EXPLORE & ENGAGE

PennState Extension

STEM

BETTER • KID • CARE

Activities to support your child's engagement, learning, and development

These science, technology, and math ideas can be adapted for one-on-one use, or for small groups.

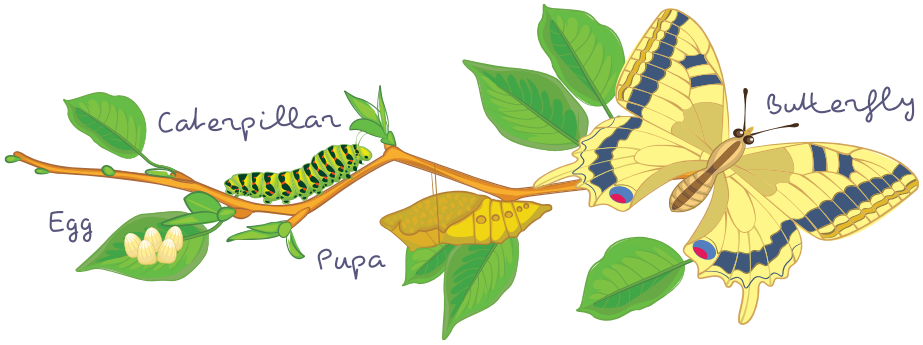
- Airplane explorations
- Discovery through science
- Exploring a bug's life: Morphing with bugs!
- Naked eggs
- STEM minutes: Simple STEM thinking challenges to offer during transitions and waiting times
- Learning, Rube Goldberg style!
- Creating structures: Common and uncommon ideas
- Active science play
- Active mathematics play
- Math skills for preschoolers
- Mathcabulary
- Move with math
- Garden activities
- Age-appropriate garden tasks

Click the links to download a PDF to view and/or print!

EXTENSION.PSU.EDU/PROGRAMS/BETTERKIDCARE

Exploring a bug's life: Morphing with bugs!

Young children are often fascinated with the insect life they see around them. Use their enthusiasm as an opportunity to explore the many fascinating things about the world of insects, including metamorphosis, one of the most interesting characteristics.



What is metamorphosis?

Metamorphosis means "to change in form." There are three types of metamorphosis: simple, incomplete, and complete. In all types of metamorphosis insects start off as eggs. In simple metamorphosis, the insect hatches from the egg and looks like a tiny adult. The insect goes through several stages of eating and shedding its skin, a process called molting, until it becomes an adult. Silverfish, springtails, and lice go through simple metamorphosis.

During incomplete metamorphosis, the insect hatches as a nymph and looks like an adult insect but doesn't have fully developed wings. It goes through several molting stages until it develops a full set of wings. Insects that exhibit this type of metamorphosis include grasshoppers, earwigs, dragonflies, termites and aphids.

Complete metamorphosis is the type of metamorphosis most people are familiar with. Insects go through four distinct stages of growth. They begin as an egg, and hatch as larva (plural is larvae) that look like a worm or maggot, drastically different from the adult insect. After a larva goes through multiple stages of eating and molting, it changes into a pupa (plural is pupae) and goes into a quiet stage of rest, not feeding or moving. When the insect emerges from the pupa, it is the adult insect. Butterflies, moths, bees, beetles, and flies are a few examples of insects that go through complete metamorphosis.

There are many activities, crafts and books associated with insects and metamorphosis.

Here are a few ideas to get you started:

Movement:

Try a "Doing the butterfly" activity having children and adults act out the four stages of metamorphosis of a butterfly:

Stage 1 – Become the egg by squatting down in a small ball. Tuck your head down and wrap your arms around your legs.

Stage 2 – Hatch out of the egg as a caterpillar by standing up and keeping your arms tight against your body. Wiggle around like a caterpillar would. Open and close your mouth to "eat" until you get enough food and then "shed" your skin (molting - make movements like you're peeling your skin off). Repeat wiggling around, eating and molting several times before moving to stage 3.

Stage 3 – After the caterpillar has its last meal, put your arms down to your sides and spin in a circle to become a pupa (called a chrysalis for butterflies). Stand very, very still and quiet for a minute or so.

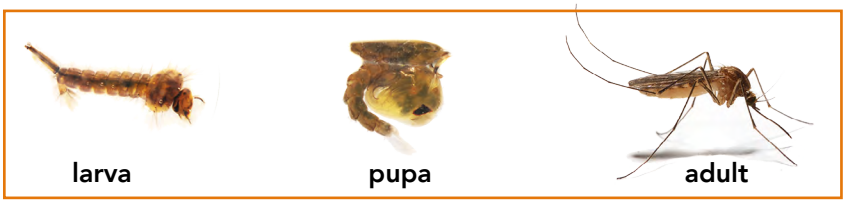
Stage 4 – Emerge from the pupa as an adult butterfly. Start moving your arms, gently fluttering and extending them up and outward. Be careful not to hit neighboring butterflies!

To extend the activity, ask the children where butterflies go to find food (answer: flowers – they use their proboscis, a long tube-like straw/tongue, to suck up nectar). Children flutter over to a flower, roll out their proboscis (they can make a funny noise when they do) and suck up the nectar (make a sucking noise). Ah, now all children are full and happy butterflies!

Reading and music:

Are You a Ladybug? by Judy Allen, illustrated by Tudor Humphries (2000), ISBN 0-7534-5603-6. Introduce preschoolers to the changes a ladybug goes through during metamorphosis. Other titles are available in the series (ant, bee, dragonfly, grasshopper, snail, spider).

There are a variety of metamorphosis songs and poems already created. Check out "Mr. R's Butterfly Metamorphosis Song" which includes a video and lyrics (see link below). Charlotte Diamond also has the song "Metamorphosis" available (see link below). Be creative and write your own song or poem!



Art:

Illustrate the life cycle of an insect using a variety of craft materials. This example is for the complete metamorphosis of a butterfly:

- Divide a paper plate into 4 sections (egg, larva, pupa, and adult) and decide what insect to illustrate. You will glue components for each section to the paper plate.
- In the egg section, create a small egg on a leaf. Use real leaves or cut them out of paper. The "egg" can be a white bean, small ball of cotton, paper, etc.
- In the larva section, make a caterpillar. Use pom-pom balls, clay, spiral-shaped pasta, pipe cleaners, paper, etc.
- In the pupa section, make a pupa that is hanging from a branch. Use a shell-shaped pasta, clay, or crayons for the pupa or cut one out of paper or fabric material.
- In the adult section, make a butterfly with its wings spread open. Use fabric material, glitter, bow-tie pasta, tissue paper, pipe cleaners, markers, etc.

Exploration:

What better place to find, study and enjoy insects than the great outdoors? Spring, summer and fall are filled with buzzing sounds and beautiful fluttering wings. Go outside and see what you can find! Look under logs and small rocks, examine the trunks of trees, look along sidewalks, in the grass, and around flowers. Can you find insects that go through complete or incomplete metamorphosis? Catch insects in plastic jars so everyone can see them up close. Release them when you are done. If you don't want to get too up close and personal with insects, use your senses to experience the insect's environment. Is it warm, or moist, or dark? What does it sound like? What does it smell like? What does the tree trunk, the grass, or under the rock feel like?

Resources:

If you don't have a good outside location to see live insects, bring them inside! You can raise butterflies, mealworms or other insects in your classroom. Visit Carolina Biological Supply (http://www.carolina.com/) or Insect Lore (http://www.insectlore.com/) for more information on purchasing and raising live insects. Care sheets are also available for specific insects.

- Mr. R's Butterfly Metamorphosis Song http://sciencepoems.net/sciencevideos/butterflyYT.aspx#.VND7xsbcEf8
- Charlotte Diamond's song "Metamorphosis" http://www.charlottediamond.com/catalog/product_info.php?products_id=67

Choking cautions

Young children can choke on small objects and toy parts. All items used for children under three years of age and any children who put toys in their mouths should be at least 1¼ inch in diameter and between 1 inch and 2¼ inches in length. Oval balls and toys should be at least 1¾ inch in diameter. Toys should meet federal small parts standards. Any toys or games labeled as unsuitable for children under three should not be used.

Other items that pose a safety risk and should not be accessible to children under three include, but are not limited to: button batteries, magnets, plastic bags, styrofoam objects, coins, balloons, latex gloves, and glitter.

Be aware of choking risks and food allergies when preparing and serving meals and snacks. Think about the size, shape, and consistency when choosing foods due to the potential choking risks in children. Food cut in large chunks, small hard foods, and soft and sticky foods should be avoided. The top choking hazards for children include: hotdogs, meats, sausages, fish with bones, spoonfuls of peanut butter, popcorn, chips, pretzel nuggets, raisins, whole grapes, raw carrots, fruits and vegetables with skins, and marshmallows. Be sure that food is cut in small pieces (no larger than ½ inch), grated, or finely chopped. Be sure that children are closely supervised when they are eating.

Dental health is a growing concern with young children, so it is important to keep in mind that starchy, sticky, and sugary foods can cause tooth decay. Children should brush their teeth after any meal or snack, but particularly when you serve these foods.

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

PENNSTATE
1855
Cooperative Extension
College of Agricultural Sciences

Activities1705.indd

Airplane explorations

Children are fascinated with airplanes. This fascination can be a doorway to rich STEM (science, technology, engineering, and math) learning even for the youngest children. When outdoors, encourage children to slow down and observe the sky. Look for clouds, birds, and planes. Notice wind speed and direction. Track contrails. Invite children to move their bodies like imaginary airplanes. These can be sources of inspiration for young aviators.

