



Beyond Calendars and Today's Weather: Improving Instructional Quality and Learning Outcomes for Pre-K Mathematics and Science

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Pattern Blocks

How many different ways can you put the blocks together to make a hexagon?



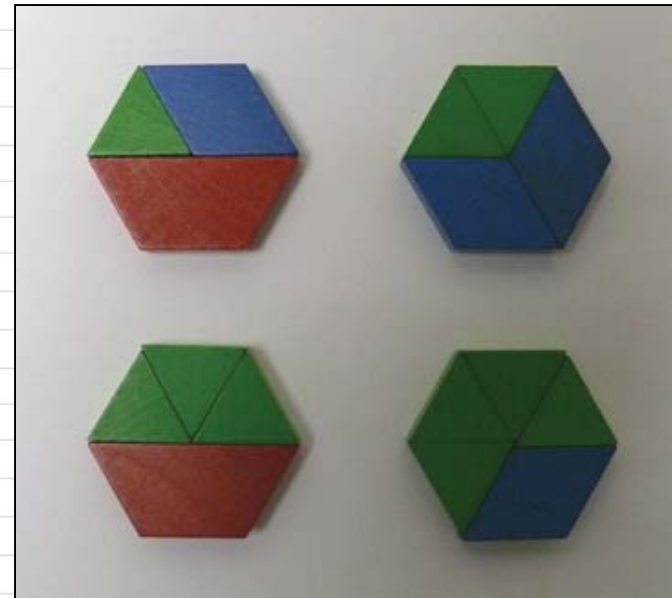


A few solutions...





A few more solutions...





Beyond exact matching...

What other *interesting* discoveries could a child make with these blocks?





Math and Science Subdomains

- Number and Numerical Operations
 - Functional counting
 - Numerical operations
 - Written numbers
- Geometry and Measurement
 - Identifying and using shapes
 - Measurement
- Observation and Classification
- Scientific Inquiry
 - Prediction
 - Investigation
 - Reporting/Recording



Why Math *and* Science?

- reasoning skills used across domains
 - classification
 - predicting and checking
- measurement
- data collection & analysis



classification

- Using observations of attributes to group and order objects
- Requires inductive reasoning and problem solving skills
- Prepares children for future experiences with numerical operations and concepts of probability
- And for scientific classification, for example, of elements or biological taxonomies



predicting and checking*

Adult: I need 10 seeds. Now I have 5. How many more do I need?

Child: Six....

Adult: OK, let's try it out. I have 5. Now I'm going to add 6. 1,2,3,4,5,6. I did 5 plus 6. Does that equal 10?

Child: Yeah.

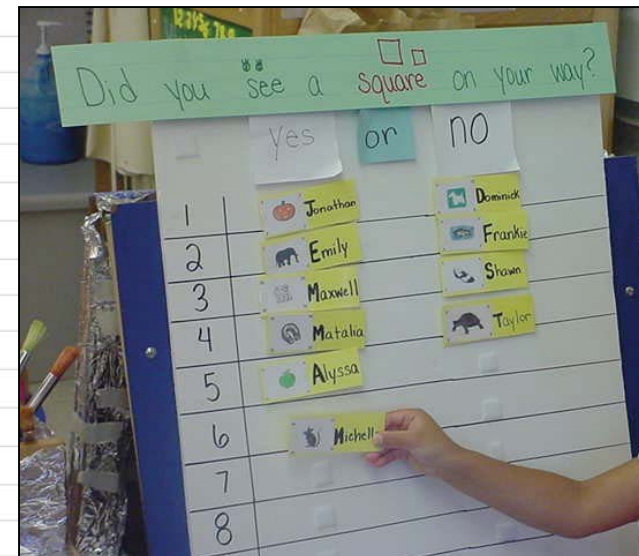
Adult: Can you check to find out for sure?

Child counts, then self-corrects by removing one seed.

* Excerpted from Brenneman, K. (2009). Let's find out! Preschoolers as scientific explorers. *Young Children*, 64(6), 54-61.



data collection and analysis





measurement





Math and science throughout the classroom

- Do materials in each learning area support scientific and mathematical explorations?
- Do materials support comprehensive mathematics, not just shape and number?
- Do materials support explorations of both biological and non-biological science?
- Are materials arranged to invite deeper explorations and reasoning?
- Matrix approach can help ensure that the answers are “yes.”

