



Connecting Trigonometric Operations and Trigonometric Functions

Total time: 150 minutes but could be shortened to 75 minutes if needed. See page 2 for recommendations for a 75-minute module.

Situating the Module within the PTMT Algebra Materials: This Module could be used alongside Chapter 7: Function Families of the PTMT Algebra Materials. Section 4: Modeling Data Using Function Families: Examples with Trigonometric Functions includes two examples of modeling data using trigonometric functions. The first uses hours of daylight data and the second trigonometric functions to represent sound. If using both sets of materials we recommend using the modeling tasks in the PTMT Algebra materials first as they provide examples of students with no prior experience engaging with an informal introduction to the sine function.

Overview of the Module: This module uses a Desmos teacher-created file to explore the sine graph with a focus on the Common Core State Standards for Mathematics call for students to “Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline” (F.TF.5) Within this context, as the culminating module, the module is designed to provide teachers will the opportunity to approximate all of the 5 Practices for orchestrating discussions and all components of the NITE framework. One set of video clips from this unit are from the context of remote instruction where the whole class discussion and the teacher’s movement among pairs of students in breakout rooms are shown. The other set is pairs of students working in a face to face instructional setting. To build on teachers noticing and their orchestration of the five practices, this module uses a pre-populated Desmos’ Teacher Dashboard for teachers to practice the skills of notice/monitor student thinking and select/sequence student work in support of whole class discussions.

Module Goals:

- Build an understanding of the ways in which relationships between changing parameters result in changes in the graph of a sine function. Specifically, making sense of function parameters as they relate to amplitude, midline, and period.
- Examine student practices when working within the Introduction to Sine Activity.
- Consider how to use the Desmos Teacher Dashboard to monitor and elicit student thinking.
- Practice the pedagogical skills of anticipating, monitoring, and selecting and sequencing students’ work (Smith & Stein, 2018).



Table 1: Timeline of Tasks in the Module

Timeline of tasks in the Module	Day 0	Homework	7.1 Engage in Introduction to the Sine Graph Desmos Activity
	Day 1	20 min	7.1 Discussion of Introduction to the Sine Graph Desmos Activity 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 of Introduction to the Sine Function: Monitoring Student Thinking
		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)

Recommendations for 75-minute module:

This module is designed for 150 minutes but could be shortened to 75 minutes if needed. Suggestions include:

- One approach is to engage in either Day 1 or Day 2, with 7.1 as the homework prior to either based on your pedagogical focus. Day 1 pedagogical focus is on the teacher moves and Day 2 is on noticing and monitoring student work.
- Tasks 7.5 and 7.6 are not sequential. Therefore, you can choose to change the order or remove an assignment to fit your course. If you choose only one task, we recommend 7.6 Noticing Student Thinking about Period since it provides teachers an opportunity to engage in many of the pedagogical skills that have been developed across the seven modules (i.e., noticing, posing questions, connecting to learning goals)

MTE preparation for Module 7:

- Engage with Desmos: Introduction to the Sine Graph
- Familiarize yourself with the research on effective task launches.
 - Jackson, K. J., Shahan, E. C., Gibbons, L. K., & Cobb, P. A. (2012). Launching complex tasks. *Mathematics Teaching in the Middle School*, 18(1), 24–29.
 - NC²ML (2018, February). Launching a task: Providing opportunities for all students to learn. *Research-Practice Briefs*. North Carolina Collaborative for Mathematics Learning. Greensboro, NC. Retrieved from nc2ml.org/brief22.
- (Re) Familiarize yourself with the 5 Practices for Orchestrating Productive Discussions.





- Suggested Refresher: Nabb, K., Hofacker, E. B., Ernie, K. T., & Ahrendt, S. (2018). Using the 5 practices in mathematics teaching: Selecting and sequencing student work with cognitively demanding tasks in a group environment can teach important mathematical ideas. *Mathematics Teacher*, 111(5), 367–373.
- For Digging Deeper: Smith, M. & Sherin, M. G. (2020). The 5 Practices in Practice: Successfully Orchestrating Mathematical Discussions in Your High School Classroom. NCTM. Chapters 3 - 5.
- Read facilitation notes, engage with assignments (including watching associated videos), and look over sample student responses.

