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TO "have the ongoing responsibility for providing advice and guidance to policymakers in the development of statewide policies and in the allocation of resources to improve mathematics achievement"

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Mathematical Fluency and Response to Intervention (RtI)

Effective implementation of the Kentucky Core Academic Standards for Mathematics (KCASM, also known as the Common Core State Standards for Mathematics (CCSSM)), in connection with Response to Intervention (RtI), calls for the deliberate teaching and learning of foundational progressions leading to mathematical fluency and proficiency. Mathematical fluency is defined in this document as a deep understanding of mathematical concepts, which results in the facility to efficiently and accurately access, compare, and apply strategies, knowledge, and skills in a variety of contexts. The current mathematics reform movement in Kentucky presents an opportunity to support intensive teacher growth, including the development and provision of appropriate resources, for understanding and facilitating numeracy development through careful assessment and instruction of student foundational fluency progressions (see Diagram 1).

Fluency within the Kentucky Core Academic Standards for Mathematics

Whereas there are few KCASM standards (1 or 2 per grade in K-5) explicitly using the words "fluency" or "fluently," the standards are rich with opportunities across the years to lead students to deeper understanding in order to become fluent. Lack of focus on the requisite foundations for fluency results in gaps, that for many students, fuel worsening mathematical difficulties. According to Common Core State Standards for Mathematics author

