The University of Texas at Austin
Charles A. Dana Center

Louisiana Instructional Model and Planning Guide

Recorded session for LDOE

Molly Ewing

– Equity — Access — Excellence –

1

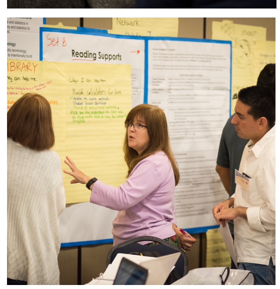
The University of Texas at Austin
Charles A. Dana Center

Our Mission

Advancing Public Education at Scale

01 70+-member team works across K–12 and higher education systems

02 Bring equity lens to ensure every student has access to high-quality, relevant mathematics & science education that's central to their postsecondary & career success



03 Nearly 30 years of experience, bringing deep understanding of how to navigate complex education systems

2

The University of Texas at Austin
Charles A. Dana Center

Learning Expectations

Participants will...

- Explore the Louisiana Instructional Model for Science through looking at an OpenSciEd unit
- Consider how the Instructional Model supports units in being phenomenon-based, coherent for students, driven by evidence, collaborative, and equitable
- Analyze how the Planning Guide for Science Instruction can be used to unpack and plan for three-dimensional instruction

5

The University of Texas at Austin
Charles A. Dana Center

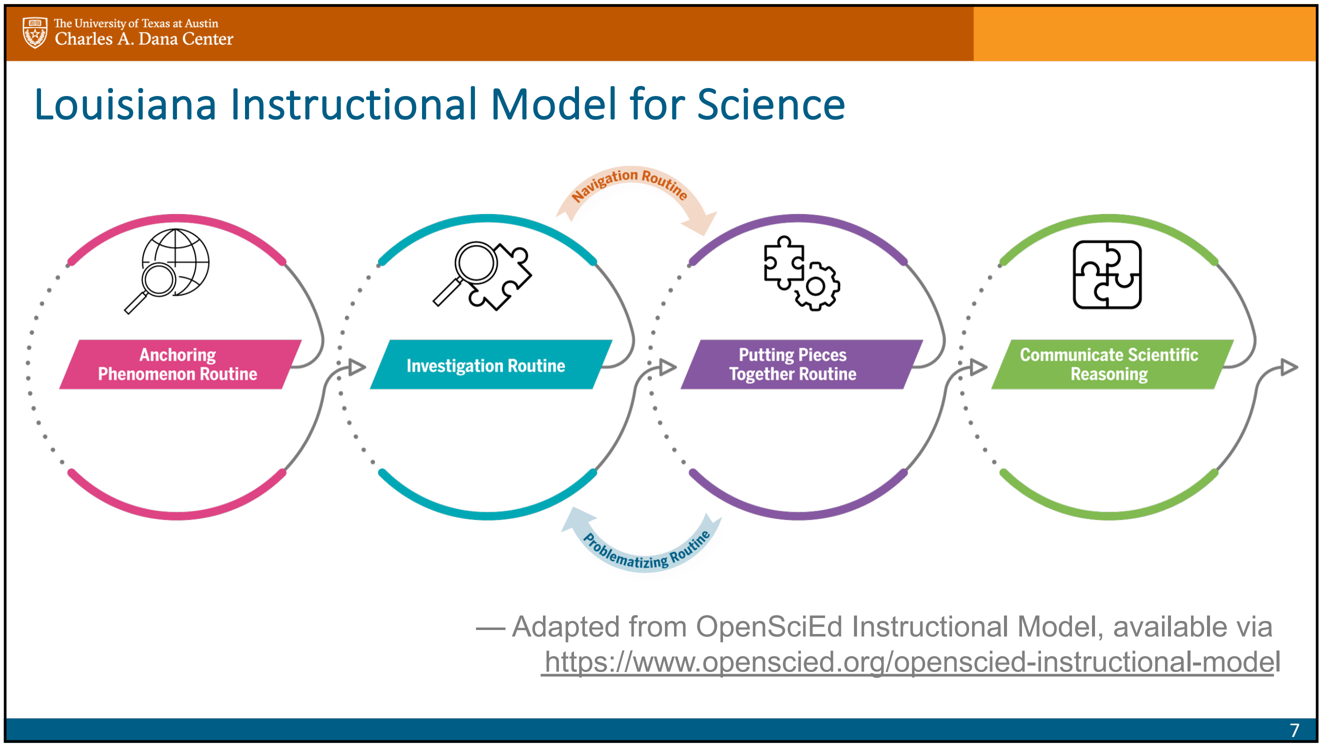
Reflection Lenses

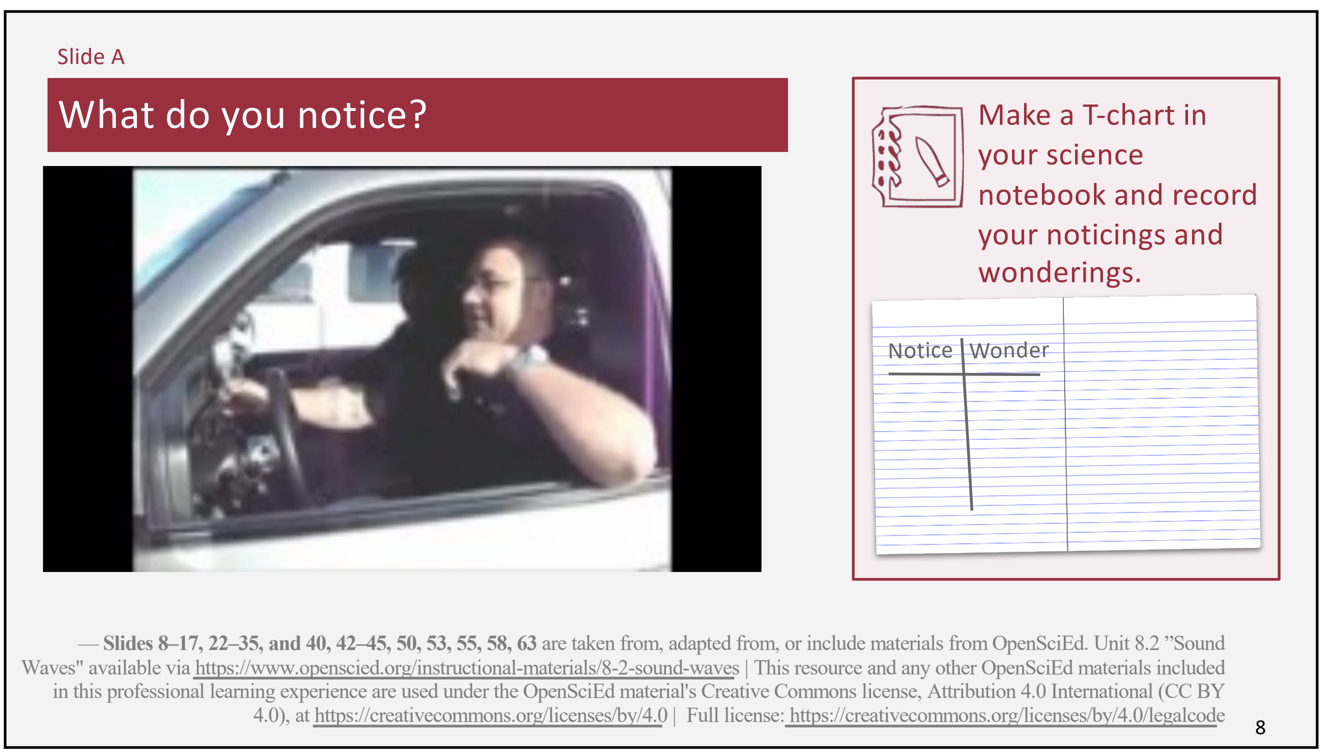
- Phenomenon-based
- Coherent for students
- Driven by evidence
- Collaborative
- Equitable

OpenSciEd Key Instructional Elements OpenSciEd

Element	Description
Phenomena Based *Centered around figuring out phenomena or solving problems*	• Students' work is anchored in meaningful phenomena or problems that motivate building ideas over time. • Anchoring phenomena and problems are complex, relevant, and returned to as we figure out more. • Students investigate related phenomena to figure out pieces of the explanation. • Assessments ask students to make sense of specific and compelling phenomena using their understandings built during the unit.
Coherent for Students *Driven by students' questions and ideas*	• Students' prior ideas and understandings are elicited, valued and built upon. • Students and teachers work together to figure out where to go next and what evidence is needed to answer their questions. • Students understand what they are doing and how it will help them answer questions about a larger phenomenon or solve a problem. • Students engage in science and engineering practices in meaningful ways in order to make progress on their questions.
Driven by Evidence *Incremental building and revision of ideas based on evidence*	• Students' ideas and questions determine what evidence to collect. • Students seek and use evidence to figure something out as they build and revise their explanations, models and arguments. • Investigations provide evidence to build new science ideas instead of confirming pre-taught ideas. • Evidence can be used to problematize our current thinking and help us think about where to go next.
Collaborative ***WE** figure out ideas together*	• Students have opportunities to use, build upon, and critique other's ideas. • Students use evidence to support ideas, ask for evidence from others and suggest ways to get additional evidence. • Students have several opportunities to give and get feedback • The culture of the classroom supports risk-taking and changing our minds.
Equitable *Requires a classroom culture that values all ideas*	• Students have multiple opportunities to make sense individually and through small and whole group discussions. • The class community values the diversity of resources students bring to science class, including language, gestures, metaphors, and various modes of expression. • Norms are established and revisited to support equitable sensemaking. • Teachers integrate a variety of assessment activities to elicit, interpret, and provide feedback to build from students' diverse ideas and experiences. • Students understand how and why what they are learning is relevant to their own lives and their communities.

