# Task Implementation Planning Template

## Lesson Topic: Characteristics of the Sine Graph - amplitude, midline, period

Connecting Trigonometric Operations and Trigonometric Functions

*Table 1:Task Implementation Planning Template for Lesson*

| Learning Goals:<br>*What understandings will students take away from this lesson?* | Evidence:<br>*What will students say, do, produce, etc., that will provide evidence of their understandings?* |
|---|---|
| • 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,<br>  ○ Amplitude is $\|a\|$<br>  ○ Midline is $y = k$<br>  ○ Period is $\frac{360}{\|b\|}$<br><br>Specific performance goals include:<br>• Given a sine function equation, students will be able to determine the amplitude, period, and midline without graphing.<br>• Given the amplitude, midline, and period, students will be able to determine the function equation.<br>• Given the graph of a sine function, students will be able to determine the amplitude, period, and midline.<br>• Given the graph of a sine function, students will be able to determine the function equation. | • Students will be able to explain (in writing in and/or when sharing their ideas verbally) which parameter ($y = a\sin(bx) + k$) affects each of amplitude, midline, and period. Specifically that $a$ is connected to amplitude, $k$ is connected to midline, and $b$ is connected to period.<br>• Students will be able to explain (in writing in and/or when sharing their ideas verbally) the relationship between the parameter and amplitude, midline, and period. Specifically that $\|a\|$ directly corresponds to amplitude, $k$ directly corresponds to midline, and $\frac{360}{\|b\|}$ determines the period.<br>• Students will be able to apply their understanding of the relationships between the parameters and amplitude, midline, and period to determine an equation when given a graph or a graph when given an equation. |

## Task

*What is the main activity that students will be working on? Briefly describe it and tell us where to find it (e.g., attached, link).*

This is a Desmos activity titled Sine Graphs Introduction. Students are asked to investigate the relationships of the parameters of the sine function ($y = a\sin(bx) + k$) using sliders for each so they can explore them dynamically. They are provided the definition for each of amplitude, midline, and period and then asked which slider alters it and what the relationship is. The activity ends with opportunities for students to apply what they have determined from the investigation.

Link to the activity is here.

## Instructional support – tools, resources, materials

*What tools or resources will be made available to give students entry to, and help them reason through, the activity?*

Each student (or pair of students) needs a computer with internet access.

In addition, we will use a Desmos activity that includes dynamic graphs (with sliders) to support student exploration of the sine function.

## Prior Knowledge

*What prior knowledge and experience will students draw on in their work on this task?*

Students will build on their knowledge of characteristics of function families and how parameters affect graphs of functions (i.e., vertical and horizontal stretch/compression, and vertical / horizontal shifts)

## Essential Questions

*What are the essential questions that I want students to be able to answer over the course of the activity?*

How can I accurately sketch a sine graph given its equation?

How can I determine a sine function equation if I am given its graph?

## Task Launch

*How will you introduce and set up the task to ensure that students understand the task and can begin productive work, without diminishing the cognitive demand of the task?*

I designed the first 5 pages of the Desmos Activity to launch the task. I will not use any of the specific terminology they will learn in this activity (i.e., amplitude, midline, period) as to not lower the cognitive demand. However, I will make sure students know to change the sliders and pay attention to the important characteristics in the graphs that result. If I know they know how to use the sliders and are paying attention to the way the graph of the sine function stretches/compresses/shifts then I know they will be ready to engage in the investigation productively.

## Anticipated Solutions and Instructional Supports

*What are the various ways that students might complete the activity? Be sure to include incorrect, correct, and incomplete solutions.*

*What questions might you ask students that will support their exploration of the activity and bridge between what they did and what you want them to learn? These questions should assess what a student currently knows and advance him/her toward the goals of the lesson. Be sure to consider questions that you will ask to students who can't get started as well as students who finish quickly.*

*Use the monitoring chart (below) to provide the details related to Anticipated Solutions and Instructional Support*

## Sharing and Discussing the Task

### Selecting and Sequencing

*Which solutions do you want students to share during the lesson?*

*In what order? Why?*

After students have completed the activity I plan to have a discussion about amplitude, midline, and period.

