Mathematics Education: Being Outwitted by Stupidity

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In a well-publicized paper that addressed why some students were not learning to read, Reid Lyon (2001) concluded that children from disadvantaged backgrounds where early childhood education was not available failed to read because they did not receive effective instruction in the early grades. Many of these children then required special education services to make up for this early failure in reading instruction, which were by and large instruction in phonics as the means of decoding. Some of these students had no specific learning disability other than lack of access to effective instruction. These findings are significant because a similar dynamic is at play in math education: the effective treatment for many students who would otherwise be labeled learning disabled is also the effective preventative measure.

In 2010 approximately 2.4 million students were identified with learning disabilities — about three times as many as were identified in 1976-1977. (See http://nces.ed.gov/programs/digest/d10/tables/xls/tabn045.xls and http://www.ideadata.org/arc_toc12.asp#partbEX). This increase raises the question of whether the shift in instructional emphasis over the past several decades has increased the number of low achieving children because of poor or ineffective instruction who would have swum with the rest of the pack when traditional math teaching prevailed. I believe that what is offered as treatment for learning disabilities in mathematics is what we could have done—and need to be doing—in the first place. While there has been a good amount of research and effort into early interventions in reading and decoding instruction, extremely little research of equivalent quality on the learning of math in the United States exists. Given the education establishment's resistance to the idea that traditional math teaching methods are effective, this research is very much needed to draw such a definitive conclusion about the effect of instruction on the diagnosis of learning disabilities.[1]

Some Background

Over the past several decades, math education in the United States has shifted from the traditional model of math instruction to "reform math". The traditional model has been criticized for relying on rote memorization rather than conceptual understanding. Calling the traditional approach "skills based", math reformers deride it and claim that it teaches students only how to follow the teacher's direction in solving routine problems, but does not teach students how to think critically or to solve non-routine problems. Traditional/skills-based teaching, the argument goes, doesn't meet the demands of our 21st century world.

As I've discussed elsewhere, the criticism of traditional math teaching is based largely on a mischaracterization of how it is/has been taught, and misrepresented as having failed thousands of students in math education despite evidence of its effectiveness in the 1940s, '50s and '60s. Reacting to this characterization of the traditional model, math reformers promote a teaching approach in which understanding and process dominate over content. In lower grades, mental math and number sense are emphasized before students are fluent with procedures and number facts. Procedural fluency is seldom achieved. In lieu of the standard methods for adding/subtracting, multiplying and dividing, in some programs students are taught strategies and alternative methods. Whole class and teacher-led explicit instruction (and even teacher-led discovery) has given way to what the education establishment believes is superior: students working in groups in a collaborative learning environment. Classrooms have become student-centered and inquiry-based. The grouping of students by ability has almost entirely disappeared in the lower grades—full inclusion has become the norm. Reformers dismiss the

possibility that understanding and discovery can be achieved by students working on sets of math problems individually and that procedural fluency is a prerequisite to understanding. Much of the education establishment now believes it is the other way around; if students have the understanding, then the need to work many problems (which they term "drill and kill") can be avoided.

The de-emphasis on mastery of basic facts, skills and procedures has met with growing opposition, not only from parents but also from university mathematicians. At a recent conference on math education held in Winnipeg, math professor Stephen Wilson from Johns Hopkins University said, much to the consternation of the educationists on the panel, that "the way mathematicians learn is to learn how to do it first and then figure out how it works later." This sentiment was also echoed in an article written by Keith Devlin (2006). Such opposition has had limited success, however, in turning the tide away from reform approaches.

The Growth of Learning Disabilities

Students struggling in math may not have an actual learning disability but may be in the category termed "low achieving" (LA). Recent studies have begun to distinguish between students who are LA and those who have mathematical learning disabilities (MLD). Geary (2004) states that LA students don't have any serious cognitive deficits that would prevent them from learning math with appropriate instruction. Students with MLD, however, (about 5-6% of students) do appear to have both general (working memory) and specific (fact retrieval) deficits that result in a real learning disability. Among other reasons, ineffective instruction, may account for the subset of LA students struggling in mathematics.