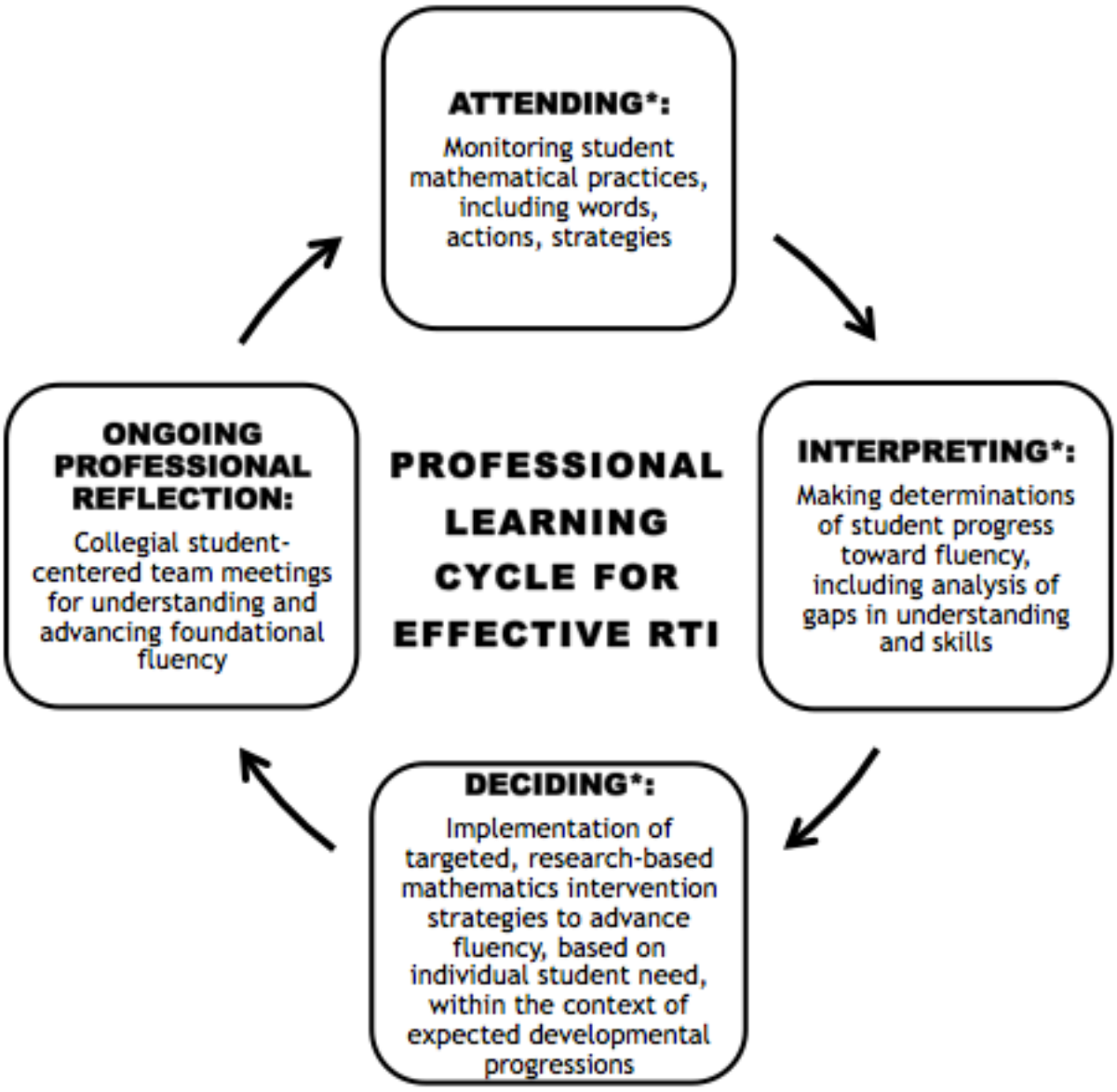

Diagram 1. The Professional Learning Cycle for Effective Response to Intervention

*The three interrelated components of professional noticing as defined by Jacobs, Lamb, and Philipp, 2010.

Jason Zimba, "When one standard depends upon many, the one can be a referendum on the many. We might expect that performance will be low on such a standard, with lots of ways for students to be missing pieces of the puzzle. These post cursors may also be resistant to specific intervention; instead, they may be important opportunities for formative assessment that casts a sufficiently wide net to consider the contributing factors."

Assessment and learning of the foundational fluency progressions are an important focus of effective RtI. For example, a student may not be able to meet 1.OA.6 - …demonstrating fluency for addition and subtraction within 10… without first being able to meet these: K.OA.2 (word problems, use objects or drawings…); K.OA.3 (decompose numbers…); K.OA.4 (find the number that makes 10 when added to the given number…); K.OA.5 (fluently add and subtract within 5); 1.OA.3 (apply properties of operations…); 1.OA.4 (understand subtraction); 1.OA.5 (relate counting to addition and subtraction).

Hence, fluency mandated in KCASM 1.OA.6, should be an outgrowth of substantial learning that happens in kindergarten and first grade, rather than an isolated instructional objective. Fluency mandated in other grades should likewise be supported through deep learning of connected, foundational standards. RtI teachers should be equipped to carefully monitor, interpret, and advance student learning in the context of the KCASM progressions, with attention to the development of advanced mental computation strategies and connected concepts leading to fluency. Note that the emphasis is on conceptual development first, followed by practice to increase efficiency with number and operations, rather than shallow practice of teaching students to memorize and recall the correct numeral when hearing or seeing a basic fact prompt. Students will truly "know from memory all sums of two one-digit numbers," (as indicated in KCASM 2.OA.2) when given an opportunity to engage in a rigorous, systematic learning process with intentional opportunities for understanding of number relationships and quantities leading to facile number knowledge and fluency.

Professional Learning for Effective RtI

Enacting reform of mathematics teaching practices at the school and district level is an incredibly difficult task. Given the manner in which individuals are socialized into education, first as students and later as teachers, there is often a 'washing-out' of experiences from individuals' post-secondary teacher preparation (Zeichner, 1981), which result in many new teachers continuing a cycle of teaching as they were taught. Additionally, there exists some documentation of a fragility of content knowledge among educational practitioners, including high-school teachers (Stylianides, Stylianides, & Philippou, 2007); moreover, this fragility increases considerably for teachers at the elementary levels (Ball, 1990; Foss & Kleinasser, 1996; Swars, Hart, Smith, Smith, & Tolar, 2007). Given these two phenomena (1.washing-out of preservice preparation experiences; 2. mathematical fragility among practitioners), in-service professional development is of considerable importance to effect meaningful and sustained change in the practices of mathematics teachers and those who work with struggling students. Effective RtI for mathematics can be enacted through high-quality professional development strengthening teachers' pedagogical content knowledge and diagnostic skills with appropriate and accessible resources for professional learning (see Diagram 1).

Professional development for mathematics RtI that is sustained, job-embedded, and student-centered will provide opportunities for collegial reflection and student-centered problem solving. Professional learning activities, including administration and analysis of diagnostic assessments to determine readiness and needed instructional strategies, with an eye on expected learning progressions for mathematical fluency, will allow for teachers to attend to and interpret student thinking and to make appropriate instructional decisions (Jacobs, Lamb, and Philipp, 2010). And, professional learning activities that allow

participants to understand the profound complexity of early arithmetic inherent within the KCASM will lead to more careful reflection of and response to student difficulties.

