BRINGING MATH TO LIFE in Kindergarten

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This guide is designed to provide teachers with tools that aid in the development of a successful kindergarten mathematics program. Problem solving has been presented as the basis for the strategies above, "in all the real-life needs for arithmetic, problems do not present themselves ready for calculation. Deciding what to do is the important first step before doing any calculation" (Burns, 2000). This demonstrates the importance of moving away from worksheets and toward the implementation of effective practices and learning experiences such as math stations and creative problem solving. Children must have daily opportunities to participate in cooperative problem solving about thought-provoking questions. They must be encouraged to discuss their thinking and reasoning (even their struggles). To build this conceptual understanding, students must have ample opportunities to work with numbers in a variety of ways.

BRINING MATH TO LIFE IN KINDERGARTEN

EARLY FOUNDATIONS

For years, children have been taught how to “do math.” Traditionally, doing math meant memorizing **facts** and **algorithms**. Great memorizers tended to translate into great math students. Consequently, students who did not memorize well often struggled with math. An increasing research base has helped educators identify an important component that has often been left out of the mathematics education equation, **constructed understanding**. According to Ely (2005), kindergartners demonstrated “limited memory for unrelated or nonmeaningful information while showing good memory for information that is meaningful to them.”

This tells us that if mathematics is presented to children in meaningful ways, they are more likely to commit the concepts to memory.

Developmentally Appropriate Practices

Meaningful learning often occurs when children are encouraged to build on their own prior knowledge and abilities. This constructed understanding is the very core of ***Developmentally Appropriate Practices*** (DAP). DAP are research supported teaching practices that help educators plan for and facilitate optimal learning environments for young children. The big ideas behind DAP are 1) meeting learners where they are; 2) setting goals for children that are both challenging and achievable; and 3) recognizing that challenging and achievable goals vary from child to child (Copple et al., 2014). It is important to remember that kindergartners greatly benefit from the use of developmentally appropriate practices in all aspects of their education, including mathematics.

Number Sense

Providing children with meaningful learning opportunities is hardly a new idea. Many teachers know how to plan and facilitate engaging units of study that help children make sense of the world. However, these opportunities are not often implemented in the area of mathematics. It seems faster and easier to have children memorize algorithms (e.g. 2 + 2 = 4), than to allow them the discovery that 2 balloons and 2 more balloons create a total of 4 balloons. Of these two approaches, only one encourages the development of number sense. ***Number sense*** refers to the ability to think of and use numbers flexibly in a variety of scenarios. Children who develop strong number sense come to understand that "numbers are meaningful, and outcomes are sensible and expected" (Burns, 2007). They understand that numerals represent actual quantities. Providing children with opportunities to apply mathematics to real world scenarios helps them relate to numbers in ways that are naturally motivating and facilitates deep, foundational connections.

Number sense is not something that can be explicitly taught over the course of a six-week unit. Rather, it is mathematical understanding that children construct gradually over time through problem-solving contexts. Mathematics instruction that values number sense focuses on thinking and reasoning. Teachers who nurture this development, display interest in student thinking and value inventiveness. Encouraging children to construct their own understanding does not imply that learning basic math facts is any less important. Mathematical expectations have expanded to include understanding as an important concept of teaching basic math facts (O'Connell & SanGiovanni, 2011). A comprehensive math program values conceptual understanding and math ***fluency***. According to the Arizona Department of Education (standards), there are two critical areas that Kindergarten mathematics instructional time should focus on. One area is representing, relating, and operating on whole numbers, initially with sets of objects. The second area is describing shapes and space. "More learning time in Kindergarten should be related to numbers than to other concepts" (Arizona Department of Education, 2013).

A heavy portion of the kindergarten math standards revolve around counting and arithmetic. To effectively meet these standards, while also developing number sense, number operations (e.g. addition and subtraction) should be explored from the beginning of the school year. During this time, students should work to develop:

- Quantity (How many)
- Comparing (More Than, Less Than, Equal To)
- Modeling (Show what is happening- **Physically** through acting or demonstrating using manipulatives, **Pictorially** through drawing, **Numerically** through written numbers and equations)
- Place Value (Tens and Ones)
- Problem Solving (Approaching mathematical situations using own thoughts and ideas- not being shown how to solve the problem)

There has been a paradigm shift regarding what children should know and be able to do upon the completion of kindergarten. ***More recent expectations focus on depth of conceptual understanding over breadth of exposure to many different topics***.

Creative Problem-Solving & Math Stations

Creative problem-solving opportunities and math stations offer children the opportunity to construct understanding of number sense *and* develop mathematical fluency.

