Inquiry, Exploration, Problem-solving: Nurturing STEM Thinking in All Young Learners

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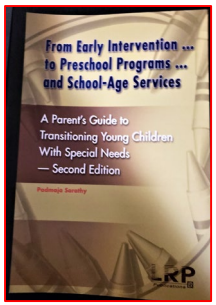
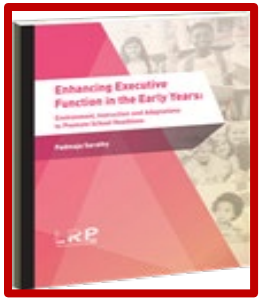
Outcomes

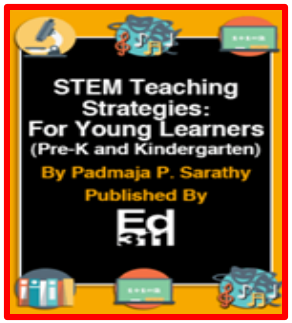
- Identify strategies to create learning environments that promote children's STEM-focused thinking and concept development embedded within multiple domains:
  - Foster young learner's curiosity, exploration, problem-solving, critical thinking skills integrating with language, cognition, social emotional development.
- Design STEM learning experiences integrating UDL strategies so that all children with and without disabilities can develop critical thinking and problem-solving skills and/or pre-requisite skills.
- A number of children's books and visual supports are used to Illustrate above strategies.

Sarathy's Publications: Books and Quick Reference Guides

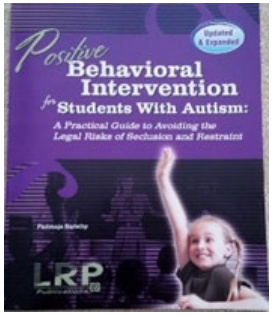


Behavior Guide



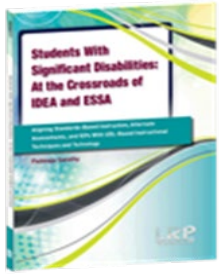


Recent Publications: 12/2018 & 2/2019



Focus Areas

- **Autism: Support Strategies & Interventions, Music CD – Transitions**
- **Behavior Guide (Preventive and Positive Approaches)**
- **Early Childhood: Transition, Parent Guide and STEM Teaching Strategies**
- **Executive Function - Early Years**
- **Paraeducator Training Guide and DVD**
- **Severe and Multiple Disabilities**
- **Significant Disabilities and ESSA**



Why STEM
In the Early Years?

- Math knowledge in preschool predicts math achievement even into the high school years.
- **Preschool math skills predict later academic achievement** more consistently than early reading or attention skills.

  (National Mathematics Advisory Panel, 2008). Foundations for success: The final report of the National Mathematics Advisory Panel. U.S. Department of Education; 13 National Research Council, 2009).
- **High-quality early STEM experiences can support children's growth across areas** as diverse as executive function and literacy development.
- Most importantly, **brain grows at the fastest rate in the early years** - neural connections (synapses) develop very rapidly at a rate of 1 million synapses per second.

STEM-focused Thinking Skills

Inquiry

CRITICAL THINKING

Imagination

Problem Solving

Curiosity

Finding Answers

Asking Questions

Discovery

CREATIVE THINKING

Activate Critical Thinking and Vocabulary

Following reading of *Brown Bear, Brown Bear, What Do You See?*

- **Strengthen critical thinking essential for science inquiry.**
- **Ask multi-level questions (easy/complex/open-ended), for e.g.,**

- Who has a dog (Cat, Bird or Horse) at home? (recall, attention)
- Does a dog make a good pet? Why? (critical thinking, open-ended)
- Can you have a bear as a pet? Why or why not? (for critical thinking, open-ended, and making connections)
- Where would you see a red bird or a yellow duck? (recall, attention, working memory)
- Have you seen a blue horse or a purple cat? (recall, attention)
- Are blue horses and purple cats real or imaginary? (memory and making connections)
- Is a bear a mammal or a reptile? (a challenge question requiring higher concept knowledge)

Play Verbal Games: Build Knowledge

- **Play verbal games** to build **science knowledge** (Increasing motivation and attention, thinking and language skills).

- **Play "I am going to the zoo and I will see…**
  - Start with the teacher (adult) modeling (saying), "I am going to the zoo and I will see a (name the animal) – e.g., **tiger**".
  - Next, a student repeats the sentence and adds her/his animal name, "I am going to the zoo. I will see a tiger and a lion."
  - See how long the list can go before someone forgets one of the animal names on the list.
  - The game can start over without anyone losing at this point.

