

Nevada Educator Performance Framework

Workshop Series Guide for SCIENCE Educators

STANDARD 1 New Learning is Connected to Prior Learning and Experience 1	STANDARD 2 Learning Tasks have High Cognitive Demand for Diverse Learners 2	STANDARD 3 Students Engage in Meaning-Making through Discourse and Other Strategies 3	STANDARD 4 Students Engage in Metacognitive Activity to Increase Understanding of and Responsibility for Their Own Learning 4	STANDARD 5 Assessment is Integrated into Instruction 5
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Standard 4: Students Engage in Metacognitive Activity to Increase Understanding of and Responsibility for Their Own Learning

Indicator 1 - Teacher and all students understand what students are learning, why they are learning it, and how they will know if they have learned it

Indicator 2 - Teacher structures opportunities for self-monitored learning for all students

Indicator 3 - Teacher supports all students to take actions based on the students' own self-monitoring processes

Science Teacher Professional Development Sessions Sequence:

Session I (20 min.)

- Introduction
- Video

Session II (20 min.)

- Video
- Strategy Highlights

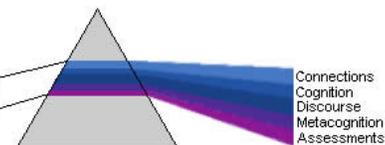
Session III (20 min.)

- Strategy Highlights
- Team Talk
- Applications

Session IV (20 min.)

- Applications
- Reflection

SCIENCE



Key Ideas from Theory and Research:

- Metacognition is a foundational cognitive process for effective learning in all disciplines. At its most basic, it is "thinking about thinking" (Flavell, 1979).
- Students who monitor their own thinking and take action are more successful than their peers in academic activities (e.g., Bransford et al., 1982; Slife, Weiss, & Bell, 1985; Zimmerman & Martinez-Pons, 1992).
- The 21st Century skill of adaptability, including the ability to respond effectively to feedback, is what the learner does in the monitoring and reflection phase of self-regulated learning (e.g., National Research Council, 2012)
- Affective self-regulation (the ability to properly regulate one's emotions) is related to academic success through motivation, a state supported by metacognition (Bandura, 1986; Eisenberg, Valiente, & Eggum, 2010; Ray & Smith, 2010).
- A learning goal orientation supports adaptive motivational patterns that promote the establishment, maintenance, and attainment of personally challenging and valued learning goals (e.g., Dweck & Leggett, 1988; Elliott & Dweck, 1988).
- Instructional strategies for teaching metacognition and encouraging motivation to use metacognitive strategies need to occur at a meta-level instead of performance level (Kuhn, 2000).

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Standard 4: Students Engage in Metacognitive Activity to Increase Understanding of and Responsibility for Their Own Learning

Session I:

Introduction: 1 min.

In this session you will watch about 8:00 minutes of a video that presents an argument about the way in which we learn and then review some common structures of metacognitive strategies. This specific video is about misconceptions. Throughout this module we will discuss the implementation of strategies to promote metacognition to support student ownership of their learning.

Before watching the video you should know that metacognition is **NOT** simply "thinking." More accurately, metacognition refers to the processes used to plan, monitor, and assess one's understanding and performance, it is more simply put, thinking about the effectiveness of personal learning strategies. Metacognition includes a critical awareness of a) one's thinking and learning and b) oneself as a thinker and learner. Metacognition can be thought of as a process to evaluate the effectiveness of cognitive strategies... thinking about how well you performed, what you should do differently, and how you will prepare to do it differently.

So how can this happen in an overcrowded classroom?

How on Earth can you, a single teacher, support **ALL** students to develop metacognitive strategies?

The good news is there are some simple steps to support you as you support your students.

Video: 8:03 min.

<http://www.youtube.com/watch?v=eVtCO84MDj8&feature=share&list=PL772556F1EFC4D01C&index=24>

Video segments with independent, teacher focus questions.

Time: 0:00 - 8:03

What makes a student watching a Khan Academy video different from a student watching a classroom lecture?

What strategies do you think you are currently using to support metacognitively active students?

What strategies do you think you could be using to support metacognitively active students?

What strategies do you want to learn more about to support metacognitively active students?

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Metacognition into Classroom Practice: 10 min.

In this last part of Session I you will think about a few strategies that can easily be applied to a secondary science classroom. In "Promoting Student Metacognition," Tanner (2012) offers a handful of specific activities for a biology class. However, these specifically targeted strategies can apply to all secondary classrooms. Think about how each currently looks, and/or could look in your classroom. What changes would need to be made to incorporate these metacognitive activities?

