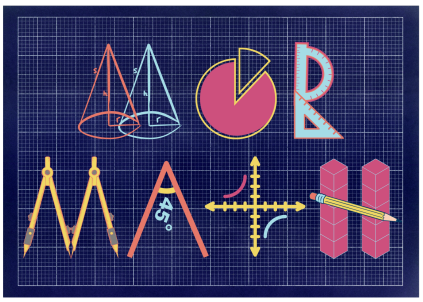
Monongalia Rigorous Mathematics

MoR Questioning Participant Workbook

September 20, 2023



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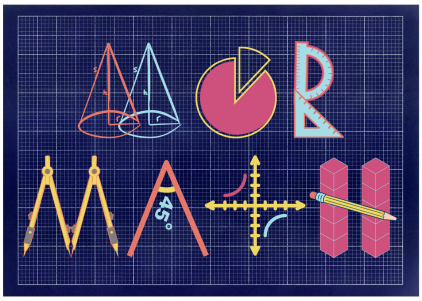


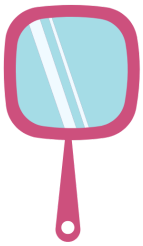
Year-Long Goal:
Increase the level of student engagement and discourse (Rigor = Student Thinking + Student Talking)

Year-Long Objectives:

- MoR Math teacher participants will develop an understanding of what rigor in the mathematics classroom looks like
- MoR Math teacher participants will utilize formative assessment strategies to gather data about student conceptual understanding
- MoR Math teacher participants will engage students in rich mathematical tasks to provide opportunities to deepen mathematical reasoning through productive struggle

Today's Session Goal:
Increase questioning effectiveness to elicit student discussion and justification

TRUE	**NOT TRUE**
TRUE **WITH MODIFICATIONS**	**UNABLE TO DETERMINE** **based on information learned**



Task Reflection

With your group, discuss the following:
• Briefly summarize the task that you completed with your students. • What did you learn about your students during this task? • How did this task encourage your students to talk and think mathematically? • What types of questions did your students ask during this task (proximity, stop thinking, keep thinking questions)? • What were some "Wows" and "Wonders" during your task?

Be prepared to share one group "Wow" and one group "Wonder". These can be specific to one group member's task or it can be something that came up during group discussion.	
Wow (One "a-ha" or highlight)	*We were wowed by...*
Wonder (One question or need)	*We wonder...*

Never Ask A Question A Horse Could Answer
From Robert Kaplisky's Blog, robertkaplinsky.com
January 30, 2018

If you've ever asked students a question only to have tentative responses come back like "Yes… No… Uh… Yes…", then you'll enjoy this story.

In the early 1900s, there was a famous horse named Clever Hans that amazed people because of his intelligence. At first Hans was able to count objects and then tap his hoof to state the number of objects. So, if he saw 4 objects, he would tap his hoof 4 times. Over time his owner Wilhelm von Osten was able to teach him how to add and subtract. Then he was taught to "multiply, divide, work with fractions, tell time, keep track of the calendar, differentiate musical tones, and read, spell, and understand German."

This amazed audiences of people who came to observe this feat. Obviously, people suspected fraud, because how could a horse do something like this? Here's what happened:

As a result of the large amount of public interest in Clever Hans, the German board of education appointed a commission to investigate von Osten's scientific claims. Philosopher and psychologist Carl Stumpf formed a panel of 13 people, known as the Hans Commission. This commission consisted of a veterinarian, a circus manager, a Cavalry officer, a number of school teachers, and the director of the Berlin zoological gardens. This commission concluded in September 1904 that no tricks were involved in Hans's performance.

They even ruled out fraud by writing the questions on paper, having someone else ask the questions, and removing von Osten from the room. For a while, no one could figure out how the horse was able to answer these questions.

Eventually the breakthrough came when they realized that Clever Hans "got the right answer only when the questioner knew what the answer was, and the horse could see the questioner." If the person asking the question knew the correct answer, Hans correctly answered the question 89% of the time, but when the person asking the question didn't know the answer, Hans got it right only 6% of the time!

[Oskar] Pfungst then proceeded to examine the behaviour of the questioner in detail, and showed that as the horse's taps approached the right answer, the questioner's posture and facial expression changed in ways that were consistent with an increase in tension, which was released when the horse made the final, correct tap. This provided a cue that the horse could use to tell it to stop tapping.

