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Noticing before responding

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Noticing before Responding

When teaching at the secondary level, our decisions in the classroom about what to do next to support students' understanding are often based on observations, what we hear, or from analyzing students' work. For many, we call this formative assessment and we gather information from walking around and talking to students, observing their work, or engaging students in discussions about their thinking. Effective teachers then take the information gathered and plan subsequent instructional decisions around their findings from these experiences. Mathematics education researchers have found the use of these behaviors for instructional decisions to be an important practice (Schoenfeld, 2015), yet specialized focus and care should be given to how teachers are eliciting student thinking, interpreting this thinking, and ultimately making informed decisions to respond—a process recently referred to as professional noticing (Jacobs, Lamb, & Philipp, 2010). Professional noticing is a specific set of skills that can be applied whether the teacher is in the process of formatively assessing, or generally teaching a lesson. In efforts to make decisions on the basis of students' thinking, pedagogical questions arise about *when* and *how* these decisions occur and the deliberateness of teachers' noticing. This article builds from research on noticing, along with our own experiences teaching, and outlines a process in which teachers can follow to professionally notice students' thinking in their classrooms and ultimately improve their instructional practice.

As teachers of secondary students, and having been involved in research about teachers' noticing and decision making, we contend that teachers should be deliberate in their consideration of students' thinking before they determine how and what they will teach next. We have found that making instructional decisions works best when the decisions are based on interactions with students and when evidence is used to make decisions. To be successful in this process, we created and used a framework that breaks down the process of professional noticing. This framework has a specific focus on evidence generation and has helped us when we are teaching secondary students. Although the helpfulness of this framework varies based on the task, we have found that using the framework has resulted in more deliberate and meaningful pedagogical decisions based on students' mathematical thinking, which ultimately supports students in learning mathematics content. The following section describes the background for this framework, rooted in the work on professional noticing, and then describes how you can use the framework to be deliberate about what and how you notice in your classroom.

Professional Noticing

Jacobs et al. (2010) described a set of skills teachers should use to professionally notice children's mathematical thinking. In their work, they state teachers should: (a) *attend* to students' mathematical thinking, (b) *interpret* students' mathematical thinking, and (c) *decide how to respond* to students' thinking. We build on this model and present a modified approach in our framework that can be used at the secondary level (see Figure 1). As teachers, we concur with Erickson (2011) that before attending to students' thinking, the first decision teachers make instructionally should be carefully articulated to ensure the outcome will elicit opportunities to understand and analyze students' thinking. We believe that teachers' decisions to respond, or what they do next, should be based on evidence they generate from their teaching. Figure 1 illustrates this Noticing Evidence Framework that we have found helpful for teaching in the secondary classroom.