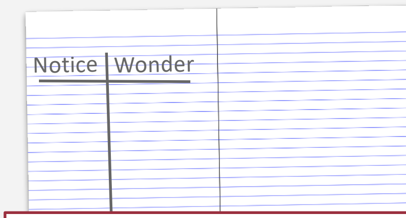
6


The University of Texas at Austin
Charles A. Dana Center
Louisiana Instructional Model for Science
Navigation Routine
Anchoring Phenomenon Routine
Investigation Routine
Putting Pieces Together Routine
Communicate Scientific Reasoning
Problematizing Routine
— Adapted from OpenSciEd Instructional Model, available via https://www.openscied.org/openscied-instructional-model
7


Slide A
What do you notice?
Make a T-chart in your science notebook and record your noticings and wonderings.
Notice
Wonder
— Slides 8–17, 22–35, and 40, 42–45, 50, 53, 55, 58, 63 are taken from, adapted from, or include materials from OpenSciEd. Unit 8.2 "Sound Waves" available via https://www.openscied.org/instructional-materials/8-2-sound-waves | This resource and any other OpenSciEd materials included in this professional learning experience are used under the OpenSciEd material's Creative Commons license, Attribution 4.0 International (CC BY 4.0), at https://creativecommons.org/licenses/by/4.0 | Full license: https://creativecommons.org/licenses/by/4.0/legalcode
8

Slide D

Make Observations of a Speaker



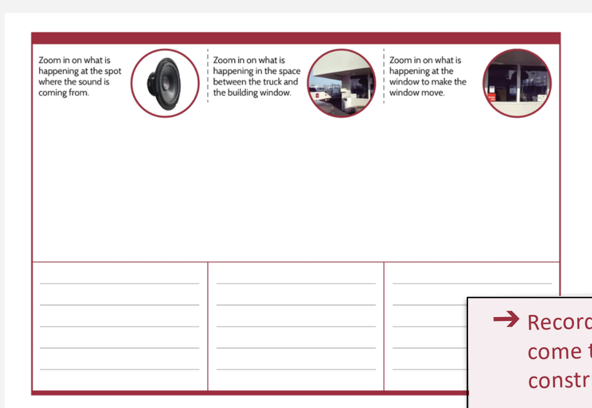
- What is the speaker doing while it is making sounds?
- What do you see happening that might help us understand what's happening in the video of the truck and the window?

9

Slide E

Develop Initial Models

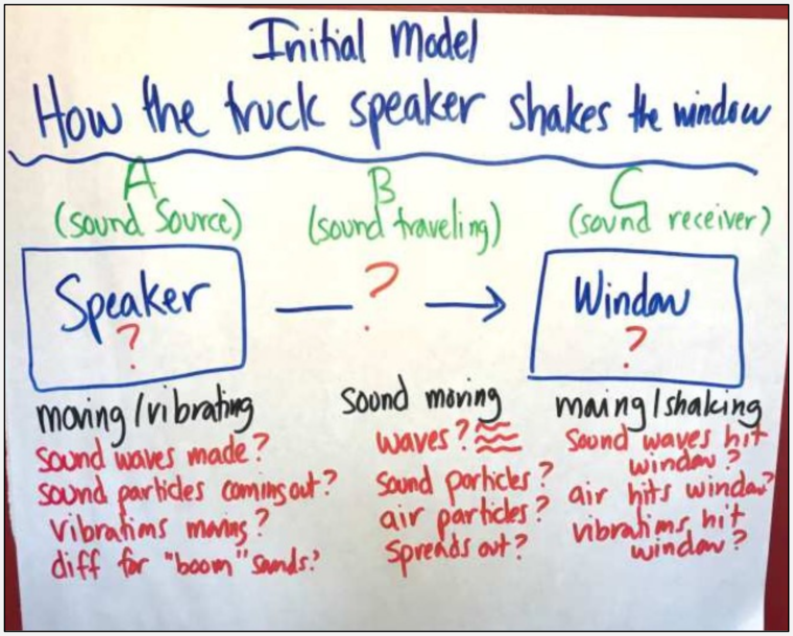
Develop an initial model to explain, "Why would a sound coming from one thing make another thing far away move?" Use *pictures*, *symbols*, and *words* in your model to help represent and further explain what you think is happening in each of the 3 locations on a zoomed-in scale.



→ Record questions that come to mind as you are constructing your model.

10

Example Initial Consensus Model



11

Slide I

Where have you seen something like this?

Add a "Related phenomena" section to your science notebook and jot down other experiences you have had that relate to what we've observed so far.

Use these questions to guide your brainstorming:

- When or where have you seen before a time where an object making sounds caused something to move or shake, like the window in the video?
- When or where have you seen sounds being made before? What was making those sounds?
- When or where have you experienced a sound being received before? What objects have you seen receiving sounds besides the window in the video?
- Have you ever experienced a sound going over a distance, like in the video?

12

Slide K

What questions do you have?

Add a "Questions" section to your science notebook and jot down any questions you have that relate to what we have observed so far.

To help you brainstorm your questions, look back at these resources:

- your Notice and Wonder charts
- your initial model
- your lists of related phenomena
- the class's consensus model

13

Slide L

Revise Our Questions

Review the questions you brainstormed at the end of last class. Use these question starters to create two revised or new questions to post to our Driving Question Board:

- Why ...?
- How ...?
- How would it be different if ...?
- What if ...?
- What is the purpose of ...?
- What causes ...?

Then write one question per sticky note.

Write in marker--big and bold.

Put your initials on the back in pencil.

14

Slide M

Driving Question Board (DQB)

Take out your sticky notes with questions.
Bring those with you to our Scientists Circle, along with your science notebook.

Let's build our Driving Question Board (DQB).

How can we detect sounds from a distance?

15

Slide N

Ideas for Investigations

What kinds of investigations could we do and/or what additional sources of data might we need to figure out the answers to our questions?

Add your ideas to a new notebook page titled:

Ideas for Future Investigations and Data We Need

Ideas for Future Investigations and Data We Need

→ Be prepared to share these with the whole class.

16

Slide O

Where should we start?

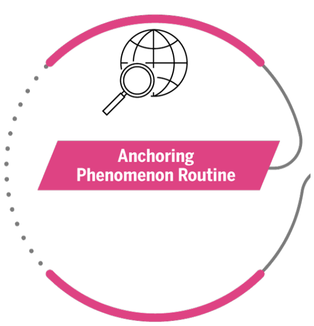
Take a moment to look at our questions on our Driving Question Board.

- What part of the model does it make sense to explore first? Why?
- What are we going to need to do to explore this part?

17

The University of Texas at Austin
Charles A. Dana Center

Anchoring Phenomenon Routine Elements



Element #1:	Element #2:	Element #3:	Element #4:
Explore the Anchoring Phenomenon	Attempt to Make Sense of the Phenomenon	Identify Related Phenomena	Develop Questions & Next Steps

