Commentary on Early Identification and Interventions for Students With Mathematical Difficulties:

Make Sense–Do the Math

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Abstract

Gersten, Jordan, and Flojo (in this issue) have written an elegant summary of the research on early identification and interventions for students with mathematical difficulties. The general constructs of arithmetic combinations, counting strategies, and number sense encapsulate elemental components of early math learning and suggest approaches to remediation. Recent changes in the Individuals with Disabilities Education Act may enhance opportunities for researchers, practitioners, and young learners to benefit from this knowledge.

Russell Gersten, Nancy C. Jordan, and Jonathan R. Flojo (in this issue) have written a cogent, useful, but unavoidably brief synopsis of key components associated with the early identification and remediation of math difficulties (MD). They admitted the paucity of general knowledge in these areas in the first sentence of their abstract ("the small body of research") and reiterated that caveat throughout the article. Nevertheless, for many involved in learning disability (LD) research and even more for those involved in the instruction of young children with MD, this summarized knowledge may be both novel and valuable. In fact, the relative simplification of evidence and paradigms in this domain might be a boon, in terms of its potential for their dissemination and application.

Gersten, Jordan, and Flojo's (in this issue) review was heuristically organized around four general domains: (a) the nature of MD; (b) the role of "number sense" in young children; (c) valid screening measures; and (d) early intervention and instruction. In each of these areas, they provided clarity on both the principal findings from available research and their implications for research and practice. Although consistently admitting the limitations of knowledge and the critical need for more research in these areas, they also advocated for improved actions in practice where justified (e.g., in screening and in instructional supports). In this commentary, I will attempt to highlight some of those elements and to suggest methods that will support progress in early identification and intervention, including contextualizing some of these possibilities in light of important, recent changes to the Individuals with Disabilities Education Act of 1997 (IDEA; amended through the Individuals with Disabilities Education Improvement Act of 2004).

Who's Who and What's What

Gersten et al. (in this issue) introduced their section on "The Nature of Mathematical Difficulties" with the clarification that "we use the term *mathematics difficulties* rather than *mathematics disabilities*." This was an important distinction, especially as their article is appearing in the *Journal of Learning Disabilities*. In actuality, most of the research they cited was conducted with students who had not (yet) been formally identified by the schools as having LD. In general, identification of children with LD is problematic in preschool and the early elementary grades. Whereas children with specific learning disabilities (SLD) typically account for one half of all identified students with disabilities (U.S. Department of Education, 2002, p. II-20), the proportional rates of their identification vary greatly across grade ranges. Table 1 shows the most recent national SLD identification rates for children of ages 3 to 18. Preschool children (ages 3–5) make up only 1% to 3% of children identified with disabilities in those age ranges. Identification rates increase appreciably following entrance to elementary school, but the specific rates for the early grades, K–2 (ages 6–8), are

relatively low (8%, 18%, and 31%) in comparison to SLD rates in later grades (particularly in high school—around 60%).

These data confirm the urgency behind efforts to improve *earlier* identification and intervention with these students. Moreover, better identification and intervention can also (hopefully) remediate apparent weaknesses in children who have not developed a true disability. Gersten et al.'s (in this issue) emphasis on the importance of longitudinal studies supports the power of prevention. In citing the work of David Geary, Nancy Jordan, and their colleagues, they noted that

> for many children, mathematics difficulties are not stable over time, identifying a group of "variable" children who showed mathematics difficulties on a standardized test in first grade but not in second grade. It is likely that some of these children outgrew their developmental delays, whereas others were misidentified to begin with.

The potential for misidentification is a powerful disincentive for the classification of a student, particularly a young child, as having a disability. That has clearly been a factor, along with difficulties in traditional eligibility determination based on intelligence–achievement discrepancies, in the depression of SLD identification in the early grades.

TABLE 1
Proportional Rates of Specific Learning Disability (SLD) Identification Across Age Groups

Age	Children with SLD	All Children with Disabilities	Proportion (SLD/All)
3	1969	149551	.0132
4	3484	254832	.0137
5	8707	275759	.0316
6	27931	350670	.0797
7	74331	402009	.1849
8	139963	458835	.3050
9	203191	503072	.4039
10	247732	523392	.4733
11	277947	532106	.5224
12	305352	541623	.5638
13	319612	547303	.5840
14	314660	528749	.5951
15	301281	503156	.5988
16	274516	458324	.5990
17	234073	391112	.5985
18	116489	205288	.5674