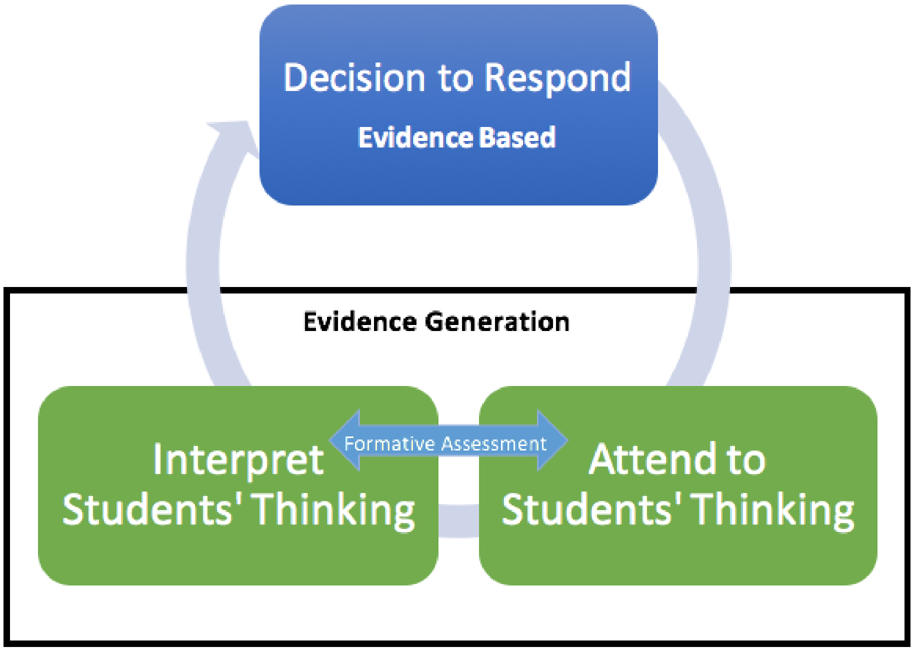
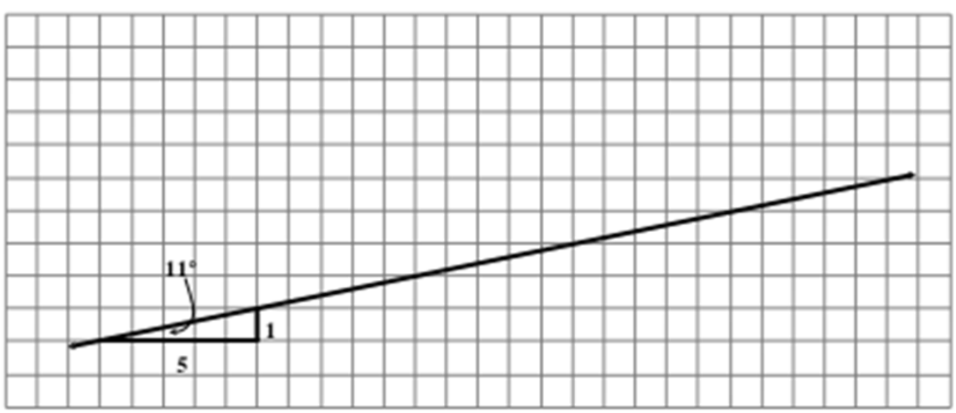


Figure 1. Noticing Evidence Framework; professional noticing cycle foregrounding *decisions to respond*.

As teachers, we need to begin with intentional instructional designs (e.g. Smith & Stein, 2011) that will then provide opportunity for evidence generation, which includes attending to, and interpreting, students' thinking. This process looks something like this: (a) begin with an intentional instructional decision based on evidence (Figure 1, blue cell), (b) begin teaching the lesson (Figure 1, follow light blue arrow) (c) attend to, and interpret, students' thinking to generate evidence (Figure 1, green cells), and then (d) make the next instructional decision and execute the decision based on the evidence generated (Figure 1, blue cell again). While generating evidence and teaching, the teacher may use formative assessment techniques, such as asking additional probing questions to generate enough evidence and make a decision to respond (Author, 2018). We recognize that many teachers may already take part in a similar process, but we want to encourage teachers to consider this framework and be even more deliberate with the decisions they are making. This has helped us focus our teaching, as we describe in the following example.

Illustrative Example

To consider how you might notice within the classroom context, we present an actual classroom case as an example. We recognize that the task could be altered to increase cognitive demand and some teachers may implement the task differently. That being said, we use this case as an example of a real-life classroom and the interactions that can ensue as a teacher is noticing. On day one of a unit with goals around slope ratios, a secondary geometry teacher set the background for more complex tasks and made the decision to give his students the following task (Figure 2), adapted from the College Preparatory Mathematics (CPM) curriculum (Dietiker, Kysh, Sallee, & Hoey, 2007) so they could explore the relationship between slope and angles using right triangles on a coordinate grid. (We note that for the task, students were told that all angles were rounded to the nearest degree.)



a. Draw three new slope triangles on the line. Each should be a different size. Label each triangle with as much information as you can, such as its horizontal and vertical lengths and its angle measures.
b. Explain why all of the slope triangles on this line must be similar.
c. Since the triangles are similar, what does that tell you about the slope ratios?

Figure 2. One of the opening questions from the task.

