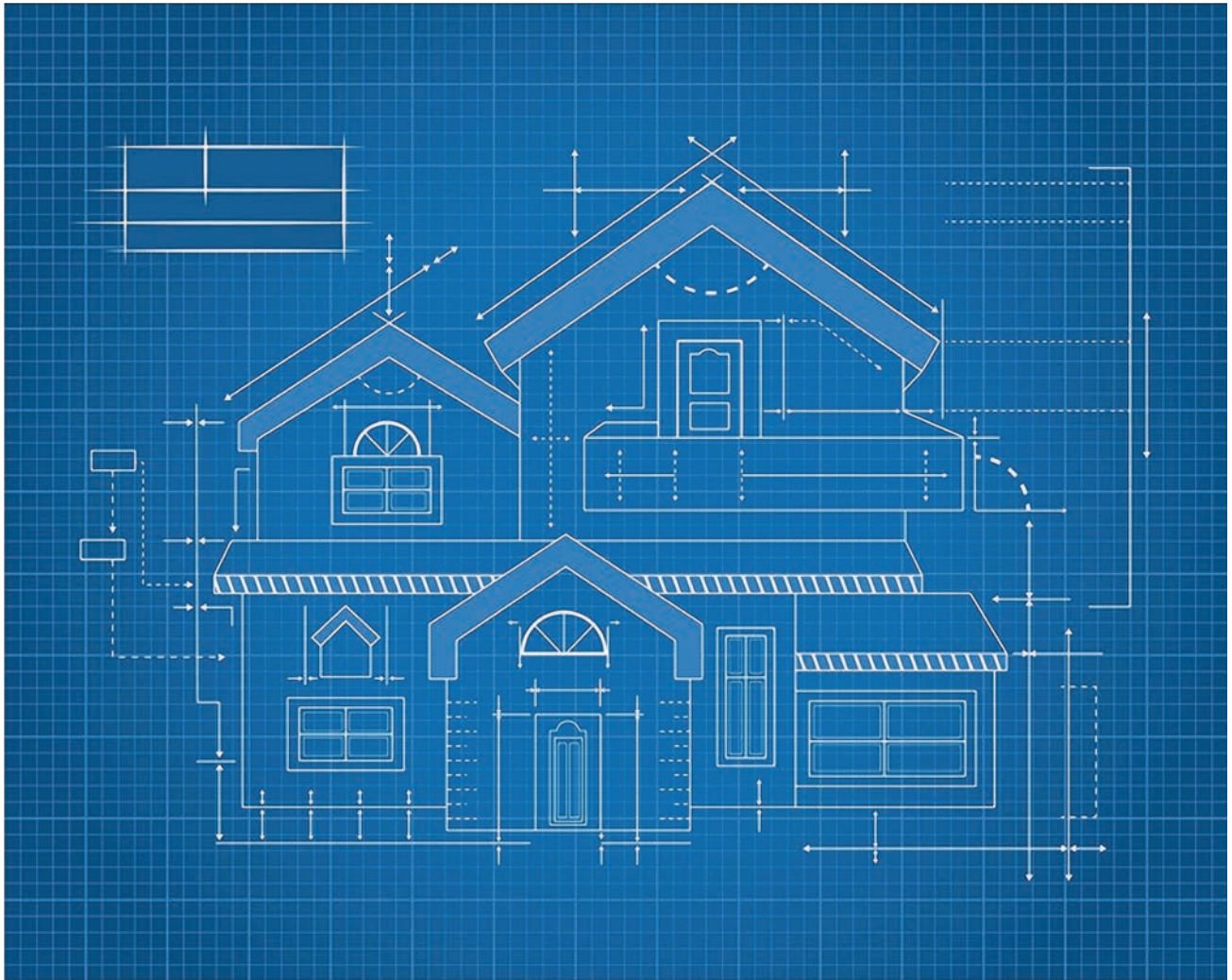
- On the title page, there is an image of a design plan (blueprint) above the title. Share this with children. What do they think workers will build with this design plan?
- You can introduce new vocabulary as you read. For example, on the page that says, “a machine digs a big hole,” you can explain that this machine is called an *excavator*.
- On the page where the builders are putting up the walls, see if children can find the hammer and saw. What do they think the builders are doing? What do they predict those lines of wood will become?
- On the page where the bricklayer lays large white blocks, ask the children if this looks like their block structure? What is the same and different?
- On the page where the workers are building the roof, can children find the ladder? Where is the roof of a house? Why do the workers need a ladder?
- On the page where the worker is putting in pipes, explain that every building has pipes hidden in the walls to move water into the faucets and out of the drains. See if you can find any pipes in your classroom.
- When the workers start to paint the house, ask children what color house they would like to have someday.
- When the house is done, ask the children if they think the design plan helped the workers know what to build. (Show children the picture at the beginning of the book again to compare.)
- On the last page where the family moves into the house, ask the children how they think the family members feel about their new house.

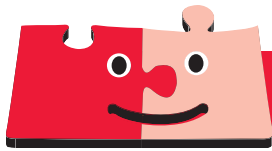
BUILD ON THE BOOK: OUTSIDE THE BOX STRUCTURES

Materials: Many different sizes of boxes, craft sticks, straws, clean plastic food containers (like yogurt cups), and other non-traditional building materials. Masking tape or painter’s tape. Paper/crayons/markers for creating plans.

Encourage children to build their own house using the materials provided. Suggest drawing a design plan first and then using the materials to create their structure. Some children may focus on an aspect of the house built in the story (like the pipes or bricks), which is fine. Encourage children to share their plans—whether they are telling you about them or drawing them—and how they intend to build their structure. When they are done, you might ask what was challenging about building and what they enjoyed.

Handout 1: Design Plans



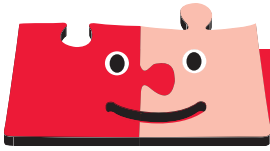


Learning about Engineering

This week, children are learning about the work of engineers and engineering design. They will be building structures using materials like cardboard boxes and blocks. You can help children practice these engineering skills at home by trying the activities below.

- **Build a fort together:** Use blankets, pillows, and couch cushions to create a fort for the family. Talk about how you will build walls, a door, or even a little window to peek through. Encourage everyone to work together to build and enjoy the fort. Sit inside your fort and share a snack or a story together.
- **Notice construction in the world around you.** Is there any construction happening in your community? Let your child stop to watch the construction workers from a safe distance. Talk about what they may be building. What machinery and vehicles do children see? What is going on at the construction site? Explain that the workers have a design plan, so they know what to build, and where to put walls, doors and windows.





Solo para familias

Aprender sobre ingeniería

Esta semana, los niños están aprendiendo sobre el trabajo de los ingenieros y el diseño de ingeniería. Van a construir estructuras con materiales como cajas de cartón y bloques. Puede ayudar a los niños a practicar estos conocimientos de ingeniería en casa con las actividades que se indican a continuación.

- **Construir juntos un fuerte:** Utilice mantas, almohadas y cojines del sofá para crear un fuerte para la familia. Hablen de cómo construirán las paredes, una puerta o hasta una ventana para asomarse. Invítelos a todos a trabajar juntos para construir y disfrutar del fuerte.
- **Observen la construcción en el mundo que los rodea** ¿Hay alguna obra en construcción en su comunidad? Deje que su niño se detenga a observar a los obreros de la construcción desde una distancia segura. Hable de lo que pueden estar construyendo. Explíquele que los obreros tienen un plan de diseño para saber qué construir y dónde colocar las paredes, puertas y ventanas.

