Regional Mathematics Centers provide research-based professional development for Idaho educators. Our programs are made possible through funding and support from the Idaho State Department of Education.

Dr. Julie Amador, Director
Professor of Mathematics Education
Julie teaches elementary/middle school mathematics and technology education at the University of Idaho, in the College of Education, Health and Human Science's department of Curriculum and Instruction. She researches lesson study and how teachers design and enact lessons, with a strong emphasis on what teachers notice about student thinking.

Courtney Greene
Regional Mathematics Specialist
Fueled by 20-plus years of teaching at the elementary and middle school levels, Courtney’s passion is inquiry specific to STEM education; especially the role that math plays as the language of the sciences. She is the 2019 recipient of the Presidential Award For Excellence in Math and Science Teaching. Her current work centers on enhancing math curriculums by integrating the use of Smith and Stein’s (2011, 2018) The Five Practices for Orchestrating productive Math Discussions.

Jode Keehr
Program Coordinator
Jode brings creative energy and a service mentality to her work supporting teachers in Region 1. She also works closely with higher education partners to create and manage digital assets promoting mathematics professional development across the state.

Josué Rhoads
Administrative Specialist
Josué comes to the University of Idaho with a background in film, music, writing, and education. He has worked as a social worker, K-12 educator, and music production instructor. Josué enjoys filming videos, acting, recording music, and writing screenplays and novels. He holds a bachelor’s degree in creative writing from Cal State Long Beach.
Effective Questions

Effective Teaching

Knowing what students understand and do not understand is a critical component of teaching. Millions of dollars are spent each year to purchase assessments and train teachers in administering and interpreting results of these tests. It is difficult to argue against the usefulness of teachers having tools like this at their disposal, but that is only one piece of the puzzle. Teachers need to orchestrate learning in the moment. Good questioning techniques make all the difference when it comes to lesson planning and effective teaching. This article outlines research-based structures for improving questioning and will provide examples teachers can start using immediately.

(Continued on page 4.)
Danielson (2019) illustrates the impact of good questioning across subject areas in her 2019 Framework for Teaching Clusters document. Questioning is specifically discussed in Cluster 4, focusing on Intellectual Engagement, where she clarifies that the point of asking questions is to “deepen student understanding rather than serve as recitation, or a verbal ‘quiz’” (Danielson, 2019, p. 13). This distinction is important. Teachers may recall how the questioning they experienced in their own education seemed to direct them to a single answer. Questions that focus students towards a singular, correct answer [what the teacher wants to hear] and do not allow for critical interpretation are sometimes referred to as funneling questions (Herbel-Eisenmann & Breyfogle, 2005).

<table>
<thead>
<tr>
<th>Funneling Questions</th>
<th>Focusing Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher:  (0, 0) and (4, 1) [are two points on the line when graphed]. Great. What's the slope? (Long pause - no response from students.)</td>
<td>Teacher:  So, y = 1/ 4 x? Or y = 0.25x would be your equation.</td>
</tr>
<tr>
<td>Teacher:  What is the rise? You’re going from 0 on the y-axis up to 1? What is the rise?</td>
<td>Teacher:  (0,0) and (4,1) [are two points on the line when graphed]. Great. What's the slope? [Long pause - no response from students.]</td>
</tr>
<tr>
<td>Students:  1.</td>
<td>Teacher:  What do you think of when I say slope?</td>
</tr>
<tr>
<td>Teacher:  1. What’s the run? You’re going from 0 to 4 on the x-axis?</td>
<td>Student 1:  The angle of the line.</td>
</tr>
<tr>
<td>Students:  4.</td>
<td>Teacher:  What do you mean by the angle of the line?</td>
</tr>
<tr>
<td>Teacher:  So, the slope is ___? (In unison with the teacher).</td>
<td>Student 1:  What angle it sits at compared to the x- and y-axis.</td>
</tr>
<tr>
<td>Students:  1/ 4.</td>
<td>Teacher:  [Pause for students to think.]</td>
</tr>
<tr>
<td>Teacher:  And the y-intercept is?</td>
<td>Student 1:  What do you think student 1 means?</td>
</tr>
<tr>
<td>Students:  0.</td>
<td>Student 2:  I see what student 1 is saying, sort of like when we measured the steps in the cafeteria and the steps that go up to the music room - each set of steps went up</td>
</tr>
</tbody>
</table>