All students in the class explored right triangles with an 11° angle, which they found to have a slope ratio of approximately 1/5. After engaging students in the task, and attending to and interpreting their thinking to generate evidence of their thinking (using questioning techniques for formative assessment, e.g. How did you arrive at the slope?), the teacher had a better understanding of students' background and how they were reasoning and made the decision that the students needed further opportunities explore relationships of slope ratios. From listening to students, the teacher anticipated that students may apply a multiplicative relationship to tasks relating to triangles and wanted to explore whether or not this misconception would arise. As a result, working with the curriculum materials and task as presented in CMP, he made the *decision to respond* by determining students would create a list of slope ratios of the hypotenuse for triangles with different angles the next day, starting with one specific triangle (Figure 3).

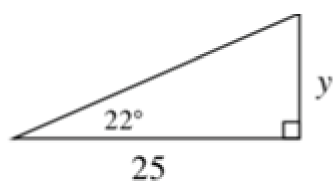


Figure 3. A question from the second task.

For this new task on day two, students created a triangle with a horizontal leg of 25 and a base angle of 22º and determined the vertical leg would be approximately 10. As shown in the following discussion, one group of students attempted to apply a multiplicative relationship when reasoning about a right triangle with a 22° angle. The teacher listened in to hear one group's conversation and to generate evidence for his future decisions. The following is actual student dialogue during instruction (all names are pseudonyms):

Willie:	You're right. You have two-fifths.
Joanne:	Is it?
Tonya:	It's twice 11. So y = ... 10? And then, this is a two-fifths ratio, so we know 22°.
Willie:	Well, we didn't know...
Joanne:	He used the protractor, and he graphed it.
Willie:	I saw that it was a two-fifths ratio. Tonya said earlier because it's double the angle, that we can double it. We didn't know for sure.
Tonya:	That was just a thought.

While listening to the group, the teacher *attended to* and *interpreted* (Figure 1) the students' thinking to generate evidence. He then realized that the students attempted to use what they already knew about right triangles with an 11° angle to determine missing information about the triangle in Figure 2. It is possible that the teacher anticipated this would be the case, or that the curriculum authors designed this intentionally. Nevertheless, the students applied multiplicative reasoning by multiplying the angle measure by 2 and expecting the resulting triangle with a horizontal leg of 25 to have a vertical leg of measure 2*5=10. Based on his noticing, the teacher confirmed the students were applying a multiplicative relationship. He paused to reflect on the exact student thinking (see Figure 1, green rectangles) and then made a *decision to respond* (Figure 1, blue rectangle) based on the evidence generated. The decision was to pose a follow-up task that would encourage the students to further explore their multiplicative thinking and lead them to question their initial assumptions. The teacher posed the following to the group, "Let's take a moment to think about this. Go ahead and create a slope triangle and calculate the slope ratio for an angle with a measure of 55°." Following the teacher's *decision to respond* with this new task, the students in the group engaged in the following conversation:

Tonya:	55 is a multiple of 11.
Joanne:	So do we think that would be…
Tonya:	Well, if 22 is twice ... 22 degrees is two-fifths, would 33 be three-fifths? No, that doesn't work.

Willie: That's why I was questioning.

This led the student group to go back and reexamine their assumptions about the relationship between angle measure and the slope ratio of a right triangle. Later, a whole-class discussion occurred around how the students (in the example group and other groups) often initially think of multiplicative relationships as a viable solution strategy when solving problems involving two quantities. Most students in the class had initially used multiplicative reasoning when looking at the relationship between angle and slope ratio, but they quickly recognized why this reasoning was incorrect when given the follow-up task. One student summarized these struggles:

> That's to get the misconceptions clear, for example, you're graphing y = 2/5*x. If you double the x, you double the y-values. So, you might think, if you double the theta, you double the trig results, but it doesn't always work like that. You have the 11, 22 degrees, so we can have some evidence it won't always work.

With this realization, based on additional evidence, the teacher was then able to pause again and think about this common misconception more broadly within his class. He considered the confusion arising from students because this slope ratio of an angle is the same as the tangent of that angle, and so the relationship between slope and angle is not multiplicative, it is trigonometric. He then decided that he should include future tasks in the course—and specifically the next day—that would provide students with opportunities to continue to explore relationships between quantities, further demonstrating the cycle shown in Figure 1. Figure 4 shows direct application of the Figure 1 framework, as it applied in this context.