The Individuals with Disabilities Education Act (IDEA) initially established the criteria by which students are designated as "learning disabled". IDEA was reauthorized in 2004 and renamed the Individuals with Disabilities Education Improvement Act (IDEIA). The reauthorized act changed the criteria by which learning disabilities are defined and removed the requirements of the "significant discrepancy" formula. That formula identified students as learning disabled if they performed significantly worse in school than indicated by their cognitive potential as measured by IQ. IDEIA required instead that states must permit districts to adopt alternative models including the "Response to Intervention" (RtI) model in which struggling students are pulled out of class and given alternative instruction.

What type of alternative instruction is effective? A popular textbook on special education (Rosenberg, et. al, 2008), notes that up to 50% of students with learning disabilities have been shown to overcome their learning difficulties when given explicit instruction. This idea is echoed by others and has become the mainstay of the Response to Intervention model. What Works Clearinghouse finds strong evidence that explicit instruction is an effective intervention, stating: "Instruction during the intervention should be explicit and systematic. This includes providing models of proficient problem solving, verbalization of thought processes, guided practice, corrective feedback, and frequent cumulative review". Also, the final report of the President's National Math Advisory Panel states: "Explicit instruction with students who have mathematical difficulties has shown consistently positive effects on performance with word problems and computation. Results are consistent for students with learning disabilities, as well as other students who perform in the lowest third of a typical class." (p. xxiii). The treatment for low achieving, learning disabled and otherwise struggling students in math thus includes math memorization and the other traditional methods for teaching the subject that have been decried by reformers as having failed millions of students.

The Stealth Growth of Effective Instruction

Although the number of students classified as learning disabled has grown since 1976, the number of students classified as LD since the passage of IDEIA has decreased (see Figure 1). Why the decrease has occurred is not clear. A number of factors may be at play. One may be a provision of No Child Left Behind that allows schools with low numbers of special-education students to avoid reporting the academic progress of those students. Other factors include more charter schools, expanded access to preschools, improved technologies, and greater understanding of which students need specialized services. Last but not least, the decrease may also be due to targeted RtI programs that have reduced the identification of struggling and/or low achieving students as learning disabled. .

Having seen the results of ineffective math curricula and pedagogy as well as having worked with the casualties of such educational experiments, I have no difficulty assuming that RtI plays a significant role in reducing the identification of students with learning disabilities. In my opinion it is only a matter of time before high-quality research and the best professional judgment and experience of accomplished classroom teachers verify it. Such research should include 1) the effect of collaborative/group work compared to individual work, including the effect of grouping on students who may have difficulty socially; 2) the degree to which students on the autistic spectrum (as well as those with other learning disabilities) may depend on direct, structured, systematic instruction; 3) the effect of explicit and systematic instruction of procedures, skills and problem solving, compared with inquiry-based approaches; 4) the effect of sequential and logical presentation of topics that require mastery of specific skills, compared with a spiral approaches to topics that do not lead to closure and 5) Identifying which conditions result in student-led/teacher-facilitated discovery, inquiry-based, and problem-based learning having a positive effect, compared with teacher-led discovery, inquiry-based and problem-based learning. Would such research show that the use of RtI is higher in schools that rely on programs that are low on skills and content but high on trendy unproven techniques and which promise to build critical thinking and higher order thinking skills? If so, shouldn't we be doing more of the RtI style of teaching in the first place instead of waiting to heal the casualties of reform math?

Until any such research is in, the educational establishment will continue to resist recognizing the merits of traditional math teaching. One education professor with whom I spoke stated that the RtI education model fits mathematics for the 1960s, when "skills throughout the K-8 spectrum were the main focus of instruction and is seriously out of date." Another reformer argued that reform curricula require a good deal of conceptual understanding and that students have to do more than solve word problems. These confident statements assume that traditional methods—and the methods used in RtI—do not provide this understanding. In their view, students who respond to more explicit instruction constitute a group who may simply learn better on a superficial level. Based on these views, I fear that RtI will incorporate the pedagogical features of reform math that has resulted in the use of RtI in the first place.

While the criticism of traditional methods may have merit for those occasions when it has been taught poorly, the fact that traditional math has been taught badly doesn't mean we should give up on teaching it properly. Without sufficient skills, critical thinking doesn't amount to much more than a sound bite. If in fact there is an increasing trend toward effective math instruction, it will have to be stealth enough to fly underneath the radar of the dominant edu-reformers. Unless and until this happens, the thoughtworld of the well-intentioned educational establishment will prevail. Parents and professionals who benefitted from traditional teaching techniques and environments will remain on the outside — and the public will continue to be outwitted by stupidity.