[Module 7 Overview Document]

Table 1: Timeline of Tasks in the Module

Timeline of tasks in the Module	Day 0	Homework	7.1 Introduction to the Sine Graph Desmos Task
	Day 1	20 min	7.1 Discussion Optional: Extend the Discussion: Task Design
		35 min	7.2 Launching a Technology-Mediated Math Task
		20 min	7.3 Noticing Student-Teacher Interactions
		Homework	7.4 Monitoring Student Thinking: Introduction to the Sine Function
	Day 2	15 min	7.4 Discussion
		20 min	7.5 Noticing Student Thinking about Amplitude
		40 min	7.6 Noticing Student Thinking about Period
	Day 3	40 min	7.7 Designing a Sequence of Tasks (optional project)

7.5 Facilitation Notes

The students in this video are not from the class in which the videos included in tasks 7.2–7.4 were recorded. However, it is the same lesson and was implemented very similarly in a face-to-face setting in Fall 2021 (Note: You will see students wearing face masks in the classroom). The students had previously learned about many function families (e.g., linear, quadratic, exponential, absolute value) through similar parameter explorations, but had not been formally introduced to the sine function prior to this task. However, students have seen that the sine function creates a “wave” through looking at models of a cart moving around a Ferris Wheel over time (like in Module 3: Desmos Function Carnival).

If teachers have completed 7.4 Noticing Student-Teacher Interactions in a Technology-Mediated Environment, they have seen short snippets of students thinking about various parts of this task. Here they will have the opportunity to examine authentic student work on the task. They will see a pair of students who are working collaboratively on one laptop. They will see the students’ computer screen (i.e., their technology engagement) and listen to them discuss their ideas. Specifically, this video clip is focused on a pair of students, Xarielle and Kei, making sense of the relationship between two sliders, a and k, and the amplitude of the sine function $y = a\sin(bx) + k$.

We recommend that teachers work in pairs on this task. Providing teachers with the transcript of the video to refer to as they are responding to the task prompts is helpful.

After the teachers complete the task, one suggestion for a follow-up whole class discussion is to put the teachers into four groups and assign each group one of the four questions to discuss and share with the whole class.

If you are short on time you might consider discussing 7.5 and 7.6 together after completing both tasks.

7.5 Sample Responses
Noticing Student Thinking about Amplitude

Context

Ms. Fye is using the [Introduction to the Sine Graph Desmos Task] an in-person class.

This is an introduction task focused on reasoning about the relationship between the equation of a sine function and characteristics of the sine graph. Ms. Fye designed the task knowing that her students had explored the relationship between function structure and their graphs by varying the parameters for many different function families. With that in mind she had the following learning goals:

- Students will recognize the connection between the structure of a sine function equation (i.e., $y = a\sin(bx) + k$) and its related graph with respect to amplitude, midline, and period. Specifically,
    - Amplitude is $|a|$
    - Midline is $y = k$
    - Period is $\frac{360}{|b|}$

Specific performance goals include:
- Given a sine function equation, students will determine the amplitude, period, and midline without graphing.
- Given the amplitude, midline, and period, students will determine the function equation.
- Given the graph of a sine function, students will determine the amplitude, period, and midline.
- Given the graph of a sine function, students will determine the function equation.

Xarielle and Kei are discussing page 6 of the Desmos task. Specifically, they are working to determine which parameter affects the amplitude of a sine graph. The students each provide justification for why they think a certain parameter affects the amplitude. Watch the clip and answer the questions below.

[Xarielle and Kei Exploring Amplitude of the Sine Function]

Q1. Attend to (describe in detail) how the students make sense of which parameter affects the amplitude.

