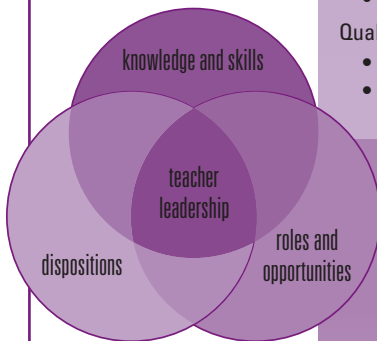


MATHEMATICS: KNOWLEDGE OF CONTENT AND PEDAGOGY

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Children's goals and beliefs about learning are related to their mathematics performance. Experimental studies have demonstrated that changing children's beliefs from a focus on ability to a focus on effort increases their engagement in mathematics learning, which in turn improves mathematics outcomes: When children believe that their efforts to learn make them "smarter," they show greater persistence in mathematics learning.



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Demonstrates Strong Subject Matter Knowledge

Teacher leaders have a deep understanding of the relevant spectrum of mathematics and use that knowledge to help students learn. They know how the mathematics standards and expectations build on what comes before and contributes to what students will experience next, as well as the specialized content knowledge in mathematics necessary to address a student's misconceptions. Teacher leaders understand the linkages between the content expectations, instructional materials and various assessments - summative and formative.

Mathematics background

- Mathematics coursework to build and support content knowledge and pedagogy
- Broad understanding of P-12 mathematics
- Math endorsement and/or advanced certification (i.e. NBPTS)

Standards for mathematical practice and thinking

- Reason abstractly and quantitatively
- Construct viable arguments and critique the reasoning of others
- Represent and model mathematics
- Use appropriate tools strategically
- Attend to precision
- Look for and make use of structure
- Look for and express regularity in repeated reasoning
- Explore and make conjectures
- Use strategic and adaptive reasoning and problem solving

Core mathematical knowledge

- Number and operation sense
- Algebra and functions
- Geometry and measurement
- Statistics, probability and data analysis
- Content related to STEM pathway as delineated by Common Core

Learning progressions: P-12

- Content for teaching assignment as related to previous and subsequent courses
- Vertical alignment P-12
- Knowledge of students' preconceptions and misconceptions

Quality assessment system

- Understand language and purpose of all types of assessments
- Strategies for making meaning from assessment data

Resources

- ◆ *Foundations for Success*. National Mathematics Advisory Panel, 2008
- ◆ *Common Core State Standards for Mathematics*. NRC, 2010
- ◆ NBPTS Teaching Standards: EA and AYA Mathematics
- ◆ *Mathematics Systems Improvement Framework*. OSPI, 2010
- ◆ *Learning Progressions: Supporting Instruction and Formative Assessment*. CCSSO, 2008
- ◆ *Knowing and Teaching Elementary Mathematics*. MA, 1999
- ◆ *Elementary and Middle School Mathematics: Teaching Developmentally*. VanDeWalle, 2007
- ◆ *Mindset*. Dweck, 2006
- ◆ *Washington State Diagnostic Assessment Guide*. OSPI, 2009
- ◆ *Washington State Formative Assessment Comparative Guide - Consumer Report*. OSPI, 2009
- ◆ *Envisioning a State Education System Improving Learning Through a Comprehensive Assessment System*. OSPI, 2010
- ◆ *Transformative Assessment*. Popham, 2008
- ◆ *The Professional Education and Development of Teachers of Mathematics: The 15th ICMI Study*. Ruhama & Ball, 2009

Demonstrates Accomplished Mathematics Teaching Using Effective Pedagogical Strategies

Teacher leaders in mathematics call upon successful teaching experience to work with colleagues. They have a repertoire of effective instructional strategies to engage students in learning, and understand the complexity of facilitating classroom discourse in math. They know multiple solutions to problems and students' error patterns to be able to diagnose and address naive conceptions and misconceptions. They use a variety of culturally responsive and developmentally appropriate strategies. Teacher leaders use technology both to reinforce skills and to increase student understanding and problem solving ability by modeling mathematics.

Use appropriate pedagogy to support students' mathematical proficiency

- Conceptual understanding
- Procedural fluency
- Strategic competence
- Adaptive reasoning
- Productive disposition

Proficiency in teaching mathematics

- Knowledge of connections between content and pedagogy
- Strategic application of instructional routines
- Reflective practice

Strategies for differentiation and student engagement

- Create supported, culturally responsive learning environments
- Design authentic problem solving and real world mathematical situations
- Help students make sense of the world mathematically
- Help students to persevere and to see mathematics as useful
- Promote the use of multiple strategies and representations for problem solving
- Promote mathematical discourse
- Use of effective questioning in math
- Strategic grouping and collaboration

Make instructional decisions based on student thinking

- Ability to analyze and diagnose student thinking
- Understand common preconceptions and misconceptions

Resources

- ◆ *Foundations for Success*. National Mathematics Advisory Panel, 2008
- ◆ *Adding It Up*. NRC, 2001
- ◆ *Helping Children Learn Mathematics*. NRC, 2002
- ◆ *How Students Learn*. NRC, 2005
- ◆ *Knowledge and reasoning in mathematical pedagogy: Examining what prospective teachers bring to teacher education (Unpublished Doctoral Dissertation)*. Ball, 1988
- ◆ NBPTS Standards: EA and AYA Math
- ◆ CSTP website: www.cstp-wa.org/teacher-development/cultural-competency
- ◆ OSPI website: <http://www.k12.wa.us/CISL>
- ◆ *Mindset*. Dweck, 2006
- ◆ *Effective Supervision: Applying the Art and Science of Teaching*. Marzano, 2011.
- ◆ *The Differentiated School: Making Revolutionary Changes in Teaching and Learning*. Tomlinson, 2008.

