Mathematical fluency in young children: Perspectives from policy and practice

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In practice

Mathematical fluency as defined by Russell (2000) includes efficiency, accuracy, and flexibility. This means that students should not only be able to provide correct answers quickly but also to use facts and computation strategies they know to efficiently determine answers that they do not know. (See http://investigations.terc.edu/library/bookpapers/comp_fluency.cfm for Russell's detailed explanation of this idea.)

In Stow-Munroe Falls, we view fluency with basic facts as one *end goal* of second grade (for addition and subtraction facts) **and fourth grade** (for multiplication and division facts), **rather than primarily as a *prerequisite* for learning and solving problems**. Many students, even with a great deal of concept development and practice, do not reach these fluency goals by the end of these grades. Most have reached them by a year or two later as they have more experience with these facts. The Ohio Academic Content Standards (2001) require addition/subtraction fact fluency by the end of second grade and multiplication/division fact fluency by the end of third grade. The Common Core State Standards (2010), adopted in Ohio in June 2010, include similar goals.

Although we do find that students who are fluent in facts have fewer obstacles when engaging in more complex problem-solving, we also find that many students who *are* fluent in facts still struggle with such problem-solving, and many who *are not yet* fluent are able to generate highly sophisticated solution strategies to different types of problems.

In order to develop fluency in addition and subtraction facts (as defined above), teachers develop the following concepts with students in kindergarten through second grade:

- Conservation of quantity (the number of items does not change when no items are added or taken away, even if they are moved)
- Counting with meaning (knowing the number name sequence, understanding that each successive number word spoken indicates "one more," associating each number spoken with one item, understanding that the last number spoken is the number of items in the set regardless of the order in which they are counted)
- *Part-part-total* concept in addition and subtraction (these three elements are always present, and we must decide which is missing and how to determine what that number is)
- Counting on and counting back (e.g., to add 2 to 5, start at 5 and count up 2; students often struggle with whether to count the initial number, even after repeated practice)
- Using facts to find other facts (e.g., using the fact that 3 + 3 = 6 to determine that 3 + 4 = 7; 4 is one more than 3, so 7 is one more than 6)
- Using the above strategies more efficiently over time to eventually allow for quick recall of facts

Dr. Thompson's conclusion that environmental factors as well as genetic factors influence children's mathematical development certainly rings true for classroom teachers. In Stow-Munroe Falls, we believe that environmental factors also include the types of experiences provided by teachers in classrooms and the degree to which children have opportunities to reflect on these experiences in order to learn from them. However, the same types of opportunities in class do not produce the same results for all students. Though there are some common types of responses that teachers can expect when presenting a group of students with opportunities for learning and reflection, for any given individual student, the teacher must anticipate a wide range of possible responses to the same instructional activity, given the student's prior understandings AND the student's thinking "in the moment," which is influenced by the context(s) of the learning experience.

In policy

Both the Ohio Academic Content Standards and the Common Core State Standards include a variety of sophisticated mathematical ideas, as well as elements of fact and computational fluency, at every level including the primary grades. The *Principles and Standards for School Mathematics*, published by the National Council of Teachers of Mathematics (2000), as well as a broad base of research in mathematics education, strongly influenced the goals in both of these sets of standards. Thus, teachers must carefully develop these important mathematical ideas and reasoning processes with students at each level while also developing fluency. This lack of hierarchy for elements of general mathematical proficiency is described effectively in *Adding It Up*, a publication of the National Research Council (2001).

Response to Intervention was introduced in federal policy as part of the Elementary and Secondary Education ("No Child Left Behind") Act (ESEA) of 2001. This rather general mandate requires that schools periodically assess all students on important goals in reading and mathematics so that students who are struggling can be provided with additional support. The materials used are to be research-based, but one large challenge in mathematics has been that such materials are not yet (even now) readily available on a wide-scale basis. However, the idea of early and effective intervention is an important goal for which all schools should strive.

Policy at all levels, then, should support teachers in providing students with a range of experiences with the mathematical ideas listed on the reverse side of this sheet (for addition/subtraction fact fluency), along with the other important ideas included in the standards. These ideas include (but are not limited to) base ten understanding (place value), geometric and measurement reasoning, algebraic reasoning, analysis of data and statistics, and the use of concrete, visual, verbal, and symbolic representations to connect and communicate mathematical ideas. Further, policy should provide additional support for teachers and others who work with students who struggle with these ideas.
(See http://www.learningforward.org/standfor/definition.cfm for proposed language drafted by the National Staff Development Council related to professional development in the reauthorization of ESEA.)

Specific policies should involve:

- *Ongoing professional learning and involvement for all educators engaged in the following activities*
- Identification of important mathematical goals in each grade (perhaps more specific at local level)
- Resources/strategies for teachers to provide effective regular instruction relative to these goals
- Identification/creation of assessment tasks that will make explicit students' progress toward these goals
- Periodic (e.g., 3x per year) assessment of all students' progress toward these goals
- Review and compilation of data from assessments to provide a general picture of student understanding as well as an indication of which students need more support on each goal
- Provision of sufficient time, space, and resources for teachers/intervention specialists/tutors to support struggling students outside of the regular mathematics class

Additional references

National Research Council (2001). *Adding it up: Helping children learn mathematics* (J. Kilpatrick, J. Swafford, & B. Findell, Eds.). Washington, D.C.: National Academy Press.

National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics*. Reston, VA: NCTM.

Russell, S. J. (2000). Developing computational fluency with whole numbers in the elementary grades. *The New England Math Journal, 32*(2), 40-54.

Common Core State Standards in Mathematics: http://www.corestandards.org

Elementary and Secondary Education Act (2001): http://www2.ed.gov/policy/elsec/leg/esea02/index.html

Ohio Academic Content Standards in Mathematics: http://www.ode.state.oh.us - search for "academic content standards"