MPRES Toolkit for
Teacher Concept Change

Table of Contents

This toolkit was developed as a professional development resource to train teachers in the concepts of the Framework for K-12 Science Education and the Next Generation Science Standards. It was the product of the STEM Framework Course component of the MPRES Grant. It is not intended to be used as curriculum for classroom instruction.
April 2014

NOTE: This is a DRAFT version

The purpose of this Toolkit is to assist teachers of science in the conceptual development and acquisition of the K-12 Science Framework Dimension of Science & Engineering Practices. The goal is that teachers of science fully implement Science & Engineering Practices in all their teaching and that the Practices will be a natural component of their teaching repertoire. The authors of the Toolkit acknowledge that full implementation of the Next Generation Science Standards involves the integration of the three Dimensions of the K-12 Science Framework: Science & Engineering Practices, Crosscutting Concepts and Disciplinary Core Ideas. The transition from a one dimensional teacher, defined as a teacher who focuses on a single dimension such as content standards, to a three dimensional teacher, one who seamlessly weaves all three dimensions into lessons as appropriate, is a complex cognitive, pedagogical and paradigm challenge. Simply stated, this is not a quick, painless process. The transition to a three dimensional teacher should be viewed as a life-long journey.

A Three Dimensional Teacher is one who seamlessly integrates the three Dimensions of the K-12 Science Framework in all science instruction.

Click here to view one teacher's explanation of her beginning journey from a one dimensional to a three dimensional teacher.

Based on the work of Llewellyn (2013), becoming a three dimensional teacher involves five essential stages:

1. Building an understanding of the three dimensions
2. Developing an understanding of the change process
3. Constructing a mind-set for the emerging pedagogy
4. Translating new knowledge into action
5. Creating a culture of three dimensional practice (p. 60).

"In the final analysis, it's important to realize how you goals and beliefs foster the legacy you create as a teacher" (Llewllyn, 2013, p. 62).

This Toolkit provides a starting point to engage in the steps listed above. An understanding of the Science & Engineering Practices Dimension is provided through examples of the Practices with supporting resources. The activities included in the Toolkit are not meant to serve as lesson plans, but have been chosen to highlight the concepts of each of the Practices. It is expected that teachers using the Toolkit will connect the practice to their specific grade level and lessons. In order to develop an understanding of the change process, each Practice will follow the steps of the Conceptual Change Model (Stephans, 2003). The six stages of the Conceptual Change Model have been modified to fit the development of understanding the Practices as follows:

1. Teachers becoming aware of their own preconceptions about the Practices
2. Teachers expose their beliefs about the practices, sharing their ideas with others
3. Teachers confront their beliefs by engaging in a specific Practices activity
4. Teachers work toward resolving conflicts (if any) between their ideas and their experience with the Practices, thus accommodating the Practice
5. Teachers extend the concept by connecting the Practices specifically to instruction
6. Teacher go beyond by continually reflecting on the Practices, asking questions and engaging with other teachers about the Practices (p. 7).

"Preexisting beliefs are tenacious and may require repeated challenges in different settings and context to replace" (Stephans, 2003, p. 7).

The activities for each Practice allow teachers to work through the Conceptual Change Model by reflecting on each of the steps of the model: Awareness, Expose Beliefs, Confront Beliefs, Resolve Beliefs, Extend the Concept and Go Beyond. The questions posted for each steps are intended to be shared in a professional learning community (PLC), but can also be used for personal reflection as part of the life-long learning process.