Teach literacy in math

- Explicitly teach students how to read and interpret math text, math prompts, math assessments
- Provide opportunities to learn reading and writing skills in math contexts

Promote a culture of persistence

- Consistently model and reinforce with students and parents that an emphasis on persistence is related to improved mathematics performance

Purposeful use of technology such as calculators and instructional software

- ◆ Mathematics Education Collaborative: <http://www.mec-math.org/resources/instructional-practice-focused-survey>
- ◆ Marzano Research Laboratory: http://www.marzanoresearch.com/research/researched_strategies.aspx
- ◆ *Learning and Leading with Habits of Mind*. Costa, 2008
- ◆ Habits of Mind website: <http://www.instituteforhabitsofmind.com>

Demonstrates Ability to Discuss Both Subject Matter Concepts and Pedagogical Strategies

Teacher leaders have a vision of high quality mathematics instruction and are able to articulate this vision with colleagues and community. They know and share relevant research. They share their views and listen to others' perspectives in order to continually reflect and re-examine their own practice. Teacher leaders facilitate collaborative conversations about high quality, culturally responsive teaching and learning.

Build shared knowledge of current research to develop a shared vision of high quality mathematics instruction**Explore mathematical thinking with colleagues**

- Collaboratively solve mathematical tasks to foster rich and relevant discussion
- Use questioning techniques that deepen and expand colleagues' understanding

Facilitate collaboration with colleagues

- Develop and teach others to use classroom observation tools and appropriate protocols for collaboration
- Use data to frame mathematically productive professional discussions

Generate solutions/options that provide all students equal access to high quality, challenging curriculum**Resources**

- ◆ *The Myth of Equal Content*. Schmidt and Cogan, 2009
- ◆ *Mathematics Systems Improvement Framework*. OSPI, 2010
- ◆ *Adding It Up*. NRC, 2001
- ◆ *Helping Children Learn Mathematics*. NRC, 2002
- ◆ *How Students Learn*. NRC, 2005
- ◆ *Mathematics, teaching, and multimedia: Investigations of real practice*. Lampert & Ball, 1998
- ◆ *Understanding By Design*. Wiggins, 2005
- ◆ *Lesson Study: A Handbook of teacher-led instructional change*. Lewis, 2002

Demonstrates Ability to Assist Colleagues at Multiple Entry Points to Increase Content Knowledge and Classroom Application

Teacher leaders differentiate work with colleagues to support math teachers along a continuum of development. They enhance understanding of the linkages between content expectations, instructional materials and various assessments – formative and summative – at the classroom, district and state levels.

Build teacher capacity to improve classroom management

- Demonstrate cultural sensitivity in teaching and in relationships with students, families, and community members
- Develop productive relationships with students
- Communicate high expectations, uphold academic rigor and celebrate accomplishments
- Teach self-management of student learning
- Facilitate collaborative skills and group processes

Build teacher capacity to increase mathematical knowledge

- Understand the big ideas of mathematics
- Articulate vertical alignment K-12
- Engage in collaborative professional learning
- Scaffold conceptual understanding
- Plan for and resolve typical preconceptions and misconceptions

Build teacher capacity to use instructional and formative assessment strategies that support math understanding

- Gather, read, analyze and interpret evidence of student learning
- Plan next instructional steps based on student data
- Guide discussions about student work and student learning
- Build shared knowledge of quality math assessment systems
- Utilize tools to enhance instruction and aid in formative assessment
- Apply reading and writing strategies
- Teach academic vocabulary
- Differentiate instruction based on the diverse needs of student
- Provide opportunities for students to make real world connections

Resources

- ◆ *Instructional Coaching*. Knight, 2008
- ◆ *Effort-based Principles of Learning*. Resnick & Hall, 2000
- ◆ *Content Focused Coaching: Transforming Mathematics Lessons*. West & Staub, 2003
- ◆ Success at the Core website: <http://www.successatthecore.com>
- ◆ *Teacher Leadership in Mathematics and Science*. B. Miller, et al. 2000
- ◆ *Windows on Teaching Mathematics*. Merseth, 2003
- ◆ Inside Mathematics website: <http://www.insidemathematics.org/>
- ◆ *Data Wise: A Step-by-Step Guide to Using Assessment Results to Improve Teaching and Learning*. Parker Boudett, 2005
- ◆ *Summit Mathematics Benchmark Assessment Data Analysis and Decision Making Protocol*. OSPI DSIA
- ◆ *Washington State Formative Assessment Comparative Guide - Consumer Report*. OSPI, 2009
- ◆ *Mathematics Curriculum Topic Study*. Rose and Keeley, 2006
- ◆ *Uncovering Student Thinking in Mathematics: 25 Formative Assessment Probes*. Rose and Keeley, 2007
- ◆ *Classroom Assessment for Student Learning: Doing It Right – Using It Well*. Stiggins, Arter, Chappuis & Chappuis, 2004
- ◆ *Cultivating a Math Coaching Practice: A Guide for K-8 Math Educators*. Amy Morse, 2009

Teachers and other educational leaders should consistently help students and parents to understand that an increased emphasis on the importance of effort is related to improved mathematics performance. This is a critical point because much of the public's self-evident resignation about mathematics education (together with the common tendencies to dismiss weak achievement and to give up early) seems rooted in the erroneous idea that success is largely a matter of inherent talent or ability, not effort."