For each I'm thinking I will share (in this order):
An informal description of how the slider alters the graph (i.e., stretch/compress/shift)
A description that includes the mathematical term that was introduced (amplitude, midline, period)

Then for the relationships
One or two more informal descriptions of the relationship between the slider and amplitude/midline/period
A precisely described mathematical relationship for each of amplitude (direct - $a$), midline (direct - $k$), period ($\frac{360}{|b|}$)

### Connecting Responses

*What specific questions will you ask so that students*

- *Make sense of the mathematical ideas that you want them to learn?*
- *Make connections among the different strategies / solutions that are presented?*

I'll list my questions in the monitoring chart below but for now, this is what I'm thinking about making connections:

I want to make sure to make connections between the informal language of

- Vertical compression/stretch with amplitude
- Vertical shift with midline
- Horizontal stretch/compress with period

I want to make sure to make connections between the patterns that are described informally with the mathematical relationship and we can explain why it makes sense

- If $a$ is large the amplitude is big, if $a$ is small the amplitude is small → the $|a|$ is the amplitude → the amplitude directly relates to $a$.
- The $k$ slider moves the midline up and down → The midline is at $y = k$
- The distance between the peaks increases and decreases based on $b$ → if $b$ value is bigger, the period is smaller → $b$ determines how many peaks there are in 360 → To find the period you do 360 divided by $|b|$.

# Monitoring Chart: Introduction to Sine Graphs

| Anticipated Solutions/Strategies | Instructional Support | | Who | Select / Sequence |
|---|---|---|---|---|
| | Assessing Questions | Advancing Questions | | |
| Amplitude → the $a$ slider alters the amplitude, it stretches and compresses the graph vertically, if $a$ is larger than 1 the graph gets "taller" if it is less than one it gets "shorter", the $\|a\|$ is directly related to the amplitude. | Tell me how you determined the relationship between the sliders and amplitude.<br><br>How is the value of the slider related to the amplitude?<br><br>Maybe ask about a particular value - if my slider is set to 5, what would you expect the amplitude to be? | If assessing pans out (can explain robustly) then invite them to move to the next page and investigate midline. | | |
| Amplitude → might consider "height" can be negative and include the sign in their relationship rather than \|a\|. | Tell me how you determined the relationship between the sliders and amplitude. Compare your strategy to the definition (and picture provided) of amplitude. What do you notice?<br><br>Think back to our work with previous functions, how did "a" affect the graph? What if "a" was negative? (The goal is to separate the negative and the value - as one reflects and the other stretches/compresses) | What would you expect the amplitude to be if $a$ was 9? -9? Why?<br><br>Can you prove it to yourself on slide 5? Try testing a value. | | |
| Amplitude → might consider amplitude to be the difference between the maximum and minimum. | Tell me how you determined the relationship between the sliders and amplitude. Compare your strategy to the definition (and picture provided) of amplitude. What do you notice? | Can you prove it to yourself on slide 5? Try testing a value. | | |
| Midline → the $k$ slider alters the midline, translates it up and down, $k$ is directly related to the midline | Tell me about how you determined the relationship between $k$ and the midline. | If assessing pans out (can explain robustly) then invite them to move to the next page and investigate the period. | | |

| | | | | |
|---|---|---|---|---|
| Midline → might be having difficulty identifying "where" a midline is on any graph. | Where is the midline on the standard function? (Y = sin x) How might we be able to figure out where to sketch that in on any graph? | What if we translated the graph up two units, what would you expect to happen to the midline? Why? Try it. | | |
| Period → the $b$ slider alters the period, it stretches / compresses the graph horizontally, the period is determined by $\frac{360}{\lvert b \rvert}$ | Tell me how you determined the relationship between $b$ and the period. | If assessing pans out (can explain robustly) then invite them to move to the next page to apply what they have figured out about amplitude, midline, and period. | | |
| Period → might think that the distance between peaks suggests that the relationship is a difference (subtracting x value for each peak) | Tell me how you determined the relationship between $b$ and the period.<br><br>Is it a direct relationship like the others? How do you know? | Lets try some other values for b. Does it always work? | | |
| Period → might have difficulty "seeing" where a period is on the graph. | Let's look at the graph. Use points to show me where a period starts and ends. (Then also say how long that period is so there is a connection between what looking at and the value.)<br><br>Change $b$ and try another. | Ok, now that we are clear on what period is in the graph, play around with b, try some different values. What is the relationship between $b$ and the period. | | |
| Determining relationships (generally) → might have difficulty stating the mathematical relationship between a slider and amplitude, midline, or period. | What kind of relationship does it appear to be? (I'm curious if they recognize direct / indirect.) Are they equal? Are they in some sort of proportion to one another?<br><br>Which slider seems to alter the ___? What values have you tried so far? | If my slider is set to (pick a value), what would you expect the (amplitude, midline, period) to be? Try it. | | |