	Asking Questions in Science & Defining Problems in Engineering
AWARENESS Framework Rationale	**Science** Science begins with a question about a phenomenon, such as “Why is the sky blue?” or “What causes cancer?” and seeks to develop theories that can provide explanatory answers to such questions. A basic practice of the scientist is formulating empirically answerable questions about phenomena, establishing what is already known, and determining what questions have yet to be satisfactorily answered. **Engineering** Engineering begins with a problem, need, or desire that suggests an engineering problem that needs to be solved. A societal problem such as reducing the nation’s dependence on fossil fuels may engender a variety of engineering problems, such as designing more efficient transportation systems, or alternative power generation devices such as improved solar cells. Engineers ask questions to define the engineering problems, determine criteria for a successful solution, and identify constraints. From the [A Framework for K-12 Science Education], 2011, p. 50
Background Information	Asking questions is essential to developing scientific habits of mind. Even for individuals who do not become scientists or engineers, the ability to ask well-defined questions is an important component of science literacy, helping to make them critical consumers of scientific knowledge. Scientific questions arise in a variety of ways. They can be driven by curiosity about the world. They can be inspired by a model’s or theory’s predictions or attempts to extend or refine a model or theory. Or they can result from the need to provide better solutions to a problem. The experience of learning science and engineering should therefore develop students’ ability to ask- and indeed, encourage them to ask-well formulated questions that can be investigated empirically. Students also need to recognize the distinction between questions that can be answered empirically and those that are answerable only in other domains of knowledge or human experience. Defining problems in engineering is essential for the creation of new products, making improvements to existing materials and working with systems. Engineers ask questions like what is the problem, who has the problem and why is it important to solve the problem? These become the who, what and why in the defining problems process. The who is the user, the what is the need and the why is the insight. As students work through defining problems, it is important for them to keep the who, what and why of the problem in mind.
EXPOSE BELIEFS	[Asking Questions and Defining Problems Podcast]

	[NGSS @ NSTA](#) 1. What are your current beliefs about this practice? 2. In what ways do you think you are using this practice? 3. What challenges do you see to using this practice? 
CONFRONT BELIEFS	Conceptual Change Activities: Asking Questions Activity #1: Balloons and Skewer Asking Questions Activity #2: Lake Cabin Asking Questions Activity #3: Rope Tube Defining Problems Activity #1: Heat Transfer Defining Problems Activity #2: Pringles Potato Chip Challenge

Developing Conceptual Understanding of the Asking Questions Practice Activities Background

The purpose of the following activities is to engage teachers in the Practice of Asking Questions and Defining Problems. The emphasis is NOT on the activity itself, but rather the conceptual change related to the practice. Consumers of this Toolkit are reminded to not get wrapped up in the activity, but rather continually reflect on the conceptual nature of the Practice to gain deeper understanding. Three activities have been provided to engage in each Practice.

Facilitators should lead students through a discussion of the first three stages of the Conceptual Change Model before doing the activity.

AWARENESS

1. From the background information, what new awareness do you have about asking questions?
2. In a 3-Dimensional classroom, who do you think needs to be asking questions?
3. What questions did the background raise for you?

EXPOSE BELIEFS

1. What are your current beliefs about the asking questions Practice?
2. What beliefs do you have from prior knowledge, education or professional development regarding this Practice?
3. How well do you feel you meet the expectations of this Practice as a teacher?

CONFRONT BELIEFS

Asking Questions #1: Balloons and Skewers

General Objective: To provide an opportunity for students to ask questions in science by observing a phenomenon and experiencing that phenomenon.

The facilitator does the following:

1. Show a balloon and a skewer.
2. Blow up balloon.
3. Ask what happens when a sharp object and a balloon come into contact.
4. When people say that the balloon pops, then pop the balloon.
5. Blow up a 2nd balloon. Say something like "Wouldn't it be interesting if I could push the skewer through the balloon without popping it?" Do it as you say it.
6. Let students observe the skewer in the balloon. Solicit questions from students and encourage them to record those questions in their notebooks.
7. You can help students differentiate between researchable questions and testable questions. Researchable questions are those that can be looked up in a resource such as a dictionary or a on a web search. Testable questions are those can that be tested to determine the answer.
8. Have students write questions in their notebooks.
9. Lead a discussion of the questions that have been written. Encourage students to ask deeper questions.

10. Pass out balloons and skewers to everyone.
10. Assist students as needed.
11. Once everyone has been successful, have students revisit their questions and answer them. Share with the full class.

The balloons and skewers activity is an example of a discrepant event. Discrepant events usually involve a phenomenon that is counter intuitive and creates cognitive dissonance for the learner. They are excellent ways to help learners ASK their own questions based on the phenomenon observed. The role of the presenter is to generate opportunities for the learners to ask questions. If learners are utilizing science notebooks, science journals or other personal record-keeping tools, student-generated questions should be put in the notebooks.

Not only should learners be encouraged to ask questions, but they should be expected to find answers to their own questions as well.

[Other Discrepant Events]

Science Notebooks [podcast]

Connection to Cross Cutting Concepts

- Structure and Function
- Cause and Effect

Debrief the activity focusing on the conceptual understanding of the Practice using the following prompts:

RESOLVE BELIEFS

1. In what ways did this activity change your beliefs about asking questions in science?
2. How can discrepant events be used to generate questions in science?
3. What discrepant events do you currently use and HOW do you use them?