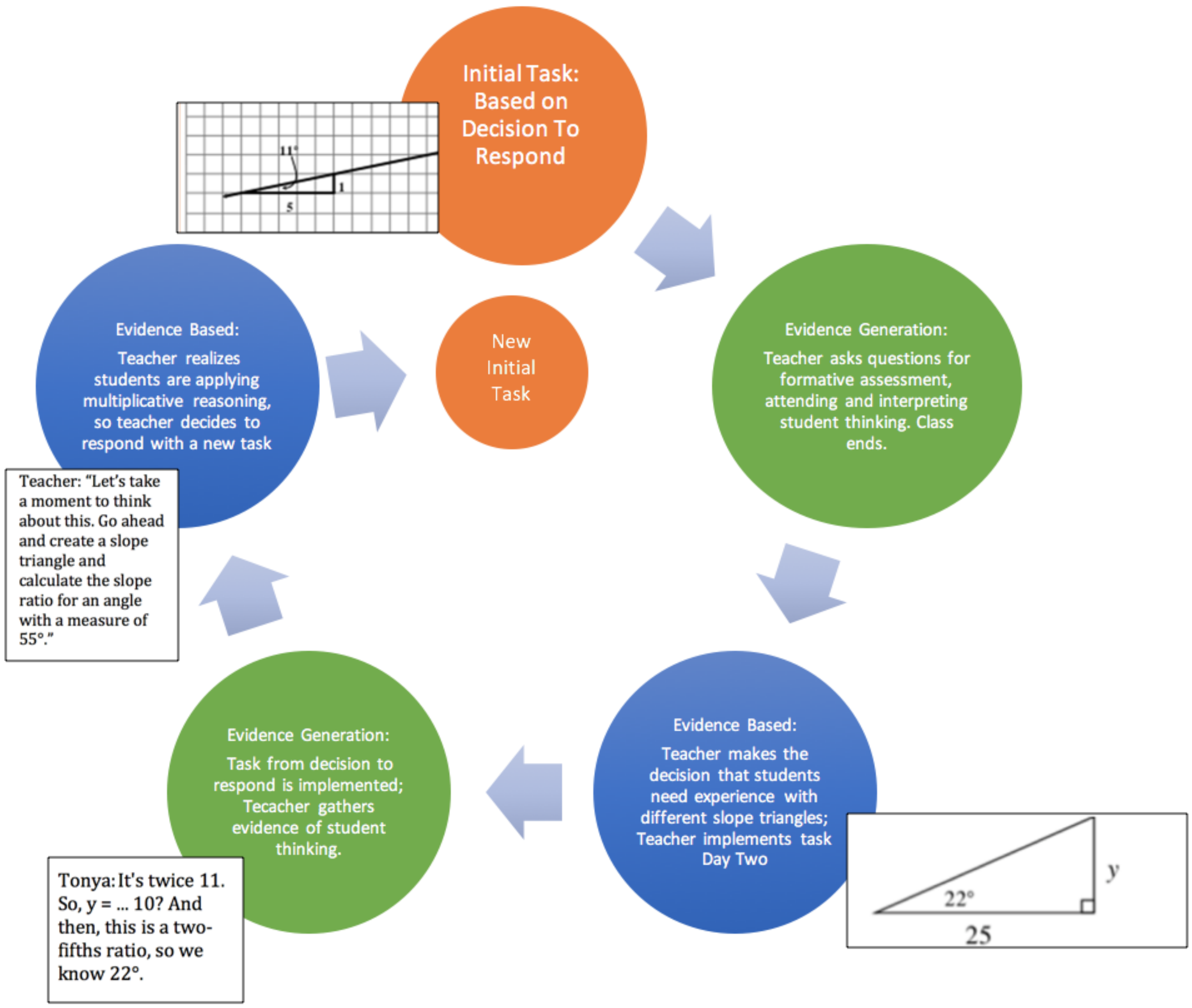


Figure 4. Application of the Noticing Evidence Framework to the example

Implications and Application

Based on the example provided, and other uses of the framework, we found that using the Noticing Evidence Framework in our own work supported us in clarifying the process of noticing (including attending, interpreting, and deciding to respond). As teachers, we can *attend to* and make *interpretations* based on how students reason, but we must make deliberate and meaningful decisions that are evidence-based to respond in ways that more fully support students' knowledge development and understanding. These decisions to respond may occur within a lesson or between lessons and in accordance with the sequence suggested in curriculum materials or not. They are thoughtful decisions that are based on evidence that is gathered as teachers attend to and interpret students' mathematical thinking. Based on our experiences, we have suggestions for secondary teachers wishing to implement this framework in their classroom.