Funneling versus Focusing Questions

Although necessary at times, teachers should be mindful of how they use funneling questions and how often they use these types of questions. With this type of questioning, the teacher narrows students’ thinking patterns and leads them through a series of questions until they arrive at a chosen conclusion. Funneling questioning leaves minimal room for students to investigate different paths in solving a problem, thereby shifting the responsibility for learning from the student to the teacher. In contrast, focusing questions are created as a response to student feedback and consider student thinking; they allow students to figure out the answer in a way they understand, rather than as an attempt to guess what the teacher wants to hear. Figure 1 gives an example of how funneling and focusing questions lead to different outcomes in a lesson. Notice that it is unclear whether the student in the funneling example really understand what the \( \frac{1}{4} \) means. The student arrives at this answer after a series of what he or she may see as unrelated questions. When the teacher in the focusing example chooses to reframe the conversation to slope, it is a deliberate evaluation of the students’ readiness to progress in the discussion. The question acts as a formative assessment of prior learning and invites other voices into the conversation. The teacher using focusing questions is better positioned to surface misunderstandings while the teacher using funneling questions runs the risk of moving forward in the lesson when students may not fully understand the concept because they hear what they want to hear.

The questions teachers use, such as funneling or focusing questions, affect how tasks get implemented and the opportunities for learning. Stein et al. (2009) cite a number of reasons for the decline of a high-level cognitive task, including limited time, classroom management issues, or a shift from focusing on meaning-making to correctness and completeness of a task. Additionally, as teachers begin shifting toward more student-centered questioning techniques they must be prepared for potential resistance from students, especially those in older grades. Many students have been successful in classrooms where answering teacher’s questions correctly required stating a previously developed fact or idea. Creating an environment where students are willing to take greater risks and engage in discussion of open-ended questions will require deliberate planning on the part of the teacher.

Classroom Environment

Creating an environment where all students can be heard is a lofty goal in the world of teaching, but the importance cannot be overstated. Hiebert et al. (1997) articulate this when they state, “the learning opportunities for the entire class increase when all children’s ideas can become part of the discourse” (p. 71). This value is reinforced through the current Standards for Mathematical Practice and a focus on communication, critique, and precision in discussion. Teachers are obligated to nurture students’ confidence in talking about mathematics, and questioning structures is one way to do this.

The National Council of Teachers of Mathematics (2014) provides examples of different question types that can help to promote student discussions (see Fig. 2). As teachers plan their lessons, or reflect on lessons taught, thinking about the structure of questions asked during instruction may present some insights. Varying the types of questions
asked will expand students’ understanding of what it means to engage in mathematics. If teachers only ever ask gathering information questions, then students may develop a limited view of mathematics. Teachers who use sense making questions reposition the responsibility for learning on the student, inviting more ownership of understanding. Some teachers may liken this shift to moving up on Bloom’s Taxonomy or as an increase in students’ Depth of Knowledge (Webb, 1997). These are also useful tools for thinking about teacher questioning.

As students begin to feel that their voices are valued and feel more responsibility for their own learning, they will begin to feel more comfortable in the classroom. Research projects conducted locally by the Regional Mathematics Center (Amador, Wallin, & Keehr, 2019; Wallin & Amador, 2019) have continually shown that question-rich classrooms and high expectations for student engagement, guided by the Standards for Mathematical Practice, have had positive impacts on student outcomes and efficacy. These projects have required a great deal of self-evaluation by teachers but have been well worth it in the end.

**Getting Started**

One of the first steps to effective student questioning is for teachers to become aware of the types of questions they’re using in the classroom. Given the fast pace of teaching, it can be difficult to track questioning in real time. Although many instructors shy away from recording their lessons,

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### Figure 2. Questions for Promoting Discussion