EXTEND THE CONCEPT

1. How do you currently help students to ask question in your classroom?
2. Review a recent lesson you taught and evaluate the effectiveness of engaging students in asking questions.

GO BEYOND

1. Ask a colleague to observe one of your lessons OR video yourself teaching and tally the number of questions YOU ask and the number of questions STUDENT ask.
2. Use the [EQuiP Rubric] for Lessons & Units: Science to evaluate a recent science lesson you taught.

[Link to the Balloons & Skewer Lesson]

Asking Questions #2: Lake Cabin Mystery

CONFRONT BELIEFS

Give everyone a copy of the [Lake Cabin] page. Students may ask the facilitator YES or NO questions only. Students are encouraged to take notes as the questions are answered. Once a student BELIEVES they have a solution to the problem, they are NOT to give the solution, but instead are encouraged to ask and answer their own question in a statement. An example might be, "I believe the tracks leading into the woods were made by the person after they left the garage." Students should be encouraged to create statements for questions that have NOT been asked previously to avoid repetition of questions/answers. Facilitator Answer Sheet.

RESOLVE BELIEFS

1. In what ways did this activity change your beliefs about asking questions in science?
2. How can inquiry maps like this be used to generate questions in science?
3. Discuss the importance of *yes* answers versus *no* answers

EXTEND THE CONCEPT

1. How do you currently help students to ask question in your classroom?
2. Review a recent lesson you taught and evaluate the effectiveness of engaging students in asking questions.

GO BEYOND

1. Ask a colleague to observe one of your lessons OR video yourself teaching and tally the number of questions YOU ask and the number of questions STUDENT ask.
2. Use the EQuiP Rubric for Lessons & Units: Science to evaluate a recent science lesson you taught.

Asking Questions #3: Rope Tube

General Objective: To provide an opportunity for students to ask questions in science by observing a phenomenon and experiencing that phenomenon.

The facilitator does the following:

1. Using the rope tube, demonstrate that the ropes are all connected to each other. Rope Tube podcast.
2. After students have observed the operation of the rope tube, solicit questions from students..
3. You can help students differentiate between researchable questions and testable questions. Researchable questions are those that can be looked up in a resource such as a dictionary or a on a web search. Testable questions are those can that be tested to determine the answer.
4. Have students write questions in their notebooks.
5. Lead a discussion of the questions that have been written. Encourage students to ask deeper questions.

The purpose of this activity is ONLY to generate questions. The rope tube is also used with the Science & Engineering Practices of Developing and Using Models, Constructing Explanations and Designing Solutions and Arguing from Evidence.

The Rope Tube is an example of a discrepant event. Discrepant events usually involve a phenomenon that is counter intuitive and creates cognitive dissonance for the learner. They are excellent ways to help learners ASK their own questions based on the phenomenon observed. The role of the presenter is to generate opportunities for the learners to ask questions. If learners are utilizing science notebooks, science journals or other personal record-keeping tools, student-generated questions should be put in the notebooks. Not only should learners be encouraged to ask questions, but they should be expected to find answers to their own questions as well.

Debrief the activity focusing on the conceptual understanding of the Practice using the following prompts:

RESOLVE BELIEFS

1. In what ways did this activity change your beliefs about asking questions in science?
2. How can discrepant events be used to generate questions in science?
3. What discrepant events do you currently use and HOW do you use them?

EXTEND THE CONCEPT

1. How do you currently help students to ask question in your classroom?
2. Review a recent lesson you taught and evaluate the effectiveness of engaging students in asking questions.

GO BEYOND

1. Ask a colleague to observe one of your lessons OR video yourself teaching and tally the number of questions YOU ask and the number of questions STUDENT ask.
2. Use the EQuIP Rubric for Lessons & Units: Science to evaluate a recent science lesson you taught.

Links to possible solutions to the Rope Tube. In addition to the solution shown here, the ropes can also be connected with a washer, paper clip or knots.

Developing Conceptual Understand of the Defining Problems Practice Activities Background

AWARENESS

1. From the background information, what new awareness do you have about defining problems?
2. What is and is not included in this Practice?
3. What questions did the background raise for you?

EXPOSE BELIEFS

1. What are your current beliefs about the defining problems Practice?
2. What beliefs do you have from prior knowledge, education or professional development regarding this Practice?
3. How well do you feel you meet the expectations of this Practice as a teacher?
4. Discuss what is meant by constraints in engineering and how are these different than variables?