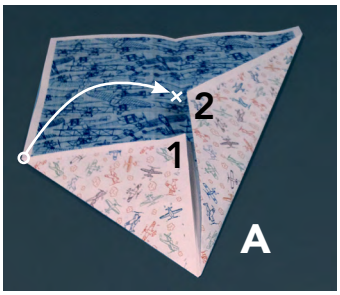
Inventors of early flying machines often were inspired by nature. "The invention of the modern airplane… depended upon the scientific analysis of the anatomy of bird wings and the invention of the internal combustion engine." (Bellis 2015 Gliders) Both Leonardo da Vinci and the Wright brothers hoped to replicate the flight of winged animals like bats and birds. (Leonardo da Vinci Inventions 2008; Bellis 2015 Wright Brothers)

Folded paper airplanes

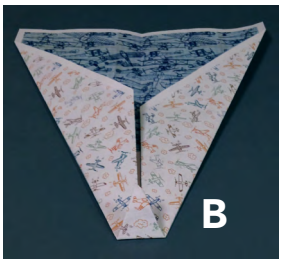
Folded paper airplanes are "gliders"—aircraft with no power source. Making and playing with paper planes can lead to discussions about aerodynamics (the forces that impact plane flight): thrust, lift, drag, and gravity/weight. Older children can also learn about plane movements like roll, yaw, and pitch. "The most amazing thing about a paper airplane is that all you need to make one is a sheet of paper—nothing more. You don't need scissors, glue, tape, or paper clips. A few folds, a couple of adjustments, and you have a superb paper flyer. The properties of paper give the airplane all the attributes it needs." (Doherty n.d.)

Older children may enjoy making planes that the youngest children in the program can play with. Young preschoolers may need assistance folding their planes. Toddlers will enjoy chasing after planes thrown by older people and bringing them back for another flight. Allow children to decorate and personalize the paper prior to folding the design. More experienced children can tackle folding designs for specific flight outcomes.

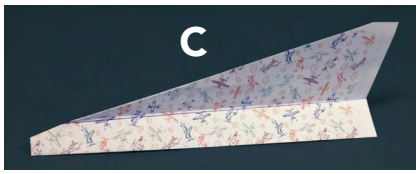
1. Fold the paper vertically and then open to create a center line.
2. Fold the top corners down to meet the center (1). Fold the top corners down a second time to meet the center (2). You now have the wings and nose of the plane. (A)



3. Fold the tip of the nose up and back towards the center. (B)
4. Fold the wings together, flattening the plane. Draw a line the length of the plane ½"-1" from the bottom. Then fold each wing down along the line, creating the airplane body to grip. (C)

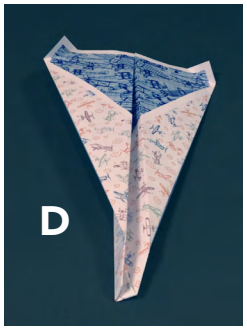


5. Create winglets by folding up the back tips of the wings, about a ½" fold. (D)
6. Time to fly your plane!



(Adapted from: Civil Air Patrol's ACE Program)

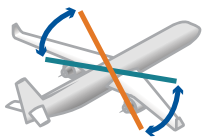
Children will have more success if the paper airplane nose is heavier than the tail section. This is usually accomplished with some extra folds. If the nose drops and the plane dives into the ground, bend up the back of the wings. A little bend goes a long way. If the nose rises first and then drops, the plane is stalling. Bend down the back of the wing. (Doherty n.d.)



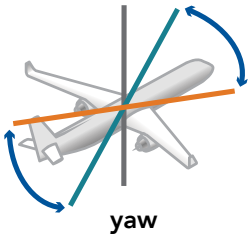
Making paper airplane fun more STEM-rich

Children experience Newton's laws of motion when they play with homemade airplanes. They realize that no still object will start moving by itself. It needs a push—the harder the push, the farther or faster the flight. A forward moving object will meet with a resisting force. (Doherty n.d.)

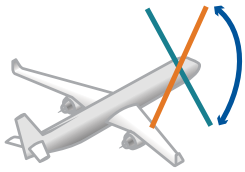
To increase the amount of discovery and experimentation, provide several paper airplane design ideas and have children make a variety and compare flight results. Name or number the planes and keep a chart of the distances. Use a long tape measure or skein of yarn to measure distance of flights, and masking tape or craft sticks to mark the end spot of each flight. Conduct several test flights with each plane and average the results. A wide open space like a gym or gross motor play area is a great place to test paper airplanes. Choose a day with no wind for the most satisfying outdoor testing.



roll



yaw



pitch

Where to find other design ideas

Public and school libraries often have books on paper airplane folding. The following websites also provide many options for children to explore:

- **Alex's paper airplanes** http://www.paperairplanes.co.uk/
- **Amazing Paper Airplanes** http://www.amazingpaperairplanes.com/Simple.html (also has video clips of real planes that align with the paper plane designs!)
- **Science Buddies** http://www.sciencebuddies.org/science-fair-projects/project_ideas/Aero_p046.shtml#background (contains more information on how paper airplanes work.)

References:

About.com Inventors. 2015. "The Dynamics of Airplane Flight." About.com. http://inventors.about.com/library/inventors/blairplanedynamics.htm

Bellis, Mary. 2015. "Conquest of the Air – Introducing The Wright Brothers." About.com. http://inventors.about.com/cs/inventorsalphabet/a/wright_brothers.htm

Bellis, Mary. 2015. "The Conquest of the Air – Gliders." About.com. http://inventors.about.com/od/gstartinventions/a/gliders.htm

Civil Air Patrol's Ace Program. 2011. "Paper Airplanes, Grade 4 Academic Lesson #3." Civil Air Patrol. Civil Air Patrol. Educators page. http://www.gocivilairpatrol.com/cap_home/educators/

Doherty, Paul. (n.d.) "Paper Airplanes." *Exploratorium* 23(2). http://www.exploratorium.edu/exploring/paper/airplanes.html

Leonardo da Vinci Inventions. 2008. "Flying Machine." Leonardo da Vinci Inventions. http://www.da-vinci-inventions.com/flying-machine.aspx

Science Buddies. 2014. "How Far Will It Fly? Build & Test Paper Planes with Different Drag." Science Buddies. http://www.sciencebuddies.org/science-fair-projects/project_ideas/Aero_p046.shtml

Choking cautions

Young children can choke on small objects and toy parts. All items used for children under three years of age and any children who put toys in their mouths should be at least 1¼ inch in diameter and between 1 inch and 2¼ inches in length. Oval balls and toys should be at least 1¾ inch in diameter. Toys should meet federal small parts standards. Any toys or games labeled as unsuitable for children under three should not be used.

Other items that pose a safety risk and should not be accessible to children under three include, but are not limited to: button batteries, magnets, plastic bags, styrofoam objects, coins, balloons, latex gloves, and glitter.

Be aware of choking risks and food allergies when preparing and serving meals and snacks. Think about the size, shape, and consistency when choosing foods due to the potential choking risks in children. Food cut in large chunks, small hard foods, and soft and sticky foods should be avoided. The top choking hazards for children include: hotdogs, meats, sausages, fish with bones, spoonfuls of peanut butter, popcorn, chips, pretzel nuggets, raisins, whole grapes, raw carrots, fruits and vegetables with skins, and marshmallows. Be sure that food is cut in small pieces (no larger than ½ inch), grated, or finely chopped. Be sure that children are closely supervised when they are eating.

Dental health is a growing concern with young children, so it is important to keep in mind that starchy, sticky, and sugary foods can cause tooth decay. Children should brush their teeth after any meal or snack, but particularly when you serve these foods.

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

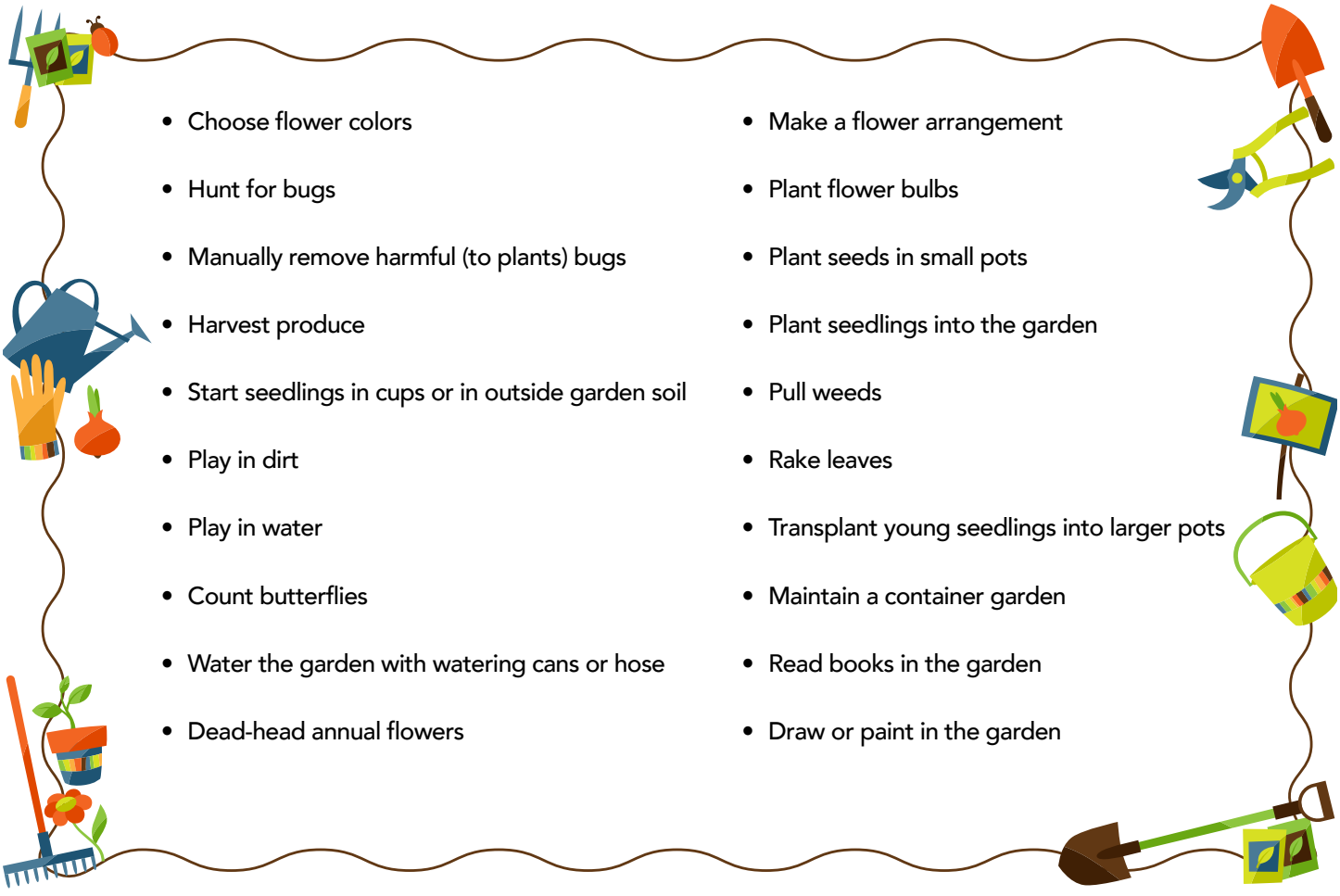
Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

