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Graphic Organizers Applied to Higher-Level Secondary Math

Description: This intervention would be useful for instruction in secondary math, in particular, algebra. Students with language disorders can sometimes be at a significant disadvantage when mathematics instruction relies so heavily on language skills. Graphic organizers have been effective in improving student performance in this area. This intervention focuses on negative integer exponents but can be adapted to other math concepts. Negative integer exponents are usually introduced to students in their first course in algebra. The topic is usually presented as a definition, in the form of an algebraic equation that must be memorized, rather than a meaningful concept that is related to information the students have already covered. The relationship between students' understanding of positive integer exponents and the concept between those that are negative can be pointed out with the help of a graphic organizer.

Materials
- Graphic organizer, without frames

Preparation
- Let students know they will be learning about negative exponents
- Give them an opportunity to brainstorm, and let them share ideas they already understand about exponents

Steps in Implementing this Intervention
1. A column of exponent mathematics facts is built. This is the left column of the graphic organizer for teaching negative exponents ($2^1=2$, $2^2=4$, and so on...). Start with the lowest exponent and proceed up the column.
2. Give students an opportunity to recognize patterns in this information. Example (typical student responses in italics):
   When we go up from 2^3 to 2^4, how did the exponent change? *It went up by one.*
   How did it go up? Was that by adding, subtracting, multiplying or dividing? *Adding.*
   When we go up from 2^4 to 2^5, how did the exponent change? *Plus one. Added one.*
   If we went up one more row, what would the next exponent be? *6*
   How do you know? *You just add one.*
   Good. Now let's look at the values on the other side of the equal side of the equal sign. Can we get from 8 to 16 by adding 1? *No.*
   How can we get from 8 to 16? *You double it. Times two.*
   Does that still work when we move from 16 to 32? *Yes.*
   Using that pattern, what will 2^6 equal? *64*
   Check that on your calculators. Is that right? *Yes.*
3. Once the pattern of incrementing exponents and multiplying values is established, the next step is to reverse directions and look at the same relationships. Example:
   If we keep going will we eventually reach negative exponents? *No.*
   Why not? *They keep getting bigger.*
   Let's look at what we're doing and try to figure out how to go backward. If we go down from 2^6 to 2^5, how does the exponent change? *One smaller. Subtract one.*
   (Keep giving examples such as this.)
   Now let's look at the values on the other side of the equal sign again. When we went up we multiplied by 2. What happens when we go down from 64 to 32? *Divide by two. It's half.*

From 32 to 16? *Divide by 2. It's half.*
(Keep going in this pattern....)
Great. Let's keep going. The exponents go down 5, 4, 3, 2. What would the next one be? *1.*
Why? *You go down by one.*
What about the values? They go 32, 16, 8, 4. What would the next one be? *2.*
Why? *You divide by 2. You halve it.*
Is that equation right? Does $2^1 = 2$? *Yes.*
Are we getting closer to negative exponents now? *Yes*

4. Up to this point, the column of exponent facts has grown vertically, first upward then downward. The relative position of exponent math facts changes as the lesson proceeds from here.
5. For the completed graphic organizer, write positive and negative exponent facts next to each other. Example:

$$2^6 = 64 \qquad 2^{-6} = 1/64$$
$$2^5 = 32 \qquad 2^{-5} = 1/32$$
$$2^4 = 16 \qquad 2^{-4} = 1/16$$

... and so on...
5. The lesson proceeds, reiterating these patterns until the right-hand column of the organizer is completed.
6. Students are encouraged to find patterns in the organizer.

Tips
- Students rarely have difficulty recognizing that exponents on the left column are opposites of those in the right column while values in the left column are reciprocals of those in the right column
- If they do, horizontal lines can be drawn to make the relationship clearer
- Make more organizers with different bases, and put them next to each other.
- For each organizer, the exponential mathematics fact with the zero power is isolated at the bottom of the organizer. Students can be led to understand that when the exponent is zero, the value is always one.

References
Ives, B. & Hoy, C. (2003). Graphic organizers applied to higher-level secondary mathematics. *Learning Disabilities Research & Practice, 18*(1), 36-51.