CONFRONT BELIEFS

The second component of this Practice is defining problems in engineering. People are faced with challenges everyday that can be solved through engineering. These challenges usually present themselves as a PROBLEM, a NEED or a DESIRE . The identification and verbalization of a problem leads to its successful solution. A component of that solution is the identification of constraints on the challenge. These may include time, money, other resources, equipment, manpower and more. In the following activities, a PROBLEM, a NEED and a DESIRE are presented and students are to define the problem and identify the constraints. This Practice is not about finding and designing a solution; that's a different Practice. The engineering design process is introduced in these activities, but ONLY the ASK step is the focus for this Practice. The steps of the engineering design process include ASK, IMAGINE, PLAN, CREATE, IMPROVE (2006, Museum of Science, Boston).

Defining Problems Activity #1: Heat Transfer

1. Give students a copy of the Heat Transfer sheet. The full case study is available here. After students have read the narrative, have them write a statement that DEFINES THE PROBLEM and then list the CONSTRAINTS of the challenge.
2. After students have finished, lead a discussion of what was written.

RESOLVE BELIEFS

1. In what ways did this activity change your beliefs about defining problems in engineering?
2. How difficult was it to define the problem?
3. What clarity was brought to the problem once it was defined?
4. How difficult was it to identify the constraints?
5. What clarity was brought to the problem once constraints were identified?

EXTEND THE CONCEPT

1. How do you currently help students to define problems in engineering in your classroom?
2. Review a recent lesson you taught and evaluate the effectiveness of defining problems in engineering..

GO BEYOND

1. Share lessons in which you could implement the Practice of defining problems.
2. Ask a colleague to observe one of your lessons OR video yourself teaching and reflect specifically on defining problems and identifying constraints.

3. Use the EQuiP Rubric for Lessons & Units: Science to evaluate a recent science lesson you taught.

Defining Problems Activity #2: Pringles Potato Chip Mailing Challenge

1. Show the students a single Pringles potato chip. Tell them that they have been requested to ship a single chip through the mail. Engage the students in a question/answer discussion that lead them to DEFINE THE PROBLEM and then determine the CONSTRAINTS of the challenge. Do NOT tell them the constraints ahead of time, lead them to the constraints through the discussion. Use the Pringles Chip Challenge as a facilitator guide.
2. After students have finished, lead a discussion of what was written.

RESOLVE BELIEFS

1. In what ways did this activity change your beliefs about defining problems in engineering?
2. How difficult was it to define the problem?
3. What clarity was brought to the problem once it was defined?
4. How difficult was it to identify the constraints?
5. What clarity was brought to the problem once constraints were identified?

EXTEND THE CONCEPT

1. How do you currently help students to define problems in engineering in your classroom?
2. Review a recent lesson you taught and evaluate the effectiveness of defining problems in engineering..

GO BEYOND

1. Share lessons in which you could implement the Practice of defining problems.
2. Ask a colleague to observe one of your lessons OR video yourself teaching and reflect specifically on defining problems and identifying constraints.
3. Use the EQuiP Rubric for Lessons & Units: Science to evaluate a recent science lesson you taught.

Note to Self: Additional Resources *NOTE: THE LESSONS WOULD BE HYPERLINKED*

Exploring Insects (Elementary level K-3)
Magnets (Intermediate level 4-5)
How Much Gas...Pop Rocks Expander (Intermediate level 4-5)
How to Make a Compass (Middle level 6-8)

Ditch Water Activity (High School level 9-12)

	Constructing Explanations & Designing Solutions
AWARENESS Framework Rationale	**In Science:** Engaging students and helping them gain an understanding of the major ideas that science has developed is a central part of science education. Scientists achieve their own understanding by building theories and theory-based explanations with the aid of models and representations and by drawing on data and evidence. **In Engineering:** In engineering, the goal is a design rather than an explanation. Engineering activities have different elements than those of scientists in that they include such elements as constraints, desired qualities of the solution, developing a design plan, producing models or prototypes to optimize achievement of design criteria, or refining design based on performance. Scientists have the, "oh, so that's why that happens" thought process, and engineers have the, "oh, so that's what happens, but what happens if we tweak it like this…. or what will this make it better?" thought process. From the A Framework for K-12 Science Education, 2011, p. 52
Background Information	Scientific theories are developed to provide explanations aimed at illuminating the nature of particular phenomena, predicting future events, or making inferences about past events. These theories are not mere guesses, and they can provide explanations for multiple instances. In addition, the term "hypothesis" is also used as an explanation for an observed phenomenon that can predict what will happen in a given situation. It, too, is made based on existing theoretical understanding relevant to the situation. From the A Framework for K-12 Science Education, 2011, p. 67-69
EXPOSE BELIEFS	Constructing Explanations & Designing Solutions podcast Webinar on Constructing Explanations NGSS @ NSTA

	1. What are your current beliefs about this practice? 2. In what ways to you think you are using this practice? 3. What challenges do you see to using this practice? 