PENNSTATE
1855
Cooperative Extension
College of Agricultural Sciences

Age appropriate garden tasks: 18 months to 8 years

Play and work in the garden should be fun, and never a chore. Most gardening projects can be made into a game or a new learning adventure. Simple gardening tasks that are easy for adults can be an exciting journey for young children. The simplest idea can capture a child's imagination and attention for long periods of time. Allow the children to join in or not, as they choose.

The tasks below should be evaluated based on each child's motor skill development.



- Choose flower colors
- Hunt for bugs
- Manually remove harmful (to plants) bugs
- Harvest produce
- Start seedlings in cups or in outside garden soil
- Play in dirt
- Play in water
- Count butterflies
- Water the garden with watering cans or hose
- Dead-head annual flowers
- Make a flower arrangement
- Plant flower bulbs
- Plant seeds in small pots
- Plant seedlings into the garden
- Pull weeds
- Rake leaves
- Transplant young seedlings into larger pots
- Maintain a container garden
- Read books in the garden
- Draw or paint in the garden

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

PENNSTATE
1855
Cooperative Extension
College of Agricultural Sciences

HO_AgeApprGardening.indd

Move with math

> "If the kids don't have the math in their hands and bodies, it will never get into their heads!"
>
> – Addy, pre-K inclusion classroom teacher as quoted in Big Ideas of Early Mathematics

Math doesn't have to be quiet and reflective! Challenge children to use math thinking as you get them up and moving to wake up many areas of their brains. Movement strengthens their understanding of, and retention of, math concepts. Plus it's FUN! Doug Clements, developer of the Building Blocks early childhood mathematics curriculum, says he wants kids "running around the classroom and bumping into mathematics at every turn." Children learn and enjoy movement as they sing, dance, and experience math concepts and movement patterns with their whole bodies.

Try these active movement math experiences:

Shape walk

As children hold samples of a given shape—a rhombus, a triangle, a cylinder—take a walk outside and look for examples of that shape in nature and architecture. Use careful observations to determine if the real world example meets all the definitions of the shape or is "similar to" the shape.

Shape step

Make masking tape geometric shapes on the classroom floor or trace chalk shapes on a sidewalk outdoors. Challenge children to only step in a certain shape category (like a rhombus) while other children watch for accuracy. Rotate steppers and watchers. Ask children how they decided what shape to step on.

Punch right-left count

Children punch the air across their bodies. When they punch with the right fist, they shout *"1"* and then punch left and shout *"2,"* alternating until the group reaches a designated total of 50 or 100 punches. This is a great way to get some movement, focus energy, and deal with restlessness while reinforcing math counting rules.

Number jump

The teacher or a child holds up a certain number of fingers (or a card with a number on it, or a display of dots) and the children jump and call out loud each number as they jump *"1, 2, 3."*

Number scavenger hunt

Each child finds a specific quantity of things, for example, "*Everybody bring me four of the same thing*" (such as four pencils, four blocks, four napkins). Give each child a number card or dot card to take with them on the hunt. Or children could be assigned different numbers based on ability. An adult can check their work or each child can self-check with the card.

People sort

Place two hoops or circles of yarn on the floor. Call up a group of children and say, *"I see (say the number) children. Some are wearing socks (point to one hoop) and some are not (point to the other hoop)."* Allow the children to self-select the group where they belong. Children can take turns to call some categories and check each other's work.

Obstacle course

Call out the directions as the child moves through the course as an extra reinforcement. For example, *"Across the beam, through the tunnel, under the limbo stick…"* The obstacle course could be a reenactment of a path from a familiar story such as Red Riding Hood going through the forest (along a plank on the ground), into the doorway (crawl under a climber), into Grandmother's room (around a swing), and through a tunnel as she escapes from the wolf.

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

HO_BeyondCounting_MoveWithMath.indd

Naked eggs

Remove an eggshell using chemical reactions. This experiment combines a common household acid (vinegar) with the base calcium carbonate (main component of the eggshell).

Materials:

One raw egg

2-cup measuring bowl or cup

1 ½ cups vinegar

Instructions:

Place the egg (still in its shell) in the bowl. Pour the vinegar over the egg until the egg is covered. Notice any tiny bubbles floating off the eggshell as soon as it is immersed. Cover the container with a lid or wrap.

Wait two days.

After two days, carefully remove the egg from the vinegar bath with a slotted spoon. Place it on a plate or smooth surface to examine. Is the shell still there? What is the consistency of the egg? How has it changed? What is the explanation for the change?

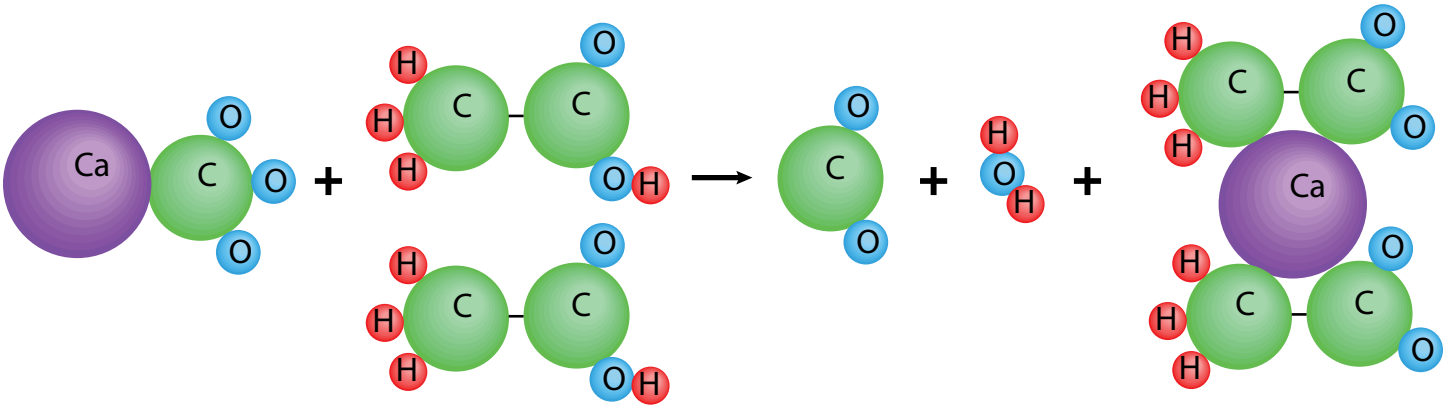
What's the chemical explanation?

In its most basic form, chemistry is the study of how things change and how things can be changed by people. This experiment focuses on how acid and base substances change when mixed.

When a base and acid mix, heat is always produced. The mixing results in the production of water and some sort of salt, in this case calcium acetate. Carbon dioxide is also produced.

In this experiment, when the eggshell comes in contact with the vinegar, carbon dioxide bubbles escape and rise through the vinegar, and some of the calcium leaves the shell membrane making it very thin, perhaps even totally dissolved.

Here is a model of the molecules and how they change from being a calcium-based eggshell and vinegar to water, carbon dioxide gas, and a salt.



$CaCO_3$	+	$2\ CH_3COOH$	→	CO_2	+	H_2O	+	$Ca(CH_3COO)_2$
Egg shell (Calcium Carbonate)	plus	Vinegar (Acetic Acid)	creates	Carbon Dioxide	and	Water	and	Calcium Acetate

Expand the inquiry of this experience

1. Before conducting the experiment, review the instructions and ask the children to make predictions about what they think will happen to the egg (or to the vinegar). Have a student record the various predictions. Ask why they have made the prediction they have made—what previous experiences or knowledge are they drawing upon to make this hypothesis?