Math materials matrix

| Kinds of Math Materials & Classroom Areas | Number - functional counting and operations | Number symbols | Classification/ Seriation/ Patterning | Shapes/ Space | Measurement |
|---|---|----------------|---------------------------------------|---------------|-------------|
| Art | | | | | |
| Manipulatives | | | | | |
| Dramatic Play | | | | | |
| Blocks | | | | | |
| Library/Listening | | | | | |
| Sensory Table | | | | | |
| Writing | | | | | |
| Outside | | | | | |

THE ART AREA

| Number - functional counting and operations | Number symbols | Classification/ Seriation/ Patterning | Shapes/ Space | Measurement |
|---|--|---|---|--|
| Recipe for mixing paint | Number stickers Number stencils Number playdough stamps Number stamps Labels for shelves | Textured paper scraps Scented markers White paint to seriate color hues Most typical art materials | Shape punch Interesting paper scraps Pipe cleaners Play dough & cookie cutters | Measuring cups & spoons Rulers, paper strips, yarn in ordered units |

Science materials matrix

| Kinds of Science Materials & Classroom Areas | Interesting objects to observe - natural & human-made | Collections to sort, match, and compare | Observation and measurement tools | Materials that change or can be changed (to explore cause&effect) | Materials to read about and represent science |
|--|---|---|-----------------------------------|---|---|
| Art | | | | | |
| Manipulatives | | | | | |
| Dramatic Play | | | | | |
| Blocks | | | | | |
| Library/Listening | | | | | |
| Sensory Table | | | | | |
| Writing | | | | | |
| Outside | | | | | |

THE SENSORY TABLE

| Interesting objects to observe - natural & human-made | Collections to sort, match, and compare | Observation and measurement tools | Materials to explore cause&effect | Materials to read about and represent science |
|--|---|---|---|--|
| <p>Sand with shells, pebbles, sea "glass"</p> <p>Soil with pebbles, minerals</p> | <p>Beans</p> <p>Nuts</p> <p>Pasta</p> <p>Nuts and bolts</p> | <p>Magnifiers</p> <p>Measuring cups and spoons</p> <p>Liquid measures</p> <p>Informal volume measures</p> | <p>Water + soil</p> <p>Water + sand</p> <p>Flexible tubing & funnels</p> <p>Bowls & sieves with different sized holes</p> | <p>Science journals or paper & crayons</p> <p>Books about mud, water, etc.</p> <p>Recipes for mud, clean mud, gak, goop...</p> |

Math throughout the day matrix

| Student/ Teacher Math Interactions during Daily Routines | Number - functional counting and operations | Number symbols | Classification/ Seriation/ Patterning | Shapes/ Space | Measurement |
|--|---|-------------------|---|------------------|-------------|
| Arrival | | | | | |
| Large Group | | | | | |
| Small Group | | | | | |
| Meal | | | | | |
| Outside Time | | | | | |

Science throughout the day matrix

| Student/Teacher Science Interactions during Daily Routines | Exploring, experimenting, and discussing science | Observing & predicting | Recording science information |
|--|--|--------------------------|-------------------------------|
| Arrival | | | |
| Large Group | | | |
| Small Group | Mystery Objects Activity | Mystery Objects Activity | |
| Meal | | | |
| Outside Time | | | |



Mystery Objects - Part 1

1. You may look at the object, but do not touch it.
2. What do you notice about it?
3. What do you think it is?



Mystery Objects - Part 2

1. Now you may pick it up and explore it.
2. Do you notice anything new? What do you notice? Tell your group what you observe about the object.
3. Talk with your group about this thing. Does it remind you of any other things in the world? How are those things the same? How are they different?
4. What could you do with this thing? How could people use it?
5. What do you think it is?



During Part 2, you were...

- *making observations* using multiple senses
- *comparing and contrasting* the object with other things you know about - integrating new and known information
- *collaborating*, sharing ideas, and working together
- *questioning and acting to explore an unknown*
- *exploring a big science idea* -- form and function
- engaged in deeper thinking and learning, *not focused on one right answer*
- having more fun?



With children...

- What do you notice about this thing?
- Encourage descriptions of colors, shapes, textures, parts...
- Does it remind you of anything?
- What could you do with it?



NIEER Math/Science Initiatives

Preschool Rating Instrument for Science and Math

(PRISM): Structured Classroom Observation System

- Research derived
- Rigorous validity testing: Used in multiple studies

Self-Evaluation for Science and Math Education

(SESAME): Reflective Coaching Improvement System

- Criteria linked to PRISM
- Teacher and coach document classroom evidence and plan classroom improvement

Early Learning Scale (ELS): A Performance-Based Assessment System

- Benchmarks based on state standards and developmental research
- Established validity