Motivate and Capture Student Attention to Stimulate Thinking

(Size, Point to) Easy to Complex (Classification)

Animal Names, Characteristics, Habitat,
Classification (mammal, reptile, bird, etc.)

Build Knowledge of Science Facts Playing Games

- **Play "I Spy An Animal" Game.** (recall, attention)
  - Describe a couple of features of an animal and let the children guess the animal. "I am thinking of a large animal. It has big ears. You see it in the zoo (or in the jungle (its natural habitat). What animal is it?"
- **Play "Twenty Questions" Games.** (attention, memory)
- **Create and play an animal picture Bingo game.**
- **Apply UDL principles: Representation, Action & Expression and Engagement**
  - Provide concrete representations (toy animals) or photos for children experiencing difficulty naming an animal – can point to animal photos.
  - Use iTalk2 communicator with picture choices to select from and activate the device.

Make an Animal-Theme Book

- Use the pattern presented in Brown Bear, Brown Bear as a model to make an 'Insects' or 'Zoo Animals' or 'Pets' book.
  - Butterfly, Butterfly, What do you see?
  - I see a _____ looking at me.

- Involve the children (in Pre-K and K) in creating the book. Supply sentence frames and bank of words.
- Match corresponding animal photos to text.
- Display it in the Science center for children to read again and again.
- Read the book, **Dear Zoo by Rod Campbell** to increase animal names vocabulary for younger children.

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Science and Literacy with Dramatic Play

Role-play movements of animals.

- Engage in a joyful movement activity focusing on how animals move.
- Have children role-play and move like the various animals from the Brown Bear story and others:
  - ✓ **Walk like a bear.**
  - ✓ **Swim like a fish.**
  - ✓ **Fly like a bird.**
  - ✓ **Gallop like a horse.**
  - ✓ **Hop like a rabbit.**
  - ✓ **Slither like a snake.**
- Through performing physical actions, children will be able to visualize and recall the animal features movements and animal characteristics, applying the knowledge gained during instruction (Boosting Science knowledge)
- Build vocabulary associated with animals and actions.

Math Magic

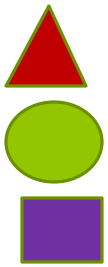
- **Count and Assemble Sets.**
  - Use plastic bear counters and foam dice.

  - Children take turns rolling dice (large foam dice) and identify the number (count the number of dots) on the top. Next, they match it to an equivalent set of bear counters.
  - Some roll two dice and add the numbers together.

- **Make size/height comparison:**
  - Compare "Which animal is larger, a bear or a cat?
  - Which animal is smaller, an elephant or a turtle?
  - Which is longer, a snake or a caterpillar?
  - Which one is taller, a horse or a giraffe?"
  - Make a chart of large/small and tall and short animals.

Math - Geometry and Spatial Sense

- Display shapes on the wall showing the specific attributes of shapes.
- Provide opportunities for students to feel the sides and count the sides:



  - A triangle has 3 sides and 3 corners.
  - A circle has no sides.
  - A square has…

- Have students create different shapes from using Wikki-Stix, play dough, toothpick, yarn, felt pieces, etc. Connect it with creativity art, boosting imagination and creativity.

Objective: Recognize, describe, and name attributes of shapes.

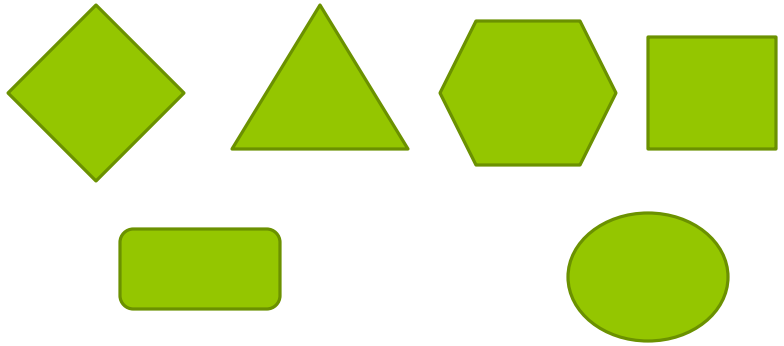
Math Fun

- **Math Walk and Talk:** Count the steps and Compare.
  - From classroom to outside door when you go to recess.
  - From classroom to cafeteria.
  - From classroom to outside for bus.
  - Count the steps and compare distance (more/less)

Math Games

1. Play **dice game**. Have students roll the dice and predict) what number it will be prior to rolling. Count the number (easy level).
2. Have students roll two dice. Next, they write the numbers and create an addition statement ( ) + ( ) = ( ) and add the numbers.

