Math: Mathematical Operations

Featured Activity:
Chessboard Challenge

- Figure out how much rice the king actually agreed to give to the wise man before finishing the story!

About the Book...

The King's Chessboard by David Birch
The story is a parable about a powerful king and a wise man whose simple request for a grain of rice doubled for each square of the king's chessboard proves to be an impossible challenge.
Call Number: J
Copies: 6

What You Need:
- "Chessboard Challenge" handout
- "Chessboard Challenge Answer Key" handout
- Pencil/pen
- Sandwich bag of rice
- Small plastic cups
- *Optional:* Newspaper sheets

Before the Activity:
- Read the book in advance so you will know where to stop and resume reading.
- Review the directions and handout so you understand the mathematical problem and solution.
- Find various books about math and place them on the table for the children to access.
- Prepare the materials on the table in advance to encourage the children to participate.

How You're Helping...

This activity fosters:
- **Narrative skills**
- **Mathematical reasoning**
- **Critical and creative thinking**

Children will learn:
- **The foundational basics of exponents and geometric progressions, which are high level mathematical concepts**

Directions:
1. Read the beginning of the book to the students, up to the point in which the King makes the deal with the wise man and leaves the hall. (Page 7)

2. Ask the children the following questions:
   - Was the king right to make the wise man accept his offer of a gift?
   - Was the wise man's request for his reward a good one? Why or why not?
   - How much rice do they think the wise man will receive before the chessboard is full?
     - Write down their estimates.

3. Challenge the children to come up with a strategy to determine how much rice will be given to the wise man by the end of the agreement.
   - Give each child a "Chessboard Challenge" handout. This will give them a visual picture of the number of squares, as well as a surface to write on if they choose.
   - Give the children cups of rice to use for the activity.
     - *Optional:* Place newspaper on the table before handing out the rice to make it easier to clean up.
   - Encourage the children to put one grain of rice on the first chess square and to double the amount on each square as explained in the book. Demonstrate the first three squares:
     - Square 1: 1 grain

- Square 2: 2 grains (1+1=2 OR 1x2=2)
- Square 3: 4 grains (2+2=4 OR 2x2=4), etc.

➤ Make sure the children understand that they are adding each square to itself (1+1 or multiplying by 2).

➤ Challenge the children to work on their chessboards for 10 minutes and fill as many squares with the right amount of rice as they can!
- They can work individually or in small groups.

4. Ask the children what they came up with for each square.
➤ The answers are on the "Chessboard Challenge Answer Key" handout.
➤ Only review the squares they were able to finish in 10 minutes.
➤ Tell the children that it's time to find out exactly how many grains of rice the wise man requested for each square!

5. Continue reading the book.
➤ As the counselors determine a number, the children can write that in the appropriate squares.
- Encourage the children to switch from "grains of rice" to "ounces", "pounds", and "tons" when the counselors switch measurements in the book!

6. Ask the children if they were surprised by how much rice it would take to fulfill the wise man's request.
➤ Then, ask the children if they think the king learned a good lesson. What was that lesson?

7. Make sure to put all of the rice back in the bag while cleaning up after the activity.

Keep in Mind...

- Instead of using rice, **older children** may prefer to do the first few calculations in their head and then write out their answers on the chessboard.

- Distribute the rice to **younger children** in small plastic cups to let them get a hands-on sense of the math required to do the activity.

More Activity Ideas:
Rice for All:
- Share the featured book with the children.
- Challenge the children to figure out on what day the wise man will receive enough rice to feed the participants at the branch.
- Use the following information to figure out the calculations:
  - Serving size: 2 ounces of rice/person
  - Convert ounces to grains using the measurements estimated by the weigher in the book (p. 12: 2,048 grains per ounce)
- If the wise man will receive more than enough rice to feed the group on the day they decide, ask the children to determine how much rice will be left over.

Double Trouble:
- Share the featured book with the children.
- Provide a doubling example for the children, such as one of the following:
  - Would you rather have an allowance of one dollar per week or receive a penny the first day, then double that penny the next day, then double the previous day's pennies for a week? (Pennies add up to $1.27)
  - How about two dollars or one penny doubled each day for two weeks? (Pennies add up to $163.83)
  - How about four dollars or one penny doubled each day for four weeks? (Pennies add up to $2,684,354.55)
- Encourage the children to write their own story using the concept of "doubling".
- Invite the children to share their stories.

You can also come up with your own ideas to extend the activity at your location.

Chessboard Challenge

How much rice will the king give the wise man on each of the 64 days? Use grains of rice to figure out the answer or calculate the amount and write it on each square!

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64

Chessboard Challenge Answer Key

The answers to the Chessboard Challenge are below, for your reference.