18

The University of Texas at Austin
Charles A. Dana Center

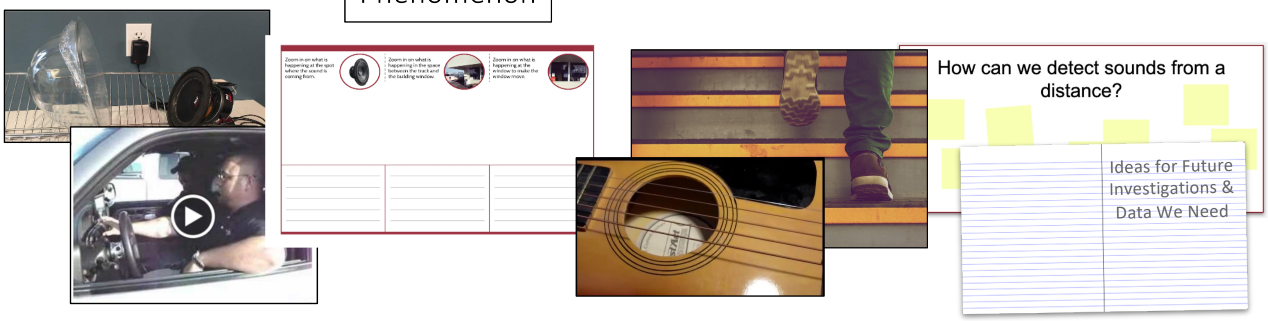
Anchoring Phenomenon Routine Elements

Element #1: Explore the Anchoring Phenomenon

Element #2: Attempt to Make Sense of the Phenomenon

Element #3: Identify Related Phenomena

Element #4: Develop Questions & Next Steps



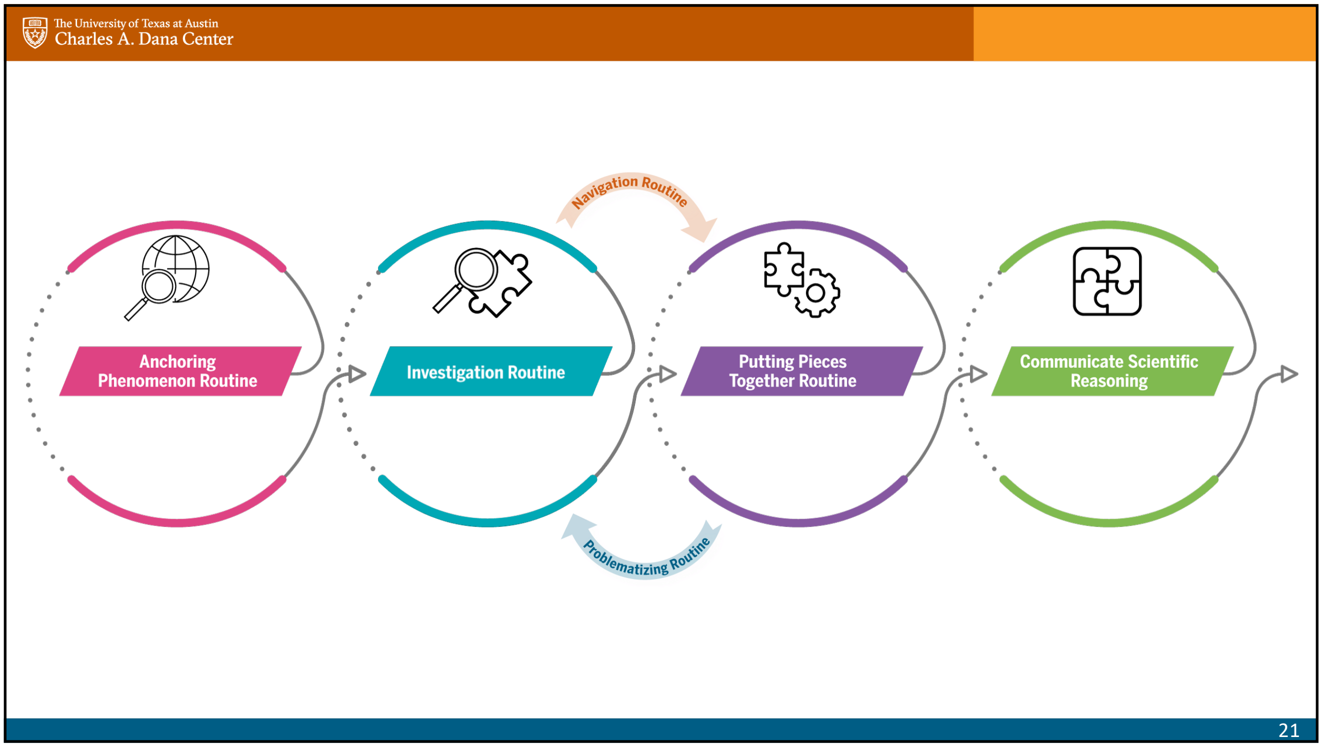
19

The University of Texas at Austin
Charles A. Dana Center

Anchoring Phenomenon Routine Reflection

- Phenomenon-based
- Coherent for students
- Driven by evidence
- Collaborative
- Equitable

20



Slide A

Navigation

We had a bunch of questions about what is happening at the sound source.

Turn and Talk

- How do you think sound sources like instruments and speakers make all those different sounds?
- What would you expect to see if you looked closely at these sound sources while they are making sounds?

22

Slide B

Exploring Sound Sources

We will have the opportunity to observe a number of different sound sources making sounds.

Create an observation table in your science notebook like the one below.

Data source	Observations

- For each new station, make a new row in your observation table to record your observations.
- In the left column, record the name of the sound source you observe.
- In the right column, record observations that you make as you watch and touch the instrument or speaker while it's making sounds.

23

Slide C

Exploring Sound Sources

Use the following prompts to guide your observations:

- How does the object look and feel **while it is being struck**?
- How does the object look and feel **while it is making sound**?
- How is what you notice **similar to or different than** what we saw the **speaker** do?
- Can the sound source make different sounds? If so, how?
- What patterns did you notice in how the objects make different sounds?

24

Slide D

Exploring Sound Sources

Share with the whole class your ideas about these questions:

- What patterns did you notice?
- What else could we do to figure out more about what is happening with these sound sources?

- How does the object look and feel **while it is being struck**?
- How does the object look and feel **while it is making sound**?
- How is what you notice **similar to or different than** what we saw the **speaker** do?
- Can the sound source make different sounds? If so, how?
- What patterns did you notice in how the objects make different sounds?

25

Slide E

Slow-Motion Videos

Add each sound source to your observation table as they are played.

Data source	Observations

26

Slide F

Slow-Motion Speaker Video

Share your observations with with the class.

27

Slide H

Slow-Motion Drum Video

Share your observations with with the class.

28

Slide J

Analyzing Our Data

In your notebook, use the observations you made in the observation table from the previous step to respond to the following questions:

- What patterns or similarities did you notice in how the different objects you observed moved while they were making sounds?
- What patterns did you notice among the instruments and the speaker?

When you have responded to these questions, share your ideas with a partner.

29

Slide K

Building Understandings Discussion

- What was similar about the motion of different objects while they made sounds? What was different?
- What type of shape changes did we see in objects when they were struck or plucked?
- How did the shape of objects keep changing after we were done striking or plucking them?

30

Slide L

Building a Consensus Model

Use this table to construct a model of how an instrument moves when it makes sounds.

Each box in the table, from left to right, will represent how the shape of a drum changes over time as it is making sounds.

31

Slide M

Applying Our Model

Individually, use our model to show what is happening with a different instrument that you observed during the lesson, like the guitar.

32

Slide N

Comparing Models

Find a partner

→ **1 min:** Use your model to explain what is happening when an instrument makes a sound.

→ **1 min:** Give feedback.

→ Switch.

Prompts to consider as you give feedback:

- I wonder about _______. I noticed you _______.
- I appreciate how you _______.
- It would be clearer if you added_________.
- I see you're thinking about_________.
- Do you think you should add_________?

33

Slide O

Progress Tracker: What have we figured out?

Question	Source of evidence
What is happening when speakers and instruments make sounds?	Observations and slow-motion videos of a speaker and instruments
What we figured out (in words/pictures)	

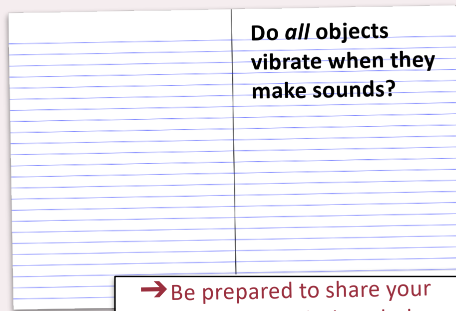
34

Slide P

Applying Our Model to Other Objects

Do *all* objects vibrate when they make sounds? (even ones that aren't musical instruments)

Write this question in your notebook, then jot down your ideas.



➔ Be prepared to share your predictions with the whole class.

35

The University of Texas at Austin
Charles A. Dana Center

Investigation Routine Elements

Element #1: Create a Plan of Action

Element #2: Do the Work with Science and Engineering Practices

Element #3: Make Sense: What did we figure out?

36

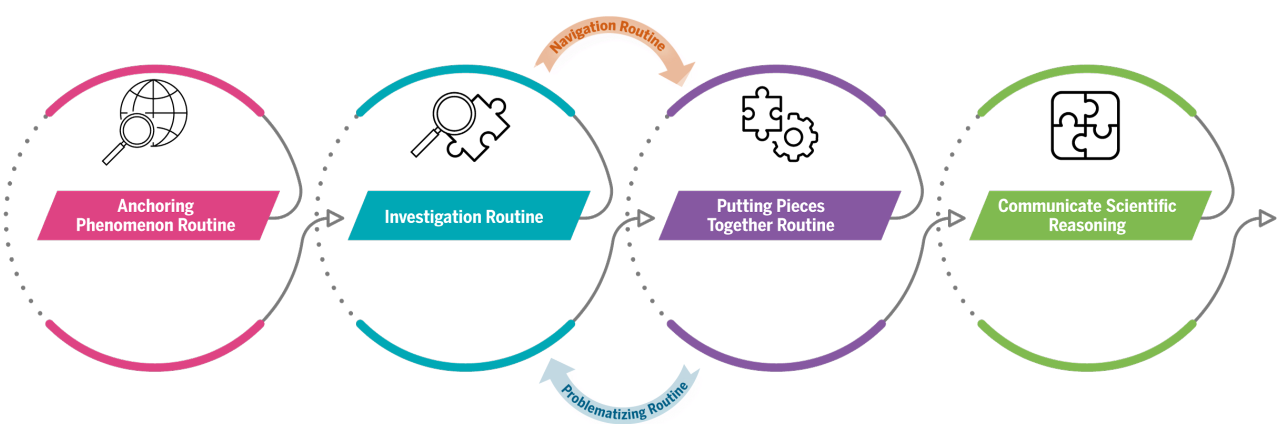
The University of Texas at Austin
Charles A. Dana Center

Investigation Routine Reflection

- Phenomenon-based
- Coherent for students
- Driven by evidence
- Collaborative
- Equitable

37

The University of Texas at Austin
Charles A. Dana Center



38

The University of Texas at Austin
Charles A. Dana Center

Navigation Routine

Navigation Routine

Look Back: How did we get here?	Take Stock: Where are we now?	Look Forward: Where are we going?
Beginning	During	Ending

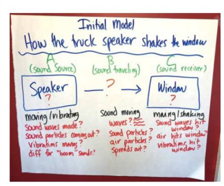
39

Unit Storyline

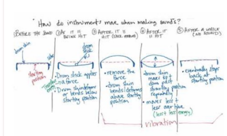
UNIT STORYLINE

How can a sound make something move?