Play **'Shape Hunt'** (scavenger hunt) game. Find shapes everywhere: inside and outside the classroom. Assign different shapes to teams of students.

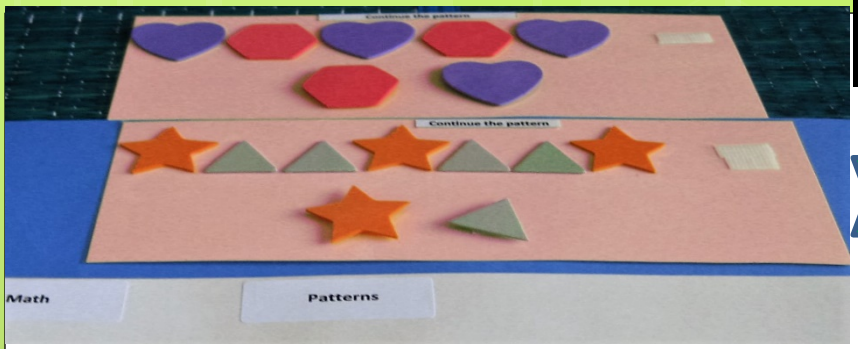


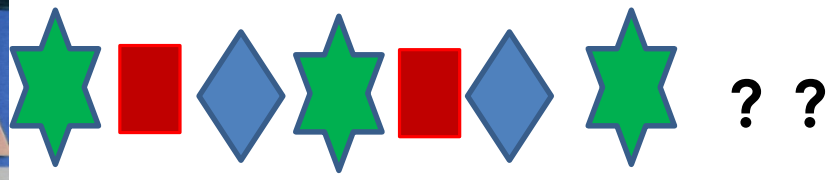
Math - Measurement

- **Measure the height:** tall/short. Have children stand from tallest to shortest. "Who is taller/shorter?"
- **Sequence by size: Large Medium and Small**
- Read the story of Goldilocks and the Three Bears. Sequence by size:
  - The three bears: Papa, Mama and Baby Bear
  - The three chairs
  - The three bowls
  - The three beds
- Demonstrate capacity at the sand/rice/bean table. Have children measure "how many spoons of sand to make a cup of…"; "how many cups of water to fill the container…"
- Compare weights of objects, which one is heavier: For e.g., cotton balls Vs bears.

Objective: Attributes of persons or objects: length, area, capacity, or weight, etc.

Math Patterns



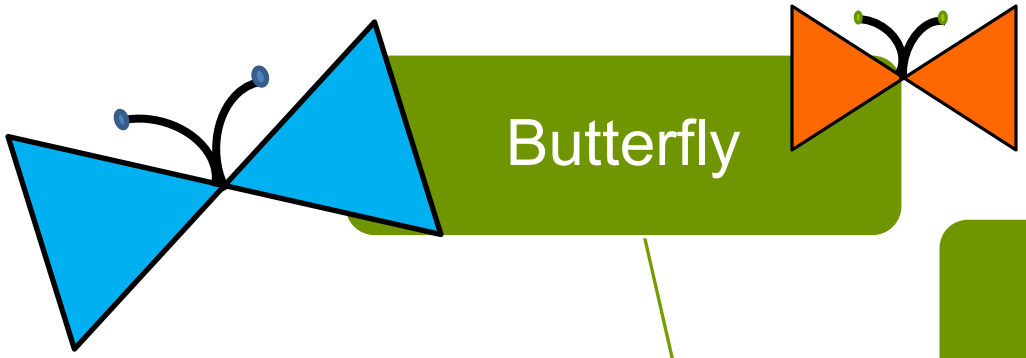


- Get children to **recognize** and **create patterns** with increasing complexity.
- Make color, shape, size and number patterns. Use colored blocks, shapes, beads, tissue paper squares, foam shapes, spoons, forks, etc. to make patterns.
- Get children to find patterns in the world around them.
  - Encourage children to look for patterns in the tiles on the classroom floor (square tiles and rectangular tiles), the bricks on the outside of the school (big bricks and small bricks), the clothing they wear (stripes, plaids, and other designs), or music they hear (verses and choruses).
  - Blocks can provide children with an opportunity to create patterns while building structures.