Furthermore…
After Pfungst had become adept at giving Hans performances himself, and was fully aware of the subtle cues which made them possible, he discovered that he would produce these cues involuntarily regardless of whether he wished to exhibit or suppress them.

I love this story for so many reasons. First, when I heard it, I was consistently wrong in guessing what the trick was. I figured that the owner was intentionally communicating the answers to Hans. Then when I heard what was really happening, I started thinking about where else the Clever Hans Effect might happen. For example, a UC Davis study has shown that the handlers of drug sniffing dogs can influence their ability to spot drugs.

I believe that this is also happening in our classrooms. Going back to the beginning of this blog post, could it be that we are doing the same thing with our students? Sometimes I feel like we ask students questions and then stand there waiting for them to tap out the answers with their hooves. Rather than really thinking about what we're asking, could it be that they're just reading our body language and adjusting their answer until it appears that they answered it correctly? It sure seems that way when we get responses like "Yes… No… Uh… Yes…"

Thinking about how to mitigate this possibility, perhaps instead of practicing our poker face to prevent this from happening, we should instead be thinking about how to ask questions that Clever Hans could not answer. When we primarily ask yes/no questions or ones with numeric values, we set ourselves up for these situations.

I've found that most questions which begin with "How…?" or "Why.. ?" get kids talking about what they know and would be unanswerable by Clever Hans. It takes practice to incorporate them, and if you're interested in some professional development tools to do so, check out these free questioning scenarios which allow you to practice questioning in trios using role-playing.

https://robertkaplinsky.com/never-ask-question-horse-answer/

https://robertkaplinsky.com/questioning-scenarios/

Reflection:

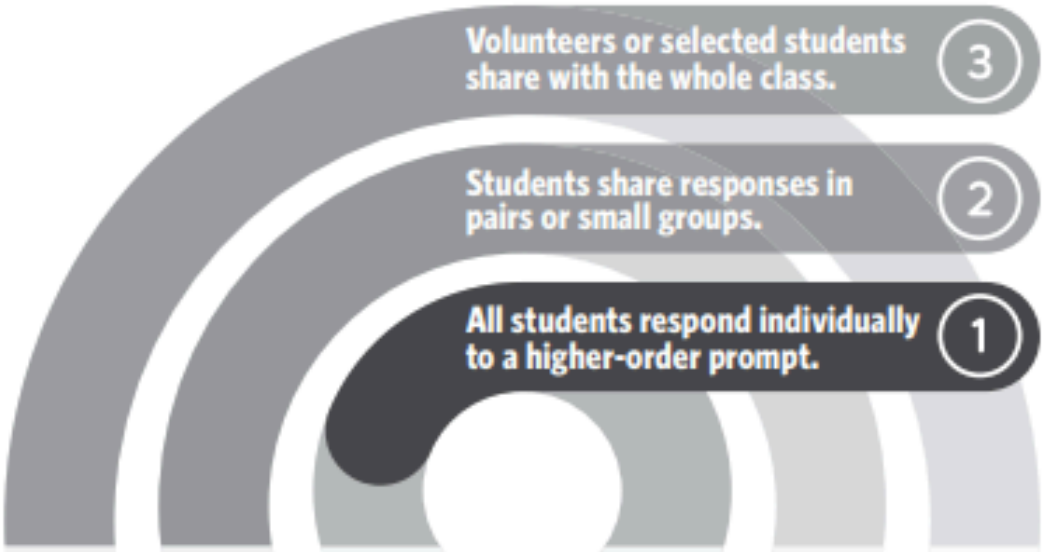
How effective are your questioning practices?

Are you asking questions a horse can answer?

Are you asking questions that can be answered by Google, Siri, Alexa?

THE RIPPLE

The Ripple is a cornerstone to understanding how to create and implement Total Participation Techniques.



The Ripple **IS** a way of posing questions to maximize actual learning time.	The Ripple **IS NOT** a traditional Q & A session.
The Ripple **IS** a way to engage each and every student.	The Ripple **IS NOT** calling on an individual student for the answer.
The Ripple **IS** all students responding to a prompt using Quick-Writes or other TPT structures.	The Ripple **IS NOT** simply group work.
The Ripple **IS** beneficial for all students, especially English language learners, socially tentative students, and students with special needs.	The Ripple **IS NOT** intimidating and does not put students "on the spot."