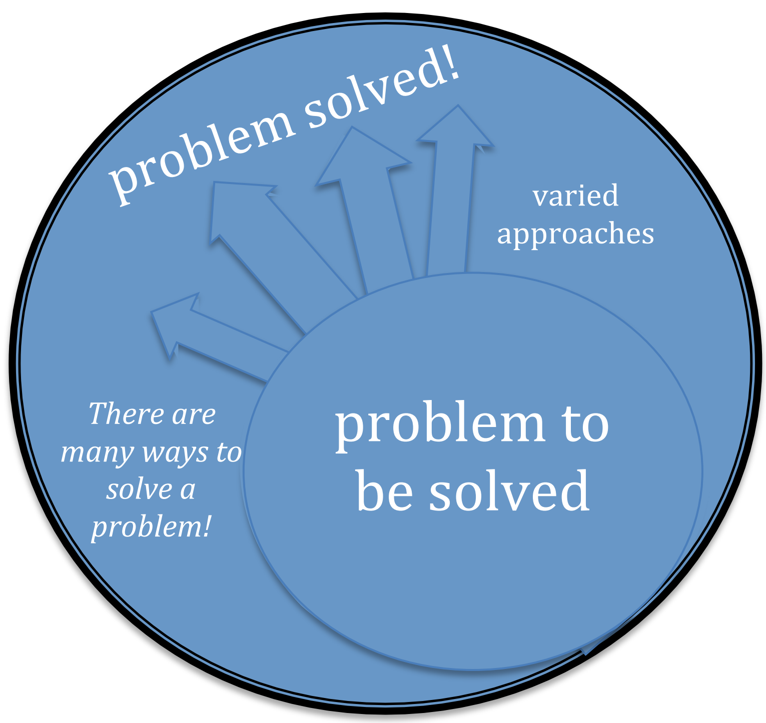
Creative Problem Solving

Cognitively Guided Instruction (CGI) is one framework for effective teaching of mathematics. It originated as a research project that examined how increased teacher knowledge of children's mathematical thinking affects student understanding of math concepts. CGI is guided by two main ideas. The first idea is children naturally possess knowledge about the world that should serve as the basis for mathematical instruction. The second idea is mathematics education should encourage relationships to form between problem solving and computational skills (rather than the memorization of facts in isolation).

Teachers who utilize this approach believe ***there is no one best or right way to solve a problem***. They do not explicitly tell students how to solve a problem. With time, experience, and listening to the problem-solving strategies of others, children refine their own strategies to become more efficient and abstract (Carpenter et al., 1999). For effective teachers, ***the process is more valuable than the product***. They reflect on their student observations and use this as a basis to intentionally plan future learning experiences.

The primary purpose of CGI is to help teachers deepen their understanding of how children think about and learn mathematics. It is a philosophy, rather than a **curriculum**, that respects the teacher as the primary decision maker in the mathematics classroom. The CGI approach supports teachers' development of lessons and activities that utilize children's natural desire to make sense of the world. "Students of teachers who knew more about their students' thinking had higher levels of achievement in problem solving than students of teachers who had less knowledge of their students' thinking" (*Carpenter et al. 1988*). Basically, teachers who understand how their learners think are better prepared to help them learn mathematics. By understanding how children naturally attempt to solve mathematical problems, teachers can better design authentic learning opportunities to help children construct a deeper understanding of mathematics.

There are common strategies that children use to solve math problems. CGI encourages teachers to help children refine these naturally-occurring approaches over time. Effective teachers provide opportunities for children to approach authentic math problems in self-selected ways. By understanding and anticipating common student errors, teachers can ask questions that help children recognize and resolve their misconceptions. Additionally, effective teachers offer children opportunities to discuss their strategies with peers. These opportunities to communicate develop a, "growing realization that there is no one best or "right" way to solve any problem" (Carpenter et al., 1999).



Problem-Solving Experience Example #1
Kindergarten Whole Group Time
Adapted from Carpenter et al., (1999)

Prompt: Six sheep were eating grass in the field. Five more sheep join them. How many sheep are in the field now? (Join Result Unknown)

1. Children sit on the rug.
2. Teacher provides a mathematical situation for problem solving.
3. Children solve the problem using materials they self-select to use as **counters**.
4. Teacher moves around to observe and ask clarifying, **open-ended questions**.
5. Teacher selects 3 children to report their solutions. (The teacher intentionally selects students who approached the problem in different ways.)
6. The group listens and the teacher/students ask **clarifying questions**.
7. Teacher asks children how each strategy is alike.
8. Teacher emphasizes **key connections** and ideas.

Examples of Different Strategies Students Might Use:

- Use counters to physically represent each sheep
- Draw a picture of each sheep
- Draw a tally mark for each sheep
- Count fingers (children who choose this method may become confused as the total number of sheep exceeds the number of fingers they have)
- Math Facts (child either knows what 6 + 5 equals or uses "derived facts" to figure out that 5 + 5 = 10, so 1 more would make 11)
- Uses number line to start at 6 and "count on"

Sample of Clarifying, Open-Ended Questions During Reporting:

How did using two different colors of counters help you?
Why did you choose to use a ten frame with your counters?
What do you think might happen if you had to draw 60 sheep and 50 more sheep? Would you still choose to draw them?

Sample of Connecting Key Connections and Ideas:

How is Anita's strategy like Jamal's strategy?
Can you think of someone else's strategy like yours? How are they alike?
Manuel and Stephanie both used white boards to solve the problem, but their work does not look the same. What did they do differently? Did they still get the same answer?
Is there a different way of solving you might want to try next time? Why do you want to try it that way?

What does it look like?