A Brain-Storming Activity to Build Thinking, Recall and Categorization Skills

Use the concept map to brainstorm insect names.

Connect it with *'The Very Hungry Caterpillar' and 'Grouchy Lady Bug'*



Butterfly

Lady Bug

Insects

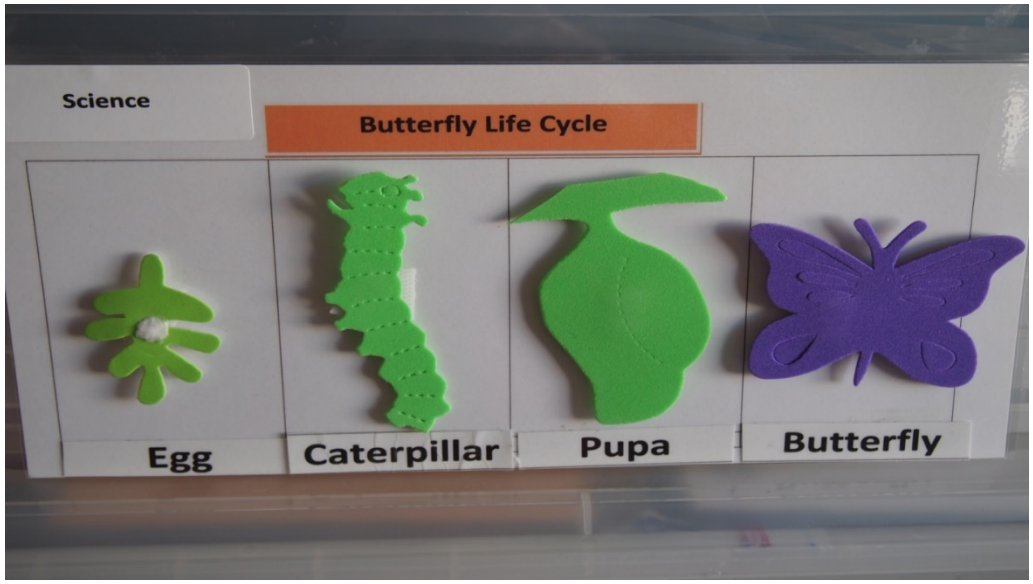
Mosquito

Beetle

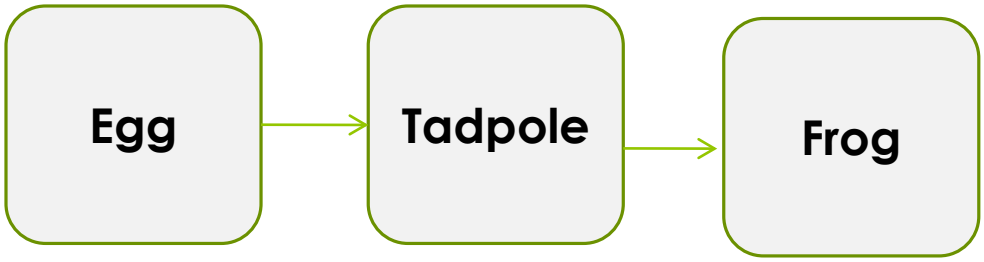
Grasshopper

Science Knowledge-building

- Teach ‘Life-Cycle’ stages : butterfly and frog.
- Post a pictorial chart of the life cycle of the animal on your science wall.
- Involve students in sequencing the life cycle stages.



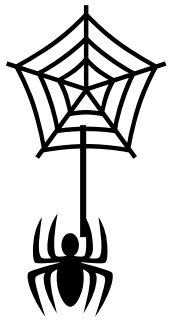
Frog Life Cycle



Science - Observation Natural World

Increase children's understanding of the natural world, their observation and classification skills. Read and share picture books about the 'Natural World'.

The Very Busy Spider by Eric Carle



Find out about spiders:

- Why do spiders spin webs?
- What are webs made of?
- How many pairs of legs do they have?
- Differences between an arachnid and an insect.

