MISSISSIPPI DEPARTMENT OF EDUCATION

Ensuring a bright future for every child

Mississippi Mathematics Manipulatives Manual

Featured Activity

“PEMDice Roll”

5.OA.1 & 5.OA.2

Spring 2021

Carey M. Wright, Ed.D.
STATE SUPERINTENDENT OF EDUCATION

Nathan Oakley, Ph.D.
CHIEF ACADEMIC OFFICER

Marla Davis, Ph.D.
ACADEMIC LIAISON
Office of Academic Education

Wendy Clemons
EXECUTIVE DIRECTOR
Office of Secondary Education, Dropout Prevention, & Professional Development

Tammy Crosetti
STATE DIRECTOR OF CURRICULUM AND INSTRUCTION
Office of Secondary Education

Tommisha Johnson, Ed.S.
K-12 MATHEMATICS CONTENT DIRECTOR
Office of Secondary Education

As we continue our efforts to develop high-quality instructional materials (HQIM) and resources, the Mississippi Department of Education (MDE), through the Academic Education Office, would like to showcase instructional practices and activities that foster conceptual understanding through the use of manipulatives in the mathematics classroom.

The **Mississippi Mathematics Manipulatives Manual** features activities meant to serve as short, hands-on procedures that may be implemented before, during, or after a lesson to support the teaching and learning process of the Mississippi College- and Career-Readiness Standards (MCCRS) for Mathematics. Alignment with the MCCRS Scaffolding Document has been included for additional support. Teachers may contact staff at the MDE if they would like to borrow manipulatives for classroom use.

Teachers may modify these activities to meet the needs of the students they serve and their instructional delivery model (virtual, in-person, or hybrid).

Special Thanks:
Pamela Franklin, Ed.S.,
Jackson Public School District

PEMDice Roll

MANIPULATIVE(S):

- PEMDice™ by Eric Olson/Didax
- PEMDice Container or Styrofoam Cup

Note: *Teachers without access to PEMDice can create their own version by using blank cubes and permanent markers.*

GRADE LEVEL OR COURSE TITLE:

CCR Mathematics Grade 5

DOMAIN AND CLUSTER HEADING:

Operations and Algebraic Thinking (OA):

Write and interpret numerical expressions

STANDARD(S):

5.OA.1: Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.

5.OA.2: Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them. For example, express the calculation "add 8 and 7, then multiply by 2" as 2 × (8 + 7). Recognize that 3 × (18932 + 921) is three times as large as 18932 + 921, without having to calculate the indicated sum or product.

PREREQUISITE SKILLS:

- Know the mathematics symbols for operations of addition, subtraction, multiplication, and division.
- Know there are numerous ways to write the different operations and some situations require different mathematical symbols.
- Know parentheses are often used when working with multiplication and can be used to illustrate the Associative Property of Multiplication and the Distributive Property of Multiplication.
- Know the difference between an expression and an equation.
- Know parentheses are used to group expressions together.
- Know it is possible to multiply any given expression by another quantity.
- Know how the Distributive Property of Multiplication can be written as an expression.

ACTIVITY: Note: Activity Sheet Attached

Note: This game can be played with 2 players or two teams of 2 players each. Ensure students have access to a full set of PEMDice that consists of 15 dice: 6 white numerical dice, 6 red operator dice, and 3 black dice with (,), and =. *(See a picture of the complete PEMDice set in figure 1.)*

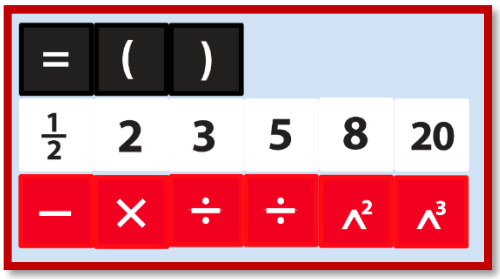

Figure 1 (Complete set of PEMDice)

1. Provide each player with a set of PEMDice and a Score Sheet. ***Note:*** Students will need either the PEMDice container or a plastic or Styrofoam cup to roll the dice.
2. Have each player place their set of PEMDice into the container or cup, shake, and roll the dice onto the table/desk.
3. Each player is to be given 20 minutes (or other reasonable time allotment as decided upon by the teacher) to make as many true equations as possible and record each on the Score Sheet.