- Children are **actively engaged** using self-selected materials and methods to solve the problem.
- The teacher is circulating, **actively listening** and asking open-ended questions to prompt children to explain their thinking.
- The teacher records **observations** specific to each student's problem-solving strategies.
- Children present their problem-solving strategies orally, with counters or by drawing on chart paper/white board.
- Peers listen respectfully and ask questions when they are unclear about an explanation.
- The teacher asks questions to draw attention to the similarities between solution strategies (e.g. direct modeling, counting, grouping by 10).

What does it sound like?

This learning scenario may sound something like this:

Teacher: *"How did you try to solve the problem?"*
Student: *"I counted my fingers, but it didn't work."*
Teacher: *"Why do you think it didn't work?"*
Student: *"I didn't have enough fingers."*
Teacher: *"What else could you use to solve the problem?"*
Student: *"I could use cubes."*

What does it feel like?

- Children feel *confident* selecting their own materials to work with.
- Children feel *capable* of approaching the problem in their own ways.
- Children who are confused feel *comfortable* telling others that they are stuck and need help.
- Children are *supportive* as they work with peers who request help.
- Children feel *safe* to explain their thinking individually and to the group.
- Children listen to each other's ideas *respectfully*.

In Problem-Solving Experience Example #1, the teacher encourages children to explain their thinking both while problem solving individually and when reporting to the whole group. This communication component is important as it encourages children to think about and reflect on what they have done. This "thinking about your thinking" is called **metacognition**. Five and six-year old children can reflect on how they know something, make connections with other things they've learned, and use that information to plan for the future (Copple et al., 2014). These conversations especially benefit lower achieving children by helping them develop higher order thinking skills that higher achieving students tend to already have (Clements & Sarama, 2014).

Prompting children to explain their thinking to a group fosters a deeper level of understanding. This type of communicating becomes easier with time and experience. When children listen to their peers' strategies, they come to value the thoughts and ideas of others. "When a teacher expects and values a diversity of solution strategies, children realize that multiple strategies are not only acceptable but desirable" (Carpenter et.al, 1999). Children using lower-level problem solving strategies are often inspired to try a higher-level strategy that they may not have considered before. Additionally, this student-centered communication provides opportunities for teachers to "highlight links and connections between mathematical ideas and between mathematics and everyday problems to be solved" (Askew et al., 1997); (Clements & Sarama, 2007, 2008).

Formative Assessment

Problem-Solving Experience Example #1 mentioned that the teacher recorded notes and observations about the processes children used while problem solving. This, of course, does not mean that the teacher had time to record notes on every child's strategies during a single math experience. In CGI classrooms, there are multiple opportunities to observe and record children's mathematical understanding. According to research by the National Mathematics Advisory Panel (2008), **formative assessment** was one of the strongest supported instructional practices for math teachers. Formative assessments help teachers monitor student progress and provide a basis for planning future instruction. This is particularly helpful when differentiating for each student's unique learning needs. These formative assessments can be as simple as noting that a child uses his/her fingers to count. Formative assessment allows teachers to understand their students' thought processes. "Children continue to build on their early knowledge areas, and teachers who are sensitive to what children already know and think can help them refine and add to that base" (Copple et al., 2014).

Formative Assessment Tips

When monitoring student understanding, teachers should consider the following questions:

- What is the key error?
- What is the probable reason the child made this error?
- How can I guide the child to avoid this error in the future?
(Shepard, 2005)

Problem-Solving Experience Example #2
Kindergarten Collaborative Problem-Solving Time- Pairs
(Adapted from Carpenter et al., 1999)

Prompt: Determine as many number combinations as you can that make the quantity of five. Record the number sentences for each combination. Tell and draw a number story for each number combination.

1. With a partner, children determine how they will approach the learning experience (e.g. drawing a model, using counters, using a five or ten frame).
2. Partners collaborate to identify possible number combinations.
3. Children record a number story for each combination they identify (on paper or white board).
4. Children verbally tell (to the teacher or each other) the number story they linked the quantities to.
5. Children draw a picture that represents the story problem they linked the quantities to.

What does it look like?

- Partners are sharing the task responsibilities and taking turns.
- Children are actively engaged with a partner, using self-selected materials and methods to solve the problem.
- The teacher is circulating, actively listening and asking open-ended questions to prompt children to explain their thinking.
- The teacher records observations specific to each student's problem-solving strategies.
- If one partner is confused, the other gives explanations not answers.

What does it sound like?

This learning scenario may sound something like this:

Partner A: *"Do you want to write the number sentences or move the beads to make the combinations?"*

Partner A: *"How about our story is about horses?"*
Partner B: *"Okay, maybe there are two grown up horses and three baby horses."*
Partner A: *"Yes! I'll draw the picture… The two grown-ups are going to be big and the three babies are going to be small."*

What does it feel like?

- Children feel *confident* that they know and can do what is expected of them.
- Children feel *comfortable* self-selecting materials to work with.
- Children feel *safe* sharing their thoughts and ideas with their partners.
- Children listen to each other's ideas *respectfully*.
- Children are *supportive* when their partners are confused.