CONFRONT BELIEFS	Conceptual Change Activities: Constructing Explanations Activity #1: Rope Tube Constructing Explanations Activity #2: Balloons & Skewers Designing Solutions Activity #1: Rope Tube Designing Solutions Activity #2: Pringles Potato Chip Challenge

Developing Conceptual Understand of the Constructing Explanations Activities Background

The purpose of the following activities is to engage teachers in the Practice of Constructing Explanations. The emphasis is NOT on the activity itself, but rather the conceptual change related to the practice. Consumers of this Toolkit are reminded to not get wrapped up in the activity, but rather continually reflect on the conceptual nature of the Practice to gain deeper understanding. Three activities have been provided to engage in each Practice.

Facilitators should lead students through a discussion of the first three stages of the Conceptual Change Model before doing the activity.

AWARENESS

1. From the background information, what new awareness do you have about constructing explanations?
2. How does this Practice support Asking Questions?
4. In a 3 Dimensional classroom, who do you think needs to be constructing explanations?
5. What questions did the background raise for you?

EXPOSE BELIEFS

1. What are your current beliefs about the constructing explanations Practice?
2. What beliefs do you have from prior knowledge, education or professional development regarding this Practice?
3. How well do you feel you meet the expectations of this Practice as a teacher?

CONFRONT BELIEFS

Constructing Explanations Activity #1: Rope Tube

To be completed AFTER the Designing Solutions activity: Rope Tube

General Objective: To provide an opportunity for students to construct explanations in science based on observing a phenomenon and asking questions.

The facilitator does the following:

1. Once students have seen the Rope Tube phenomenon, asked questions and designed solutions, have them construct an explanation of the phenomenon based on the created model: Rope Tube vodcast.
2. Students should be able to construct their explanation both in written and verbal form.

At this point, do NOT expect all students to have the same answer, but needs to be based on their designed solution.

Debrief the activity focusing on the conceptual understanding of the Practice using the following prompts:

RESOLVE BELIEFS

1. In what ways did this activity change your beliefs about constructing explanations in science?
2. How difficult do you find it to construct an explanation?
3. Discuss your level of confidence along the process of constructing an explanation?

EXTEND THE CONCEPT

1. How do you currently help students construct explanations of science phenomenon in your classroom?
2. Review a recent lesson you taught and evaluate the effectiveness of engaging students in constructing explanations.
3. What is the relationship between this Practice and others?

GO BEYOND

1. Ask a colleague to observe one of your lessons OR video yourself teaching and tally the number of questions YOU ask and the number of questions STUDENT ask.
2. Use the EQuiP Rubric for Lessons & Units: Science to evaluate a recent science lesson you taught.

Links to possible solutions to the Rope Tube. In addition to the solution shown here, the ropes can also be connected with a washer, paper clip or knots.

Constructing Explanations Activity #2: Balloons & Skewers

To be completed AFTER the Asking Questions Activity: Balloons & Skewers

General Objective: To provide an opportunity for students to construct explanations in science based on observing a phenomenon and asking questions.

The facilitator does the following:

1. Once students have seen the Balloon & Skewer phenomenon, asked questions, and successfully done the phenomenon themselves, have them construct an explanation of the phenomenon.
2. Students should be able to construct their explanation both in written and verbal form.
3. Finding an explanation for this phenomenon may require outside research, since this is a RESEARCHABLE explanation. Explanations should be include, but are not limited to, properties of polymers; chemical bonds; elasticity; application to wounds caused by impaled objects; nails in tires, etc.
4. Resources can include, but are not limited to science textbooks, encyclopedias, internet.

Debrief the activity focusing on the conceptual understanding of the Practice using the following prompts:

RESOLVE BELIEFS

1. In what ways did this activity change your beliefs about constructing explanations in science?
2. How difficult do you find it to construct an explanation?
3. Discuss your level of confidence along the process of constructing an explanation?
4. What resources did you find most useful?
5. Discuss the difference between verbal and written explanations?