Note: *The order of operations (PE-MD-AS) must be followed when building and evaluating expressions on either side of the equation; the "+" die cannot be used in front of a number to start an equation, but the "-" die could be used at the beginning of an equation to indicate a negative number. Equations such as 3 + 4 = 7 and 4 + 3 = 7 that demonstrate the Commutative Property cannot be counted as two different equations.*

4. Have students score each equation by counting the total number of dice used and then squaring that number. The longer the equation, the more points are scored. *For example, if a player built 3 + 5 = 10 - 2 using 7 dice, the score would be $7^2 = 49$ points.*

Note: *For the parentheses dice to be counted, the equation must compute differently when the parentheses are removed. For example, 3 + (4 + 5) = 6 x 2 computes or simplifies to the same number as 3 + 4 + 5 = 6 x 2 when the parentheses are removed. But in the equation 8 ÷(4 - 2) = 4 we get a different result when removing the parentheses: 8 ÷ 4 - 2 = 0. (See example score sheet for a variety of sample equations that could be built using some or all the PEMDice that have been rolled.)*

5. Once the allotted time is up, each player/team adds up all the points from all the equations on their score sheet. The player or team with the most points is the winner.

QUESTIONS TO CONSIDER:

- What strategies can you use to include as many dice as possible in your equation?
- When do the parenthesis *matter* in an equation and when are they trivial?
- What are the different meanings of parentheses in an equation or expression?
- What relationships do you notice among your numerals dice? How can this help you build multiple equations?
- When, if ever, can two operators be combined one directly after the other?
- How can 1 be multiplied in a form different from "x 1"?

RESOURCES:

- Mississippi Mathematics Scaffolding Document (Grade 5, Page 1-3)
- 2016 MCCRS for Mathematics
- PEMDice Order of Operations Game- Eric Olson, Creator- Didax Video
- PEMDice® Order of Operations Game -Didax Education Video
- Teach PEMDAS with PEMDice- Blog by Eric Olson
- Original Scoreboard and Instructions- Order of Operations Game by Eric Olson

Optional: The University of Mississippi's Center for Mathematics and Science Education has an extensive inventory of math (and science and technology) tools and manipulatives that teachers may borrow for classroom use at no charge. Click the link below to access the inventory list and complete a check-out request.

- CMSE Manipulatives

BEYOND THE ACTIVITY:

- **Accommodation(s)**: The rules of the game can be enriched for students needing an extra challenge or scaffolded for struggling students by making any combination of the following adjustments: increase/decrease the amount of time for each game; reduce the number of dice used in the set; strategically select certain dice that *must* be used in the equation and set them to the side -- they would not be "rolled"; require an equation to be built using all 15 cubes; strategically remove certain dice from the set; allow students to "change" a certain number of their dice with an associated penalty in scoring, etc.
- **Misconceptions:** Students may apply PEMDAS literally, meaning that they believe multiplication comes before division and addition comes before subtraction, instead of working from left to right. Similarly, with parentheses and exponents, these are both grouping methods, and *either* could be simplified first. Students should understand to simplify from the innermost grouping to the outermost. Unlike multiplication and division and addition and subtraction, parentheses do not have to be simplified left to right. Also, anticipate that some

students may use parentheses when they are not necessary or may not use parentheses to properly communicate their intended operations.

Activity Sheet

Original Scoreboard- Order of Operations Game by Eric Olson

PEMDice™ Roll Score Sheet

1. Record the dice that came up when you rolled them. Remember, unless given different directions, you will always have one "=" die and two "(" dice. It may help to list all of you numeral dice from least to greatest, and then you operator dice.
2. Once you build your equation, count the number of dice you used and square that number to determine the number of points you earned for that equation. Remember parentheses can only be counted if the equation results in a different number when removed.
3. Add all of your points from each different equation to find your **game total** at the bottom.

=	(	)												

															: _____ points
															: _____ points
															: _____ points
															: _____ points
															: _____ points

Game Total: _____

Continue on back, if more space is needed.

Activity Sheet

Example

PEMDice™ Roll Score Sheet

1. Record the dice that came up when you rolled them. Remember, unless given different directions, you will always have one "=" die and two "(" dice. It may help to list all of you numeral dice from least to greatest, and then you operator dice.
2. Once you build your equation, count the number of dice you used and square that number to determine the number of points you earned for that equation. Remember parentheses can only be counted if the equation results in a different number when removed.
3. Add all of your points from each different equation to find your **game total** at the bottom.

=	(	)	2	3	5	6	8	60	÷	−	+	−	×	√

60	÷	6	=	5	×	2									: 49	points
√	(	60	+	6	−	2	)	=	8						: 100	points
60	−	(	8	×	5	)	=	6	×	3	+	2			: 169	points
5	×	3	=	60	÷	√	(	8	+	6	−	−	2	)	: 225	points
															:	points

Game Total: 543

Continue on back, if more space is needed.