Note. Extrapolation from current Child Count Data in National Tables (Table AA7, Number of Children Served Under IDEA, Part B, By Disability and Age, 2003; available at http://www.ideadata.org/tables27th/ar_aa7.xls)

What Works

Gersten et al. (in this issue) did an excellent job of encapsulating, to a fairly limited number, the sets of key components in early math learning that readily lend themselves to use as both indicators of difficulty and objects of instruction. Chief among these were (a) arithmetic combinations, (b) counting strategies, and (c) number sense. Each of these general components has multiple derivatives but, in terms of a clear and understandable overall framework (i.e., for teachers and parents), these three categories seem to cover a lot of the territory. Within each category, research studies have documented specific cases of association or correlation between particular measures of the components' elements and more general difficulties in elementary mathematical learning.

In the section on "Mathematics Difficulties and Reading Difficulties," they also documented evidence from available research on the disproportionate impact of different factors on children whose math difficulties (MD) were accompanied by or separate from reading difficulties. In general, achievement growth was better for children with MD only, with some exceptions (e.g., in calculation fluency); reading difficulties seemed to have a more pervasive impact.

Gersten et al. (in this issue) found that number sense (magnitude, reasonability, flexibility, representation), a construct largely derived from cognitive psychology rather than education, was a key component of early mathematical success and difficulty. Furthermore, they noted that the building blocks of number sense appeared highly responsive to instruction:

> Number sense development may be linked to the amount of informal instruction that students receive at home on number concepts and . . . some students, when provided with appropriate instruction in preschool, kindergarten, or first grade in the more complex aspects such as quantity discrimination, may quickly catch up with their peers.

In their sections on "Early Detection of MD and Potential Screening Measures" and "Use of Rate Measures as Early Predictors of MD," Gersten et al. (in this issue) found that the *Number Knowledge Test* (Okamoto & Case, 1996) was the strongest screening measure for math difficulties, but also concluded that additional research needs to be conducted to refine instrumentation (e.g., whether measures should be timed or untimed; whether to include additional items).

Their examination of "Instructional Implications" was, again, limited by the "paucity of research," but interpolations from some longitudinal

studies found agreement on logical goals for interventions (e.g., increased fluency and accuracy in arithmetic combinations, better counting strategies, and instruction in the components of number sense). In general, they repeated a point made throughout the article—that teachers need to be made aware of specific math weaknesses (in the key component areas) in their students and provide those students with explicit instruction and additional time to address those deficits.

What's Next?

I think it is propitious that Gersten et al.'s (in this issue) highly readable condensation of the research on the early identification and intervention of MD is being published so shortly after the 2004 reauthorization of IDEA. The new amendments to the legislation include a number of provisions that could favorably advance the use of more effective practices in elementary schools, such as those that Gersten et al. have advocated in early screening and intervention. These changes address aspects of previous legislation that directly affected students with LD, their families, and their teachers (see Note).

- *Determination of Eligibility.* When determining whether a child has a specific learning disability, school districts will no longer be required to consider whether a child has a severe discrepancy between achievement and intellectual ability in oral expression, listening comprehension, written expression, basic reading skill, reading comprehension, mathematical calculation, or mathematical reasoning. (paraphrased; for exact language, see Section 614(a)(6)(A).)
- *Response to Intervention.* In determining whether a child has a specific learning disability, a school district may use a process that determines if the child responds to scientific, research-based intervention as a part of the evaluation. (paraphrased; for exact language, see Section 614(a)(6)(B).)
- *Early Intervening Services.* A school district may use up to 15% of its federal funds, in combination with other (e.g., local, state) funds, to support "early intervening services" for students in K–12 (with an emphasis on K–3) who have not been identified as needing special education or related services but who need additional academic and behavioral support to succeed in general education environments. (paraphrased; for exact language, see Section 613(f)(1). For additional details, see also Sections 613(f)(2)–613(f)(5).)

These are provisions of "recent" law (December 3, 2004), so their exact meanings cannot be interpreted pending publication of the Federal Regulations for Part B of the Act (forthcoming) and the actions and reactions that states and local school districts will pursue related to their implementation. Nevertheless, a layperson with interest in this field can recognize that these changes to the law are directly related to many of the issues described in Gersten et al.'s (in this issue) article and other recent reviews (e.g., Danielson, Bradley, & Hallahan, 2002).

