Frequently Asked Questions

Basic Facts and Operational Skills

"The Ontario Mathematics Curriculum is based on the belief that students learn mathematics most effectively when they are given opportunities to investigate ideas and concepts through problem solving and are then guided carefully into an understanding of the mathematics principles involved. At the same time, it promotes a balanced program in mathematics. The acquisition of operational skills remains an important focus of the curriculum."

The Ontario Curriculum, Grades 1-8, Mathematics

"The required knowledge and skills include not only important mathematical facts and procedures but also the mathematical concepts students need to understand and the mathematical processes they must learn to apply."

The Ontario Curriculum, Grades 11 and 12, Mathematics

1. What are basic facts?

The Guides to Effective Instruction in Mathematics define basic facts as addition, subtraction, multiplication, and division using numbers from 0-9. Basic fact fluency is referred to as automaticity. Automaticity is the relatively effortless recall of facts and provides opportunities for students to engage more easily in the types of problem-solving we expect of them. Automaticity is a consequence of brief, frequent, interactive, engaging activities that provide students with repeated exposure to math facts.

Students' facility in using basic math facts often has a significant effect on their ability to view themselves as mathematicians and on their confidence. This confidence can be diminished if teachers pay excessive attention to memorization and speed and spend too little time helping students to understand the relationships and patterns in the basic facts. For many students, anxiety is associated with memorization tasks, particularly during speed drills and elimination games. The goal in math classrooms is to shift from simply memorizing facts to supporting increased understanding of math skills and concepts.

"*The best way to develop fluency with numbers is to develop number sense and to work with numbers in different ways, not to blindly memorize without number sense.*"

Boaler, 2015

2. What does it mean to master basic facts?

Memorizing basic facts is not the same as the mastery of basic facts. Mastering basic facts includes developing a conceptual understanding of the relationship between numbers and how these relationships can be extended into strategies for doing the computations in a meaningful, logical manner. Students who learn the basic facts using a variety of computational strategies will be able to extend these strategies and their understanding of number to multidigit computations. It is important to note key researchers (Jo Boaler, Marian Small, et al) have shown that an overreliance on memorized procedures prevents students from using mathematical reasoning. A combination of strategies which includes having students engage in problems where they need to use lots of basic facts to solve the problem, and participating in games where students are motivated to know facts fairly quickly, are recommended.

> *"I do not believe that it's a return to flash cards or 'mad minutes', whether on paper or digital, that we should be envisioning. I think we need the continued commitment to making calculations make sense..."*
>
> Small, 2011

3. What is mental math?

Mental computations, or mental math, are often used to calculate, estimate, or visualize using mathematical relationships and strategies that were previously learned conceptually, without the use of pencil/paper, calculators or thinking tools. Mental math strategies help to further develop students' basic fact fluency, thus leading to mastery. Mental math strategies include, but are not limited to, making 5's and 10's, making jumps of ten, and composing and decomposing numbers.

> *"Solving questions mentally helps to force a student to focus on relationships between numbers and the effect of number operations, as opposed to simply memorizing rules."*
>
> Small, 2008

4. What are operational skills?

A skill implies being able to do something well or proficiently. A student possessing operational skills in mathematics is able to competently perform basic operations with all types of numbers appropriate to their own development, as well as within a variety of algorithms. Basic fact fluency (i.e., automaticity) may assist students with the development of their operational skills, however, use of mental math strategies, thinking tools and technology would improve their proficiency with these skills while laying the groundwork for deeper understanding.

A student possessing operational fluency means a student knows *when* to perform the basic operations, however it does not necessarily indicate an ability to judge the reasonableness of the answers provided.

> *"…to master these bits and pieces [operational skills] is no more doing mathematics than playing scales on the piano is making music."*
>
> Van de Walle, 2007

5. Can we teach through problem solving without students knowing their basic facts?

When teaching through problem solving, the work of doing math begins with problems which contain important and interesting math, and lead to the development of procedural and conceptual understanding. It is an opportunity for students to make sense of mathematical concepts. Teaching through problem solving gives students the opportunities to make sense of their thinking and the thinking of others through the mathematical processes. Having basic fact fluency (i.e. automaticity) frees the brain to focus on the work of doing math and the mathematical concepts.