2. Allow the children to compare a variety of egg "baths." Ask the children to think of two to four liquids to use as baths for the eggs. For example, the children may choose to use water, vegetable oil, and salt water in addition to the vinegar bath. Compare the results in the changes (or lack of changes) in the egg based on liquids used. Children may also want to compare the results over time. For example, what is the change in the egg after three hours? Twenty-four hours? Forty-eight hours? Chart the findings, take photos, write descriptions in a science journal. Besides shell texture or thickness, what other data might be collected—weight of the egg, consistency of the white and yolk of the egg, smell?

What's the application?

Besides being an interesting experience, how might children connect this to their lives, now that they have understanding about acids and their ability to change other ingredients? Some educators have used this experiment to help children understand that the acid in their saliva or food, or acid created by bacteria in the mouth, can damage the calcium in the surface of their teeth (therefore, it is important to brush your teeth regularly so that your teeth don't become damaged by acid). What does the shell do for the egg? Help children to connect the shell to the role enamel plays in their healthy, protected teeth. There is also a connection with the use of antacids as a treatment for stomach indigestion. The calcium-based tablets help to neutralize the acid in a person's stomach. A related, but not identical, reaction happens over time as the chloride in deicers reacts with the calcium in concrete sidewalks, damaging the surface.

References:

Bardhan-Quallen , Sudipta. 2010. *Kitchen Science Experiments: How Does Your Mold Garden Grow?* Sterling Publishing.

Hemmer, Sean. "Why does vinegar affect limestone?" eHow. http://www.ehow.com/info_7888211_vinegar-affect-limestone.html

Morin, Amanda. "Egg in vinegar: A dental health activity." Kids' Learning Activities. About.com. http://kidsactivities.about.com/od/scienceandnature/a/Egg-In-Vinegar-A-Dental-Health-Activity.htm

PENNSTATE Cooperative Extension
College of Agricultural Sciences

Visit Penn State Extension on the web: **extension.psu.edu**

This publication is available in alternative media on request.

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204, State College, PA 16803
Web site: extension.psu.edu/youth/betterkidcare

HO_C2S_NakedEggs–Jul 08, 2015

STEM Minutes

Simple STEM "thinking" challenges to offer during transitions and waiting times

To help youth stay engaged during waiting times, staff can invite them to play thinking games that use science knowledge, critical thinking, mental math, and logic skills. Simple STEM topics and brain teasers can minimize challenging behavior during transitions. As children become accustomed to these STEM minutes, they may transition quickly in order to participate in the lively exchange that these activities provide.

The ideas presented are a brief sampling of possibilities. Staff and youth will discover (or recall from childhood) many more in an ever-expanding collection of possibilities. Staff may want to enlist help from youth in bringing STEM facts to share or in leading STEM minute activities.

Fun facts: Did you know?

Share fun, or amazing facts relative to science, math, and technology. For example, did you know that instead of drinking water, frogs soak it into their body through their skin? Excellent website sources for facts include:

http://www.sciencekids.co.nz/sciencefacts/animals.html

https://kids.nationalgeographic.com/videos/topic/things-you-wanna-know

https://www.guinnessworldrecords.com/records/showcase/animals/

http://www.nasa.gov/facts/Space/

STEM Riddles

Riddles challenge a child to think outside the box and to think beyond the obvious information to the less obvious in order to explain a situation. A riddle a day can transform waiting time into thinking time. For example: A young boy lives on the 10th floor of a 10-story apartment building. Each morning he rides the elevator down from the 10th floor to the first floor and goes to school. When he comes home from school, he gets on the elevator, rides to the 5th floor and then walks the final five sets of stairs to the 10th floor. Why?

Answer: He is only tall enough to reach the button for the 5th floor. The higher-numbered buttons are out of his reach. For lots more riddles, check out: http://kids.niehs.nih.gov/games/riddles/tuff_stuff_riddles_rd2.htm or http://www.brainbashers.com/

Categories

Youth can take turns picking STEM topics or categories. For instance, "Name six animals that live underground." Or pick a letter and a category and go down the line of waiting children allowing each to contribute an item to the category. For example, for the letter "T" and the category "Food," children could respond "tacos," "turnips," and "toast." Keep going until no one can think of another item that fits the category. Then start with a new letter and a new, STEM-related category.

Animal-Vegetable-Mineral or 20 Questions

This classic waiting game begins with the announcement, "I'm thinking of something …" The first guessing player asks, "Is it animal, vegetable, or mineral (anything that is not an animal or a plant)." Then individuals take turns asking yes and no questions, trying to figure out what the item is. The group has to make a guess within 20 questions.

Going on a Picnic (or Going on an Expedition)

This oldie but goodie requires memory, patterning, and categorization skills. In the most familiar version, the caller begins, "I'm going on a picnic, and I'm taking _____." Usually the pattern involves each child bringing an item that begins with a letter in alphabetical order (apple, banana, carrot…), or an item that begins with the letter of their name (my name is Rebecca and I'm bringing raspberries). A variation is for the leader to pick a secret rule/category and the players must ask if they can bring an item: "May I bring a Frisbee?" If the secret rule is things that are round/circular, then the answer is yes. If the secret rule is things that are alive, then the answer is no. Players keep asking questions until they think they know what the secret rule is and they present their guess to the leader for confirmation. Think about how this might change what children would take if the group goes on an "expedition" or "trip to Australia"!

Mental Math

Challenge children to do simple math problems in their heads while waiting. Older children might practice multiplication tables or multistep problems. Younger children could be asked simple addition or subtraction questions.

24® Game (easier if you have a specialized deck of cards)

This popular classroom and on-line math game can be played during waiting times. The caller presents four numbers. The children need to think about how they could add, subtract, multiply or divide the single digit numbers to get the answer 24.

Taps (sometimes called Chopsticks)

This is an active game involving 2 players, known to many school-age children. It involves strategizing to get the opponent to point 5 fingers on one hand. The game begins with each player pointing their index fingers toward one another. The players take turns tapping the other player's fingers, adding the number of fingers together. This is a wonderful seated game for children who love to move! For more about how the game is played, check http://en.wikipedia.org/wiki/Chopsticks_%28hand_game%29

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

Claudia C. Mincemoyer, Ph.D., Better Kid Care Program Director

18 months – 8 years

Sprouting beans

Materials

- Sensory table or tub
- Soil without fertilizer
- Bean seeds (larger seeds are best)
- Water
- Watering can
- Age appropriate hand shovels

Procedure

- Guide the children to fill the table or tub half full of soil. Let children add water until the soil is moist throughout.
- Add seeds to the soil. Children can manipulate the soil, and bury and dig up the seeds. Do not cover. Covering the table creates an environment for mold to grow.
- Children can dig, check the soil, and observe and record changes in the seeds each day.

PENNSTATE Cooperative Extension College of Agricultural Sciences

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

HO_GardenActivities.indd

Penn State **Extension** • B E T T E R · K I D · C A R E

18 months – 8 years

Garden surprise

Materials

Surprise of the day (a pine cone, a unique rock, a shell from the beach, a gardening book, a snake skin, a bird nest, an egg, and so on)

An old mailbox (or make one as a class project)

Procedure

- Set up the mailbox in the garden or in a special place. Encourage the students to paint it and name the box.
- Each week (frequency is up to the teacher or facilitator) put an educational nature surprise in the mailbox.
- Children can take turns to check the mailbox and bring the surprise to group time.
- Discuss the object with the students.

extension.psu.edu/youth/betterkidcare

PENNSTATE Cooperative Extension College of Agricultural Sciences

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Penn State is an equal opportunity, affirmative action employer, and is committed to providing employment opportunities to minorities, women, veterans, individuals with disabilities, and other protected groups. Nondiscrimination: http://guru.psu.edu/policies/AD85.html

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

HO_GardenActivities.indd

© 2015 The Pennsylvania State University

The smelly game

Materials

- Sensory table
- Aromatic fresh herbs (dill, rosemary, mint, basil, thyme, oregano)

Procedure

- Lay the herbs in separate sections on the table.
- Allow the child to explore each herb through smell, touch, and sight.
- Show them how to rub the herbs between their fingers to release more aromas.
- Talk about the different parts of each plant: roots, leaves, flower, and stem.
- If time permits, you can use the herbs (if still whole) as paintbrushes for unique artwork.

PENNSTATE Cooperative Extension College of Agricultural Sciences

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

HO_GardenActivities.indd

Penn State **Extension** • B E T T E R · K I D · C A R E

18 months – 8 years

Critter hunting

Materials

- Shovel
- Containers with lids
- Trays
- Magnifying glasses

Procedure

- Take the children outside to find insects and critters. They can check under rocks, in rotting logs, cement cracks, or in compost if available. The most common bugs found are usually butterflies, bumble bees, caterpillars, ants, worms, sow bugs, beetles, grasshoppers, and pill bugs.
- Collect insects in a container, take inside, and place containers on trays to observe the specimens.
- Older children can look up common facts about their chosen specimen using reference materials, and report on it to the class. They can also draw their specimen on paper.
- Talk about the body parts, color, appearance, and behavior of each critter.
- Release the bugs back into their natural habitat.

extension.psu.edu/youth/betterkidcare

PENNSTATE Cooperative Extension College of Agricultural Sciences

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Penn State is an equal opportunity, affirmative action employer, and is committed to providing employment opportunities to minorities, women, veterans, individuals with disabilities, and other protected groups. Nondiscrimination: http://guru.psu.edu/policies/AD85.html

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

HO_GardenActivities.indd

© 2015 The Pennsylvania State University

Bug hotel

Materials

- 20 oz. plastic bottle, empty and with label removed
- Small diameter sticks
- Pinecones
- Bark
- Pieces of long dried grass (hay)
- Adult sized scissors

Procedure

- Children can collect the sticks, pinecones, hay, and bark outdoors from home, the facility, the schoolyard, or on a walk.
- Cut the bottom and top of the bottle off, and cut the plastic bottle into two cylinders. Adults might have to do this, depending on ages of children.
- Children can arrange the sticks, pinecones, hay, and bark in each cylinder lengthwise, filling the cylinder so the contents fit snuggly to prevent the materials from blowing out. Children may have to break the sticks to fit the length of the bottle sections.
- The materials create dark places for the bugs to hide.
- Place the bug hotel in the garden, or hang it outside with string, to attract all kinds of bugs.