Five Principles for Effective Questioning

From the Math Assessment Project, Improving Learning Through Questioning
https://www.map.mathshell.org/pd/modules/4_Questioning/html/index.htm

1. Plan to use questions that encourage thinking and reasoning

Really effective questions are planned beforehand. It is helpful to plan *sequences* of questions that build on and extend students' thinking. A good questioner, of course, remains flexible and allows time to follow up responses.

Beginning an inquiry (Entry)	• What do you already know that might be useful here? • What sort of diagram might be helpful? • Can you invent a simple notation for this? • How can you simplify this problem? • What is known and what is unknown? • What assumptions might we make?
Progressing with an inquiry (Moving)	• Where have you seen something like this before? • What is fixed here, and what can we change? • What is the same and what is different here? • What would happen if I changed this ... to this ... ? • Is this approach going anywhere? • What will you do when you get that answer? • This is just a special case of ... what? • Can you form any hypotheses? • Can you think of any counterexamples? • What mistakes have we made? • Can you suggest a different way of doing this? • What conclusions can you make from this data? • How can we check this calculation without doing it all again? • What is a sensible way to record this?
Interpreting and evaluating the results of an inquiry	• How can you best display your data? • Is it better to use this type of chart or that one? Why? • What patterns can you see in this data? • What reasons might there be for these patterns? • Can you give me a convincing argument for that statement? • Do you think that answer is reasonable? Why? • How can you be 100% sure that is true? Convince me! • What do you think of Anne's argument? Why? • Which method might be best to use here? Why?
Communicating conclusions and reflecting (Reflection)	• What method did you use? • What other methods have you considered? • Which of your methods was the best? Why? • Which method was the quickest? • Where have you seen a problem like this before? • What methods did you use last time? Would they have worked here? • What helpful strategies have you learned for next time?

2. Ask questions in ways that include everyone

It is very important that everyone is included in thinking about the questions asked. Here are three ways that teachers have tried to achieve this:

- Use a 'no hands up' rule. After a few hands have gone up some students stop thinking because they know that the teacher will not ask them. When students have their hands up they too stop thinking as they already have the answer they want. 'No hands up' encourages everyone to keep thinking as anyone may be called upon to respond.
- Ask questions that encourage a range of responses. Rather than asking for specific right answers, ask for ideas and suggestions: "How can we get started on this?", "What do you notice about this?" Everyone will then be able to offer a response.
- Avoid teacher - student - teacher - student 'ping pong'. Encourage students to listen to and to reply to each other's responses. Aim for a pattern more like: teacher - student A - student B - student C - teacher.
- Arrange the room to encourage participation. Think about where students are sitting – are there some who cannot hear? Can students see and hear one another so that they can respond to the points another student makes? It is often better to sit students in a U-shape, if possible.

3. Give students time to think

The time interval between a teacher asking a question and supplying the answer herself, or following up with an additional question or comment, is commonly called 'wait time'. For many teachers, the mean wait time is less than one second (Rowe (1974)). When teachers increase this wait time to between three and five seconds the research shows that students begin to:

- respond at greater length and with greater confidence;
- offer more unsolicited, but appropriate, responses;
- offer more diverse, alternative explanations;
- relate responses to those from other students.

Increasing wait time is difficult. Silence in a classroom can be hard to bear!

- Talk to students about 'wait time'. Make sure that students *know* that they must take time to think before responding. (Some teachers even make themselves wait by counting slowly to themselves: "One, two, three, four, got to wait a little more"!)
- Use "Think - Pair – Share". Ask the question, give 10 seconds thinking time and then allow 30 seconds for talking to a partner. After this, everyone should be ready with an answer and they should know that anyone may be asked for what they think.
- Use mini whiteboards. Ask the students to spend 30 seconds thinking about the problem and jotting ideas for the solution onto their mini whiteboards. Then ask the students to share the ideas they had for starting the problem

4. Avoid judging students' responses

Interestingly, Rowe (1974) found that if a teacher made judgmental comments, even positive ones such as "Well done!", then this negatively affected students' verbal performance even with the lengthened wait times. Task persistence was greatest where verbal rewards were fewer. When a teacher judges every response with 'yes', 'good', 'nearly' and so on, students are likely to reason to themselves:

"The teacher said that was good. That is not what I was going to say. So what I was going to say cannot be good. So I won't say anything."
Ask open questions that permit a greater variety of responses and reply to students with comments that do not close off alternative ideas.