Collaborative Learning

In Problem-Solving Experience Example #2, students engaged in **collaborative learning**. This is very common in classrooms that practice creative problem solving. Kindergartners' cognitive development is greatly promoted when teachers design learning environments and plan experiences that encourage children to interact and collaborate (Copple et al., 2014). Children tend to learn better from listening to their peers than listening to their teacher. Additionally, Clements & Sarama (2014) concluded that children working effectively with peers develop positive group interdependence, reciprocal sense making, and consensus building. Working positively with a partner or in a small group may not come easy for many young children. There are certain social skills that must developed and practiced for collaborative learning to be productive and beneficial.

"Promoting the Development of Effective Collaborative Skills"
(Adapted from Clements & Sarama, 2014)

- Encourage students to provide help for peers. Emphasize that the goal is for all students to learn and be successful.
- Teach specific communication skills such as active listening, asking and answering questions, providing explanations and effective debating techniques.
- Teach students to give feedback to each other. In addition, model appropriate interactive behavior.
- Teach and model conflict resolution skills such as negotiation, compromise, and cooperative problem solving.
- Encourage perspective taking ("put yourself in the other person's shoes") consistent with the students' developmental levels.
- Encourage reflection of what they learned and how their collaborative work helped them learn or how they could collaborate better.

Integration of Concepts
Problem-Solving Experience Example #2 featured a prompt that integrated several mathematical concepts. Children were asked to decompose the quantity of five in several different ways, record a number sentence for each combination and create story problems in which the number sentences would have real world meaning. The *integration of concepts* is a major component in effective classrooms. In these classrooms, math concepts are not taught in isolation. For example, there is not a "unit" on addition or subtraction. Conversely, addition and subtraction are taught simultaneously through authentic scenarios (as they are inverse operations).

Number Facts & Fluency
Kindergartners are working to develop fluency of addition and subtraction facts within 5. **Fluency** refers to efficient, accurate and flexible ways of learning. Traditionally, math facts have been taught through memorization (most commonly flash card drills and timed tests). In addition to creating stressful learning situations, memorization left many children devoid of understanding. Fluency, on the other hand, means that students have acquired efficient, accurate and flexible ways of learning through conceptual understanding. With regular problem-solving opportunities, young children develop key math concepts and skills with understanding. They begin to recognize that "number facts are related, and these relationships can be used to simplify the process of solving problems" (Carpenter et. al., 1999). The fluent child can use number facts in context. Students who learned via memorization often cannot.

The Teacher's Role
The role of an effective teacher is filled with personal growth, intentional planning and creating a supportive environment. Effective teachers actively listen to understand children's thinking and use that information to plan engaging learning opportunities. They respect each child's thoughts and ideas and encourage others to do the same. These teachers construct an environment where students can confidently take chances, share their ideas and ask for help. One of the key characteristics of an effective teacher is the desire to continuously grow his/her knowledge of how children develop skills and concepts. They are reflective of their teaching practices and strive to find ways to best ***scaffold*** their students' understanding of mathematics.

Intentional Planning

Over time, “CGI teachers understand the way children think, understand what makes problems easier or more difficult to solve, and then make decisions that enable children to engage in successful problem solving with problems that are neither too easy nor too difficult” (Carpenter et. al., 1999). This very intentional design of learning opportunities can be likened to the story of Goldilocks and the Three Bears. Just as the porridge was “neither too hot nor too cold,” problems posed for children to solve should be “just right.” As you can guess, this framework is not a one-size fits all approach to mathematics education. Some children may require more support while others may require more challenge. Understanding where each child is and where he/she needs to go is the key to effective instructional planning.

Education is not the learning of facts but of training the mind how to think.

- Albert Einstein

Levels Strategy Development
(Adapted from Carpenter et al, 1999)

Research has helped to identify common invented strategies that young children use to solve arithmetic problems and how they evolve over time. Here are two strategies used by young children as they approach new problem-solving situations:

1. **Direct Modeling**
   Direct modeling is usually the first strategy used to solve mathematical problems. It is very literal and follows the "action" of the problem. Children represent all sets of quantities in the problem. They do so by taking concrete actions- drawing a picture, using fingers, drawing tallies, using counters, etc. Direct modelers think one step at a time and so they only tend to experience the most success while solving basic "Join All" or "Separate From" problems. (p. 26-27)

   There are 2 red cars and 3 blue cars on the road. How many cars are there on the road?

   Direct Modeling Example
   Ann makes a set of 2 cubes then adds 3 more cubes to the set. She then counts all the cubes and arrives at the answer of 5 cubes (cars).