PENNSTATE Cooperative Extension College of Agricultural Sciences

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

HO_GardenActivities.indd

Penn State **Extension** • B E T T E R · K I D · C A R E

18 months – 8 years

Veggie stamping

Materials

- Vegetable scraps (celery ends, carrot ends, pepper slices, cut okra, and more)
- Assorted paint colors
- Paper plates
- Construction paper

Procedure

- Put paint on paper plates (one color per plate).
- Set paper plates of paint and veggie scraps on a table or floor.
- Use the vegetable scraps as stamps to create magical artwork on the construction paper.

extension.psu.edu/youth/betterkidcare

PENNSTATE Cooperative Extension College of Agricultural Sciences

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Penn State is an equal opportunity, affirmative action employer, and is committed to providing employment opportunities to minorities, women, veterans, individuals with disabilities, and other protected groups. Nondiscrimination: http://guru.psu.edu/policies/AD85.html

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

HO_GardenActivities.indd

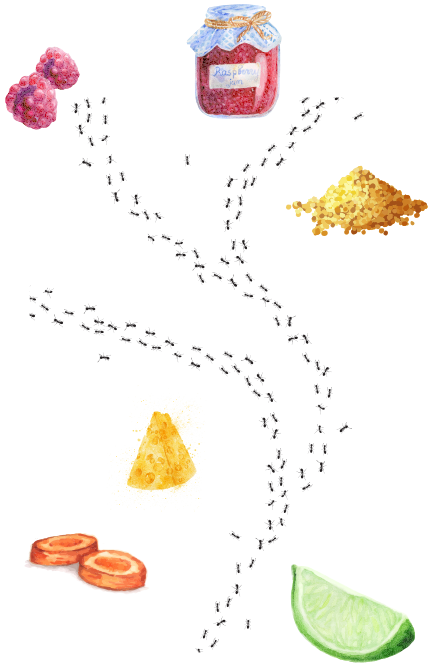
© 2015 The Pennsylvania State University

4 – 8 years

Feast of the ants

Materials

- Cardboard
- Cup
- Marker
- Assorted food: shredded carrots, jelly, syrup, chopped hotdog, sugar, slice of lime, breadcrumbs, shredded cheese, coffee grounds, and more.



Procedure

- Using the cup and marker, have the children trace a circle for each food item on the cardboard.
- Lay the cardboard outside and place the food in the circles.
- Ask the children to predict which food ants will eat.
- Leave the area and allow the ants to explore the food.
- Take the children to a separate location to read a book about ants.

Visit the site many times throughout the day to observe the feast of the ants.

PENNSTATE Cooperative Extension College of Agricultural Sciences

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

HO_GardenActivities.indd

Penn State **Extension** • B E T T E R · K I D · C A R E

5 – 8 years

Water bottle irrigation system

Materials

- Plastic soda bottle with lid, empty and with label removed, of any size: 20 oz. work well for this age
- hammer and nail

Procedure

- Cut off the bottom of the soda bottle and place the bottle upside down.
- Cut small holes throughout the body of the bottle. Pierce the lid with the nail and hammer and replace on the bottle.
- Dig a hole big enough to bury the bottle, lid end down, in dirt up to the open end.
- Depending on the size of the bed, you may need a couple of water bottle irrigation systems, or larger bottles.
- Pack soil up to the open end of the bottle.
- Fill the bottle with water.

extension.psu.edu/youth/betterkidcare

PENNSTATE Cooperative Extension College of Agricultural Sciences

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Penn State is an equal opportunity, affirmative action employer, and is committed to providing employment opportunities to minorities, women, veterans, individuals with disabilities, and other protected groups. Nondiscrimination: http://guru.psu.edu/policies/AD85.html

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

HO_GardenActivities.indd

© 2015 The Pennsylvania State University

5 – 8 years

Garden creation

Materials

- Leftover small arts and craft materials (buttons, stickers, colored cotton balls, colored pipe cleaners, glitter, mosaic stones, and more)
- Glue
- Crayons
- Paper

Procedure

- Ask the student to think of their favorite thing (car, doll, princess, frog, rainbow, heart, baseball bat).
- Ask them to draw the shape of their favorite thing on paper with the crayons. This will make a garden shaped as their favorite thing.
- Using the leftover craft materials, encourage them to create a garden. The materials represent the plants they want to grow, with the buttons, glitter, stickers, and cotton balls as the plants in the garden.

PENNSTATE Cooperative Extension College of Agricultural Sciences

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

HO_GardenActivities.indd

Penn State **Extension** • B E T T E R · K I D · C A R E

6 – 8 years

Paper pots

Materials

- Scissors
- Newspaper
- Seeds
- Soil
- 5.5 oz. juice can, 6 oz. tomato paste can, or other can (for use as a mold)

Procedure

- Children can cut strips of newspaper at least 3 inches by 10 inches (or longer and wider if a larger can is used as a mold).
- Place a strip of paper on the table with one of the short ends close to each child.
- Place the juice can at the end of the newspaper strip closest to the child, leaving an inch of paper on the long side hanging over the bottom that will become the base of the pot.
- Roll the juice can along the strip, wrapping the paper around it.
- Fold the extra 1 inch of paper close to the bottom of the can.
- Press the can into the palm of your hand or onto a table, twisting as you press down, to secure the folded bottom of the paper pot.
- Gently pull the paper off the juice can, retaining the shape of a pot.
- Fill your pot with soil, plant the seed, label, keep moist, and observe the growing plant.

extension.psu.edu/youth/betterkidcare

PENNSTATE Cooperative Extension College of Agricultural Sciences

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Penn State is an equal opportunity, affirmative action employer, and is committed to providing employment opportunities to minorities, women, veterans, individuals with disabilities, and other protected groups. Nondiscrimination: http://guru.psu.edu/policies/AD85.html

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

HO_GardenActivities.indd

© 2015 The Pennsylvania State University

Active Mathematics Play

The Early Learning Guidelines provide information related to seven universal areas of child development and learning, called domains. One of these learning guidelines is Mathematics. Young children develop number and mathematical concepts through meaningful and active learning experiences that are broader in scope than numerals and counting. Children develop awareness of numbers, numerals, sequences, counting processes, grouping, combining, and separating. In an inclusive, developmentally-appropriate play-based environment, children have opportunities to acquire and understand mathematical skills and concepts using hands-on materials and use of numbers in real-life situations. –Nebraska Early Learning Guidelines

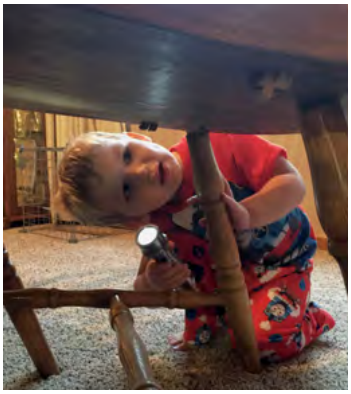
These skills can be developed during children's everyday, active play. Following are active play ideas that nurture mathematics development.

Maze of numbers

The leader or children can make a maze of numbers on the floor with tape, or on cement outside with chalk. Start by drawing a grid pattern with tape or chalk. The grid needs to have 16 squares for counting to 10 for younger children, and 30-36 squares for counting to 20 with preschoolers. The numbers 1-10 or 1-20 go in each grid. One side of each square in the grid has to be touching a square with the next number in order to make the maze trail. Put random numbers in the leftover squares. Put an arrow to start and an arrow to finish. This is great way for children to recognize and practice numbers, directions, and even drive a tricycle. (Reimer 2014)

Flashlight scavenger hunt

A leader or the children hide numbers or letters made out of a durable substance such as heavy paper or plastic around a home or room. Children use a flashlight to find the numbers, take them to the leader, and tell what number or letter they have found. As children bring back letters or numbers, they can put them in order. They can take turns hiding the numbers or letters for each other. Numbers can be in different colors so children sort them into the red pile or yellow pile. This activity can be done without flashlights, but children have more fun with flashlights whether daylight or nighttime!



Hopscotch

Adults or children make a hopscotch game with tape on the floor, or chalk on a sidewalk outside. Hopscotch is played with several players or alone. Hopscotch is a game where players toss a small object into numbered spaces of a pattern of rectangles outlined on the ground, and then hop or jump through the spaces to retrieve the object, and then to return to the beginning. The game can be played without a small object, where a leader just calls out the number for the child to turn around on and come back to the start. Or children can pause on a number called by the leader, continue to the end, turn around, and return to the start. The game can also be played by saying the number or numbers as children hop or jump on them. Several hopscotch grids might be necessary so each child has a turn, or each has his or her own grid.

Jump and measure

Children see how far they can jump, and then measure using a ruler or yardstick, and they can count the inches. Or, children can throw a bean bag and measure the throw. Instead of traditional measures, children can predict, then measure how many of their shoes placed end to end that it takes to where the beanbag landed.