- Share books about insects and spiders—preferably with photographs (National Geographic Kids offer many books on insects and their website has many videos on science topics)
- From Caterpillar to Butterfly (National Geographic Readers)

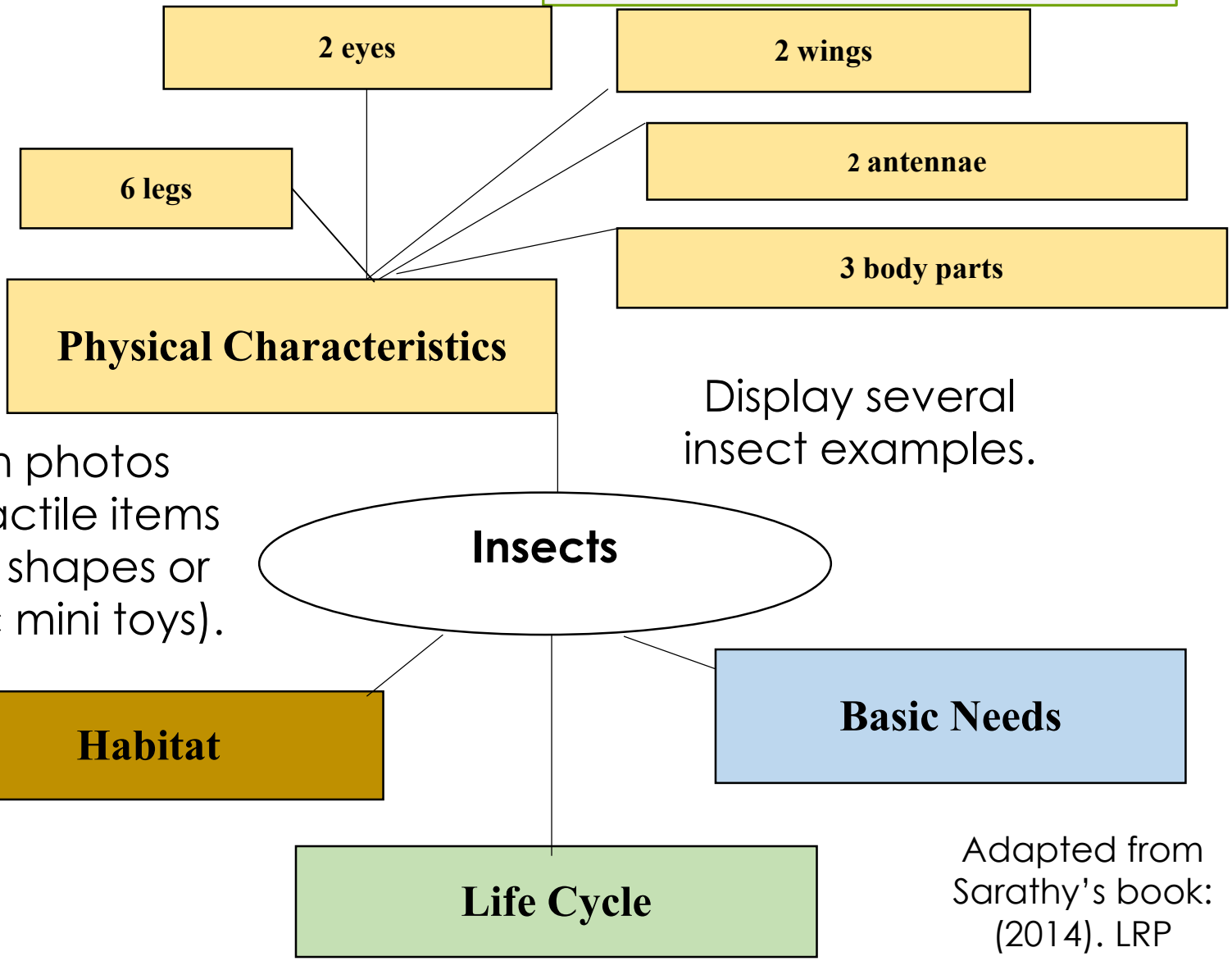
Science Inquiry

- **Set up a Science Challenge Discovery Center:** Expose learners to inquiry-based science activities.
- **Animal habitats:** At the discovery table, showcase animal habitats with photos and real objects.
  - Have students match animals to their habitats.
- **Animal Classification:**
  - Set up a 2-part chart providing some examples to classify animals into 'Mammals and Reptiles' (Bears and dogs are mammals; snakes and Turtles are reptiles).

Mammals	Reptiles
Bear	Snake

  - Provide photos of animals paired with their names. Students sort animal photos into the two categories using the chart at the science discovery center.

Science Wall: Knowledge-Building



Adapted from Sarathy's book: (2014). LRP Publications

Science is Inquiry, Problem-Solving and Discovery.