Planning:

- **Pre-assessments—**
 - Encourage students to examine their current thinking
 - Example Question: "What do I already know about this topic that could guide my learning?"
 - Example Prompt: "*I understand that... and I think this will help me learn about... because...*"
- **Time management—**
 - Give examples of strategies to manage time to complete tasks and projects
 - Example Question: "For homework tonight you will need to complete a full lab report with analysis, graph, and conclusion. How much time should you spend to complete your task?"
 - Example Teacher Model: "*I would think that you should spend about 20 min. on calculations before graphing. Then graphing the data should take you about 30 min. Finally, I would like you to spend about 40 min. writing your conclusion. This includes your argument (your claim, evidence statements and rationale) because you will share them tomorrow. In total, you need to block out 1.5 hours of time to focus on completing the lab report.*"
- **Reflective Journals—**
 - Providing a forum in which students plan time for their own thinking (this is an aspect to an interactive science notebook)
 - Example Questions: "How long do you think you need to devote to this task to complete it?"
 - Example Prompt: "*To complete this task I need to devote...*"

Monitoring:

- **The Muddiest Point—**
 - Giving students practice in identifying confusions
 - Example Question: "What was most confusing to me about the material explored in class today?"
 - Example Prompt: "*I am not sure I understood... because I do not fully understand how it relates to....*"
- **Reflective Journals—**
 - Providing a forum in which students monitor their own thinking (this is an aspect to an interactive science notebook)
 - Example Questions: "What assignments have helped me to better understand the concepts in this unit so far? In what ways?" and "After completing an assignment, but before submitting it to my teachers, should I review it?"
 - Example Prompt: "*I think the.... assignment helped me to understand the main concept and I will review that assignment before the test.*" and "*I like to review my assignments and look for... because...*"

Evaluating:

- **Retrospective Post-assessments—**
 - Pushing students to recognize conceptual change
 - Example Question: "How have your ideas changed?"
 - Example Prompts: "*Before this unit, I thought evolution was... Now I think that evolution is*" or "*How is my thinking changing (or not changing) over time?*"
- **Reflective Journals—**
 - Providing a forum in which students evaluate the effectiveness of their strategies (this is an aspect to an interactive science notebook)
 - Example Questions: "What parts of my test preparation worked well, so I will remember to do next time?" and "What did not work so well that I should not do next time or that I should change?"
 - Example Prompt: "To prepare for the test I... and this was/was not effective because..."

Teacher Reflection Questions:

What metacognitive strategies, from the three listed categories above, do your students currently use in your classroom? What evidence could you provide as support?

What metacognitive strategies, from the three listed categories above, do you think you could be using to support metacognitively active students in your classroom?

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Session II:

Understanding the reason for metacognition:

"Metacognitive practices increase students' abilities to transfer or adapt their learning to new contexts and tasks (1). They do this by gaining a level of awareness above the subject matter: they also think about the tasks and contexts of different learning situations and themselves as learners in these different contexts. When Pintrich (2002) asserts that "Students who know about the different kinds of strategies for learning, thinking, and problem solving will be more likely to use them" (p. 222), notice the students must "know about" these strategies, not just practice them. As Zohar and David (2009) explain, there must be a "conscious meta-strategic level of H[igher] O[rder] T[hinking]" (p. 179)."

1. Bransford, Brown, & Cocking, p. 12; Palincsar & Brown, 1984; Scardamalia et al., 1984; Schoenfeld, 1983, 1985, 1991
Content quote from: <http://cft.vanderbilt.edu/guides-sub-pages/metacognition/>

Metacognition Strategies to Address Science Misconceptions: 10 min.

In this part of Session II you will select from several video options. Each video is targeted for a specific science concept. Select one video, based upon the topic you are most comfortable, and think about what ownership of learning the many interviewees took. Specifically, after watching the video you will describe the content target and the common misconception. In session III you will develop metacognitive questions and prompts specific to the video you selected.

Please note: These videos are of interviews with adults from many different countries. They were created to be used formally in classrooms and informally in many settings. The focus for this lesson is to think about how metacognitive strategies (asking learners to plan, monitor, and evaluate their learning strategies) can be used to support learners in taking responsibility for their learning.

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Video: ~4 min.

Select one video, based upon the topic you are most comfortable, to watch. As you watch the video, think about the content target for the video and the common misconceptions represented in the video. In session III you will develop metacognitive questions and prompts specific to the video you selected.