Matching numbers

Use containers such as baskets or buckets that are numbered 1 to10, or for preschoolers, 1 to 20. Number other objects such as balls, balloons, toys or blocks with the same numbers. Adults or children hide the objects. Children can see how fast they can objects with a certain number into the container with that number. Children can time each other or just have fun!

Resources

Durden, Tonia R., Jennifer K. Gerdes, Ruth E. Vonderohe, Kayla Colgrove, LaDonna Werth, Lorene Bartos, Leslie Crandall, and Carrie Miller. 2013. "Keeping Children Moving, Active, and Healthy. HEF609. 2nd Revision." Faculty Publicatins from CYFS. Paper 48. http://digitalcommons.unl.edu/cyfsfacpub/48

"Learning Through Playing." Blog. Little Bins for Little Hands. http://littlebinsforlittlehands.com

"Nebraska Early Learning Guidelines, 2nd Revision." August 2013. Nebraska Health and Human Services System and the Nebraska Department of Education.

Reimer, Jamie. 2014. "1. 2. 3 Counting Maze for Preschoolers." Blog. Hands on as We Grow. http://handsonaswegrow.com

Reimer, Jamie. 2014. "26 Gross Motor Activities for Preschoolers that Like to MOVE." Blog. Hands on as We Grow.

Reimer, Jamie. 2014. "Physical Activities for Toddlers With Lots of Energy." Blog. Hands on as We Grow. http://handsonaswegrow.com

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

HO_IMIL_ActivePlay_Math.indd

Active Science Play

The Early Learning Guidelines provide information related to seven universal areas of child development and learning, called domains. One of these learning guidelines is Science. Science fosters curiosity and motivation to learn with young children, who are natural scientists. They easily become fascinated by everyday happenings. Through varied and repeated opportunities to observe, manipulate, listen to, reflect, and respond to open-ended questions, children make decisions and become higher-level thinkers. Science activities require a balance of content and process, using multi-sensory experiences. In addition to science inquiry skills, children can begin to acquire a foundation of scientific concepts and knowledge on which they can build a clear understanding of their world. –Nebraska Early Learning Guidelines

These skills can be developed during children's everyday, active play. Following are active play ideas that teach science development.

Build a snow fort

A snow fort takes a lot of energy and also skill to make the walls stay up. Children have to know how to make the snow stick together as well to form the walls. This is a good activity for children and an adult to learn together. Children can practice inside with blankets, blocks, card tables, and chairs. In this exercise, children and adults need to know if the blanket is too heavy for the chair it is tied to, or how to make components balance as they experiment.

Hike in the backyard

Hike in the backyard, park, snow, or trees. Look for bugs, leaves, plants or nature objects, and collect them in a bag. Children can use the collected items for collages, for comparisons of color and size, for how they are the same and different, for counting and examining, and to write about.

Animals in action

Children act out animal sounds and movements as a leader calls out different animals. This can be done inside or outside. Or, children can sing or chant "We're Going on a Bear Hunt" and act out the hunt. Read aloud the book *Brown Bear, Brown Bear, What Do You See?* by Eric Carle while children act out each animal. A leader can call directions such as: Sway like a bird. Jump like a kangaroo. Wiggle like a snake. This visual imagery improves children's attention and participation as they learn vocabulary and analyze how animals move.

Play in nature

Play outdoors. With appropriate clothing, children can run through a sprinkler, play in mud, play in snow, make trails and snowmen and leaf piles. They can climb stumps of trees if not too high, and use fallen leaves to burrow.

Plant a garden

Planting flowers or a miniature garden is a great activity for children. Children can manipulate soil, fill containers, and plant in pails, flowerpots, or a small square raised garden made with boards. Group gardens work, and children also love to have their own space. Digging and soil preparation is one of the most exciting parts of gardening as children use their own plastic shovels and garden tools. Even a wooden kitchen spoon works. Once the soil is tilled and ready, children can mix in some organic compost or sphagnum peat (with a ratio of three soil to one peat). Children plant their own seeds and can water the soil, care for the garden, and fertilize soil in the upcoming weeks. Peppers and tomatoes are easy to grow and children can pick the vegetable and then eat them too.

Resources

Durden, Tonia R., Jennifer K. Gerdes, Ruth E. Vonderohe, Kayla Colgrove, LaDonna Werth, Lorene Bartos, Leslie Crandall, and Carrie Miller. 2013. "Keeping Children Moving, Active, and Healthy. HEF609. 2nd Revision." Faculty Publicatins from CYFS. Paper 48. http://digitalcommons.unl.edu/cyfsfacpub/48

"Nebraska Early Learning Guidelines, 2nd Revision." August 2013. Nebraska Health and Human Services System and the Nebraska Department of Education.

Reimer, Jamie. 2014. "26 Gross Motor Activities for Preschoolers that Like to MOVE." Blog. Hands on as We Grow. http://handsonaswegrow.com

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

HO_IMIL_ActivePlay_Science.indd

Math Skills for Preschoolers

	Young Children should learn to…	How to help children understand…
Numbers & Number Operations	• Use their fingers to represent numbers when they count • Count blocks in a building they have made • Match a snack to a plate one-to-one for each child • Begin to use marks on paper to represent the number of things they are counting • Use things to represent amounts up to and including five • Do one-to-one correspondence up to five (matching an item with a number) • Identify the numbers zero through five • Count up to 20 • Show more or less with blocks or other items • Group items into equal groups (divide 4 cookies into 2 groups of 2) • Identify some coins	• Teach children counting songs, rhymes, and chants ("One, two, buckle my shoe") • Share books about numbers and counting • Share things to count ("How many pinecones do we have?") • Give children daily opportunities for counting • Use number words, including zero, in everyday situations ("Do we have any shoes with red laces today? We have zero shoes with red laces today.") • Use toys to talk about adding and subtracting ("If I lose 3 buttons how many will I have?") • Ask children to set the table for snack to reinforce one place setting for each child • Ask children to compare to find out if there are more or less ("Do we have more acorns or pinecones?")
Patterns	• Sort toys by color, shape, size, and function • Tell whether something is smaller or larger • Return items to shelves by matching items with pictures • Notice patterns in the world around them, and predict what comes next • Know what to expect next in a pattern in a repetitive book, song, or poem • Make or match a pattern using art supplies or other items (three blue lids, two white lids, one red lid) • Find the same and different items in a group of familiar objects • Collect objects on walks and then sort them by size or color • Clap out rhythmic patterns	• Talk about size, shape, and color differences ("This one is bigger and this one is smaller") • Give the children things to sort, such as shells, buttons, acorns, etc. • Talk about patterns in the world around them ("I see a pattern on your shirt, white stripe and blue stripe") • Notice the patterns that children make in their artwork and play ("I see you made a pattern on your paper—one pompom, one button, and one pompom again") • Let children make patterns for others to follow • Help children talk about sequences in nature, daily routines, and stories ("First the children in the story went to the house and then they went to the store")

	Young Children should learn to…	How to help children understand…
Space & Shapes	• Recognize a circle, square, triangle, and rectangle in everyday life • Build with geometric blocks in their play • Follow directions that use positional words (in, on, under, over, next to, between, beside, above, below, front, back) • Create symmetrical figures using Legos, pattern blocks, etc. • Use geoboards to make shapes with rubber bands	• Talk about geometric shapes in the world around you and especially in the children's play ("Look at that rectangle you made with the blocks") • Take children on a shape walk, looking for geometric shapes in the world around you • Use these words with preschoolers: in, on, under, over, next to, between, beside, above, below, front, and back ("You are putting the tambourine on the shelf above the trucks") • Read books about geometric shapes • Use shapes in your child care room: name tags, job charts, and calendars • Make shapes with play dough, geoboards, Popsicle sticks, and pattern blocks • Use music and movement to explore the concepts of over, under, in, above, next to, etc. ("Dance between Arianna and Jesse") • Give children empty boxes, tubes, and containers to use in creating and constructing
Measurement	• Measure things with hands, shoe lengths, yarn, blocks, etc. • Understand that clocks are for telling time and that thermometers are for telling temperature • Use rulers, yard sticks, measuring tape, height charts • Tell what comes next in the daily schedule • Tell about events from child care or home in sequence • Use measuring cups and spoons during a cooking activity • Label times of day as morning and night time	• Show them how to measure with hands, shoes, blocks, etc. ("This rug is 6 shoes long") • Use open-ended questions ("I wonder how many cups of sand this bowl will hold?") • Provide measuring tools such as clocks, rulers, scales, thermometers, timers, and measuring cups for children to explore in their play • Suggest weighing and balancing activities using scales • Provide experiences with play money, price tags, cash registers, and clocks in dramatic play areas • Offer cooking experiences that let children measure for themselves with help • Use a calendar to discuss special days and birthdays, and talk about yesterday, today, and tomorrow

	Young Children should learn to…	How to help children understand…
Represent & Interpret Data	• Make tally marks under "yes" or "no" on a clipboard while doing a survey of what the group prefers for snack – juice or milk • Draw a picture of each object that sinks or floats after testing them at the water table • Help create a graph of how many people have sisters, how many people have brown, blue, or green eyes, etc. • Collect data about everyday events (make a prediction about what snack combination might be the most popular; for instance, crackers and cheese and milk) • Talk about graphs they have made ("I have the smallest family and Colin has the biggest family")	• Ask the children questions and help them graph the answers ("Let's find out which type of apples our group likes the most") • Create graphs about collections in the classroom ("Let's find out how many acorns, pinecones, and leaves our class collected") • Offer a chance to graph things such as the weather ("Did it rain yesterday? How many days had rain this week?") • Expand your reading by creating graphs about the topic • Ask children to explain to you their thinking ("Do you think there will be more people who like cookies than who like vegetables? Why?") • Read graphs, pictographs, photographs, vertical and horizontal bar graphs
Reason, Predict & Problem Solve	• Ask questions as they think about problems ("Will the new cage be big enough for the hamster?") • Solve problems by guessing and checking, using concrete objects, such as figuring out how many napkins, cups, and plates will be needed for snack • Make estimates ("Are there enough blocks to build a road?") • Make an observation and ask, "Why?" • Solve problems through trial and error • Find more than one solution to a problem	• Use open-ended questions to get children to think about solving problems ("We have 2 cookies and 4 people. What can we do so everyone gets a cookie?") • Talk with children about problem solving and let them work on solutions • Plan activities for children to make predictions ("Do you think there were more rainy or sunny days this week?"