Resources for Professional Learning

RtI resources for professional learning can further facilitate teacher on-the-job learning. Research-based, KCASM-related clinical diagnostic interview questions and instructional strategies for advancing students' number knowledge through rigorous sense-making, connecting of various aspects of number (verbal, symbolic, and quantitative), and enactment of the Kentucky Common Core Academic Standards for Mathematical Practice will be useful as teachers learn to monitor student practices and interpret student thinking to advance student learning. As with student fluency development, teacher fluency comes from deeper understanding and sense making and practicing with appropriate pedagogical tools, such as models, interview schedules, frameworks, questioning strategies, etc. related to the KCASM learning progressions for foundational fluency—tools which can be accessed during high-quality professional development and may ultimately be provided, validated, and refined, within Kentucky's extensive collaborative educational reform efforts at the district and/or state level.

REFERENCES

Ball, D. L. (1990). The mathematical understanding that prospective teachers bring to teacher education. *The Elementary School Journal*, 90, 449-466.

Ball, D. L. (2001, February). Developing a mathematically proficient public: What are the problems, what do we know about them, and what would it take to solve them? Paper prepared for the *Aspen Institute Congressional Conference on "Promoting Excellence in the New Economy: The Challenges to National Policy*," St. Petersburg, Florida, February 16 - 19, 2001.

Baroody, A. J., Eiland, M. D., & Baroody, S. C. (2011, April). Fostering first-graders' fluency with basic addition combinations. Paper presented at the *2011 American Educational Research Association Annual Meeting*. New Orleans, LA, April 8 – 12.

Fosnot, C. T. & Uittenbogaard, W. (2007). Minilessons for early addition and subtraction a yearlong resource. Florida: Harcourt.

Foss, D. H. & Kleinsasser, C. (1996). Preservice elementary teachers' views of pedagogical and mathematical content knowledge. *Teaching and Teacher Education*, 12, 429-442.

Garet, M., Porter, A., Desimone, L., Birman, B., & Yoon, K. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal*, 38, 915-945.

Jacobs, V. R., Lamb, L. C., & Philipp, R. A. (2010, March). Professional noticing of children's mathematical thinking. *Journal of Research in Mathematics Education*, 41, 169.

Koellner, K., Colsman, M., & Risley, R. (2011, November/December). Multidimensional assessment; Guiding response to intervention. *Teaching Exceptional Children*, 44, 48 – 56.

National Council of Teachers of Mathematics. (2011). *Achieving fluency: Special education and mathematics*. S.Fennell, (Ed.). Reston, VA: National Council of Teachers of Mathematics.

National Research Council. (2005). *How students learn*. Washington, DC: National Academy Press.

Sousa, D. (2011). The teacher's personal tour guide to the brain. *Brain Connection*. http://brainconnection.positscience.com/gen/?main=conf/nov00/sousa-int.

Sousa, D. (2008). *How the brain learns mathematics*. Thousand Oaks, California: Corwin Press.

Stylianides, G. J., Stylianides, A. J., & Philippou, G. N. (2007). Preservice teachers' knowledge of proof by mathematical induction. *Journal of Mathematics Teacher Education*, 10, 145-166.

Swars, S., Hart, L. C., Smith, M. E., Smith, S. Z., & Tolar, T. (2007). A longitudinal study of elementary pre-service teachers' mathematics beliefs and content knowledge. *School Science and Mathematics*, 107, 325-335.

Van de Walle, J., Karp, K., and Bay-Williams, J. (2013*). Elementary and middle school mathematics; Teaching developmentally, eighth edition*. Boston, MA: Pearson.

Wei, R.C., Darling-Hammond, L., Andree, A., Richardson, N., & Orphanos, S. (2009). *Professional learning in the learning profession: A status report on teacher development in the U.S. and abroad*. Dallas, TX: National Staff Development Council.

Wei, R.C., Darling-Hammond, L., & Adamson, F. (2010). Professional development in the United States: Trends and Challenges. Dallas, TX: National Staff Development Council.

Wright, R. J., Ellemor-Collins, D., and Tabor, P. D. (2012). *Developing number knowledge; Assessment, teaching, and intervention with 7—11-year-olds*. London, UK: Sage Publications.

Zimba, J. (2011). Examples of structure in the *Common Core State Standards*' Standards for Mathematical Content. Retrieved from (.docx)

http://commoncoretools.files.wordpress.com/2011/12/ccssatlas_2011_12_01_1257.docx