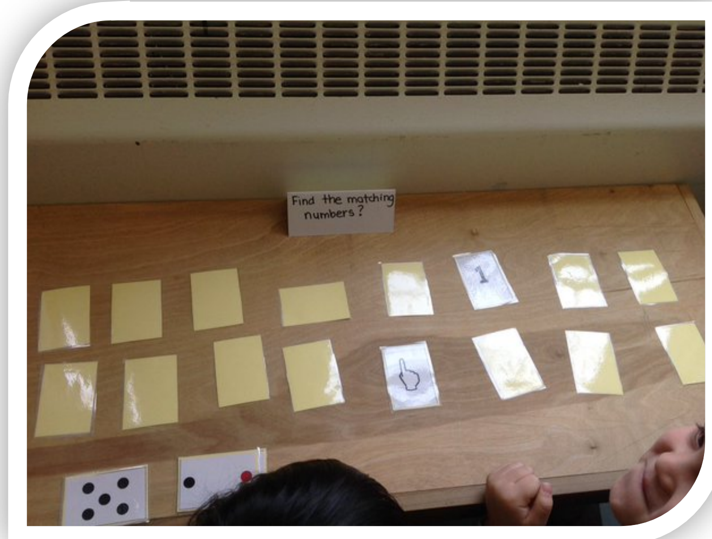
2. **Counting Strategies**
   Counting strategies indicate that a child understands number concepts enough to think of numbers abstractly. There is no longer a need for a physical representation. Since this develops over time, it is common for children to initially use both direct modeling and counting strategies concurrently. "Most children come to rely on the Counting On strategies, but not all children use Counting Down consistently because of the difficulty in counting backwards" (p. 28).

   Mom baked 9 chocolate cupcakes and 2 vanilla cupcakes. How many cupcakes did Mom bake?

   Counting Strategy Example
   Jack starts by saying, "9," and counts on using 2 fingers, "10, 11. Mom baked 11 cupcakes."

   Counting Strategy Example
   Jack thinks and counts out loud, "9, 10, 11. Mom baked 11 cupcakes."

Games and Math Stations



Math Stations: What are they?
Math Stations are short, hands-on activities that children rotate through individually, with a partner or a small group. One kindergarten goal is for children to be able to fluently manipulate values between one and five. Math stations provide children with the opportunity to investigate and manipulate numbers to help them construct a stronger number sense. These math stations provide children with opportunities to investigate the concepts behind basic math facts, explore strategies that support their construction of number sense, and engage in strategic practice to commit facts to memory and improve **fluency** (O'Connell & SanGiovanni, 2011).

Math Stations: Why are they Important?
Utilizing math stations in a kindergarten classroom has many potential benefits. First, math stations provide teachers the ability to observe and work closely with children in small groups. This provides teachers the opportunity to **differentiate** instruction according to the individual needs of students. Second, these stations encourage children to use "math talk" (math vocabulary) in meaningful contexts. Third, children tend to work harder (reducing discipline problems) when they actively engage in tasks they enjoy. Lastly, children are more likely to commit math concepts to memory when engaged in tasks they enjoy.

Math stations have been described as, "areas within the classroom where students work with a partner and use instructional materials to explore and expand their mathematical thinking" (Diller, 2011). These stations allow children opportunities to have extended interaction with math concepts that they have already been instructed on. Math stations provide opportunities for students to practice concepts to develop automaticity. Additionally, these stations provide time for teachers to work with small groups and perform formative assessments. Finally, math stations are inherently engaging, hands-on activities that allow all students to be actively participating at an appropriately challenging level. O'Connell and SanGiovanni (2011) conclude that, "through hands-on activities and thoughtful discussions, students develop deeper understandings about math facts and cultivate useful strategies related to these basic facts.

Courtesy of Wonders in Kindergarten Blogspot

Math Stations: Benefits

Math stations have many benefits in a kindergarten classroom, for the teacher and more importantly, for the students. Richardson (1999) outlines five big ideas about math stations:

- Children develop an understanding of concepts through experiences with real things rather than symbols.
- Teachers can support the development of understanding by presenting planned and focused experiences and by interacting with children as they work.
- For children to be engaged by a mathematical task, they need to be on the edge of their understanding or level of competence.
- When working independently, children should be allowed to choose from a group of related tasks.
- The most powerful learning experiences have value in being repeated.

These concepts outline some of the major benefits of having children work in math stations. Additional benefits include the opportunity for authentic collaboration among children, the use of mathematical games to engage students that encourage persistence in solving problems (Copple et al., 2014) and the promotion of mathematical language development.

Designing Math Stations

Math stations are child-centered learning experiences that utilize materials already used during instruction in your classroom. Traditional math centers often involved the teacher creating an entirely new set of manipulatives for each center. Math stations should not be flash cards or worksheets for students to work on. Math stations allow children to be actively involved in providing input for possible station ideas including the selection of their materials (Diller, 2011). Children often indicate which stations they find the most interesting. This allows the teacher to modify their stations to meet the needs of each class of children. Similar stations can be used from week to week with necessary changes to match new content. Each station will offer multiple experiences that meet the needs of children at different ability levels. Math stations on a given concept should be provided for children only after they have experienced the content multiple times with the teacher (Diller, 2011). The familiarity the children develop with the content allows them to work more efficiently with their classmates, freeing the teacher to work with small groups or perform formative assessments.

Courtesy of Wonders in Kindergarten Blogspot

Math station material ideas

- Cubes that can be linked
- Various counters (cubes, color tiles, beans, two-sided counters)
- Collections (buttons, shells, pebbles, marbles, washers)
- Wooden cubes
- Toothpicks/popsicle sticks
- Pattern or attribute blocks
- Place-value mats
- Ten frames and five frames
- Individual white boards with markers and rags
- Dice
- Playing cards

These are only a fraction of the possible materials you might use in your math stations. Similar materials can be grouped together at a station to provide students with choices for solving problems. A station might be used for several weeks as children can often explore different content using similar materials. Individual white boards, journals and other platforms for drawing and writing should be available for children to record and explain their thought processes.