EXTEND THE CONCEPT

1. How do you currently help students construct explanations of science phenomenon in your classroom?

2. Review a recent lesson you taught and evaluate the effectiveness of engaging students in constructing explanations.
3. What is the relationship between this Practice and others?

GO BEYOND

1. Ask a colleague to observe one of your lessons OR video yourself teaching and tally the number of questions YOU ask and the number of questions STUDENT ask.
2. Use the [EQuiP Rubric]() for Lessons & Units: Science to evaluate a recent science lesson you taught.

Many sources demonstrate this phenomenon in different ways. Some suggest use knitting needles; oil or water on the needle/skewer; twisting the skewer in a particular fashion. Students should discover these techniques on their own rather than being told.

Developing Conceptual Understand of the Designing Solutions Activities Background

The purpose of the following activities is to engage teachers in the Practice of Designing Solutions. The emphasis is NOT on the activity itself, but rather the conceptual change related to the practice. Consumers of this toolkit are reminded to not get wrapped up in the activity, but rather continually reflect on the conceptual nature of the Practice to gain deeper understanding. Three activities have been provided to engage in each Practice.

Facilitators should lead students through a discussion of the first three stages of the Conceptual Change Model before doing the activity.

AWARENESS

1. From the background information, what new awareness do you have about designing solutions?
2. How does this Practice support other practices?
4. In a 3 Dimensional classroom, who do you think needs to be designing solutions?
5. What questions did the background raise for you?

EXPOSE BELIEFS

1. What are your current beliefs about the designing solutions Practice?
2. What beliefs do you have from prior knowledge, education or professional development regarding this Practice?
3. How well do you feel you meet the expectations of this Practice as a teacher?

CONFRONT BELIEFS

Designing Solutions Activity #1: Rope Tube

General Objective: To provide an opportunity for students to designing solutions in science based observing a phenomenon and asking questions.

The facilitator does the following:

1. Once students have seen the Rope Tube phenomenon and asked questions, have them designing a solution of the phenomenon based on the created model. Rope Tube podcast.
2. Students should be able to design a solution that replicate the observed phenomenon of the Rope Tube.
3. Have students generate a list of needed materials and either provide the materials or have students gather the materials.
4. Provide time for students to design solutions using the Engineering Design Process.

Debrief the activity focusing on the conceptual understanding of the Practice using the following prompts:

RESOLVE BELIEFS

1. In what ways did this activity change your beliefs about designing solutions?
2. How difficult do you find it to design a solution?
3. Discuss your progression of solution design.

EXTEND THE CONCEPT

1. How do you currently help students design solutions in your classroom?
2. Review a recent lesson you taught and evaluate the effectiveness of engaging students in designing solutions..
3. What is the relationship between this Practice and others?

GO BEYOND

1. Ask a colleague to observe one of your lessons OR video yourself teaching and tally the number of questions YOU ask and the number of questions STUDENT ask.
2. Use the EQuiP Rubric for Lessons & Units: Science to evaluate a recent science lesson you taught.

Designing Solutions Activity#2: Pringles Potato Chip Mailing Challenge

The facilitator does the following:

1. After students have DEFINED the Pringles Chip Challenge, have them design a solution by first drawing sketches/diagrams of possible mailing devices.
2. Have students generate a list of needed materials and either provide the materials or have students gather the materials.
3. Provide time for students to design solutions using the Engineering Design Process.

4. Provide time for testing and redesign.
5. Use the Pringles Chip Challenge as a facilitator guide.

Debrief the activity focusing on the conceptual understanding of the Practice using the following prompts:

RESOLVE BELIEFS

1. In what ways did this activity change your beliefs about designing solutions?
2. How difficult do you find it to design a solution?
3. Discuss your progression of solution design, testing, redesigning, retesting, etc.

EXTEND THE CONCEPT

1. How do you currently help students design solutions in your classroom?
2. Review a recent lesson you taught and evaluate the effectiveness of engaging students in designing solutions..
3. What is the relationship between this Practice and others?

GO BEYOND

1. Ask a colleague to observe one of your lessons OR video your own teaching and tally the number of questions YOU ask and the number of questions STUDENT asks.
2. Use the EQuiP Rubric for Lessons & Units: Science to evaluate a recent science lesson you taught.