Supported by funds from the Office of Child Development and Early Learning, a joint office of the Pennsylvania Departments of Education and Public Welfare.

This publication is available in alternative media on request.

HO_Math4EveryAge.indd

"Mathcabulary"

Have you ever said, "Bring me the tall cup" or something similar to the children?

This kind of language teaches math ideas as part of everyday life. Use these "mathcabulary"words with the children in your care to help them learn the real-life meaning of math concepts.

Less and more

All and none

Big and small

How many

High and low

Long and short

Same and different

Empty and full

First and last

Light and heavy

Yesterday, today, and tomorrow

Few and many

Back and forth

Pair

Fast and slow

A lot and a little

One half, one third, and one fourth

Names of coins

Near and far

Hot and cold

Originally produced as part of the lesson Math for Every Age.

extension.psu.edu

PENNSTATE Cooperative Extension
College of Agricultural Sciences

An OUTREACH program of the College of Agricultural Sciences

Visit Penn State Extension on the web: **extension.psu.edu**

This publication is available in alternative media on request.

Claudia C. Mincemoyer, Ph.D., Better Kid Care Program Director
341 North Science Park Road – Suite 208, State College, PA 16803
Phone: 1-800-452-9108 • Web site: www.betterkidcare.psu.edu

Supported by funds from the Office of Child Development and Early Learning, a joint office of the Pennsylvania Departments of Education and Public Welfare.

Learning, Rube Goldberg style!

The name Rube Goldberg has become synonymous with the building of crazy contraptions. How can this kind of wacky thinking inspire early childhood classroom experiences?

Rube Goldberg machines operated on chain reaction principles. They used materials in eccentric combinations to accomplish everyday tasks. Children of all ages can benefit from Goldberg-style cause and effect experimentation. The providers who encourage them can expect great levels of laughter, creativity and out-of-the box thinking!

Part-whole connections

When children create chain reaction contraptions, they explore many concepts like:

- Basic physics and simple machines
- Design concepts—balance, symmetry
- Cause and effect (if-then thinking)
- Part-whole thinking—composition and decomposition, divergent thinking-convergent thinking
- Repurposing of materials—maker-centered learning, tinkering
- Process thinking (what else? what next? what if?)
- Eye-hand coordination
- Measuring
- Collaboration and negotiation of ideas
- Organizing and planning
- Persistence

Who was Rube Goldberg?

Rube Goldberg (1883 – 1970) was a Pulitzer-prize-winning cartoonist and satirist who drew zany invention cartoons. He had a degree in engineering from University of California—Berkeley, and is the only person listed in the Merriam-Webster Dictionary as an adjective! His "Crazy Inventions" series starred Professor Lucifer Gorgonzola Butts who created elaborate contraptions to accomplish very simple tasks. Cartoon drawings of the automatic weight-reducing machine, simple fly swatter, and others have inspired generations of chain reaction inventions in his name. ("Rube Goldberg" 2016)

What is a Rube Goldberg contraption?

Adam Sadowsky describes a Rube Goldberg contraption as an "over-engineered piece of machinery that accomplishes a relatively simple task." (Sadowsky 2010)

Rube Goldberg-like inventions use a chain reaction or cause and effect principles to accomplish an end goal.

Start small

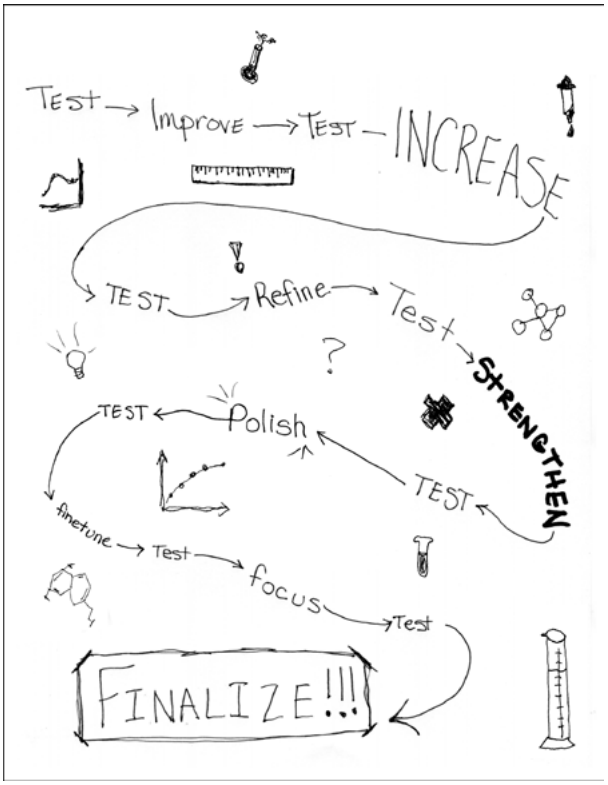
Encourage young inventors to think in sections with a cause and effect for each section. With inexperienced children, chaining together two sections of causes and effects with a bit of movement may be enough. Success with a small chain encourages further inventing with more elaborate connections. These types of experiments can be set up for toddlers to enjoy. It might be something as simple as rolling a ball down a ramp in the classroom. At the bottom, the ball knocks over a stack of cardboard blocks, and then a falling block bumps a tap bell. Preschoolers can be part of the construction and imagination team.

Children might discover as they create and connect that a shape like a triangle has strength or that a flimsy material can become stronger if it is folded or rolled. They learn that small components contribute in important ways. They learn the importance of testing one section of the chain reaction at a time in order to make sure it works. When children conduct tests or trials, they are acting like young engineers.

Test and improve

Providers should expect progress, not perfection, as children brainstorm and then build their chain reactions. Encourage testing of each section as the creating progresses. Trial runs or preliminary models allow children to measure, observe, collect data, and use tools; to design, develop, and implement solutions; to evaluate ideas; and to problem solve. These are all valuable STEM skills. Professionals run trials or tests all the time, and use words like:

- Alpha test
- Beta test
- Clinical trial
- Draft
- Experimental group vs control group
- Pilot
- Prototype
- Rough copy
- Run
- Straw man proposal
- Test recipe
- Working model



The children will simply work on their chain reaction inventions, but as educators, the staff knows that these experiences are nurturing important "21st century" abilities:

- View failure as an opportunity to learn
- Assess own ideas in order to improve
- Understand how parts impact one another
- Deal positively with praise, setbacks, and criticism
- Solve new problems in both expected and innovative ways
- Realize that creativity and innovation are long-term, cyclical processes of "small successes and frequent mistakes"

(The Partnership for 21st Century Skills 2009)

Provider strategies

1. Use spatial language—words like over, under, next to, through.
Children who are exposed to more spatial language during their preschool years outperform their peers in spatial tests years later.

2. Don't rush in and fix a design idea when it doesn't work the way the child expected.
Instead, help them to observe, see what happened, what they thought would happen and encourage them to adjust it and try again. "Support, rather than intervention, is a mark of respect for the child." (Christie 2015)

3. Have an ample supply of open-ended materials and loose parts—
get families engaged by asking them to send in recyclables to be part of the building supplies. Provide lots of connecting supplies—wire or twist ties, masking tape, yarn, tubes.

4. Provide clipboards, pencils and paper to sketch a plan or ideas.
Children as young as three years of age can make a connection between a simple map or diagram and the physical world.

5. Invite engineers from your early childhood families or from the community to come and mentor the young chain reaction builders.

6. Take video clips of the planning, constructing, and test runs to document the learning.

Tool is not a toy

As children take apart things and repurpose parts, it's a perfect time to learn about the safe, proper use of tools. Learning the names of tools and how to use things like a screwdriver, pliers, wire cutters, scissors, tape measures, and tweezers are important life skills. The building and tinkering during creation of a Rube Goldberg contraption provides an appropriate platform to demonstrate those skills in a meaningful way. Rebecca Grabman, MAKESHOP Manager, Children's Museum of Pittsburgh, explains that children sometimes need to be told that they don't stick tools into sockets, puncture anything, or use them as weapons. They need to be coached about trying not to break pieces as they disassemble machines or toys for use in other projects. If children misuse a tool, they are not allowed to use the tool until they are retrained on the safety procedures and demonstrate "good judgement" because a tool is not a toy.

Lasting life lessons

Cause and effect—why experience it? Experiencing and understanding cause and effect is not only an academic lesson, but also a life lesson: Each action or effort brings a result. When children experiment with chain reactions, they learn at a very basic level that "I have power and can affect the future by my choices and decisions." They nurture an internal locus of control. That's an investment that every early childhood professional will find worth making!

Want to think about these ideas more?