<table>
<thead>
<tr>
<th>Question Type</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gathering Information</td>
<td>Students recall facts, definitions, or procedures.</td>
<td>When you write an equation, what does the equal sign tell you? When is the formula for finding the area of a rectangle? What does the interquartile range indicate for a set of data?</td>
</tr>
<tr>
<td>Probing Thinking</td>
<td>Students explain, elaborate, or clarify their thinking, including articulating the steps in solution methods or the completion of a task.</td>
<td>As you drew that number line, what decisions did you make so that you could represent 7 fourths on it? Can you show and explain more about how you used a table to find the answer to the Smartphone task? It is still not clear how you figured out that 20 was the scale factor, so can you explain it another way?</td>
</tr>
<tr>
<td>Making the Mathematics Visible</td>
<td>Students discuss mathematical structures and make connections among mathematical ideas and relationships.</td>
<td>How does your equation relate to the band concert situation? How does that array relate to multiplication and division? In what ways might the normal distribution apply to this situation?</td>
</tr>
<tr>
<td>Encouraging Reflection and Justification</td>
<td>Students reveal deeper understanding of their reasoning actions, including making an argument for the validity of their work.</td>
<td>How might you prove that 51 is the solution? How do you know that the sum of two odd numbers will always be even? Why does plan A in the Smartphone Plans task start out cheaper but become more expensive in the long run?</td>
</tr>
</tbody>
</table>

From the NCTM’s *Principles to Actions: Ensuring, 2014, p. 36-37*
watching video of their own teaching may be a good way to self-analyze the types of questions being asked.

Your Regional Mathematics Specialist can help you with setting up video observations in your classroom. The process begins with setting clearly-defined goals prior to instruction followed by a post-observation discussion. This cyclical process provides teachers with supports and next steps for shifting current practice. Contact your Regional Math Specialist to check for availability.

We have resources available to help teachers think about their own questioning practices. Anticipating student responses and responding through thoughtful questioning is outlined in both editions of the Five Practices for Orchestrating Productive Mathematics Discussion (Smith & Stein, 2011; Smith & Stein, 2018). Teachers can build confidence in asking the right question at the right time with this approach to questioning.

A more structured way to improve questioning is to fully script questions during lesson planning. This method is related to the anticipating step recommended by Smith and Stein. An example of this can be found in Kelemanick, Lucenta, and Creighton’s (2016) Routines for Reasoning. All questions are fully scripted and students are given sentence frames to aid in their responses. Findings across the region support the use of this process, boosting both student efficacy and teachers’ confidence in leading better discussions.

Finally, we’ve included examples of general, open-ended questions we’ve put together over years working in Region 1 classrooms to support teachers as they think about their questioning. (See Figure 3).

**Conclusion**

Good questioning is an essential part of knowing what students understand and a skill that is helpful to support students. At the heart of good questioning is valuing the voice of every student and providing an opportunity for everyone in class to contribute to the discussion. This may require teachers to slow down, suffer a few awkward silences, and anticipate some misunderstandings, but the result will be a greater knowledge of each student’s understanding and a deeper sense of belonging in the classroom. The benefits seem to outweigh the costs.

**REFERENCES**


Figure 3. Questions to Facilitate Learning

Examples of Open-Ended Questions

<table>
<thead>
<tr>
<th>Question</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>What would be a reasonable estimate for the answer?</td>
<td>What is another example of ...?</td>
</tr>
<tr>
<td>How did you solve that problem?</td>
<td>Are there other patterns of ...?</td>
</tr>
<tr>
<td>Can you solve that in a different way?</td>
<td>What do you think would happen if ...?</td>
</tr>
<tr>
<td>What is different about these solutions?</td>
<td>What do you still not understand about this?</td>
</tr>
<tr>
<td>What pattern do you see?</td>
<td>How would you help someone else understand?</td>
</tr>
<tr>
<td>Can you explain that a different way?</td>
<td>How is _____ related to _____?</td>
</tr>
<tr>
<td>What pattern can you construct?</td>
<td>How is this _____ related to _____ that we studied earlier?</td>
</tr>
<tr>
<td>Explain how ...?</td>
<td>How would you use this _____ to _____?</td>
</tr>
<tr>
<td>Explain why ...?</td>
<td>How does _____ affect _____?</td>
</tr>
<tr>
<td>What are some possible solutions for ...?</td>
<td>How are _____ and _____ similar?</td>
</tr>
<tr>
<td>Would this work if the numbers were...?</td>
<td>How are _____ and _____ different?</td>
</tr>
</tbody>
</table>

All questions are appropriate for either teachers or students to ask.