> *"The highest achievers in the world are those who focus on big ideas in mathematics, and connections between ideas. Students develop a connected view of mathematics when they work on mathematics conceptually and blind memorization is replaced by sense making."*
>
> Boaler, 2015

6. How can technology support the development of basic facts and operational skills?

Technology plays an essential role in enhancing the learning and doing of mathematics. They are important problem solving tools which help support reasoning, promote thinking and conceptual development, and can also enhance operational fluency. When purposefully used, computer software, web-based applications, apps, and calculators can help students practice skills, reinforce what they have learned, and build confidence.

Calculators in particular have sparked many debates regarding the role of technology in the mathematics classroom. A meta-analysis by Smith (1997) on the role of calculators showed that their use improved conceptual knowledge, problem solving skills, and computation, and did not hinder pencil-and-paper skills. Furthermore, it is the recommendation of the National Council of Teachers of Mathematics that calculators be used in all aspects of math instruction, from the development of concepts to the acquisition of operational skills. Calculator use should only be restricted when students are focusing on mental math strategies.

As with all forms of technology in the mathematics classroom, teachers and students must consider when it is purposeful to use them.

> *"Although students must develop basic operational skills, calculators and computers can help them extend their capacity to investigate and analyse mathematical concepts and reduce the time they might otherwise spend on purely mechanical activities."*
>
> Ministry of Education, 2005

References and Ministry Resources

Boaler, J. (2002). *Experiencing school mathematics: Traditional and reform approaches to teaching and their impact on student learning*. New Jersey: Routledge.

Boaler, J. (2015). Fluency Without Fear. Retrieved from: http://youcubed2.s3-website-us-west-2.amazonaws.com/wordpress/wp-content/uploads/FluencyWithoutFear-Jan-28-2015.pdf?d0372bj

Brown, S., Seidelmann, A., & Zimmermann, G. (n.d.). Mathematically Sane. Retrieved September 16, 2014 from http://mathematicallysane.com/in-the-trenches/

Dessart, D.J , DeRidder, C.M., Ellington, A. J. (n.d.). The Research Backs Calculators. Retrieved September 16, 2014.http://www.nctm.org/resources/content.aspx?id=8216

Ontario Ministry of Education. (2006). A Guide to Effective Instruction in Mathematics, Kindergarten to Grade 6. Volumes One to Five. Toronto, ON: Queens Printer for Ontario. http://www.edu.gov.on.ca/eng/teacher/litK6.pdf

Ontario Ministry of Education. (2004). Teaching and Learning Mathematics: The Report of the Expert Panel on Mathematics in Grades 4 to 6 in Ontario. Toronto, ON: Queen's Printer for Ontario. http://www.edu.gov.on.ca/eng/document/reports/numeracy/panel/numeracy.pdf
Ontario Ministry of Education. (2005). The Ontario curriculum: Grades 1-8 mathematics. Toronto, ON: Queen's Printer for Ontario.
http://www.edu.gov.on.ca/eng/curriculum/elementary/math18curr.pdf

Ontario Ministry of Education. (2007). The Ontario curriculum: Grades 9 and 10 mathematics. Toronto, ON: Queen's Printer for Ontario.
http://www.edu.gov.on.ca/eng/curriculum/secondary/math910curr.pdf

Ontario Ministry of Education. (2007). The Ontario curriculum: Grade 11 and 12. Toronto, ON: Queen's Printer for Ontario.
http://www.edu.gov.on.ca/eng/curriculum/secondary/math1112currb.pdf

Schwartz, J. E. (2008). *Elementary mathematics pedagogical content knowledge: powerful ideas for teachers*. New York: Prentice Hall.

Small, M. (2011). Editors Message. *OAME/AOEM*.

Small, M. (2012). *Making math meaningful to Canadian students, K-8, second edition* (2nd ed.). Toronto: Nelson Education.

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2007). Elementary and middle school mathematics: Teaching developmentally. New York: Pearson.