How students will engage with each of the phenomena: HANDS-ON/ LAB ACTIVITIES; VIDEOS OR IMAGES; DATA SETS; READINGS; COMPUTER INTERACTIVES

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 1 3 days **How does a sound source make something like this happen?** Anchoring Phenomenon	 *Loud music from a truck makes a window in the parking lot move. A speaker moved when it produced sound.*	We observe a perplexing phenomenon: Sound from a truck appears to make a window move from the parking lot. We note observations of this phenomenon as well as of a speaker in the classroom. Our observations, models, and other sound-related phenomena lead us to add a broad set of questions about sound to our DQB and to list ideas for investigations to pursue. We figure out these concepts: • A speaker making sounds can be detected from a distance and can even cause things like a nearby window to move. • The speaker moves back and forth when it is making sound. • Students agree that the sound source, how sound travels, and how sounds are received are important parts of explaining how sounds can make things move.	

⇓ **Navigation to Next Lesson:** After seeing how the speaker moves when it makes sounds, we wonder if other sound-makers show similar patterns. We decide to bring in other sound-makers to look for patterns in what each does when making sounds.

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 2 2 days **What is happening when speakers and other music makers make sounds?** Investigation	 *Musical instruments and speakers vibrate (move back and forth) when a force is applied.*	When an instrument vibrates (makes sounds) it includes the following actions: • A force is applied to a part of an object; that part bends or deforms and changes shape. Energy is transferred to the object. • When the force is removed, that part of the object springs back and overshoots its starting position. • That part of the object then repeatedly bends back and forth for a bit (we call this vibration) before stopping. When it stops vibrating, it stops making sounds	

⇓ **Navigation to Next Lesson:** We figured out that instruments and speakers are vibrating (bending back and forth). This made us wonder whether all objects, even something solid like a table, are bending back and forth (vibrating) when they make sounds.

40

The University of Texas at Austin
Charles A. Dana Center

Navigation Routine Reflection

- Phenomenon-based
- Coherent for students
- Driven by evidence
- Collaborative
- Equitable

41

Slide A

Navigation

Turn and Talk

Would you expect any object that makes sounds to move in the same way we saw the musical instruments and speaker move? Why or why not?

→ Be ready to share your thoughts with the group.

42

Video: Rock Dropping

43

Slide B

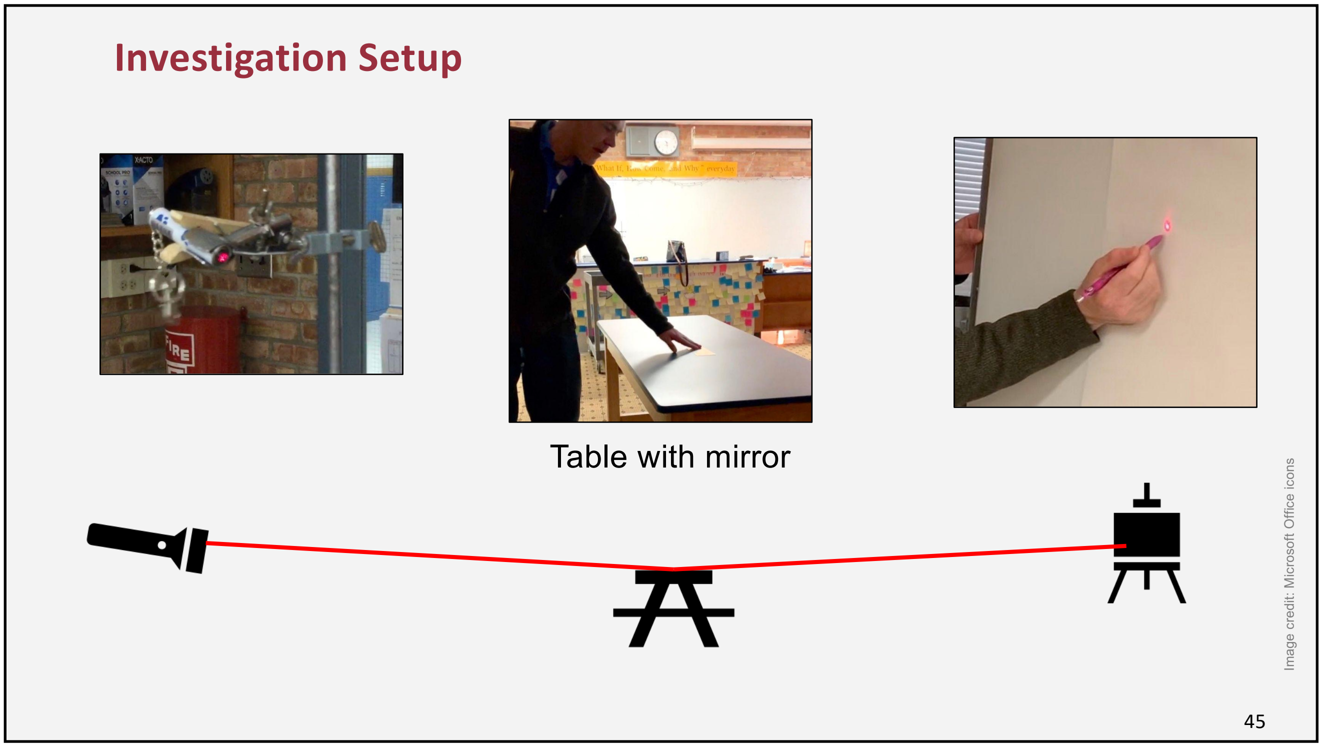
Investigation Planning

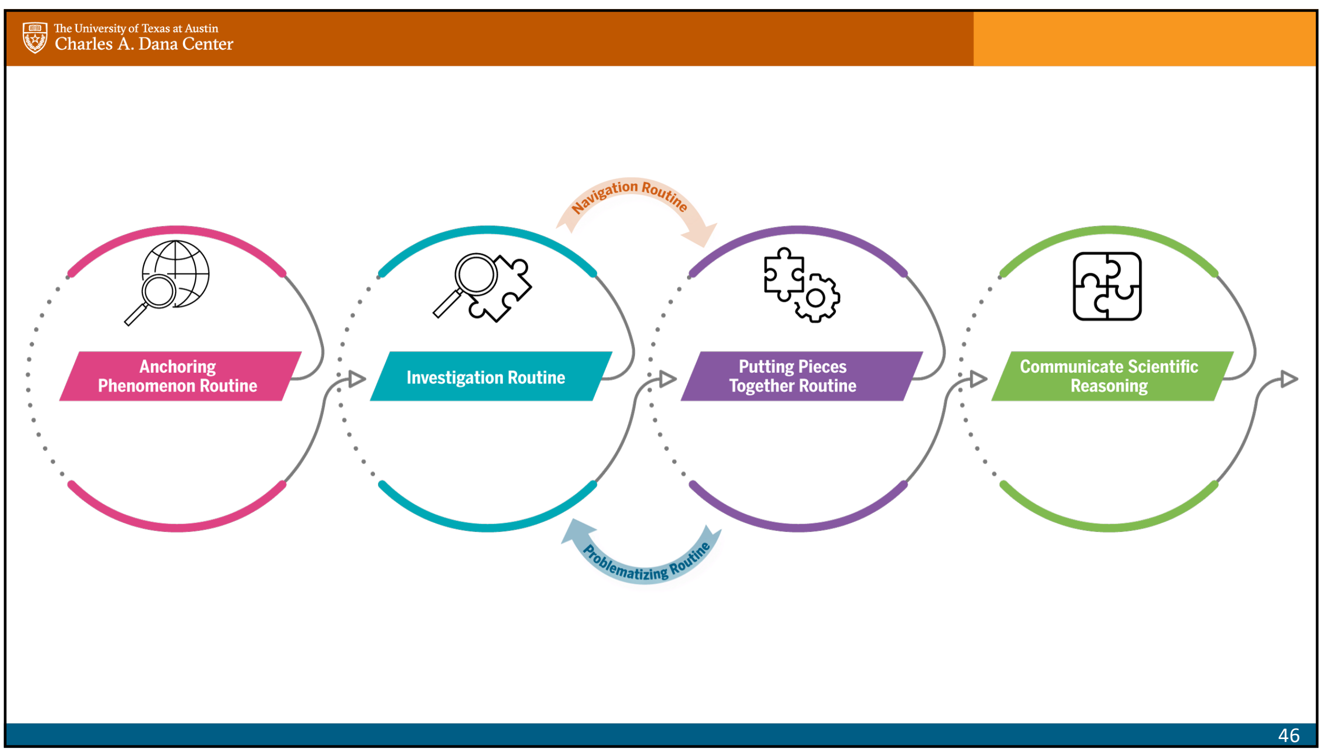
Let's work together to make a plan ...

