Instructions for Facilitator in working with teachers through the MIT BLOSSOMS video lesson, "Hanging by a Thread", including discussion guide for teacher reflection after participating in lesson.

This BLOSSOMS lesson was aligned to the following Next Generation Science Standards Performance Expectation:

HS-PS2-1: Motion and Stability, Forces and Interactions
Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. [Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object sliding down a ramp, or a moving object being pulled by a constant force.] [*Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.*]

Intended Audiences

This guide was developed with the intention to be used with grade 6-12 science teachers (in-service and preservice), coaches, and administrators with a goal to support professional learning of three-dimensional instruction.

Materials (Per Group)

- Ring Stand or similar structure
- 2 - identical 200-gram masses
- Sewing thread (strong enough to support the masses, light enough to break when pulled)
- Metric rule
- Scissors
- Spring scales (10 - 20 N range) or digital force probes
- Poster paper
- Markers
- Tape (to post poster paper on walls)

Suggested Ancillary Materials:

- Framework for K-12 Science Education
- Next Generation Science Standards
- MIT BLOSSOMS Coaching Template for "Hanging By A Thread"

Grouping – Groups of four

Morning Session Outline:

	Description	Time
Welcome	Introductions of facilitator and participants. • Describe the BLOSSOMS concept and process • Provide a brief description of the day and ancillary tools and resources	15 Minutes
Introduction to the Three Dimensions of the *Framework*	Provide a brief overview of the three dimensions as described by the *Framework for K-12 for Science Education* and how they are integrated during instruction: • *Phenomena* • *Dimension 1 - Science and Engineering Practices* • *Dimension 2 - Crosscutting Concepts* • *Dimension 3 - Disciplinary Core Ideas*	25 Minutes
Activity 1	Participants will watch the "*Hanging by a Thread*" video featuring Activity 1 (0:00 – 2:42) and make a prediction based upon the following questions: • Which thread breaks when you pull the bottom string quickly? • Which thread breaks when you pull the bottom thread slowly?	20 Minutes
Break		15 Minutes
Activity 2	Participants will watch the "*Hanging by a Thread*" video featuring Activity 2 (2:42 – 5:26) and watch a demonstration of the phenomenon. TPL participants will revise their model using a force diagram (free body diagram) to: • Explain what is happening within the thread-mass system using their force diagrams. • Determine which of Newton's Laws best applies to their explanation.	30 Minutes
Activity 3	Participants will watch the "*Hanging by a Thread*" video featuring Activity 3 (5:26 – 8:39) and revise their models (force diagrams) and form a hypothesis, perform an investigation and: • Use measurements and collected data from the investigation to support or reject your hypothesis.	40 Minutes
Concluding Segment	Participants will watch the "*Hanging by a Thread*" video featuring the concluding segment (8:39 – 11:16).	5 Minutes
Teacher Guide Segment	Participants will watch the "*Hanging by a Thread*" video Teacher Guide Segment (11:16 – 17:34).	10 Minutes
Master Teacher Implementation Video	Participants will watch the Master Teacher implementing the *Hanging by a Thread* lesson with his/her students. • Participants will share their observations and make connections to their own investigation experiences.	20 Minutes

Introduction:
This BLOSSOMS NGSS Facilitator's Guide is designed to provide a step-by-step approach to conducting and facilitating a BLOSSOMS Teacher Professional Learning (TPL) Workshop. Teaching is a profession and, like most professions, teachers need to learn new content and best practice in order to grow and learn. This professional learning is especially true for science teachers as they have the responsibility to implement the instructional shifts required by three-dimensional state science standards such as the Next Generation Science Standards (NGSS Lead States, 2013). These standards have been developed with the guidance of the seminal foundational document, *A Framework for K-12 Science Education* (NRC, 2012). Currently there are 45 states which have created state science standards based upon the *Framework*. The *Framework* is designed to help realize a vision for education in the sciences and engineering in which students, over multiple years of school, actively engage in scientific and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas in these fields. (NRC, 2012, p. 10)

As a TPL facilitator you will lead a participant-centered professional development focused modeling three-dimensional teaching and learning that is aligned to the vision of the *Framework*. The BLOSSOMS TPL process is a model of a classroom involved in a three-dimensional lesson. In this professional development the TPL facilitator leads the TPL participants through the lesson in the same manner as a teacher would in a classroom using a traditional BLOSSOMS lesson. The TPL participants experience, discuss, and learn how the integration of the three dimensions of the *Framework* work together in the same manner as students would...to explain phenomena and solve problems. TPL Participants will use the crosscutting concepts as a lens with which to focus on a specific aspect of a phenomenon, the science and engineering practices as tools to "figure out" the phenomenon, and apply their learning towards a deeper understanding of the disciplinary core ideas of science.