Math Station Learning Experience
"Egg Carton Addition"

Materials

- Egg carton with numbers 0-5 written out of order in egg cups (every number will be used twice)
- Two marbles
- Items to use as counters (beans, buttons, cubes, two sided counters)
- White board
- Dry erase marker

Learning Targets/Objectives

- I can identify numbers 0-5 out of order.
- I can build sets with 0-5 items.
- I can add two sets of items together.
- I can write a number sentence.

Procedure

- Children work with a partner for this activity
- Place two marbles in an egg carton, close the carton and shake
- Open the egg carton and identify the cup numbers the marbles landed in
- Use counters to build sets for each number
- Add the sets together
- Write the number sentence on the recording sheet

Extension (For early finishers)

- Children can tell partner a "math story" that goes with the numbers they are adding together ("I have 3 apples and you have 2 oranges. We have 5 pieces of fruit altogether").

Modification (For students who struggle)

- Children can work with an egg carton that has smaller numbers (ex: 0-3).

Differentiation

In this math station learning experience, children are actively engaged with their partner as they explore the concept of addition. This learning experience has built in differentiation for children who are working at various ability levels. The extension and modification are simple ways for children to select activities at the same station that are a better fit for their level of understanding. Teachers can indicate the difficulty level of a problem set with a colored sticker on the material container or baggy. Children can then select the appropriate set of problems/materials for their level.

Choices

One of the most important aspects of math stations is the freedom to choose. By giving children the choice between two or three activities within each math station, they are more motivated to pursue activities that are appropriately challenging. Additionally, discipline challenges and interruptions decline when children are actively engaged in tasks they enjoy. Contrary to what some might believe, “teachers who offer children choices do not give up control, nor are they passive” (Copple et al., 2014). They actively look for new ways to engage their students.

Management Tips

The idea of implementing math stations as a learning context might seem overwhelming to some teachers. There are things you can do to help prepare your children for the effective self-management and increased responsibility.

- Practicing procedures will decrease student anxiety about knowing what to do and increase the amount of time spent on task.
- Demonstrate how to play new math station games and provide children a few opportunities to practice before placing them in a station.
- Create a chart or set of instructions that uses pictures and short sentences to outline the steps of each station.
- Model "math talk" and inform students that they should be using this type of vocabulary.
- Intentionally design activities that have high expectations, but are still realistic (Diller, 2011).
- Decide on a way to manage your stations that is flexible and easy to follow. *A pocket chart that allows children to place their photo/name cards next to the station they choose is a good way for children to see which choices are open.
- Teachers may alternate days they work with small groups and days they circulate around the stations providing feedback and recording observations.

Math Scheduling

One of the challenges all teachers face is finding time to implement hands-on activities in place of worksheets and moving the emphasis of the lessons from the teacher to the children. Teachers are required to conform to the schedules provided by their schools. With this in mind, the following are suggestions for scheduling time for math stations given a variety of math block schedules.

Given a full day schedule with a 60-minute math block:

5 min: Partner Warm-Up
15 min: CGI Problem Solving
30 min: Math Stations (rotation)
10 min: Journals

Given a half day schedule with a 30-minute math block:

Day 1
5 min: Partner Warm-Up
20 min: CGI Problem Solving
10 min: Journals

Day 2
5 min: Partner Warm-Up
25 min: Math Stations (rotation)

These are only suggestions for possible schedules that include a variety of math activities. Research has shown that, “Kindergartners in well-structured and well-supported classrooms can often work for 15-20 minutes at a time on a quiet, seated activity” (Wood, 2007). This provides a framework for scheduling math activities throughout the day and week.

Parent Involvement

We have established that it is important for children to learn how to use mathematics in real world contexts. One of the ways we can encourage children to practice this, is by keeping parents informed about the concepts their child is learning and how they can meaningfully extend the learning at home. These updates and suggestions can be shared through class websites, newsletters, math nights and conferences.

Some teachers assign “paper and pencil” homework that is intended for students to practice procedures they have been shown at school. This method of reinforcing student learning is based more on memorization than concept development and understanding. Instead of using basic worksheets there are other, more impactful options for extending the learning at home. These methods include having children gather materials or information at home that can be used in class and providing prepared learning experiences or math games that children can check out in bags or containers. These extensions are helpful; however, the teacher knows their class members best and can offer these homework opportunities as best fits the home environments of their children.

Math Integration
There are many ways to incorporate mathematics while exploring concepts that are not inherently math-related. This is particularly helpful when a minimal amount of time is allotted for mathematics in your daily schedule. The following are quick examples of how math can be integrated across the academic content standards.

Language Arts
- **Features of Print:** Count the number of *letters* in names (or words) and compare with a partner or class. *If comparing as a class, children would create a graph to display the comparisons.
- **Segment Syllables**: Count the number of *syllables* in names (or words) and compare with a partner or class. *If comparing as a class, children would create a graph to display the comparisons.
- **Features of Print:** Count the number of words in sentences.
- **Features of Print:** Create sentences using a certain number of words.
- **Writing:** Write or dictate math stories during journal time.
- **Writing:** Write a shared math story (whole or small group) and illustrate a class book where children represent the problem/solution pictorially.
- **Writing:** Create counting books where each child 1) writes the number, 2) draws the corresponding quantity and 3) writes a sentence about the quantity on each page.
- **Isolate Sounds:** Count the number of students whose names *begin* with the same sounds. Create a class graph to display the results.
- **Isolate Sounds**: Count the number of students whose names *end* with the same sounds. Create a class graph to display the results.
- **Rhyming:** Count the number of rhymes children can generate.