- What question are we trying to answer?
- How can we use these materials to investigate this question?
- How will we be changing the scale of the vibrations? Why?

Do not direct the laser or its reflection near anyone's face or eyes.

44


Investigation Setup
Table with mirror
Image credit: Microsoft Office icons
45


The University of Texas at Austin
Charles A. Dana Center
Navigation Routine
Anchoring Phenomenon Routine
Investigation Routine
Putting Pieces Together Routine
Communicate Scientific Reasoning
Problematizing Routine
46

The University of Texas at Austin
Charles A. Dana Center

Problematizing Routine

Element #1: Foreground a New Question or Phenomenon	Element #2: Argue for Competing Ideas	Element #3: Determine a Way to Resolve a Question

47

The University of Texas at Austin
Charles A. Dana Center

Problematizing Routine

Element #1: Foreground a New Question or Phenomenon	Element #2: Argue for Competing Ideas	Element #3: Determine a Way to Resolve a Question

48

The University of Texas at Austin
Charles A. Dana Center

Problematizing Routine Reflection

- Phenomenon-based
- Coherent for students
- Driven by evidence
- Collaborative
- Equitable

49

The University of Texas at Austin
Charles A. Dana Center

Lesson 3

2 days

Do all objects vibrate when they make sounds?

Problematizing, Investigation

⇓ Navigation to Next Lesson: What do

Lesson 4

2 days

How do the vibrations of the sound source compare for louder versus softer sounds?

Investigation

Lesson 5

1 day

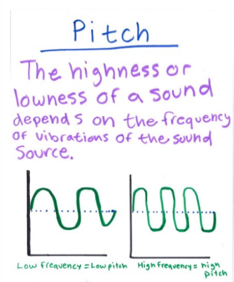
How do the vibrations from a sound source compare for higher-pitch versus lower-pitch sounds?

Investigation

A shorter stick vibrates faster than the longer stick, and the graph of the motion of the speaker also shows faster vibrations for higher pitch.

We use mathematical representations of Position versus Time graphs generated from a tool used to scale up the vibrations of an object to describe wave patterns and support scientific conclusions about how objects move when they make higher-pitch and lower-pitch sounds. We figure out these ideas:

- Shorter-length bars produce higher-pitch sounds when struck.
- Shorter-length bars vibrate more frequently than longer-length bars when struck.
- Sound sources that produce higher-pitch notes vibrate more frequently.



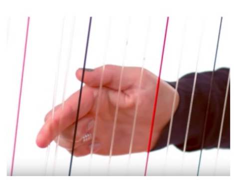
⇓ Navigation to Next Lesson: We figured out that a shorter stick vibrates faster than a longer one and the speaker vibrates faster for higher-pitch sounds. This made us wonder if we can put our ideas about frequency and amplitude together to see if we can explain how any object can make so many different sounds.

Lesson 6

2 days

How can any object make so many different sounds?

Putting Pieces Together

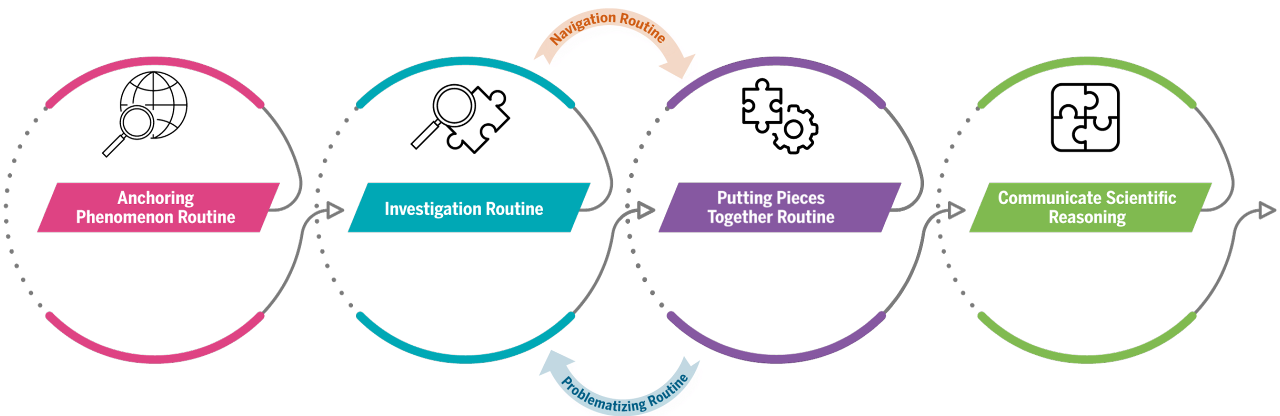


A video and graphs of the motion of a harp making sounds are used to model and argue for the different sounds being made.

We apply our understanding to explain different sounds coming from different objects, complete a summative mid-unit assessment, and return to our DQB.

50

The University of Texas at Austin
Charles A. Dana Center



51

The University of Texas at Austin
Charles A. Dana Center

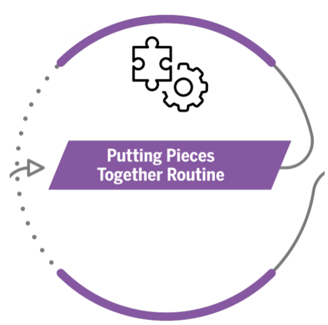
Putting Pieces Together Routine Elements

<u>Element #1:</u> Take Stock

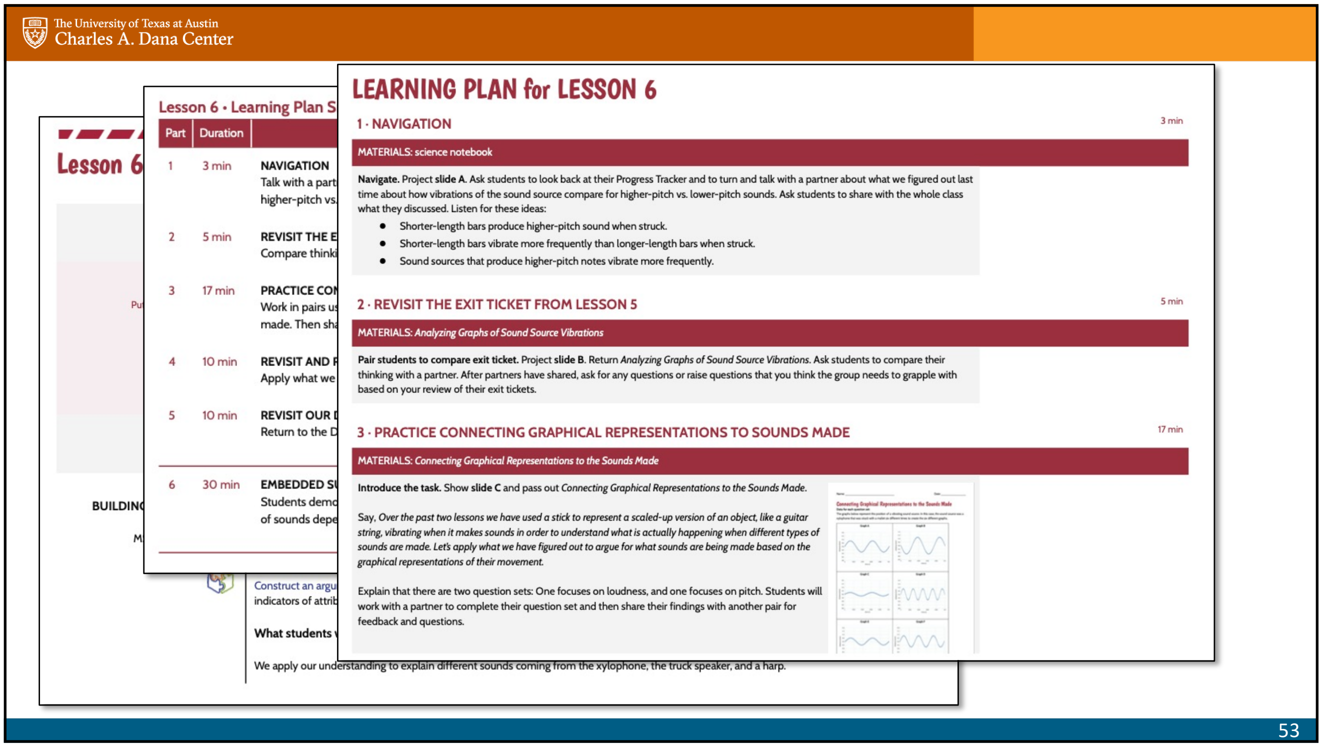
<u>Element #2:</u> Put Pieces Together (i.e., revise the consensus model)