Suggested Readings for Teachers:







- Jackson, K. J., Shahan, E. C., Gibbons, L. K., & Cobb, P. A. (2012). Launching complex tasks. *Mathematics Teaching in the Middle School*, 18(1), 24 - 29.
- NC²ML (2018, February). Launching a task: Providing opportunities for all students to learn. *Research-Practice Briefs*. North Carolina Collaborative for Mathematics Learning. Greensboro, NC. Retrieved from nc2ml.org/brief22.

Detailed Agenda for Module 7





Table 2: Agenda

	Description of Module Tasks	Facilitation Notes
Day 0 / Homework	7.1 Engage in Introduction to the Sine Graph  Teacher devices  Desmos Activity Teachers complete the Desmos Activity that has them engage with the introduction to Sine activity exploring effects of parameters on the amplitude, midline and period.	Create a class code for the Desmos Activity and provide the link to your students. We recommend assigning Jackson et al. (2013) as a reading for homework as it will be useful for the teachers' engagement with 7.2 in class the next day. See the full Facilitation Notes which includes the Sample Responses to prepare yourself for a whole class discussion the following day.











Day 1	<p>7.1 Engage in Introduction to Sine Graph (20 minutes)</p> <p>  Teacher devices  Desmos Activity  Task Planning Guide </p> <p>Teachers first participate in a small group discussion about characteristics of sine graphs and then participate in a whole class discussion about the mathematics behind the task and how it relates to Ms. Fry's instructional goals.</p> <p>Optional Extended Discussion:  Introduction to Sine Graphs Task </p>	<p>Have the teachers login to their Desmos account and review their work on the Introduction to Sine Graph task. We suggest first having small groups of teachers discuss the characteristics of sine graphs they found most difficult for themselves as a learner and those they expect to be difficult for students. Next facilitate a whole class discussion focused on pages 3 and 4 of the activity. At this point, we recommend sharing the task planning guide that Ms. Fye (the teacher who designed this activity) created to guide her instruction and discuss the mathematics in the task and how it aligns to Ms. Fye's stated goals.</p> <p>Extending the Discussion: Task Design (+20 min) If it is appropriate for the goals of your course and you have time, after discussing the big mathematical ideas in the activity, you might discuss the design of the task.</p> <p>See the full Facilitation Notes which includes the Sample Responses and details surrounding the optional extended discussion.</p>
	<p>7.2 Launching a Technology-Mediated Task (35 minutes)</p> <p>  Teacher devices  Worksheet Link </p>	<p>Begin with a whole class discussion about the effective launch of a high cognitive demand task that incorporates math action technology. Use the adapted Jackson et al.'s (2013) elements of an effective launch to include the role of technology in a launch as a guide. We believe it is helpful to ask teachers to consider what would be important to add to Jackson et al.'s four elements if the task being launched includes the use of a math action technology. After recording their ideas, pass out the activity sheet. Compare and contrast their list of brainstormed ideas with the descriptions in the activity.</p> <p>Next, share the activity worksheet electronically with students as it has hyperlinks to videos and various documents within. In the activity, teachers will first consider what they think would be important to include in a launch of the Introduction to the Sine Graph activity and then compare their ideas to what the teacher, Ms. Fye, actually did in her launch of the activity. Finally, teachers will plan how to launch a similar task using a different technology, explaining how their launch addresses the elements of an effective launch. We suggest having the teachers work through the activity in pairs or groups of three.</p> <p>See the full Facilitation Notes which includes additional commentary and the Sample Responses.</p>