From the Resource Library

THE FIVE PRACTICES IN PRACTICE

Based on Smith and Stein’s (2018) *5 Practices for Orchestrating Productive Mathematics Discussions*, the *The 5 Practices in Practice* series, jointly published by the National Council of Teachers of Mathematics and Corwin Mathematics (2020), gives teachers a more in-depth look at how to apply the strategies at the elementary, middle, and high school levels. The books follow the five practices: setting goals and selecting tasks, anticipating student responses, monitoring student work, selecting and sequencing student solutions, and connecting student solutions through rich tasks. The books and companion websites offer resources to help you tackle common challenges to guiding meaningful mathematical discussion in your classroom. Contact us if you’d like to check-out a copy from our resource library.

REFERENCES


This fall, 15 teachers have been working with the Regional Mathematics Center to create math lesson plans based on five children’s books. The group is using lesson frameworks from Hintz and Smith’s (2022) *Mathematizing Children’s Literature* and referencing *Exploring Mathematics through Literature* (National Council of Teacher’s of Mathematics, 2004) to develop rich mathematical tasks to help students in kindergarten through second grade gain number sense.

Engaging in productive discussions about student learning, best practices, and incorporating literature in math, teachers collaboratively plan a lesson each week by identifying targeted learning goals, building tasks, and composing questions. At the end of the book study, teachers will keep all five books and have a bank of lesson plans from which to draw. We plan to continue showcasing the integration of math and literature by forming a working group. Five new books will be selected to help teachers deepen student’s mathematical thinking through literature. Watch for details on our events webpage.

**REFERENCES**


CONCEPTUAL BINGO

Of the many programs, books, and manipulatives offered by the Idaho Regional Mathematics Center, Conceptual Bingo is a great tool teachers can use to engage their students in a fun and creative way. Blending important math concepts with the familiar game of bingo, students and teachers alike will enjoy playing Conceptual Bingo—while learning and increasing their mathematical knowledge. We currently have six Conceptual Bingo games, each focusing on specific content: Integers, Polynomials, Fractions, Rational Numbers, and Square Roots & Quadratic Equations. Each game includes 36 unique playing cards, 360 plastic markers, and 61 calling cards. Teachers can utilize this learning game as a class warmup, end of class transition, or supplemental activity for small groups or the entire class. Contact us if you’d like to reserve Conceptual Bingo for your classroom!

REKENREKS

Using rekenreks in your classroom is an interactive, engaging way to help kids develop number sense. They can be used in multiple ways. Simply observing elementary children “play” with them can help teachers assess their students’ understanding of numbers: which strategies do they use? Are they counting? Are they able to recognize patterns? Can they subitize? Do they understand part-part-whole? Are they able to visualize without using the manipulative itself? Some other uses for the math racks are working on number strings and having students model story problems. We have kits available in our resource library. Contact us if you’d like to reserve a kit for your students!
A look at opportunities available to mathematics educators in Region 1.

**UPCOMING EVENTS**

**register**

**COACHING SUMMITS**
These one-day workshops held twice yearly are open to coaches from all districts. We invite you to connect with others, share resources, and discuss common issues.
Oct. 31, 2022, 9 a.m.–3:30 p.m.
Feb. 14, 2023, 9 a.m.–3:30 p.m.

**TEACHING MATHEMATICAL THINKING (TMT) COURSE**
Reserve your spot! Our spring TMT course (grades 3–5) will meet synchronously, online on Thursday afternoons from 4–7 p.m., January 19–March 9, 2023.

**MATH LITERATURE LESSON WORKING GROUP**
Interested in developing math lessons from children's literature? Connect, build, and share with other educators doing the same. Email us to let us know you'd like more information.

**BUILDING THINKING CLASSROOMS**
This book study will focus on implementing classroom practices that encourage deep mathematics learning in your students. Starts March 1 and runs through April 12, on Wednesdays from 4:15–5:30 p.m.

**THE FIVE PRACTICES IN PRACTICE BOOK STUDY**
Want to learn more about implementing Smith and Stein's (2011, 2018) framework in your elementary, middle, or high school classroom? Spring book study details coming soon.

**HERE TO SUPPORT YOU**
We are happy to work with teachers and administrators to conduct curricular and assessment reviews, develop instructional plans, or address other concerns at no cost.

We gratefully acknowledge funding and support from the Idaho State Department of Education which makes these programs possible.

**watch for details**

**District Level Mathematics Support**
Free resources for K-12 educators

**contact us**

**reserve a spot**

Click the links in the yellow bars for information or visit our events page: https://www.uidaho.edu/irmc-events.