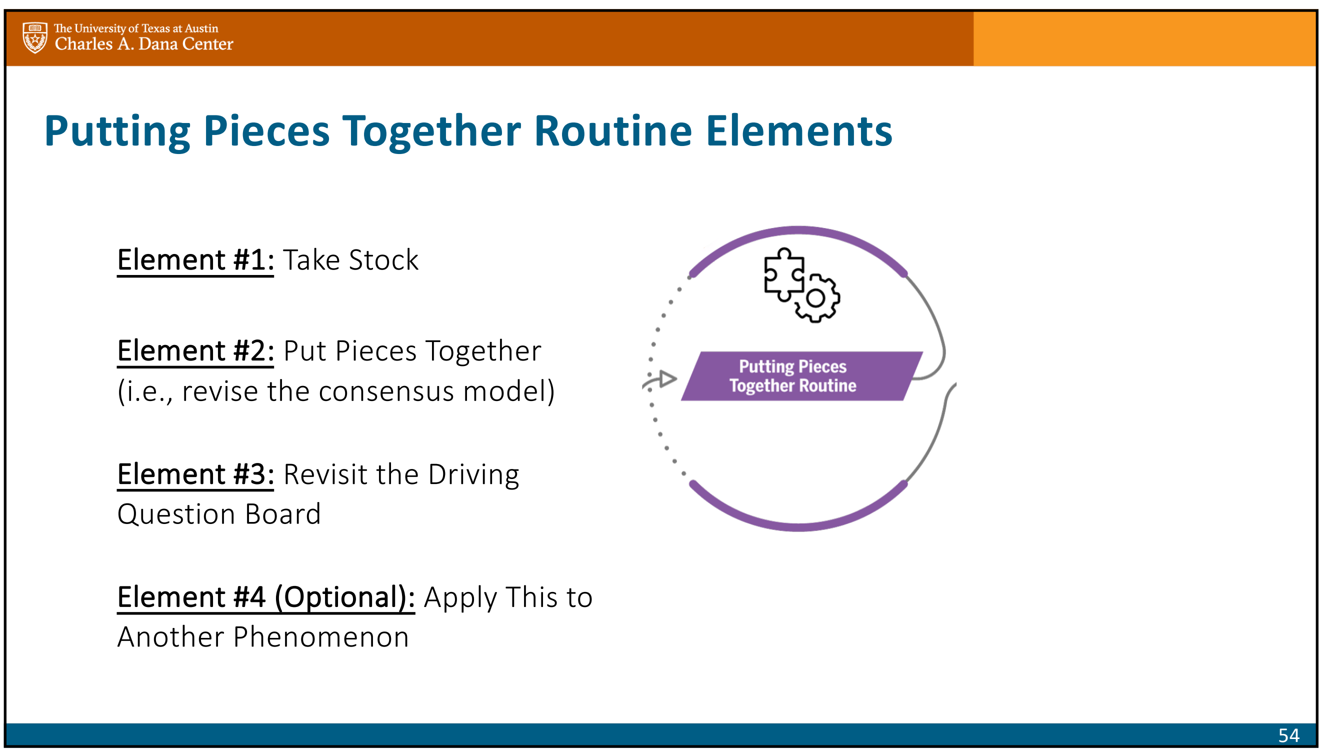
<u>Element #3:</u> Revisit the Driving Question Board

<u>Element #4 (Optional):</u> Apply This to Another Phenomenon



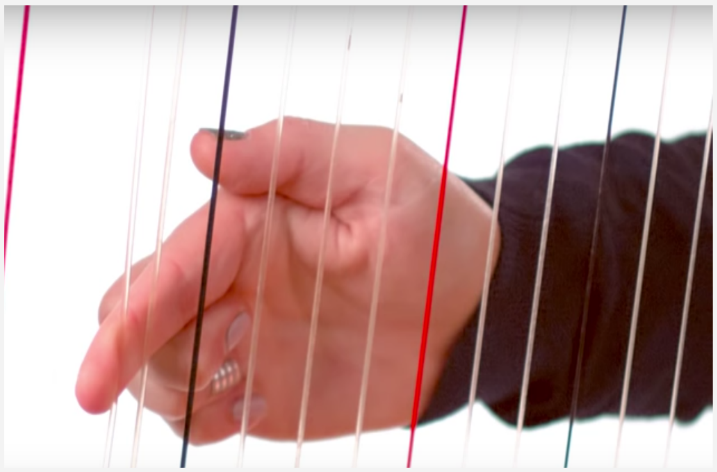
52


The University of Texas at Austin
Charles A. Dana Center
LEARNING PLAN for LESSON 6
1 · NAVIGATION
3 min
MATERIALS: science notebook
Navigate. Project slide A. Ask students to look back at their Progress Tracker and to turn and talk with a partner about what we figured out last time about how vibrations of the sound source compare for higher-pitch vs. lower-pitch sounds. Ask students to share with the whole class what they discussed. Listen for these ideas:
Shorter-length bars produce higher-pitch sound when struck.
Shorter-length bars vibrate more frequently than longer-length bars when struck.
Sound sources that produce higher-pitch notes vibrate more frequently.
2 · REVISIT THE EXIT TICKET FROM LESSON 5
5 min
MATERIALS: Analyzing Graphs of Sound Source Vibrations
Pair students to compare exit ticket. Project slide B. Return Analyzing Graphs of Sound Source Vibrations. Ask students to compare their thinking with a partner. After partners have shared, ask for any questions or raise questions that you think the group needs to grapple with based on your review of their exit tickets.
3 · PRACTICE CONNECTING GRAPHICAL REPRESENTATIONS TO SOUNDS MADE
17 min
MATERIALS: Connecting Graphical Representations to the Sounds Made
Introduce the task. Show slide C and pass out Connecting Graphical Representations to the Sounds Made.
Say, Over the past two lessons we have used a stick to represent a scaled-up version of an object, like a guitar string, vibrating when it makes sounds in order to understand what is actually happening when different types of sounds are made. Let's apply what we have figured out to argue for what sounds are being made based on the graphical representations of their movement.
Explain that there are two question sets: One focuses on loudness, and one focuses on pitch. Students will work with a partner to complete their question set and then share their findings with another pair for feedback and questions.
Lesson 6 · Learning Plan S
Part
Duration
1
3 min
NAVIGATION
2
5 min
3
17 min
4
10 min
5
10 min
6
30 min
Lesson 6
We apply our understanding to explain different sounds coming from the xylophone, the truck speaker, and a harp.
53


The University of Texas at Austin
Charles A. Dana Center
Putting Pieces Together Routine Elements
Element #1: Take Stock
Element #2: Put Pieces Together
(i.e., revise the consensus model)
Element #3: Revisit the Driving
Question Board
Element #4 (Optional): Apply This to
Another Phenomenon
Putting Pieces
Together Routine
54

Slide G

Assessment: Video of Harp Player



55

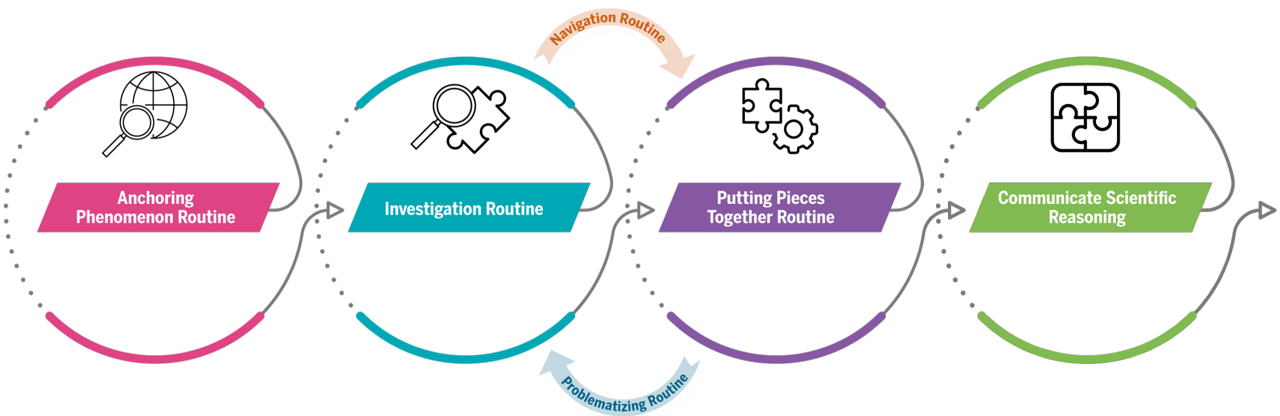
The University of Texas at Austin
Charles A. Dana Center

Putting Pieces Together Routine Reflection

- Phenomenon-based
- Coherent for students
- Driven by evidence
- Collaborative
- Equitable

56

The University of Texas at Austin
Charles A. Dana Center



57

The University of Texas at Austin
Charles A. Dana Center

Name: ______________________________ Date: _______________

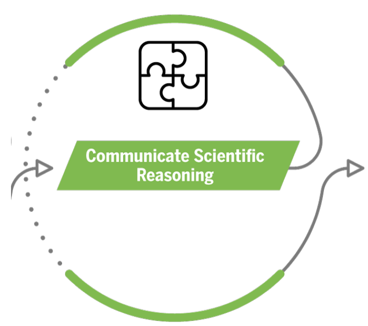
Assessment

A harp, an instrument we have not yet seen, makes sounds like all instruments. Your teacher will play a video showing a harp making different sounds. Answer the questions below to use what we've learned so far about sound sources to model what we see in this video.