Social Studies
- **Native Americans as First Inhabitants**: Count and sort beans and colored corn while creating early housing mosaics during a Native American study.
- **Hunting and Gathering**: Create counting books about *things that were hunted and gathered* by early people.
- **American Symbols**: Create counting books using *various American symbols* (flags, eagles, statues of liberty, white houses).
- **Local Environment**: Create counting books using *plants and animals found in the local environment*.
- **Cultural Differences and Similarities**: Create a graph that represents how many people live in each student's home.
- **Cultural Differences and Similarities:** Measure ingredients when cooking cultural recipes brought in by students.

- **Maps:** Use positional words (above, below, next to, beside, between, etc.) when describing maps being studied or created by children.
- **Retelling Series of Events**: Order photos of class events according to when they happen (e.g. arrival, morning meeting, language arts, music, recess).
- **Jobs People Do:** Sort "day," "night," or "both" jobs using a Venn Diagram.

Science

- **Body Parts:** Children collect eye color information and represent the information with a graph.
- **Body Parts:** Children count body parts (e.g. knees, elbows, chins, ears) in their families by examining photos or drawings they created.
- **Body Parts:** Partners compare how many of each body part they have (e.g. eyes, ankles, shoulders) they have. *Children will discover their comparisons will all be equal!
- **Body Parts:** Determine how many children would be in a group with 6 feet. *This exploration can be done with various body parts and quantities.
- **Five Senses:** Children create graphs based on correct and incorrect predictions when doing blindfolded sensory experiments. (e.g. 10 children guessed correctly when tasting the apple; 3 children guessed correctly when smelling the orange).
- **Five Senses:** Children create graphs to display their favorite tastes, smells, sounds, things to touch, and sights. *Children can draw and label their ideas on sticky notes and post them on the board or a sheet of butcher paper to create the class graph.
- **Five Senses:** Children create counting books with a certain number of sensory items on each page. (e.g. 5 things you can smell; 4 things you can touch; 3 things you can taste; 2 things you can hear; 1 thing you can see).
- **Life Cycles:** Measure plant growth using nonstandard units of measure (e.g. links, seeds or cubes) and document by drawing a picture in a "plant journal."
- **Life Cycles:** Measure plant growth using a popsicle stick by drawing a line (at various intervals) to measure the growing plant.
- **Life Cycles:** Graph predictions as to how many days it will take the class caterpillar to emerge from its chrysalis as a butterfly. Compare child predictions with how many days it actually took to transform.
- **Living/Nonliving:** Sort items or photos by the attribute of living or nonliving.
- **Living/Nonliving:** Create a Venn diagram based on the attributes of living and nonliving bears (e.g. teddy bears and real bears).
- **Energy and Magnetism**: Sort items by the attribute of whether or not they are attracted to a magnet.
- **Properties of Materials**: Sort recyclable materials by their property attributes (e.g. plastic, paper, aluminum).

- **Properties of Materials:** Create counting books based on physical properties of recyclable materials (e.g. 5 things made from plastic; 4 things made from paper; 3 things made from aluminum; 2 things made from glass; 1 thing made from styrofoam).
- **Changes in the Earth and Sky:** Create counting books based on the weather (Ex: 4 things people can do when the weather is sunny; 3 things people can do when the weather is snowy; 2 things people can do when the weather is rainy; 1 thing people can do when the weather is windy.

The Arts

- **Music:** Count the music notes in one line of a simple song.
- **Music**: Tap rhythm sticks a certain number of times (e.g. "Tap your sticks 4 times very slowly/quickly"). *Can be done during circle time or as a lesson warm up.
- **Dance:** Use certain movements (hop, skip, gallop etc.) a set number of times. *Can be done as a lesson warm up or transition. (e.g. "Everyone hop 5 times")
- **Visual Arts: Create** math manipulatives out of various materials.

This guide accompanies *BRINGING MATH TO LIFE in Kindergarten* training module and is to be used as supplemental resource for teachers as they learn to implement strategies that support children's math skills.

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The trailblazing kindergarten teachers who work tirelessly to intentionally support children's learning, growth and development in math…and beyond!

Glossary

Actively Engaged: Children are physically and mentally working on the intended learning opportunity.

Actively Listening: Children are looking at and listening to the speaker whether it is a teacher or a peer.

Algorithms: A process or set of rules used for solving mathematical problems. *Example: Borrowing from the tens column when subtracting double digit numbers.*

Clarifying Questions: Questions that help guide children's thought processes.

Cognitively Guided Instruction (CGI): When teachers use their knowledge of how children think to inform their planning and instruction.

Collaborative Learning: Children work together to develop their understanding of concepts.

Constructed Understanding: The idea that students create new knowledge based on what they already know.