- Science is a systematic study of the structure and behavior of the physical and natural world through observation and experiment." i.e. how stuff works.
- Children are natural learners—inquisitive, energetic, curious.
- Increase their thirst, curiosity and enjoyment related to discovery. Encourage love of exploration and experimentation.
- Make science exciting! Create hands-on science lessons so concepts come to life.
  - Provide objects for students to observe, conduct experiments and discover how things work.
- Get parents involved (to pursue activities at home).

Inquiry, Observation and Discovery

Objects - Floated	Objects - Sank

- ***Floating and Sinking Activity:*** Get your students to put things in water and observe if the object sinks or floats.
  - Ask questions as to why some objects floated and others sank.
- **Magnet Activity:**

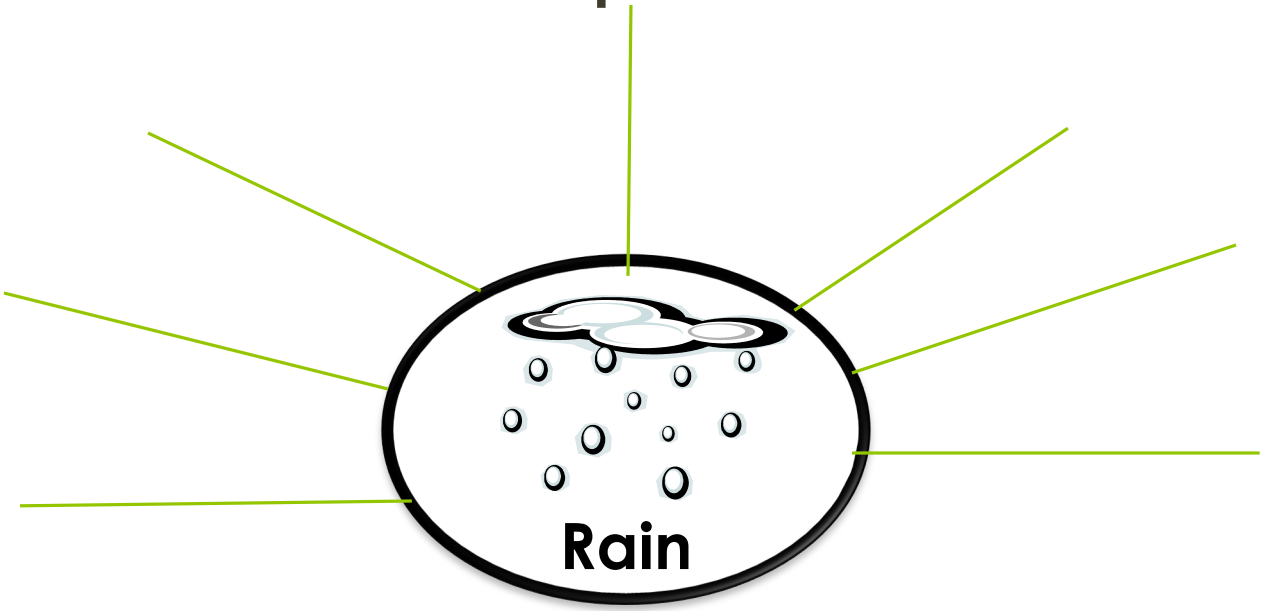
  Have your students experiment with a number of items – paper clips, scissors, pencil/crayon, a metal spoon, a plastic spoon, etc. to see if the magnet will attract or repel the item.

A magnet attracts paper clip because it contain iron.	A magnet repels paper because it does not contain iron.
Magnet Attracted:	**Magnet Repels:**

Critical Thinking – Problem-Solving

Open-ended Questioning
Brainstorm to Promote Critical Thinking and Problem-Solving skills

What would happen if it did not rain for months?
All the water dried up in the lakes and rivers…



What are some things that would happen if it rained heavily for several days?

Critical Thinking – Open-ended Questioning

- Read the book,'*10 Things I can Do To Help My World*' (by Melanie Walsh)

Play with her

Share toys

Talk to her nicely

5 Things I can do to keep my classroom clean

What are some things you can do to help a friend?