1. What parts of the instrument are the sound sources?

2. What would you expect to see these sound sources doing anytime one of them produces a sound? Explain in one sentence.

3. What does the musician need to do differently when she interacts with these sound sources in order to get them to produce softer sounds?



58

The University of Texas at Austin
Charles A. Dana Center

Communicating Scientific Reasoning Reflection

- Phenomenon-based
- Coherent for students
- Driven by evidence
- Collaborative
- Equitable

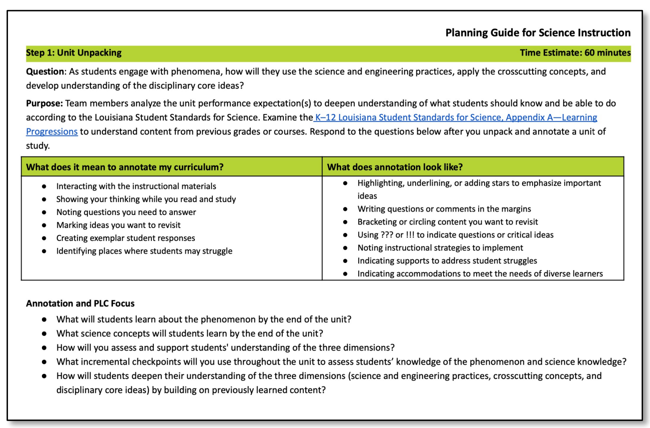
59

The University of Texas at Austin
Charles A. Dana Center

Planning Guide for Science Instruction

Tool to support teachers as they:

- collaboratively prepare to deliver high quality instruction.
- collaboratively analyze student work.



Planning Guide for Science Instruction

Step 1: Unit Unpacking **Time Estimate: 60 minutes**

Question: As students engage with phenomena, how will they use the science and engineering practices, apply the crosscutting concepts, and develop understanding of the disciplinary core ideas?

Purpose: Team members analyze the unit performance expectation(s) to deepen understanding of what students should know and be able to do according to the Louisiana Student Standards for Science. Examine the K–12 Louisiana Student Standards for Science, Appendix A—Learning Progressions to understand content from previous grades or courses. Respond to the questions below after you unpack and annotate a unit of study.

What does it mean to annotate my curriculum?	What does annotation look like?
• Interacting with the instructional materials • Showing your thinking while you read and study • Noting questions you need to answer • Marking ideas you want to revisit • Creating exemplar student responses • Identifying places where students may struggle	• Highlighting, underlining, or adding stars to emphasize important ideas • Writing questions or comments in the margins • Bracketing or circling content you want to revisit • Using ??? or !!! to indicate questions or critical ideas • Noting instructional strategies to implement • Indicating supports to address student struggles • Indicating accommodations to meet the needs of diverse learners

Annotation and PLC Focus

- What will students learn about the phenomenon by the end of the unit?
- What science concepts will students learn by the end of the unit?
- How will you assess and support students' understanding of the three dimensions?
- What incremental checkpoints will you use throughout the unit to assess students' knowledge of the phenomenon and science knowledge?
- How will students deepen their understanding of the three dimensions (science and engineering practices, crosscutting concepts, and disciplinary core ideas) by building on previously learned content?

60

The University of Texas at Austin
Charles A. Dana Center

Planning Guide for Science Instruction

Step 1: Unit Unpacking

Step 2: Unit Launch Deep Dive

Step 3: Lesson Set Annotation

Step 4: Student Work Analysis

Image credit: Microsoft Office icon

61

The University of Texas at Austin
Charles A. Dana Center

Step 1: Unit Unpacking

Planning Guide for Science Instruction

Step 1: Unit Unpacking — **Time Estimate: 60 minutes**

Question: As students engage with phenomena, how will they use the science and engineering practices, apply the crosscutting concepts, and develop understanding of the disciplinary core ideas?

Purpose: Team members analyze the unit performance expectation(s) to deepen understanding of what students should know and be able to do according to the Louisiana Student Standards for Science. Examine the K–12 Louisiana Student Standards for Science, Appendix A—Learning Progressions to understand content from previous grades or courses. Respond to the questions below after you unpack and annotate a unit of study.

What does it mean to annotate my curriculum?	What does annotation look like?
• Interacting with the instructional materials • Showing your thinking while you read and study • Noting questions you need to answer • Marking ideas you want to revisit • Creating exemplar student responses • Identifying places where students may struggle	• Highlighting, underlining, or adding stars to emphasize important ideas • Writing questions or comments in the margins • Bracketing or circling content you want to revisit • Using ??? or !!! to indicate questions or critical ideas • Noting instructional strategies to implement • Indicating supports to address student struggles • Indicating accommodations to meet the needs of diverse learners

Annotation and PLC Focus

- What will students learn about the phenomenon by the end of the unit?
- What science concepts will students learn by the end of the unit?
- How will you assess and support students' understanding of the three dimensions?
- What incremental checkpoints will you use throughout the unit to assess students' knowledge of the phenomenon and science knowledge?
- How will students deepen their understanding of the three dimensions (science and engineering practices, crosscutting concepts, and disciplinary core ideas) by building on previously learned content?

62

The University of Texas at Austin
Charles A. Dana Center

Step 1: Unit Unpacking

Selected question from Step 1: Unit Unpacking

What will students learn about the phenomenon by the end of the unit?

UNIT STORYLINE

How can a sound make something move?

How students will engage with each of the phenomena

HANDS-ON/ LAB ACTIVITIES | VIDEOS OR IMAGES | DATA SETS | READINGS | COMPUTER INTERACTIVES

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it

TEACHER BACKGROUND KNOWLEDGE

What are the Disciplinary Core Ideas (DCIs) in the context of the phenomenon?

"Disciplinary Core Ideas" are reproduced verbatim from A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. DOI: https://doi.org/10.17226/13165. National Research Council; Division of Behavioral and Social Sciences and Education; Board on Science Education; Committee on a Conceptual Framework for New K-12 Science Education Standards. National Academies Press, Washington, DC. This material may be reproduced and used by other parties with this attribution. If the original material is altered in any way, the attribution must state that the material is adapted from the original.

In this unit, students will develop ideas related to how sounds are produced, how they travel through media, and how they affect objects at a distance. Their investigations are motivated by trying to account for a perplexing anchoring phenomenon -- a truck is playing loud music in a parking lot and the windows of a building across the parking lot visibly shake in response to the music. They will make observations of sound sources to revisit the K-5 idea that objects vibrate when they make sounds. They will figure out that patterns of differences in those vibrations are tied to differences in characteristics of the sounds being made. They will gather data on *how* objects vibrate when making different sounds to characterize how vibrating objects' motion is tied to the loudness and pitch of the sounds they make. Students will also conduct experiments to support the idea that sound needs matter to travel through, and they will use models and simulations to explain how sound travels through matter at the particle level.

This unit builds towards the following NGSS Performance Expectations (PEs):
MS-PS4-1. Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. [Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.]

MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.]

This unit helps develop the following elements of Disciplinary Core Ideas (DCIs):
PS4.A: Wave Properties
- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)
- A sound wave needs a medium through which it is transmitted. (MS-PS4-2)

What should my students know from earlier grades and earlier middle school units?

Disciplinary Core Ideas
In 1st grade, students develop the idea that sound can make matter vibrate, and vibrating matter can make sound. (1-PS-4-1)
In 5th grade students develop the idea that air is made of matter, and therefore has mass. These understandings, and a model of air as made of particles too small to be seen, are foundational for students making sense of the phenomena in this unit.

However, our pilots of this unit have revealed that most middle school students have not fully developed these relevant K-5 ideas for explaining sound-related phenomena. There are two sets of ideas that we rarely see in students' initial models:
- Back and forth motion of matter (vibration) is occurring at the sound source (grade 1 DCI).
- The medium that sound is moving through (e.g. air) is made of particles (grade 5 DCI).

63

The University of Texas at Austin
Charles A. Dana Center

Step 1: Unit Unpacking

Selected question from Step 1: Unit Unpacking

How will students deepen their understanding of the three dimensions by building on previously learned content?