Square	Grains of Rice	Ounces	Pounds	Tons
1	1	-	-	-
2	2	-	-	-
3	4	-	-	-
4	8	-	-	-
5	16	-	-	-
6	32	-	-	-
7	64	-	-	-
8	128	-	-	-
9	256	-	-	-
10	512	-	-	-
11	1,024	-	-	-
12	2,048	1	-	-
13	4,096	2	-	-
14	8,192	4	-	-
15	16,384	8	-	-
16	32,768	16	1	-
17	65,536	32	2	-
18	131,072	64	4	-
19	262,144	128	8	-
20	524,288	256	16	-
21	1,048,576	512	32	-
22	2,097,152	1,024	64	-
23	4,194,304	2,048	128	-
24	8,388,608	4,096	256	-
25	16,777,216	8,192	512	-
26	33,554,432	16,384	1,024	-
27	67,108,864	32,768	2,048	1
28	134,217,728	65,536	4,096	2
29	268,435,456	131,072	8,192	4
30	536,870,912	262,144	16,384	8
31	1,073,741,824	524,288	32,768	16
32	2,147,483,648	1,048,576	65,536	32
33	4,294,967,296	2,097,152	131,072	64
34	8,589,934,592	4,194,304	262,144	128
35	17,179,869,184	8,388,608	524,288	256
36	34,359,738,368	16,777,216	1,048,576	512
37	68,719,476,736	33,554,432	2,097,152	1,024
38	137,438,953,472	67,108,864	4,194,304	2,048
39	274,877,906,944	134,217,728	8,388,608	4,096
40	549,755,813,888	268,435,456	16,777,216	8,192
41	1,099,511,627,776	536,870,912	33,554,432	16,384
42	2,199,023,255,552	1,073,741,824	67,108,864	32,768

Square	Grains of Rice	Ounces	Pounds	Tons
43	4,398,046,511,104	2,147,483,648	134,217,728	65,536
44	8,796,093,022,208	4,294,967,296	268,435,456	131,072
45	17,592,186,044,416	8,589,934,592	536,870,912	262,144
46	35,184,372,088,832	17,179,869,184	1,073,741,824	524,288
47	70,368,744,177,664	34,359,738,368	2,147,483,648	1,048,576
48	140,737,488,355,328	68,719,476,736	4,294,967,296	2,097,152
49	281,474,976,710,656	137,438,953,472	8,589,934,592	4,194,304
50	562,949,953,421,312	274,877,906,944	17,179,869,184	8,388,608
51	1,125,899,906,842,620	549,755,813,888	34,359,738,368	16,777,216
52	2,251,799,813,685,250	1,099,511,627,776	68,719,476,736	33,554,432
53	4,503,599,627,370,500	2,199,023,255,552	137,438,953,472	67,108,864
54	9,007,199,254,740,990	4,398,046,511,104	274,877,906,944	134,217,728
55	18,014,398,509,482,000	8,796,093,022,208	549,755,813,888	268,435,456
56	36,028,797,018,964,000	17,592,186,044,416	1,099,511,627,776	536,870,912
57	72,057,594,037,927,900	35,184,372,088,832	2,199,023,255,552	1,073,741,824
58	144,115,188,075,856,000	70,368,744,177,664	4,398,046,511,104	2,147,483,648
59	288,230,376,151,712,000	140,737,488,355,328	8,796,093,022,208	4,294,967,296
60	576,460,752,303,423,000	281,474,976,710,656	17,592,186,044,416	8,589,934,592
61	1,152,921,504,606,850,000	562,949,953,421,312	35,184,372,088,832	17,179,869,184
62	2,305,843,009,213,690,000	1,125,899,906,842,620	70,368,744,177,664	34,359,738,368
63	4,611,686,018,427,390,000	2,251,799,813,685,250	140,737,488,355,328	68,719,476,736
64	9,223,372,036,854,780,000	4,503,599,627,370,500	281,474,976,710,656	137,438,953,472

Recommended Additional Books

Everybody Cooks Rice by Norah Dooley
A child is sent to find a younger brother at dinnertime and is introduced to a variety of cultures through encountering the many different ways rice is prepared at the different households visited.
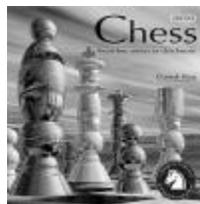**Call Number: J641.6318 D72E**
Copies: 107

G is for Googol: A Math Alphabet Book by David M. Schwartz
Explains the meaning of mathematical terms which begin with the different letters of the alphabet from abacus, binary, and cubit to zillion.
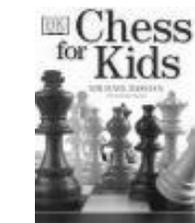**Call Number: J510 SCH95G**
Copies: 60

Chess: From First Moves to Checkmate by Daniel King
Introduces the rules and strategies of chess, as well as its history and some of the great players and matches.
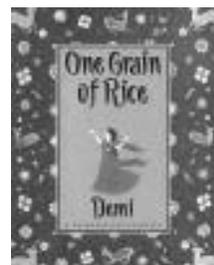**Call Number: J794.1 K581C**
Copies: 66

Chess for Kids by Michael Basman
Readers can learn all the rules of chess with annotated photsequences and advice on the game from a top game expert.
Call Number: J794.1 B292C
Copies: 25

One Grain of Rice: A Mathematical Folktale by Demi
A reward of one grain of rice doubles day by day into millions of grains of rice when a selfish raja is outwitted by a clever village girl.
Call Number: J398.2095 D395O
Copies: 15

Math by Dan Green
Presents mathematical concepts using lively descriptions and cartoon illustrations personifying each concept.
Call Number: J510 B291M
Copies: 12

Anno's Mysterious Multiplying Jar by Mitsumasa Anno
Learn about factorials and counting to 10 in this visually stunning story.
Call Number: JE 512.7 AN78A
Copies: 7

Math Fables by Greg Tang
A series of rhymes about animals introduces counting and grouping numbers, as well as examples of such behaviors as cooperation, friendship, and appreciation.
Call Number: JE 513.211 T156M
Copies: 5

Two of Everything by Lily Toy Hong
A poor old Chinese farmer finds a magic brass pot that doubles or duplicates whatever is placed inside it, but his efforts to make himself wealthy lead to unexpected complications.
Call Number: J398.21 H757T
Copies: 4

Please ask the Children's Librarian at your library work site for more suggestions!