5 Things I can do to help the world

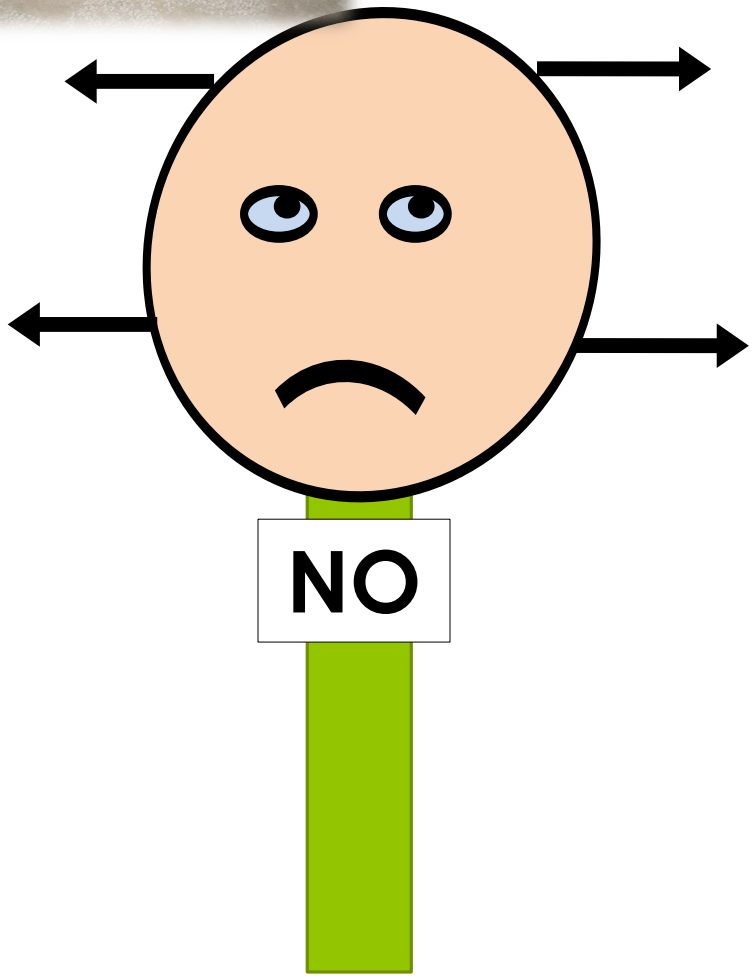
5 Things I can Do when I am feeling sad (to feel better)

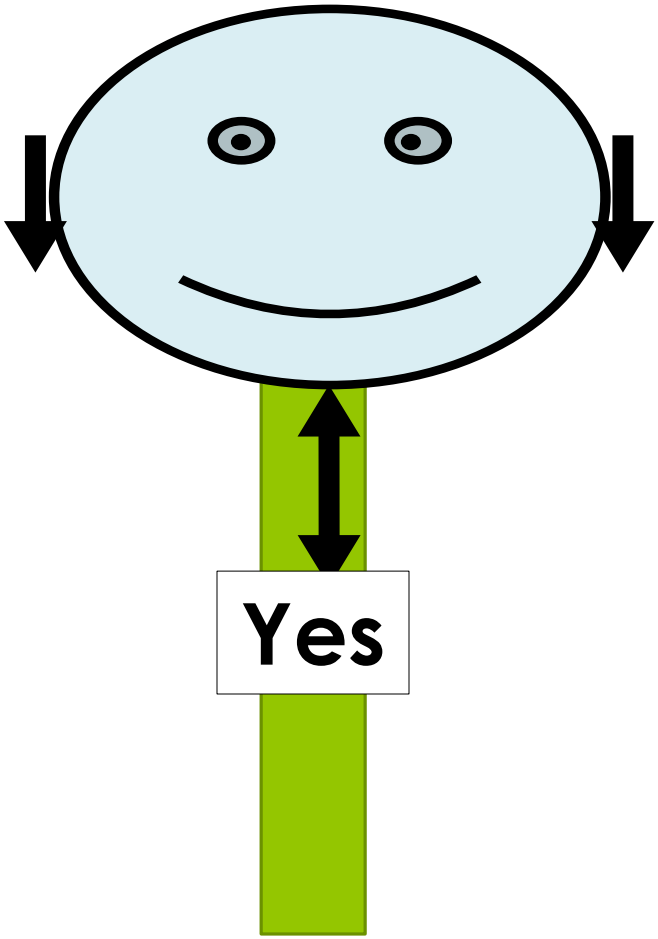
Be accepting of all responses.

Child-specific Supports

- Applying **Universal Design for Learning** principles.
- Use object representations or picture cues as supports to assist students with their responses.
- Ask questions ranging from easy to higher complexity levels to provide opportunities for all children to respond.
- Provide invisible support.
- Enable students to respond given 2 or 3 choices.
- Build in transition activities (movement activities, games, songs, etc.) to sustain student motivation and attention.
- Offer additional opportunities to take short breaks for children who appear restless and fidgety.
- Make encouraging comments (positively stroke).
- Use AT supports.