Analyze specific evidence. A key to implementing this framework and the distinguishing part of this instructional approach is collecting and analyzing specific evidence of students' thinking (Castro Superfine, Bragelman, & Fisher, 2015; Nickerson, Lamb, & LaRochelle, 2017). Author (year) discusses the importance of gathering evidence of student thinking and interpreting this thinking. In this process, identifying exact evidence such as student dialogue, actions, or written work is important for supporting future decisions. Gathering the evidence permits decisions to be based on the most accurate facts about what a student knows or may not know. Again, we recognize that not all tasks will lend themselves to this type of evidence generation, but we encourage teachers to think about how they can better notice and understand their students' thinking.

Pause and record ideas. For effective implementation, teachers should pause either between moments within instruction or from lesson to lesson (likely more feasible) and think about or record ideas, thoughts, and evidence from the cycle. Mason (2002) indicates that when teachers record their ideas after noticing, they gain a heightened awareness of that situation. We realize teachers are busy and writing down specifics is not a reality for day-to-day practice, but we believe the template below (completed based on the aforementioned example) can help structure thoughts and can be a written template, if time permits. The table can also serve as a quick-reference guideline for a non-written reflection about a lesson.

Table 1. Completed template based on example provided.

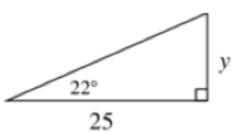
<u>Before Instruction</u> What was the last instructional decision I made? What task will we start with? Decision to Respond Evidence Based	<u>During Lesson or Segment</u> What do I notice? Attend to Students' Thinking	<u>During/After Lesson or Segment</u> What evidence do I have? (Write specific comments/examples) Evidence Generation	<u>After Lesson or Segment</u> What does this mean about their thinking? Interpret Students' Thinking	<u>Before Instruction</u> What should I do next to support students' thinking? Decision to Respond Evidence Based	<u>Before Instruction</u> When should action based on this decision occur?
- Create a list of slope ratios of the hypotenuse for triangles with different angles 	Students in groups; one group is discussing relationship between an 11 degree angle and a 22 degre angle	Tonya: It's twice 11. So y = ... 10? And then, this is a two-fifths ratio, so we know 22°. Willie: I saw that it was a two-fifths ratio. Tonya said earlier because it's double the angle, that we can double it. We didn't know for sure.	Students seem to be applying a multiplicative relationship; they think that if the slope of 1/5 is an 11 degree angle, then a slope of 2/5 would have a 22 degree angle	Have students calculate slope ratio for a angle with a measure of 55 degrees	As soon as possible to support them to understand their misconception

Table 1 merely serves as an example of an approach that could be taken; there are many other possibilities. The important takeaway is that the intersection of attending to students' thinking and interpreting students' thinking involved evidence generation. In this case, the evidence was then considered as the teacher made the decision to respond and included an additional task, with specifically chosen different numbers, for students to solve.

Conclusion

The notion of incorporating the Noticing Evidence Framework as a way to implement professional noticing in the secondary classroom is one means for us, as secondary teachers, to support ourselves in making evidence-based decisions to respond. Many researchers (e.g. Jacobs et al., 2010; van Es & Sherin, 2008) have argued for the importance of professional noticing in the classroom and this framework bridges the research literature with classroom implementation. Although the example provided is within one specific mathematics domain and the framework may not be applicable for all tasks, the process of enacting this framework to other secondary domains can be extended from this work. We contend that incorporating this practice, in addition to the formative assessments we were already using in the secondary classroom, has supported us to be more purposeful in the decisions we make about instruction, which has in turn, supported our students' mathematical learning. We believe incorporating this type of noticing will be beneficial to other secondary teachers as well.

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