"Thank you for that, that is really interesting. What other ideas do people have?"

5. Follow up students' responses in ways that encourage deeper thinking

The following approaches encourage further thinking and dialogue:

Ask students to repeat their explanation	Can you just say that again?
Invite students to elaborate	Can you just say a little more about that?
Challenge students to offer a reason	Can you explain why that works?
Cue alternative responses	Can you suggest another way of doing this?
Support with non-verbal interest	Nod head, rotate hand to indicate that you want more
Encourage students to speculate	What would happen if ...?
Make challenging statements	Someone in this group said ... were they right?
Allow rehearsal of responses	Try out the answer on your partner first.
Encourage students to ask questions	Would anyone like to ask Pat a question about that?
Ask students to think aloud	Can you go through that step by step?
Encourage students to make connections	Can you remember something else we did like this?
Thinking aloud with students	Let's think this through together ...

Four Opportunities for Questioning

Entry Questions	For students having difficulty getting started	• What is the problem asking? • What do you know? • What information do you need?
Moving Questions	For places where we anticipate students getting stuck	• What pattern(s)/relationship(s) do you see? • What strategy (ies) could be used here? Why? • How might you model the situation?
Reflection Questions	For students to consider their process after have completing the task	• How do you know if your answer is reasonable? • How might you justify your answer using a different strategy or representation? • What resources/tools were helpful? Why?
Extension Questions	For students to engage in higher order thinking skills with respect to the same concept and/or problem	• How would the solution change if the constraints in the situation? • Why did…? • How might you use the patterns/relationships you identified to make a general conjecture about…?

From "Opportunities for Questioning: Moving Both the Learner and the Learning Forward" written by Leslie Texas and Tammy Jones
http://www.texasandjones.com/media/uploads/2013/11/Opportunities-for-Questioning-Moving-Both-the-Learner-and-the-Learning-Forward.pdf

Evaluating Expressions

Using the digits 0 through 9, at most one time each, place a digit in each box to create the greatest possible value.

Space to work:
Your solution:
Briefly describe your strategy:

Evaluating Expressions

Prepared Questions to Move Students Forward

Entry Questions	For students having difficulty getting started	• What is the problem asking? • What do you know? • What assumptions can you make? • What information do you need? • How many times can you use each digit? • What do you notice about the math symbols used in the problem?
Moving Questions	For places where we anticipate students getting stuck	• What strategies could you use? • What patterns do you see? • How do order of operations help you decide what to do first? • What possible values can you make on each side? • Which side would be better to start with? • What numbers have you tried that didn't work? Why didn't they work?
Reflection Questions	For students to consider their process after have completing the task	• Explain the strategy you used to select the digits. • How do you know if your answer is reasonable? • How did the operations affect the solutions on each side? • Is it possible to have more than one solution? • Can you think of another way to get the same solution? • What resources/tools were helpful? Why?
Extension Questions	For students to engage in higher order thinking skills with respect to the same concept and/or problem	• What's the smallest number you could make? Would you use the same strategy? • How would your solution change if you didn't have the parentheses? • Where could you add another set of parentheses to get a larger number?

Task Name:		**Date:**	
Teacher(s):		**Period/Block:**	
School:		**Course:**	

Don't forget to contact your coach to schedule a visit during your task.

Step 1: Task Selection	
☐ Task encourages multiple methods, representations, and pathways ☐ Task is inquiry based ☐ Task allows students to experience mathematics conceptually before procedures ☐ Task contains a visual component ☐ Task is "low floor" and "high ceiling" ☐ Task requires students to convince, reason, or justify	Briefly describe the task:
Step 2: Pre-Assess Student Understanding	
☐ Complete the task yourself to identify potential student OMGs and solutions. ☐ Consider expected OMGs (obstacles, misconceptions, and gaps) based on formal or informal classroom observations	What are your expected OMGs?
Step 3: Grouping Students for the Task	
☐ Group students strategically	How many students per group? How will groups be determined? How did your desired task outcome affect your grouping decisions?