Response Tool





Some may respond with a Response-Participation Tool.

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Visual and AT Supports

A 3-column chart

Select/Choose

(A choice Board)

Italk2 Communicator
Enable Choice-making.

Talking Brix
Labeling & sequencing

Step by step
Step by step directions for the science experiment

Magnet	Label
Microscope	Label
Object	Label
Object	Label

STEM Vocabulary-building chart

Quick Talker and Super Talker
To promote communication, and group participation and response

Engineering, Math, and Problem-Solving Block-Building

- **Research study shows that playing with blocks can help children learn math faster by improving their spatial skills.**
  - The study looked at 3-year-old children from different socio-economic levels and found that those who were able to use the blocks to build one similar to a model were better at subtraction, addition and counting.
- Guided play with building blocks helps build math skills and executive function.
- **At the Block Center:** Build a zoo using Lego blocks.
  - Get children to build the zoo and enclosures for different animals (builds imagination & problem-solving skills – beginnings of engineering)

Technology

Technology Recommendations

Coding skills:

- **Lightbot** – A programming puzzle game
  - Age range: 4+
  - iOS and Android (iPhone, tablets, etc.) Online Version
  - Cost: Free
- **ScratchJr** (coding with blocks and characters to make games
  - Age range: 5-7
  - Cost: Free
  - https;??www.scratchjr.org/

Science:

- **Food Fight**
  - Learn about how food webs function and how they depend on multiple variables
  - Age range: 6-12
  - https://www.brainpop.com/games/foodfight/
  - Cost: Free

Act it to Make Drama
Make it fun & joyful!

Drama Integrated with Science and Literacy: The Concept of "Orbit"

Connect it to the book '**Papa, Please Get the Moon for Me**' by

- Assign different roles to students: Sun, Earth Moon and Stars.
- Give each character (the students) a prop representing their role. Students can make props out of paper plates and paint them with different colors to represent Sun, Earth, Moon and Stars.
- Act out the "Orbit" by having Earth orbiting (circling) around the Sun and the Moon orbiting (circling) around the Earth to demonstrate the concept of "Orbit" and the relationship between Sun, Earth and Moon.
- A non-ambulatory student could play the Sun or activate a device to play the script or play a theme music. Some can be stars in the sky and another can hold a large background for the sky. Rotate roles.
- Use **AT voice output devices and props** to aid the 'role play & drama' presentation.

Make STEM a joyful experience!

- Children are natural learners—inquisitive, energetic, curious.
- Make Math, Science and Technology a lot of fun!
- Create hands-on math & science lessons so concepts come to life.
- Create a Science Wall and a Science Discovery Center. Provide objects for students to observe, conduct experiments and discover through inquiry.
- Add tactile, visual and auditory appeal to materials.
- Encourage their love of exploration and experimentation. Prepare them to be problem-solvers.
- Get parents engaged.

Resources

- Sarathy, P. (2017). Sarathy, P. (2017). **Enhancing Executive Function in the Early Years: Environment, Instruction and Adaptations for School Readiness.** Horsham, PA: LRP Publications.
- Sarathy, P. (2016). **STEM Teaching Strategies for Young Learners.** Austin, Texas: Ed. 311
- Sarathy, P. (Second Edition, 2014). ***Serving students with severe and multiple disabilities: A guide to strategies for successful learning.*** Horsham, PA: LRP Publications.
- What Works Clearing house. Teaching Math to Young Children (2013). IES Practice Guide. https://ies.ed.gov/ncee/wwc/Docs/practiceguide/early_math_pg_111313.pdf
- UDL website: (Center for Applied Special Technology (CAST) http://www.cast.org/research/udl/index.html

Resources: websites, Videos

- Engineering is Elementary developed by the Museum of Science, Boston: https://info.eie.org/eie-k
- National Science Teachers Association. (2014). *NSTA position statement: Early childhood science education*. http//www.nsta.org/about/positions/earlychildhood.aspx
- Online games:
  - *www.coolmath.com*
  - *pbskids.org/lab/games*
- ThinkFun: *www.thinkfun.com*
- Tools of the Mind: *www.toolsofthemind.org*

Thank You All.

A special thanks to AbleNet University for hosting the webinar.

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The next webinar is: May 8th, 2019

Topic: Promoting and Advancing Personal Living Skills and Self-dependence in Students with Severe and Multiple Disabilities