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THE PURPOSE OF THE “FAMILIES Ask” department is to help classroom teachers respond to questions commonly asked by caregivers of their students. A commonly asked question will be posed; a rationale for the response will be presented for teachers; and a reproducible page will be offered for duplication and distribution to parents, other caregivers, administrators, or community members—anyone involved in the mathematical education of middle school children.

Here is this month’s question:

What type of algebra do students do in middle school?

“Families Ask” responds to questions commonly asked about the current issues in mathematics education. It includes a “Families Ask Take-Home Page” to share with parents, caretakers, and other interested members of the community. Readers interested in submitting manuscripts to this department should send them to “Families Ask,” MTMS, NCTM, 1906 Association Drive, Reston, VA 20191-1502.

What Does Algebraic Thinking Look Like?

Algebraic thinking is a critical skill for all students. Algebra is the study of patterns, and patterns span the curriculum. Algebraic thinking can support students’ learning of many topics. For example, if students collect data on the radius, diameter, and circumference of various-sized circles and look for patterns in their data, they will discover the formula for the circumference of a circle. Similarly, if students explore patterns in problems like $3 \div 1/2$ (how many $1/2$ s are in 3 ?), $4 \div 1/4$, and $2 \div 1/5$, they will begin to develop a strategy for the division of fractions (multiply by the denominator). Algebraic equations are used to describe real-world phenomena and can then be used to predict *new* phenomena. For example, if you know that you can walk 3 miles in an hour, then you can determine a distance for any amount of time ($d = 3t$), or how much time it will take to cover any distance ($t = d/3$).

Algebra is critical for ACT and SAT testing as well as college entrance requirements. Ferrini-Mundy, Lappan, and Phillips (1997) state, “The question of the expectations we knowingly or unknowingly set for our students is nowhere more crucial than in ... algebra,” the course that opens doors to higher mathematics.

The algebra expectations outlined in *Principles and Standards for School Mathematics* (NCTM 2000) present a comprehensive vision of what algebra all middle school students should learn. Among those expectations are the following: (1) use tables, graphs, symbols, pictures, and words to describe patterns and be able to compare these different forms; (2) develop a conceptual understanding of a variable; (3) explore linear functions, including their properties in tables, graphs, and equations; and (4) model and solve contextualized problems.

As a teacher trying to understand what algebra to teach, *Principles and Standards* can be an excellent resource. In addition to modifying one’s own perception of what algebra is important for students and why it is important, one must educate parents and community. As Steen (1992) wrote, “To regain public confidence, school mathematics must continually teach students things that thoughtful adults perceive as important.” The take-home page offers parents a chance to compare the old with the new in teaching algebra and poses two tasks that parents can do with their student. Either task could also be explored at an Open House, giving families the chance to see the different ways that people approach a problem and the various representations they might use.

Bibliography

- Ferrini-Mundy, Joan, Glenda Lappan, and Elizabeth Phillips. “Experiences with Patterning.” *Teaching Children Mathematics* 3 (February 1997): 282–88.
- Steen, Lynn Arthur. “Soundoff: Does Everybody Need to Study Algebra?” *Mathematics Teacher* 85 (April 1992): 258–60.
- National Council of Teachers of Mathematics (NCTM). *Principles and Standards for School Mathematics*. Reston, Va.: NCTM, 2000.
- . *Navigating through Algebra in Grades 6–8*. Reston, Va.: NCTM, 2001.

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Families Ask

Take-Home Page

Families often ask a question like this:

What type of algebra do students do in middle school?

What comes to mind when you hear the word “algebra”? For many adults, it brings back memories of a particular junior high school or high school mathematics class. There may be vague images of letters popping up among numbers. For many, the step-by-step process of solving an equation to arrive at the goal of “ $x = \text{something}$ ” has all but disappeared. One thing that has not been forgotten is the negative feelings connected with this course. The algebra that students learn in middle school today is most likely not what you experienced. Students today learn that algebra is much more than a “class”; it is a way of thinking.

Most people are surprised to learn that instruction in algebra starts out very simply with the study of patterns in kindergarten and first grade. Students describe and extend patterns like blue-blue-red-blue-blue-red and find missing addends in problems like $7 + \underline{\quad} = 10$. Unfortunately, in the past this more natural way of thinking about algebra virtually disappeared after first grade. It reappeared in a much more formal way in high school, which is what most people remember about algebra.

It is clear that students need to be introduced to the ideas of algebra earlier and in a more friendly way. Algebra is all around us. It is the study of patterns in our world and the attempt to analyze and describe those patterns. Algebra in the middle school attempts to build a bridge from early algebraic ideas to more formal algebra.

Principles and Standards for School Mathematics, a publication of the National Council of Teachers of Mathematics (2000), specifically states what algebra to teach and when to teach it in kindergarten through high school. In general, students in middle school should be looking for patterns in problems and in real-life events and creating algebraic ways to describe them. To better understand this idea, try working through the two problems that follow with your middle school child:

1. The summer Olympics were held in Greece in 2004. In 2006, there will be a winter Olympics. In 2008, there will again be a summer Olympics. What patterns can you describe about the years that have summer or winter Olympics? Will 2010 have summer or winter Olympics or neither? What about 2020? How can you describe the rule for what years will have summer Olympics and what years will have winter Olympics?

Unlike story problems in traditional algebra books, no pretaught method is available for solving this problem. Students look at the data, create lists or tables, and discover patterns. For example, your child might notice that the years that have Olympics are all even and that winter and summer alternate. This pattern is part of algebraic thinking. He or she might also notice that the summer Olympics are in years that are multiples of 4. For example, the year 2004 is the result of multiplying 4 by 501. To record that idea with symbols, students might write that if the year can be written as $4n$, then there will be a summer Olympics held. Winter Olympics occur every 4 years, but not as multiples of 4. Students might state this pattern in this way: “They are in the years that have a remainder of 2 when divided by 4.” They could then record it with symbols: $4n + 2$, or $4n - 2$. In these examples, students are using words and symbols to describe what is happening, which in turn gives meaning to the variables (in this case, the letter n) that they are using. The patterns can be used to predict which years will have summer Olympics and which will have winter Olympics.

Now try this problem:

2. Julie works at a restaurant. The manager asks her to push tables together until she has seats for 18 people. Julie notices that 1 table seats 4, but when she pushes 2 tables together, she can only seat 6. She wonders how many tables it will take to seat all 18 people. Continue adding to the following table and figure out the number of seats. Do you see a pattern that will help you figure out how many tables will be needed to seat 18 people?

Number of tables	1	2	3	4
Number of seats	4	6	8	10

After looking at the table, your child might notice that every table seats 2 people on each side, plus each end adds 1 more person. The total number of tables is t . This pattern in symbols could be $2t + 2$. Or your child might notice that all the middle tables seat two and the two end tables seat three. The number of middle tables is $t - 2$. So the pattern for this in symbols is $2(t - 2) + 6$. Regardless of the rule that is found, children can use it to figure out how many tables are needed to seat 18. A total of 8 tables are needed. Because your child has a situation, a picture, and a chart to use, it is much more likely that he or she will have success in solving this problem and will see that algebra is a useful tool.

It is hoped that these examples have not only helped you better understand the algebra your child is doing but helped you reflect on your own use of algebra as you go through your day. □