	7.3 Noticing Student-Teacher Interactions (20 minutes)  Teacher devices  Worksheet Link	<p>In this activity, teachers notice student thinking in the context of teacher-student small group interactions. The worksheet needs to be shared electronically with students as it has hyperlinks to videos within. As time permits, we recommend having teachers first work on Q1 in pairs or small groups, discuss their responses as a whole class and then do the same for Q2.</p> <p>See the full Facilitation Notes which includes the Sample Responses</p>
Day 1/Homework	7.4 Monitoring Student Thinking: Introduction to the Sine Function  Teacher devices  Worksheet Link <p>Teachers complete the Monitoring Student Thinking assignment in which they analyze both Ms. Fry's questioning in breakout rooms and her Teacher Dashboard for evidence of the students meeting the learning goals.</p>	<p>The worksheet needs to be shared electronically with students as it has hyperlinks to videos and Ms. Fye's Teacher Dashboard within.</p> <p>See the full Facilitation Notes which includes the Sample Responses to prepare yourself for the whole class discussion the next day.</p>



Day 2	7.4 Monitoring Student Thinking: Introduction to the Sine Function (15 minutes)	<p>Have the teachers get into small groups to review their responses to the Monitoring Student Thinking assignment. Then facilitate a whole class discussion focusing on each of the learning goals.</p> <p>See the full Facilitation Notes which includes the Sample Teacher Responses</p>
	 Teacher devices  Worksheet Link	
	7.5 Noticing Student Thinking about Amplitude (20 minutes)	<p>In this activity, teachers notice the thinking of one student pair as they work through making sense of which parameter affects the amplitude. The worksheet needs to be shared electronically with students as it has hyperlinks to videos within. We recommend having teachers work on this activity in pairs and afterwards putting students into larger groups to discuss the four questions.</p> <p>See the full Facilitation Notes which includes the Sample Responses</p>
	 Teacher devices  Worksheet Link	
	7.6 Noticing Student Thinking about Period (40 minutes)	<p>In this activity, teachers notice the thinking of one student pair as they work through making sense of how to determine the period. The worksheet needs to be shared electronically with students as it has hyperlinks to videos within. We recommend having teachers work on this activity in pairs, but in different pairs from those that worked together in 7.5. Afterwards, we recommend focusing on a subset of the questions and modeling selecting and sequencing the teacher responses as you facilitate a discussion.</p> <p>See the full Facilitation Notes which includes the Sample Responses</p>
	 Teacher devices  Worksheet Link	
	7.7 Designing a Sequence of Tasks (optional)	<p>If you choose to assign this activity as a homework assignment, it is important that teachers first develop an understanding of the difference between tasks that are intended to support students in learning a new idea, support students in further developing an idea, and applying their knowledge.</p> <p>Thus, have the teachers explore various activities in the search engine at teacher.desmos.com. Then discuss what would be important to look for when selecting a task intended to a) introduce a new concept, b) further develop that concept, c) provide opportunities to practice, and d) to apply a concept.</p> <p>See the full Facilitation Notes which includes the Sample Responses</p>
	 Teacher devices  Worksheet Link	



Day 3 / Optional Project	<p>7.7 Designing a Sequence of Tasks (optional)</p> <p> Teacher devices  Worksheet Link</p> <p>Teachers use Desmos or GeoGebra to design a next task in the instructional sequence for Ms. Fye's class.</p>	<p>This project is appropriate for courses that include selection and adaptation of technology tasks.</p> <p>Prior to introducing the project, to build an understanding of the difference between tasks available on teacher.desmos.com. Each of these activities has been labeled as “introduction”, “development”, “application” or “practice”. After this discussion, introduce the project and provide time for research and brainstorming. It is helpful for teachers to work collaboratively to brainstorm ideas for their task, but we recommend having them build their tasks outside of class time.</p> <p>The worksheet needs to be shared electronically with students as it has a hyperlink to the Task Planning template that teachers must complete.</p> <p>See the full Facilitation Notes which includes the Sample Responses</p>
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