Lesson: Introduction to Exponents  

Length: 70 minutes

Age/Grade Intended: 7th Grade

Academic Standard(s):
Standard 1 Number Sense
7.1.4 Understand and compute whole number powers of whole numbers.

Standard 2 Computation
7.2.1 Solve addition, subtraction, multiplication, and division problems that use integers, fractions, decimals, and combinations of the four operations.

Performance Objectives:
After rolling a pair of dice and choosing a base and an exponent, the students will compute the power at least six times with 80% accuracy.

After evaluating a power, the students will add or subtract the result from the running total (in the dice game) at least six times with 100% accuracy.

Assessment:
The teacher will get a small sense of the degree of students’ understanding of the material as he or she monitors the independent working of the examples. For a more definitive assessment, the teacher will collect the log sheet from the dice game. This will give the teacher a clear perspective as to whether or not the students are meeting the objectives.

Advanced Preparation by the Teacher:
The teacher will need to get a copy of One Grain of Rice: A Mathematical Folktale by Demi. Items such as dice and a spinner marked with alternating wedges marked positive and negative will also be needed for several small groups of four. A log sheet for recording the moves in the game will also be needed for each student.

Procedure:
Introduction/Motivation:
Read the opening pages of Demi’s One Grain of Rice: A Mathematical Folktale. Stop after the character Rani makes her request of the Raja (Begin with two grains of rice. Double the amount each day for thirty consecutive days.). Then ask:

• Given what you know about the king and his character, do you think he will agree to Rani’s proposal? Why or why not? (Evaluation)

• Suppose the king agrees and puts two grains in the shed on the first day. How much rice must he put in on the second day? Third day? (Comprehension)
• At the end of thirty days, how much rice do you think Rani and her fellow villagers will have? Will the Raja be able to give her that much? Why? (Analysis)

Tell the students we need to know a little more about powers and exponents before the story is finished.

Step-by-Step Plan:
1. Write the sum $3 + 3 + 3 + 3$ on the board. Ask:
   a. How can we write the same expression using multiplication? (Comprehension)
   b. Therefore, multiplication is simply ________ addition. (Comprehension)
   c. Suppose we have repeated multiplication such as (3)(3)(3)(3). How can we rewrite this in a more concise manner? (Analysis)
2. Tell the students 36 is called a power because $36 = (6)(6)$. Ask the following:
   a. Is 4 a power? How about 10? (Comprehension)
   b. Give me an example of a power. (Application)
3. Give the students the definition of a power: any product resulting from repeated multiplication of the same factor. Also give students the form in which powers are typically written: $a^b$ where $a$ is called the base (think bottom) and $b$ is called the exponent. Then ask:
   a. What do you think $b$ tells us about $a$? (Analysis)
   b. Write $(19)(19)(19)$ using an exponent. (Comprehension)
   c. Write $8^3$ as a repeated multiplication. (Comprehension)
4. Give students an opportunity to practice with the following problems. (Comprehension)
   a. Write the product using an exponent.
      i. $(11)(11)(11)(11)$
      ii. $(y)(y)(y)$
   b. Write the power as a repeated multiplication.
      i. $(0.7)^4$
      ii. $8^2$
5. Ask the students:
   a. Evaluate $2^2$, $2^3$, and $2^4$. (Comprehension)
   b. If we keep the same base and the exponent increases, what seems to be true about the product? (Analysis)
   c. Now try evaluating $(0.5)^2$ and $(0.5)^3$. (Comprehension)
   d. Revise the rule you just formulated. (Analysis)
6. Using the story One Grain of Rice: A Mathematical Folktale, have the students write powers to represent the amount of rice in the shed (for instance there are $2^1$ grains of rice on the first day, $2^2$ grains of rice on the second day, etc.). Have the students evaluate some of these powers. Then ask:
   a. Is the amount of rice in the shed growing just as you anticipated? (Analysis)
   b. Do you still believe the king will be able to fulfill his end of the agreement? (Analysis)
7. Finish reading One Grain of Rice: A Mathematical Folktale. Have the students compare the actual ending with their predictions.
8. Break the students into groups of four in order to play a game in which they practice their skills with exponents (Application). The rules are as follows:
a. For this game you will need a pair of dice and a spinner with six wedges. The alternating wedges will represent either a positive sign or a negative sign. Each player starts with 0 points.

b. The first person should roll the dice. Using the numbers from your role, decide which will be the base and which will be the power. (For instance, suppose you roll a 2 and a 3. Then you have either $2^3$ or $3^2$.)

c. Evaluate the power.

d. Next spin the spinner. If you land on a positive sign, add your evaluation to your running total. If you land on a negative sign, subtract your evaluation from your running total. Keep track of all moves on the provided log sheet.

9. Model the rules and then have the students play anywhere from five to ten rounds. At the conclusion of the game, collect the log sheets.

**Closure:**
Use the end of class for some review and an analysis of the power of powers. Ask the following questions:

- What is a power? *(Knowledge)*
- How can powers be used to more efficiently write products of the same factor? *(Analysis)*
- $2^{10} = 1024$. Does the use of a power give you any sense of the magnitude of a number? In other words, does $2^{10}$ give you any clues as to how large it really is? *(Evaluation)*

**Gardner’s Theory of Multiple Intelligences:**
*Logical/Mathematical:* Evaluating powers, writing products of the same factor using exponents, adding and subtracting positive and negative integers
*Interpersonal:* Playing the dice game in groups
*Verbal/Linguistic:* Hearing *One Grain of Rice: A Mathematical Folktale*, engaging in discussion through predicting how the book will end

**Adaptations/Enrichment:**
Student with a Learning Disability in Listening Comprehension – This student will be seated near the teacher as he or she reads from the story *One Grain of Rice: A Mathematical Folktale*. The teacher can make frequent eye contact and assess the student’s comprehension. The teacher could also ask the class to summarize the book and include this student somewhere near the middle of the summary. This student will be given an outline of the examples to be done in class in order that he or she can anticipate what the teacher will say.

Student with ADHD – This lesson uses multiple approaches to one topic. This variety in instruction will help this student to remain engaged. I foresee a problem during the dice game. This student should be paired with those who can handle the procedures and materials in a safe and productive manner. The teacher can also direct questions at the student at various points throughout the lesson to engage them again.

Gifted/Talented Students – Have these students write their own stories involving powers. Tell them to use *One Grain of Rice: A Mathematical Folktale* as a guiding source. Tell that the story is largely up to them but that the theme should concern how quickly powers grow. This is true even when dealing with small numbers such as 2 or 3.
Self-Reflection:
These questions will guide my reflection after the lesson has been taught:

- Is it a good idea to have the main means of assessing student understanding embedded within a game? Sometimes students see games as just that; taking them seriously becomes an afterthought.
- Could I use *One Grain of Rice: A Mathematical Folktale* to also support a language arts teacher and the standards he or she is responsible for covering?
- Since a more thorough assessment will take place after the students have gone, any reteaching will have to take place the following day. Is that waiting too long to address any issues?