The outcomes of TPL BLOSSOMS is for participants to come away with a deeper understanding of how the three dimensions of the *Framework* by experiencing:

- shift in an instructional approach from a teacher-focused to a student-focused approach.
- demonstrate how the three dimensions are integrated within a lesson
- how to use BLOSSOMS videos and the Teaching Duet process to engage students with novel phenomena and problems.

Broad Stroke Description of the Process:
This BLOSSOMS lesson is divided into three activities, a concluding discussion, and a Teacher Guide segment. Participants will view each segment from the video. The TPL facilitator will then pause the video at the natural breaks and facilitate the participants in their engagement of the BLOSSOMS lesson activity. For each activity the participants will engage in two steps:

Step 1:
TPL participants participate in the 3 activities within the BLOSSOMS video segments. They will be engaged in the lesson in the same manner as students would. For each activity the participants will view each segment within the BLOSSOMS lesson and then move on to Step 2.

Step 2:
In response to Step 1, TPL participants will engage in the "Hanging by a Thread: BLOSSOMS lesson in the same manner as students would. Following each natural break in the video segments, the TPL facilitator leads TPL participants through the lesson to respond to the questions posed. As a model of a classroom experience, the TPL facilitator plays the role of the teacher. For example, during the first segment of the video the TPL participants are introduced to the phenomenon of thread breaking above or below a mass depending on how quickly or slowly the thread is pulled. At the break in the video, the TPL facilitator will work with the TPL participants to focus their thinking - posing questions using embedded crosscutting concepts to help focus the TPL participants on the particular aspect of the phenomenon being investigated. Then the TPL participants will be asked to engage in the lesson, using the science and engineering practices to **gather** information, **reason** with collected data, and **communicate** their explanation of the phenomenon in the same manner as students in an actual classroom would do.

Repeat steps 1-2 for all of the additional video-activity segments, just as students would experience it in the classroom

To prepare yourself as a TPL Facilitator:

Review the Coaching Template:
It is important to familiarize yourself with the BLOSSOMS Coaching Template for the "Hanging by A Thread" lesson. Notice how the Coaching Template is divided into two columns:

- What the Teacher is Doing?
- What are the Students Doing?

When using the Coaching Template, the facilitator should be looking for evidence of participants employing the science and engineering practices to "figure out" the phenomenon. Under the "What is the Teacher Doing" column there are evidence bullets that describe actions the students would employ to effectively use the practices during the lesson. In an actual classroom environment, these evidence bullets are designed to help teachers formatively assess whether the student(s) are on or off track with respect to the lesson. In other words, they become "*look fors*" for the teacher to assess student progress. As a facilitator, use these *look fors* in the same manner as a teacher would...to shift instruction If you find your participants are moving away from the intent of the lesson or not providing evidence of the use of the practice. Use the crosscutting concept prompts to redirect the TPL participants and help structure their thinking. (See point X)

Important Points for the Facilitator to Consider:

1. Use the crosscutting concept prompts to redirect or refocus the TPL participants. The crosscutting concept prompts help to focus the participants on a specific aspect of the phenomenon that you, as facilitator, want them to pay attention to. For instance, when the TPL participants are asked to make a prediction and draw a model to explain their prediction a suggested prompt might be:
   "What would **cause** the top thread or the bottom thread depending on how quickly the thread is pulled?"

Notice the crosscutting concept, **cause**, embedded in the prompt. Through the use of these crosscutting concepts the participants are focused on a specific aspect of the phenomenon, in this case the cause of the thread breaking. These strategic prompts help to eliminate the "noise" which distracts students from focusing on the phenomenon. The crosscutting concept within these prompts becomes the lens through which the TPL participants view as they investigate and explain the phenomenon.