Counters: Small manipulatives used by children to count and perform basic arithmetic *(e.g. beans, bears, cubes).*

Curriculum: The content or total set of ideas being taught in a given unit, quarter, or year.

Developmentally Appropriate Practice (DAP): A framework of principles and guidelines for best practice in relation to the care and education of children birth through age 8. *Example: Curriculum design should be based on children's interest and prior experiences.*

Differentiate: Offering all children the opportunity to learn at the appropriate level of difficulty.

Direct Modeling: A CGI concept where a child uses physical or visual representations to show all parts of a problem. *Example: A student might draw three balls and then draw four more to represent 3 + 4.*

Fluency: The ability to choose and use problem-solving strategies accurately, efficiently and flexibly. *Fluency is more than the memorization of facts.*

Formative Assessment: Determining what children know and can do in order to plan future lessons. *This is not a formal/summative test.*

Key Connections: When children recognize relationships between numbers. *Example: a child realizes that 3 + 4 = 7 and 7 – 4 = 3 (number families)*.

Math Facts: Statements that can be proven using simple arithmetic (numbers 1-10). *Facts should be committed to memory for quick and easy recall.*

Math Stations: Child-guided and/or teacher-guided small groups using strategies that were previously learned. *Math stations provide opportunities for children to practice math skills.*

Metacognition: Thinking about your thinking.

Number Sense: A person's ability to use and understand numbers. *Understanding number values allows the person to make number-based decisions; use numbers flexibly; and develop effective problem-solving strategies.*

Observations: When a teacher records what they see and hear from children. These statements should be objective records of what occurred.

Open-Ended Questions: Questions that cannot be answered with a short, simple answer. Children are required to think and explain their understanding.

Scaffold: When teachers provide a helping hand to bring children from what they know now, to their maximum learning potential.

References

Arizona Department of Education. Arizona's college and career ready standards: Standards – mathematical practices – explanations and examples grade kindergarten, Arizona Department of Education: Phoenix, AZ, 2013.

Askew, M., Brown, M., Rhodes, V., Wiliam, D., & Johnson, D. (1997). Effective Teachers of Numeracy: Report of a study carried out for the Teacher Training Agency. London: King's College, University of London.

Burns, M. (2000). *About teaching mathematics: A K-8 resource (2nd ed.)*. Sausalito, CA: Math Solutions Publications.

Burns, M. (2007). *About teaching mathematics*: *A K-8 resource.* (3rd Ed.). Sausalito, CA: Math Solutions Publications

Carpenter, T. P., E. Fennema, P. L. Peterson, and D. A. Carey. 1988. "Teachers' Pedagogical Content Knowledge of Student's Problem Solving in Elementary Arithmetic." Journal for Research in Mathematics Education 19: 385–401.

Carpenter, T. P., Fennema, E., Franke, M. L., Levi, L., & Empson, S. B. (1999) *Children's mathematics: Cognitively guided instruction.* Portsmouth, NH: Heinemann.

Clements, D. H., & Sarama, J. (Eds.). (2004). *Engaging young children in mathematics: Standards for early childhood mathematics education.* Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Clements, D. H., & Sarama, J. (2007). Effects of a preschool mathematics curriculum: Summative research on the *Building Blocks* project. Journal for Research in Mathematics Education, 38, 136-163.

Clements, D. H., & Sarama, J. (2008). Experimental evaluation of the effects of a research-based preschool mathematics curriculum. *American Educational Research Journal,* 45, 443-494

Clements, D. H., & Sarama, J. (2014). *Learning and teaching early math: The learning trajectories approach (2nd ed.)*. New York, NY: Routledge.

Copple, C., Bredekamp, S., Koralek, D. & Charner, K. (Eds.). (2014) *Developmentally appropriate practice: Focus on kindergarteners.* Washington, DC: National Association for the Education of Young Children.

Diller, D. (2011). *Math work stations: Independent learning you can count on, K-2.* Portland, MA: Stenhouse Publishers & Markham, ON: Pembroke Publishers.

Ely, R. (2005). "Language and literacy in the school years." In *The Development of Language, 6th ed., ed. J.B. Gleason, 395-443. Boston: Allyn & Bacon.*

Garland, C. (1990). *Mathematics their way: Summary newsletter*. Saratoga, CA: Center for Innovation in Education.

National Mathematics Advisory Panel. Foundations for Success: The Final Report of the National Mathematics Advisory Panel, U.S. Department of Education: Washington, DC, 2008.

O'Connell, S., & Sangiovanni, J. (2011). *Mastering the basic math facts in addition and subtraction: Strategies, activities & interventions to move students beyond memorization*. Portsmouth, NH: Heinemann.

Richardson, K. (1999). *Developing number concepts: Addition and subtraction.* Parsippany, NJ: Dale Seymour Publications.

Shepard, L. (2005). Assessment. In L. Darling-Hammond & J. Bransford (Eds.), *Preparing teachers for a changing world* (pp. 275-326). San Francisco, CA: Jossey-Bass.

Wood, C. (2007). *Yardsticks: Children in the classroom, Ages 4-14. 3d ed. Turner Falls, MA: Northeast Foundation for Children.*