- Kei opens the discussion by saying k affects the amplitude because as she changes it she sees the function move up and down so "its going to have different amplitudes", she also says that a does not change it at all. When the teacher agrees that k moves it up and down and asks what the amplitude is right now, Xarielle clicks on a max point and a min point to see the ordered pairs for each. Since the y values for each point are decimals, they move both b and k to integers so the ordered pairs are nicer ($b = 2$ and $k = 1$). Kei says the amplitude now is 1. The teacher then prompts them to change the value of k. They change k to -1 and the teacher asks what the amplitude is. They again click on a max and min point to see the ordered pairs and Kei declares the amplitude is 1. Xarielle is still thinking and says "so we have to do negative 2 plus 1. Then the girls both agree this example has the same amplitude as the previous one. Xarielle then adds that she thinks it is a because as she changes the value of the a slider (she tells them to "watch this, watch this, watch this" as she changes it and she sees the amplitude change), but then she stops on $a = -1$ (which is the same as it was before). Ms. Fye asks again what is the amplitude now and they both say it seems to be the same. Xarielle then changes the b slider and observes the graph stretch horizontally, and asks "are they still the same?". She checks and determines they are still the same and seems surprised by that. They then start to change the a slider value again. Kei suggests trying 2. They put it on -2 and click a max and min point to see values. Then think aloud about how to use those and the midline value to get the amplitude and Kei explains it's -3 minus 1 divide by 4 then the absolute value so its 1. Neither girl seems comfortable with that answer and Ms. Fye asks to think about it further before trying another value. Xarielle says it is 2 (she counts 2). Kei is thinking more broadly about which slider than the value of the amplitude here and says she chooses a. Ms. Fye presses and asks why she says a. Kei says when you "fly a" it "stretches and it's different than if you stopped" noting that the stretch is changing the amplitude. She stops on $a = 0.6$ and tests to make sure it is different. Xarielle than changes the k slider and then agrees that it should be a. She explains that k just moves it up and down. She says a makes the sine "either larger or smaller" (showing with her hands that both the max and the min are changing when you change a). Kei adds on that k just changes the position and Xarielle restates that agreeing.

- The girls test both k and a with Kei thinking it is k and Xarielle thinking it is a when they begin. They change the k slider testing different values and eventually see that they keep getting the same amplitude when they only change k (or change k and b). They then start changing the a slider and describe that a is stretching the sine function. They test a value and see they finally got a value different from what they had been getting. They then seem to both agree that it is

a because of the stretch, but still try to make sense of why it is not k. After changing k a few times they notice it is moving the graph up and down but not changing the amplitude. Finally they agree that a (and only a) is the slider that affects the amplitude.

Q2. In what way did Xarielle and Kei's prior knowledge of functions help or hinder their investigation of the relationship between the parameters and amplitude?

- The girls seem very comfortable testing the sliders and trying to make sense of how they related to what they see on the graph. They also have the language of the function "stretching" and "moving up and down" to describe what they are observing. I don't see any hindrances here.
- Their prior knowledge of transformations of parent functions is evident in the way they attend to the graph stretching and translating (moving up and down). This language helps them describe what they are observing and connect what they see in their exploration to the new term, amplitude.

Q3. How does the students' thinking about which parameter affects the amplitude change during the video clip? Why does it change? Provide evidence from the video clip.

- They go from one of them thinking it is k and the other a, to both thinking it might be k, finally both agreeing it is a. It changes because they test each slider multiple times and work hard to not only make sense of which slider it is, but also why the other is not. See times 2:10, 2:25 - 2:40, and 3:50 - 4:10 as examples.
- [0 - 1:10] Kei thinks it is k and Xarielle thinks it is a. This seems to be because k moves it up and down and amplitude is about the max and min values. They test some values of k to determine amplitude. [2:08 - 2:24] Xarielle explains that she thinks it is a because "watch this" as she shows the a slider stretches the graph vertically. But then she stops a at the same value she started it on to check the amplitude again and sees it is still the same so this might have thrown her off. [2:50 - 3:18] They try 2 for a and see they now finally have a different amplitude, so now Kei says so it is a and k and wonders if it can be both. [3:45 - 4:09] They have both now said it is a and explain that if you "fly" a it stretches, and the amplitude is different. [4:43 - 5:01] They are both now convinced k is not it because k just moves the function up and down.

Q4. Ms. Fye's learning goal was "Students will recognize the connection between the structure of a sine function equation (i.e., $y = a\sin(bx) + k$) and its related graph with respect to amplitude". Do you feel like Xarielle and Kei have met that learning goal? Explain why or why not by providing evidence from the video clip.

- Almost...they have figured out that a (and only a) is related to determining the amplitude, but they have not yet determined that a is the amplitude. Though we do hear them trying to take the absolute value of the difference between the maximum and minimum value divided by 2, so there is a connection between the definition and the value of a. I just am not convinced they have tied it to the structure of the parent function yet.
- They seem to know which slider will be used to determine the amplitude, but I am not sure that they can explain the connection between the function equation and the slider yet. We see them making sense that the a slider does affect the amplitude by stretching the function, but there is no evidence in this particular clip that they then tie it directly to determining the amplitude from the function equation.