Step 4: Prepared Questions to Guide Students	
☐ Prepare Entry Questions prior to the task ☐ Prepare Moving Questions prior to the task ☐ Prepare Reflection Questions prior to the task ☐ Prepare Extension Questions prior to the task	List the questions you have prepared ahead of time:
Step 5: Prepare Materials for Task	
☐ Gather needed materials prior to the start of the task ☐ Provide students with access to a variety of manipulatives and/or tools	What materials do you need to prepare in advance?
Step 6: Implement the Task	
☐ Utilize student engagement strategies or routines ☐ Encourage students to take risks and persevere through productive struggle (No GPSing) ☐ Use questioning to keep students in flow ☐ Foster a classroom culture of student reasoning ☐ Help students understand the task and its context/clarify directions ☐ Allow students to self-select strategies, resources and representations to best express their thinking	Which strategies do you intend to use to encourage engagement and perseverance?

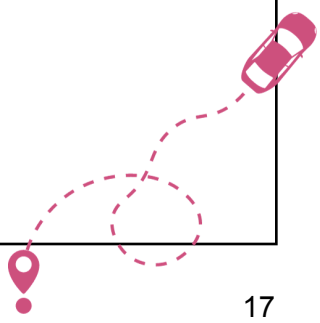
Step 7: Gather Formative Data	
☐ Note struggles and strategies of learners ☐ Create experts	Which students struggled? How/why? Which students were successful? How/why? Which students utilized creative strategies?
Step 8: Plan Intervention Based on Needs	
☐ Adjust instructional pacing as needed ☐ Plan differentiated instruction	How will your observations affect your pacing? Which students may need additional time to master the concepts?
Step 9: Reflect	
☐ Turn in an online reflection ☐ Complete wows and wonders	List some things that WOWED you:
	List some things you are WONDERING about:
	Comments or notes for using this task in the future:

Observing a Task in Action

While observing Gwen facilitate the task "Sharing Gas Costs", consider the types and the effectiveness of her questions.

Type of Question	Question Purpose	Examples of Questions Used
Entry Questions	For students having difficulty getting started	
Moving Questions	For places where we anticipate students getting stuck	
Reflection Questions	For students to consider their process after have completing the task	
Extension Questions	For students to engage in higher order thinking skills with respect to the same concept and/or problem	

What evidence did you see of Gwen using the Principles of Effective Questioning?	
Principles of Effective Questioning 1) Plan questions that encourage thinking and reasoning 2) Ask questions in ways that include everyone 3) Give students time to think 4) Avoid judging students' responses 5) Follow up responses in ways that encourage deeper thinking	Evidence in video:



MoR Homework

Assignment 1:

What	Read chapter 9 (How We Use Hints and Extensions) in "Building Thinking Classrooms in Mathematics" by Peter Liljedahl.
Where	You do not need to post a reflection anywhere, just be prepared to discuss
When	Prior to the October 20th MoR Math meeting
Why	Chapter 9 will bridge our conversations about questioning (September session) and student engagement (October session)
How	Read the chapter on your own and be prepared to discuss during our October meeting.

Assignment 2:

What	Implement your second rich math task of the school year
Where	Facilitate the task in your classroom alone or with your co-teacher. Post a reflection using a link on the MoR Math website (link will also be emailed).
When	Prior to the October MoR Math meeting
Why	Provide an opportunity for students to engage in a rich math task requiring them to reason, justify, discuss, and represent mathematics.
How	Select a task from the task library or tweak an existing lesson; prepare questions prior to implementing the lesson; invite Amanda, Monica, or Kelly Ann to visit during the task; consider areas of the Task Checklist as you plan

Assignment 3:

What	Discuss the MoR Rigor and MoR Task Selection sessions with two people.
Where	Your school
When	Prior to the October MoR Math meeting
Why	Share your learning and gain new insights
How	Talk with two people: a) A MoR Math friend from Cohort 1 (last year's group) b) A teacher not involved with MoR Math (any content area)

MoR Space for Notes

MoR Space for Notes