For example, Gersten et al.'s (in this issue) article was predicated on the importance of early identification and intervention. Discrepancy-based methods of identification have been singled out as potential obstacles to the early, valid, and reliable classification of students, including students with SLD in mathematics (Fletcher et al., 2002). In contrast, the screening methods advocated by Gersten et al. (in this issue) are based on limited but established linkages between key early math components (arithmetic combinations, counting strategies, and number sense) and early math achievement (or difficulty). Similarly, their recommendations for early interventions, based on intensive instruction in the component areas, are aligned with "response to instruction" or "response to intervention" models, primarily advocated in relationship to reading disabilities (e.g., Vaughn, Linan-Thompson, & Hickman, 2003) but intrinsically (and now legislatively) worth consideration for young students with difficulties in math.

One can imagine that the changes in IDEA may lead, in some school districts, to environments that will be more naturally supportive of progressive methods related to early identification and intervention. As teachers and administrators become more familiar with the key components and predictors of MD, they may implement better and more widespread screening techniques, such as those advocated by Gersten et al. (in this issue). Federal, state, and local funds may be more flexibly used not only to sponsor more comprehensive early identification, but also to fund intensive interventions for all children who demonstrate initial difficulties. In the past, such efforts were often called "prereferral" approaches, but federal (Part B) funds were not typically considered appropriate for their implementation.

The design of early interventions for these young students will also benefit from knowledge of the key components and what Gersten et al. (in this issue) termed "promising directions" for instruction, including the use of improved technologies that support individualized practices. In the 1980s, Ted Hasselbring, John Woodward, Al Hofmeister, Ron Thorkildsen, and other pioneers of education technology conducted much of their initial research with Apple computers and early PCs, which they often had to provide to the schools. Now the schools are much better equipped, with greatly improved and more powerful processors, multimedia, and networks, to support individualized instruction. This may be an opportunity to finally reap the envisioned benefits of previous research on "computer-assisted instruction," much of which was conducted in special education settings. Both general and special educators will be able to work cooperatively and collaboratively in classrooms to provide structured, small-

group, and individualized, explicit instruction to those children who need more attention.

Assuming that the results in real classrooms mimic the findings from research, many and perhaps most students will rapidly catch up with their peers in early mathematics. Those who do not will be more accurately and reliably recognized as requiring additional, different, or more intensive interventions. In individual cases, some of those students may be classified as students with specific learning disabilities in mathematics (or in a subset of mathematics). These classifications will stem, appropriately, from careful analyses of their responses to high-quality, evidence-based interventions. Furthermore, highly specialized educational approaches and accommodations will be implemented to compensate for or mediate their mathematical problems.

The growing availability of schools and school districts that are interested in tapping into these potentials will also provide ready laboratories for educational and cognitive researchers, who will continue to increase and make more specific the knowledge base on early (and subsequent) mathematical learning. Future studies will map out the transition steps from concrete to mental representations and increase the specificity and impact of interventions. The number of students who fail to succeed in mathematics may continue to decrease, perhaps exponentially.

Will all of this happen just because of one synoptic article and a few changes in a law? No. But it is a start. Make (number) sense. Do the math.

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NOTE

Most of the new amendments to IDEA, including those described in this article, take effect on July 1, 2005.

REFERENCES

Danielson, L., Bradley, R., & Hallahan, D. P. (Eds.). (2002). *Identification of learning disabilities: Research to practice.* Mahwah, NJ: Erlbaum.

Fletcher, J. M., Lyon, G. R., Barnes, M., Stuebing, K. K., Francis, D. J., Olson, R. K., et al. (2002). Classification of learning disabilities: An evidence-based evaluation. In L. Danielson, R. Bradley, & D. P. Hallahan (Eds.), *Identification of learning disabilities: Research to practice* (pp. 185–250). Mahwah, NJ: Erlbaum.

Individuals with Disabilities Education Act Amendments (IDEA) of 1997, 20 U.S.C. § 401(26)

Individuals with Disabilities Education Improvement Act Amendments (IDEA) of 2004, 20 U.S.C. 1400 *et seq.*

Okamoto, Y., & Case, R. (1996). Exploring the microstructure of children's central conceptual structures in the domain of number. In R. Case & Y. Okamoto (Eds.), *The role of central conceptual structures in the development of children's thought. Monographs of the Society for Research in Child Development, 61*(1–2, Serial No. 246), 27–58.

U.S. Department of Education. (2002). *Twenty-fourth annual report to Congress on the implementation of the Individuals with Disabilities Education Act.* Washington, DC: Author.

Vaughn, S., Linan-Thompson, S., & Hickman, P. (2003). Response to instruction as a means of identifying students with reading/learning disabilities. *Exceptional Children, 69*, 391–409.