2. Do not be the "answer person". Talk is an important tool for learning and as a TPL facilitator it is important to foster discourse between group members and the class as a whole. When participants question you in the direct context of the lesson, deflect their question to the individual or the TPL class at large. Windschitl et al (2018) suggest using "talk moves" to help facilitate student discussion of ideas. There are several categories of "talk moves" which can be used. For instance
    - **Probing**
        - *What did you notice happening here [before, during, or after the phenomenon]?*
    - **Follow Ups**
        - *Can you tell me more about that?*
    - **Pressing**
        - *Can you give me an example of the idea you just mentioned?*
        - *Does your claim fit with the data we have?*
    - **Using Wait Time**
        - *Allow participants think by waiting for responses after they have been prompted/*
    - **Opening Up Cross-Talk**
        - *Can you rephrase what Sue said in your own words, and check with her to see if that's what she meant?*
    - **Revoicing**
        - *Facilitator listens to an extended statement a participant has made, then paraphrases and rebroadcasts to the whole group what was said.*

    By deflecting questions that pertain to the lesson to the large group, the facilitator promotes the opportunities for the participants to engage in discourse between groups.
3. Always encourage responders to "cite evidence" for their claims. Engaging in the C-E-R process (Claims, Evidence, and Reasoning) is a way to reinforce with TPL participants the "goal" of science. Their claim is their proposed explanation. Their evidence should be information or data that describes "how you know that?" Finally, their reasoning involves a "rule" or scientific principal that describes why the evidence supports the claim. Other groups may either confirm or refute the claims of another but it is only valid when used with evidence and reasoning as justification.

Remember, participants in the TPL are essentially your "students" in a NGSS classroom. Through your modelling of the teacher's NGSS guidance, the participants will learn how to move away from fact-based, teacher-led instruction to an environment where students "figure it out" using the dimensions of the *Framework*.

Master Teacher Presentation Video and Master Teacher and Students Interview Video:
In the last portion of the TPL workshop morning session the TPL facilitator will share the video segment of the Master Teacher implementing the *Hanging by a Thread* lesson with his/her students. This is a critical portion of the morning session. The goal for this segment is to allow TPL participants to observe the interactions between the Master Teacher and his/her students as well as how the students engage with the phenomenon or problem they are being challenged with.

Prior to playing the Master Teacher video segment, the TPL facilitator will present the following suggested prompts for TPL participants to ponder as they view the video:

- What evidence did you observe that showed how students in the video were engaged in the lesson?
- Cite examples of how the science and engineering practices are being used by the students to explain the phenomenon.
- Give examples of how the crosscutting concepts were used in the lesson?
- What was the role of the teacher? What was the role of the students?
- How are these roles different from a traditional science classroom?
- Think about formative assessment. What evidence did you observe that the students were on track (or off track)?

Steps within the Master Teacher Presentation Video Portion:

1. TPL participants observe a video of a Master Teacher implementation of the BLOSSOMS lesson *Hanging by a Thread* with his/her students utilizing the Teaching Duet modality of BLOSSOMS:
    a. Following completion of the full investigation the TPL participants would then watch the videotaped lesson in action. Though the video has been edited to reduce length the video will capture the interactions between the Master Teacher and students as they engage in each of the BLOSSOMS activities. The same activities that the TPL participants have just experienced themselves.
2. Reflection, as a TPL participant:
    a. Led by the TPL facilitator, TPL participants discuss what they observed in the taped live classroom and reflect upon their own experience in the workshop.
    b. The goal for observing the Master Teacher video is to allow the TPL participants the opportunity to compare their TPL experience to the experience they observe the filmed students undergo.
    c. The TPL facilitator should foster an open and discursive environment where participants would be able to discuss their ideas, thoughts, and observations with their workshop colleagues. It is imperative that the TPL facilitator help to connect the TPL participants' experience to that of the students and the instructional shifts of the role of the teacher in an NGSS classroom.

Guide to morning session wrap-up, with view to applying lessons learned to development of participating teachers' classroom NGSS lessons.

The outcome of the morning session should be a stronger awareness of how students are engaged and how teachers address the instructional shifts of the NGSS. To prepare teachers for the work of the afternoon session reinforce the following:

1. What was the phenomenon or problem the students were trying to solve? Why is engaging a student in this manner more effective than introducing a scientific topic or engineering design?
    a. Expected response would be that a phenomenon or problem that is authentic to a student would have a much higher interest factor than a topic alone.
2. How did I (TPL Facilitator) and the Master Teacher in the video know if the students were on track with respect to their use of the practices?
    a. Expected response would be use the "look-fors".
3. Ask TPL participants to think of the lesson that they brought to the workshop. How would they have to change their lesson to make it three-dimensional?
    a. Expected responses would be to move from topic-focused to phenomenon-focused, identify the practices to be used by students and evidence of the practices, create prompts using CCCs.

Resources:

National Research Council, (2012). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education, Washington, DC: The National Academies Press.

NGSS Lead States. (2013). Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

Windschitl, M. Thompson, J. Braaten, M. (2018). Ambitious Science Teaching. Cambridge, MA: Harvard Education Press.