Check out these web documents:

Parts, Purposes, Complexities: Looking Closely
http://www.agencybydesign.org/wp-content/uploads/2014/10/AbD_PPC.pdf

Building with Wonderful Junk
http://www.edequity.org/files/After-School%20Science%20%20Plus%20Sample%20Activity.pdf

Check out these videos:

Helping Youth Explain Cause and Effect – Helping Learners Develop & Expand Explanations
https://www.youtube.com/watch?v=L3PaLLBDnC4&feature=youtu.be

C2S Testing
https://www.youtube.com/watch?v=pnVBExV4TqE&feature=youtu.be

C2S Modeling Science and Engineering
https://youtu.be/1V568Pwm-Vk

How to Engineer a Viral Music Video
https://www.ted.com/talks/adam_sadowsky_engineers_a_viral_music_video

Check out these Better Kid Care Resources:

On Demand Lesson:
Click2Science: Testing-Testing-1-2-3

I Think I Can…I Think I Can…
https://bkc.vmhost.psu.edu/documents/TIPS1508.pdf

Loose Parts: What does this mean?
https://bkc.vmhost.psu.edu/documents/tips1107.pdf

Check out another kind of building challenge:

Caine's Arcade
http://cainesarcade.com/

Imagination Foundation
http://cardboardchallenge.com/

References

- Christie, Toni. 2015. "Respectful Care of Infants." *ExchangeEveryDay*. https://www.childcareexchange.com/eed/issue/4019/
- "Rube Goldberg: About Rube." 2016. RGI. https://www.rubegoldberg.com/about/
- Sadowsky, Adam. 2010. ""How to Engineer a Viral Music Video." TED. https://www.ted.com/talks/adam_sadowsky_engineers_a_viral_music_video

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

HO_RubeGoldberg.indd

Discovery through science

As you work with young children, you see how science is very much a part of who they are. Young children are natural scientists. Just observe a child for awhile and you will see science in action. For example, a young toddler giggles as the wind blows cool air on his face and makes his hair fling about (weather, air, wind). A preschooler is crouched low to the ground pointing and gasping at a spider crawling across the floor (insects and entomology). A kindergartner stirs her ice cream until it becomes liquid (solids to liquids).

Children are natural investigators of what is around them. How exciting for early educators to tap into this discovery and support the process! Does this mean we need to learn a whole new science curriculum? Indeed not! Most science concepts can be added to existing everyday experiences and activities.

Where to start?

Find topics that interest children and are a part of their real life experiences. A good place to start is to observe children. What fascinates them? Are they wondering how something works? Are there elements in the environment that interest them?

An example of a real life science experience may be the children who saw the grayish-black spider crawling across the floor. It's been there several days and curiosity is piqued!

Support curiosity

When you support natural science curiosity, you support an array of development such as language, literacy, investigation, as well as social, emotional, physical, and cognitive development. Experiencing science through everyday opportunities (such as those listed to the right) make the exploration real and easy for the caregiver to support.

Discovery

Discovery through science is ongoing, not a one-time activity. Children should be offered the freedom to explore their ideas through many means, with ample time, resources, and materials with which to experiment.

Discovering science with children is a fascinating part of their everyday lives.

Science discovery may include:

Observations (watch and record ideas, photograph, question, discuss)

Resources (books, stories, videos, museums, specialists)

Art (create, make, paint related ideas using different materials)

Movement (move like spiders, spin webs)

Write/Create (spider stories/songs, questions, thoughts/ideas)

Habitats (making homes for spiders; what do they need? Place plastic spiders in sand/water tables)

Dramatic Play (Dress up like spiders, play spider family)

Supportive environments

The environment itself is an important component in enriching science experiences.

Consider offering water/sand tables, safe plants, items from nature (leaves, fossils, roots, rocks), materials of interests (socks, kites, pinwheels, mobiles, chimes, machines, musical instruments), art materials (paint for mixing colors, clay), building materials (blocks, wood, tubes) books, puzzles, and pictures representing interesting concepts to freely explore.

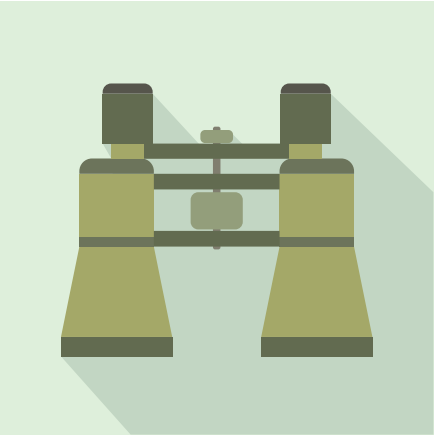
Create cozy areas for materials to be explored, such as a low table or open shelves where children can freely gather materials (consider exploring outside, also). Be open to messes and think ahead in providing what children need to explore, gather, and be safe as well as comfortable.

Children's experiences, environments, and natural curiosity will help in connecting ideas and developing critical thinking skills, as well as offer support in making sense of the world around them.

What a great adventure!

Tools to help guide explorations

- Magnifying glasses
- Measuring devices (rain gauge, rulers, tape measure, scales, timers)
- Cups, funnels, containers
- Straws, tubes, hoses
- Water droppers, basters
- Pumps, pulleys
- Mirrors
- Tongs, tweezers
- Machines and gears (pulleys, watches, old machines)
- Cameras, binoculars, telescopes, view scopes
- Pencils, pads, paper, clipboards, notebooks, envelopes



Tools for exploring

Children will also be very creative in finding materials and tools to explore; your watch, the clock on the wall, door knobs, anything from outside. Support their ideas by listening to what they are interested in and supplying your attention, time, and tools. Adults can model the use of tools and also see how the child might use tools.

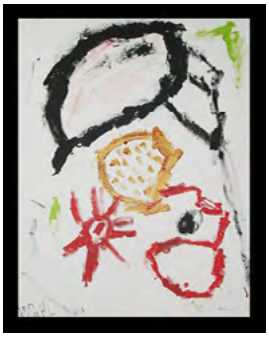
Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

TIPS0705.indd

Creating structures: Common and uncommon ideas



egg cooker-zoopty-doo-1166549

Consider the descriptions associated with the word structure: arrange, organize, construct, and form. These words describe the actions adults see children do and enjoy. Structure, by definition, is the action of building or constructing something or arranging in a definite pattern of organization.

Children naturally create structures. Outdoor environments and interesting loose materials inspire children to find ways to use the materials. They may line up sticks, arrange rocks, build mini-forts, or create clever combinations of materials. The material, space, and ideas act as encouragement; they create structures large, small, and otherwise!

> "As you provide opportunities for children to explore building materials, and guide them in their development of science inquiry skills, you will also see growth in language, literacy, mathematics, and social skills as well as in children's approaches to learning." – Ingrid Chalufour and Karen Worth, *Building Structures with Young Children*

Think outside the blocks

A common structure familiar to early educators might be a block tower or building, but the term structures invites more meaning than just block buildings. Structures may surface in many areas of an early childhood program, including the block area, art areas (sculptures, collages), dramatic play (tents, tunnels), sand/water table (bridges), outside areas (forts), and even in food (stacked cheese cubes!).

Structures show relationship to children's developmental skills and age. A very young child may be developing skills to use materials, such as an infant grasping and mouthing blocks. Toddlers may attempt stacking and organizing materials. Preschoolers may draw and write plans to symbolize their ideas as well as use complex language in describing the structure, such as balance, weight, gravity, and symmetry.

Structures may also show clear connections to children's life experiences, such as a child creating a house, airport, or zoo. Others tap into fantasy and creativity, such as a fairy house, a dragon city, or the self-titled *egg cooker-zoopty-doo-1166549* (as shown on the left after painting a portrait of her block structure).

Structures: The adult's role

The adult's role in helping to build structures consists of providing materials, conversations, observation, and environments. Fill spaces with interesting, safe, and developmentally appropriate materials for structuring. Choose areas where materials can be explored freely with enough space to work comfortably. Invite discussions about the materials and model structure vocabulary (heavy, light, base, foundation, wobbly, sturdy, balance, pattern, symmetry, design, and geometric shapes: square, rectangle, etc.).

When creating structures, children use prior knowledge, experience, and skills. Ask open-ended questions to discover what they already know.

Programs that support broad concepts of structures, common or uncommon, support children's natural curiosity and factors contributing to quality early education. The experience of creating structures sparks relationships, logical exploration, and application of developmental skills. Structures allow children to work over periods of time and process ideas and strategies while participating in enjoyable experiences.

Possible materials used for structure

Base materials

floors, tables, trays, cardboard, mat boards, benches, chairs

Building materials

blocks, cans, boxes, tubes (paper rolls, carpet rolls), wood, foam, wire, cardboard, large fabric pieces (blankets, sheets, etc.), plastic gutters, PVC-type pipes, hula hoops

Natural materials

sticks, stumps, logs, rocks, pebbles, pinecones, leaves, water, dirt

Art materials

collage items: paper, glue cardboard, wood, straws, tape, paints, clay fabrics, string, yarn, pens, markers, crayons, and recycled materials such as egg cartons, paper tubes, lids, corks, plastic cups, etc.

Planning and extended structure work materials

paper, pencils, markers, cameras, recorders (voice, video), books, pictures, blueprints

References:

Chalufour, Ingrid, and Karen Worth. 2004. *Building Structures with Young Children*. Young Scientist series. Redleaf Press.

Supported by funds from the Office of Child Development and Early Learning, jointly overseen by the Departments of Human Services and Education.

This publication is available in alternative media on request.

Claudia C. Mincemoyer, Ph.D.,
Better Kid Care Program Director
2182 Sandy Drive – Suite 204
State College, PA 16803

TIPS1312.indd