ROTTEN TO THE CORE

WHY MATH INSTRUCTION IN AMERICA IS FAILING OUR STUDENTS

01/24/2016

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The ages will vary by at least one year, and the group will include both boys and girls. We will take this incredibly diverse group of children, put a large number of them in a classroom with one teacher, and require that teacher to deliver standardized one-size-fits-all instruction to all her students.

It is a curious notion. The students will range in age and developmental readiness, language, self-regulation and social-emotional skills. Some will come from poverty while others will be from affluence and privilege.

We'll insist that all kids have a right to be exposed to the same content standards each year, and held to the same standards for learning. We'll require the teacher to cover more content than could ever be well-taught, use a rigid pacing guide that requires that she move constantly ahead whether or not kids have learned the previous lessons, use district assessments to add further pressure to the students and teacher, and evaluate the teacher on whether all kids score at a high level on high-pressure standardized tests at the end of the year. What could possibly go wrong?

Over the last several decades, in spite of many versions of state and federal school reform initiatives and many billions of dollars, math instruction has failed to produce better outcomes. According to the National Assessment of Educational Progress, which has monitored nine, 13, and 17 year-old students since the early 1970s, small improvements in math outcomes at ages nine and 13 have been noted since 1973, but no significant improvement at all can be seen among our 17-year-old high schools students. As of 2013, the NAEP reports that among 12th grade students only 26 percent of all students score at or above proficient levels in math, and among African American 12th grade students tested, only seven percent are proficient or better in math.

In the age of information and technology math skills have never been more important. Higher-level math skills open the door to high-skill and high-wage jobs. But our national math learning outcomes

have flat-lined for more than four decades while other nations have found a learning path to improved math skills. More than a third of our students end up in remedial math courses and high levels of math anxiety are reported among school-aged children, beginning in the earliest grades. Many students report that math is their least favorite subject.

In a recent report by the Educational Testing Service, "America's Skills Challenge: Millennials and the Future (2015)," the ETS compared the literacy, numeracy, and problem solving skills of 16 to 34 year olds in 22 countries using data from the OECD Programme for International Assessment of Adult Competencies. In literacy, U.S. millennials scored lower than 15 other nations. In both numeracy and problem solving, U.S. millennials were tied for last.

The delivery of standardized one-size-fits-all instruction is failing our kids. We encourage kids to memorize facts and formulas they do not understand. They learn to hate and avoid math. More than four decades of data suggest that tweaking our curriculum-driven one-size-fits-all approach to math instruction is highly unlikely to produce significant improvements in math outcomes. Requiring teachers to "cover" standardized content has not helped most students develop number sense or the ability to apply important math concepts in their lives.

In recent years, educators and politicians have spent incredible amounts of time arguing about which list of content standards to cover. These "coverage standards" are long lists of what should be covered in each grade, regardless of whether many students are ready and able to understand and learn how to use that content. Teachers are told to cover the content, give another test, assign grades and move forward.

Among the seventh grade CCSS math standards for coverage is: Understand that the additive inverse of a sum is the sum of the additive inverses, that is $–(p + q) = –p + –q$. For example, $–(6 + –2) = (–6) + 2$ because $[6 + (–2)] + [(–6) + 2] = [6 + (–6)] + [(–2) + 2] = [0] + [0] = 0$. While we can be reasonably sure that this standard is well represented in the math programs schools use, and that teachers have indeed "covered" the standard, we cannot be sure that students deeply understand the concept, or that they can use it in multiple academic contexts or in any practical context. Covered, yes, but not well learned by a considerable majority of students.

There is another way. Competency based learning is not a new concept. We already use it for the education and training of pilots, medical professionals and electricians. You can't earn a tech certificate without learning every skill in a sequence leading up to competency. A parent teaching his child to throw and catch starts with a big soft ball, and gives the child all the time and practice needed before progressing to smaller balls and more difficult throws. No one gives you a pacing guide and tells you that you must throw hard balls at six year olds.

Competency based learning starts with the identification of essential learning outcomes, knowledge and skills that a student needs to learn to absolute proficiency to be able to move forward to higher levels of learning. Then it is necessary to assess student learning skills and readiness so that instruction can be designed at the student's readiness level. Teachers monitor progress and continually adjust instruction for essential outcomes, giving students all the time and support needed to achieve competency for any skill that is essential. And competency is not just an 80 percent score on a test, but rather the ability to deeply understand content and use skills easily, in multiple contexts, and over time.

If math learning is important in the lives of our children, and it is, it deserves to be taught using a competency based learning approach. This involves identifying essential math skills, which lead to basic

number sense, and later to higher level math, giving kids all the time, instruction, and practice needed to develop deep understanding and the ability to use these concepts.

Personalized instruction for essential math skills may sound impossibly complicated, but in reality it simplifies and brings joy to the process of learning. During the early childhood years it starts with the development of number sense, including counting accurately with one-to-one correspondence, understanding basic combinations, recognizing the numerical value of groups — subitizing — recognizing number patterns, visual, and movement patterns, and then applying these skills to measurement and problem-solving. Number sense is the foundation for all higher-level mathematics.

"Essential Math Skills" (Sornson, 2014) identifies a competency framework for preschool through grade three, including a small set of target math outcomes for each grade and a variety of manipulative based learning activities to support each outcome. Teachers are encouraged to offer a rich and interesting curriculum filled with activities and projects, while carefully monitoring progress toward this set of crucial outcomes. Some children may need to work on skills from the previous grade level. Others will be working at grade level, and still others will be working on skills from a more advanced level. Proficiency for each crucial skill will only be noted when a student has demonstrated deep understanding, over a period of time, using a variety of learning materials to ensure both understanding and application.

The Khan Academy is a well-designed example of a digital math-learning program that is built with competency as the goal for each student. Students spend all the time needed to learn each skill in the sequence of skills leading to higher-level math. The use of blended learning supports personalized learning by combining digital instruction with teacher guidance and review in the classroom, and is quickly becoming a part of upper grade competency learning initiatives.

Math matters. But over the last several decades we've allowed math instruction to become a race through long lists of content objectives. Using one-size-fits-all instruction, we've taken the joy out of math learning and consistently harmed our most vulnerable kids. Our math outcomes are lousy and falling further behind most developed nations. We've compromised the mathematical futures of a large majority of our students, but rather than consider the flawed design of our system, we focus on blaming teachers, or parents, or students. No amount of tweaking or added pressure can significantly improve the outcomes of a coverage-driven system that was designed to cover, test and sort students. It was never designed to help every student become a good learner for life.

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