Louisiana STUDENT STANDARDS SCIENCE

DCI

LEARNING PROGRESSIONS

Disciplinary Core Ideas: Physical Science – Waves and their Applications (PS4)

	K-2	3-5	6-8	High School
PS4.A: Wave Properties	**Grade 1:** LE.PS4A.a Sound can make matter vibrate, and vibrating matter can make sound.	**Grade 4:** UE.PS4A.a Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; it does not move in the direction of the wave except when the water meets the beach. UE.PS4A.b Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).	**Grade 6:** MS.PS4A.a A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. MS.PS4A.b A sound wave needs a medium through which it is transmitted.	HS.PS4A.a The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. HS.PS4A.b Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. HS.PS4A.c Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet.
PS4.B: Electromagnetic Radiation	**Grade 1:** LE.PS4B.a Objects can be seen if light is available to illuminate them or if they give off their own light. Some objects give off their own light. LE.PS4B.b Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. (The idea that light travels from place to place is developed	**Grade 4:** UE.PS4B.a An object can be seen when light reflected from its surface enters the eyes.	**Grade 6:** MS.PS4B.a When light shines on an object, it is reflected, absorbed, transmitted, or scattered through the object, depending on the object's material and the frequency (color) of the light. MS.PS4B.b The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends (refraction). MS.PS4B.c A wave model of light is useful for explaining brightness, color, and the	HS.PS4B.a Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. HS.PS4B.b When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to

Page A-23 in https://www.louisianabelieves.com/docs/default-source/teacher-toolbox-resources/appendix-a---learning-progressions.pdf

64

The University of Texas at Austin
Charles A. Dana Center

Step 2: Unit Launch Deep Dive

Planning Guide for Science Instruction

Step 2: Unit Launch Deep Dive — **Time Estimate: 60 minutes**

Question: How will students engage in phenomenon-based instruction?

Purpose: Team members build an understanding of the unit launch experience by exploring the unit overview and the elements of the Anchoring Phenomenon Routine from the student's perspective.

Anchoring Phenomenon Routine Elements	Annotation Discussion Questions
Explore Phenomena	What activities will students complete during initial and consensus discussions about the phenomenon?
	How will the investigations help students develop an understanding of the phenomenon?
Make Sense of Phenomena	Highlight or note relevant data, models, images, and texts—that represent the language and style used and produced by scientists—that students will engage with to generate initial explanations about the anchoring phenomenon.
	Create sample anchor charts (e.g. notice and wonder charts, initial models, etc.) for the unit's launch.
	Identify places in the unit launch where students may struggle and determine appropriate supports.
Identify Related Phenomena	Identify local or culturally relevant phenomena that students may identify during the unit's launch.
	How will you support access to the content for students who have unfinished learning?
Develop Questions About the Phenomena	Develop evidence-based questions students may pose that can be used to navigate future lessons and investigations that advance the storyline.
	How will you use the driving question board from the anchor phenomenon launch throughout the unit of study?

65

The University of Texas at Austin
Charles A. Dana Center

Step 3: Lesson Set Annotation

Planning Guide for Science Instruction

Step 3: Lesson Set Annotation — **Time Estimate: 60 minutes**

Question: How will students incrementally develop an understanding of the anchoring phenomenon and science concepts?

Purpose: Team members annotate sequences of lessons to determine where incremental sense-making occurs in the unit of study, in order to be able to make instructional decisions that best meet the intent of the standards and the needs of all students.

Choose a lesson set from the current unit of study	Annotation Discussion Questions
Critically read the lesson-set performance expectation(s).	What Science and Engineering Practice(s) will students use?
	Where are the conceptual checkpoints for the Disciplinary Core Idea(s)?
	How will students apply the Crosscutting Concept(s)?
Identify competing ideas that students may have about phenomena.	How will you leverage these ideas during student sense-making and argumentation?
Identify instructional routines you'll use throughout the unit of study (e.g., Science Instructional Model).	What strategies, routines, and discussion protocols will you use for each lesson set?
	What tools and resources will you use to plan facilitation?
Determine how student understanding will be assessed after the lesson set.	Identify 2 to 3 of the critical tasks in the lesson set. Create or review exemplar student responses.
	Note key understandings you will look for or listen for in each task.

66

The University of Texas at Austin
Charles A. Dana Center

Step 4: Student Work Analysis

Planning Guide for Science Instruction

Step 4: Student Work Analysis **Time Estimate: 40 minutes**

Question: How do you use three-dimensional assessments to evaluate students' understanding?

Purpose: Team members establish norms for evaluating student work, analyze student work to formatively assess students' understanding, and from that analysis determine the implications for instructional practice and effectiveness.

Student Work Analysis Protocol

- Step 1: Identify criteria for analyzing student work using the performance expectation(s) and task
- Step 2: Identify exemplar student responses.
- Step 3: Analyze student work.
- Step 4: Identify and discuss trends.
- Step 5: Plan for future instruction.

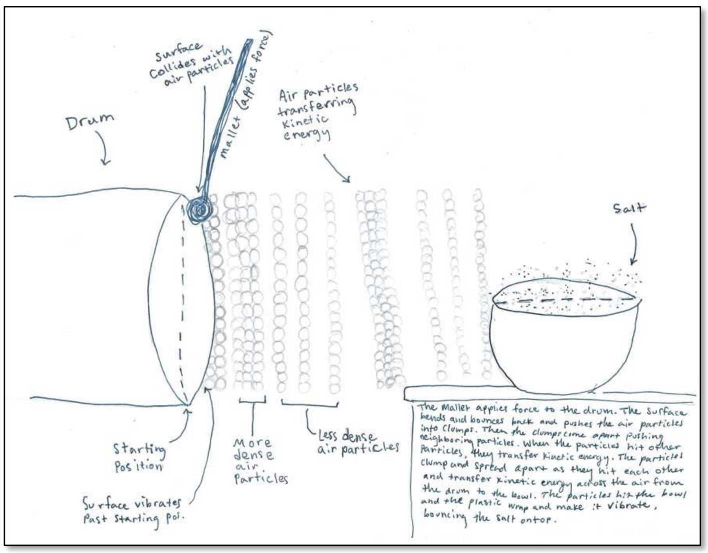
Choose a formative assessment	Annotation Discussion questions
Analyze Student Work	Where do you see evidence of students using the Science and Engineering Practices?
	Where are students applying content knowledge?
	How are students connecting ideas using crosscutting concepts?
	What are patterns and trends in what students know and can do?
Plan for Future Instruction	Based on this student work analysis, what are the implications for future instruction?
	What is the plan for responding to students' needs for just in time support and enrichment?

67

The University of Texas at Austin
Charles A. Dana Center

Step 4: Student Work Analysis

1. Identify criteria for analyzing student work using the performance expectation(s) and task.
2. Identify exemplar student responses.
3. Analyze student work.
4. Identify and discuss trends.
5. Plan for future instruction.



68

The University of Texas at Austin
Charles A. Dana Center

Reflection

Image credit: baramee2554/iStock/Thinkstock

What?

- What caught my attention in this session?

Gut?

- What surprised me?
- What was unclear?

So what?

- What are the implications for me as a science education leader?

Now what?

- What are my next steps?

69

The University of Texas at Austin
Charles A. Dana Center

Communicating Scientific Reasoning Reflection

- Phenomenon-based
- Coherent for students
- Driven by evidence
- Collaborative
- Equitable

70

The University of Texas at Austin
Charles A. Dana Center

References

Slide 6: OpenSciEd. (2020 August). "OpenSciEd Key Instructional Elements." https://issuu.com/openscied/docs/day_1.1_introduction_-_key_instructional_elements or page 10 in Teacher Handbook: Middle School Science, version 3.0: https://www.openscied.org/wp-content/uploads/2019/08/Aug-2020_-Beta-Open-SciEd-Teacher-Handbook.pdf | This and other OpenSciEd content used under OpenSciEd Creative Commons license, Attribution 4.0 International (CC BY 4.0) at https://creativecommons.org/licenses/by/4.0 | Full license: https://creativecommons.org/licenses/by/4.0/legalcode

Slides 7, 18, 19, 21, 36, 38, 39, 46, 47, 48, 51, 52, 54, 57, 58: Adapted from OpenSciEd Instructional Model, available via https://www.openscied.org/openscied-instructional-model

Slides 8–17, 22–35, and 40, 42–45, 50, 53, 55, 58, 63 are taken from, adapted from, or include materials from OpenSciEd. Unit 8.2 ”Sound Waves" available via https://www.openscied.org/instructional-materials/8-2-sound-waves | The related handout OpenSciEd. (2020 December 3). Lesson 1 in "How can a sound make something move?," is from 8.2 Sound Waves – Unit Overview, available via https://www.openscied.org/8-2-sound-waves-overview

Slide 64: Page A-23 in https://www.louisianabelieves.com/docs/default-source/teacher-toolbox-resources/appendix-a---learning-progressions.pdf

71

Direct questions or feedback to STEM@la.gov.