Earth and Space Science: The Seasons http://www.youtube.com/watch?v=b3TRUDKpoAs&list=PL772556F1EFC4D01C&feature=share&index=32	Life Science: Mass of a Tree http://www.youtube.com/watch?v=2KZb2_vcNTg&list=PL772556F1EFC4D01C&feature=share&index=2
Chemistry: Sun's Energy http://www.youtube.com/watch?v=Ux33-5k8cjq&list=PL772556F1EFC4D01C&feature=share&index=3	Physics: Heat, Temperature, and Conduction http://www.youtube.com/watch?v=vqDbMEdLiCs&list=PL772556F1EFC4D01C&feature=share&index=1

Teacher Reflection Questions:

- What was the content focus of the video that you selected?
- What is the accurate scientific concept (model) the video addressed?
- What is the most common misconception (model) from the video?



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Strategy Highlights: 10 min.

After watching the video, describing the science model, and the common misconceptions addressed in the video, your task in this session is to develop metacognitive questions and prompts around the video you watched. Your goal is to think about different ways of incorporating metacognitive activities into your classroom.

To help guide you, look at the example below.

Planning:

During this lesson you will watch a quick video of a person interviewing tourists at a museum. Outside of the museum that is a large granite (type of rock) sphere. The base for the sphere is also made of granite, but there is a constant, steady flow of water, which causes the sphere to "float" above the base. This thin layer of water allows the sphere of granite to move freely... and in this case it is spinning. Look at the picture below to "see" the layer of water.



Student Interactive Notebook Questions:

Content Question: What is a force and how does it relate to inertia?

Content Prompt: *A force is... and inertia is... . They are related in that...*

Metacognitive Question: What do I know about forces, motion, and inertia that could guide my learning?

Metacognitive Prompt: *I know that... and I think this will help me learn about... because...*

Monitoring:

As you watch the video below, compare your understanding of forces and inertia with the ideas presented by the tourists in the video.

Video, Youtube Education:

<http://www.youtube.com/watch?v=TQxautcYP6I&list=PL772556F1EFC4D01C&feature=share&index=11>

Student Interactive Notebook Questions:

Content Question: What did the tourists think caused the granite sphere to keep spinning?

Content Prompt: *The tourists INCORRECTLY thought that...*

Content Question: Why does the Earth spin?

Content Prompt: *The Earth spins because... . I can explain this by saying...*

Metacognitive Question: What was most confusing about the video?

Metacognitive Prompt: *I did not fully understand... because... . I think I need to learn more about...*

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<p>Evaluation: After watching the video you can see that many people do not understand the concepts of force and motion. Now that you have a more clear understanding, readdress the initial question.</p> <p>Student Interactive Notebook Questions:</p> <p>Content Question: What is a force and how does it relate to inertia? Content Prompt: <i>A force is... and inertia is... . They are related in that...</i></p> <p>Metacognitive Question: How have your ideas changed when compared to what you originally thought? Metacognitive Prompt: <i>Originally I thought that forces were... and inertia was... . Now I know that forces are... and inertia is... because... . The evidence that supports my understanding is...</i></p>

Your turn; using the above table as a guide, create one metacognitive question and prompt for planning, monitoring, and evaluation based upon the video you selected to watch. In other words, if you were going to show the video to your students, what metacognitive questions and prompts would you use to support their learning and ownership of learning. This is not intended to provide you with a complete lesson, but rather the model for incorporating metacognitive activities into lessons you are currently using. Use the indicators for Standard 4 as a target for your questions and prompts.

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<p>Planning: Student Interactive Notebook Questions: Metacognitive Question: Metacognitive Prompt:</p>
<p>Monitoring: Student Interactive Notebook Questions: Metacognitive Question: Metacognitive Prompt:</p>
<p>Evaluation: Student Interactive Notebook Questions: Metacognitive Question: Metacognitive Prompt:</p>

Note: In Session III you will have the opportunity to develop metacognitive questions and prompts to address the learner's understanding of the concept (cognitive strategies) and scaffolding for planning, monitoring, and self-assessing the learner's understanding and performance in a specific lesson you teach.



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Session III:

Strategy Highlights (continued): 5 min.

For this task, select a lesson that you will be teaching in the near future. Your goal is to use the model you created in Session II to create metacognitive questions and prompts to support students in planning, monitoring, and evaluation of their learning during the lesson that you have selected. Think of this as a task that will help you incorporate metacognitive activities easily into your current teaching practice.

Before you start, it is good to know that teaching students to be [self-regulated learners](#) (using cognitive, metacognitive, and motivational strategies to govern personal learning) is not an easy, nor quick task. It will not happen with one lesson. Think of developing a classroom climate that:

Gives students license to identify confusions within the classroom culture: ask students what they find confusing, acknowledge the difficulties, and provide guidance to the learning target

Integrates reflection into all aspects of course work: integrate short reflection (oral or written) that ask students what they found challenging or what questions arose during an assignment/exam/project. Further, reflection about what they did as a learner to be successful or what cause a failure on their part. Reflection is a time for the student to self evaluate.

Models metacognitive processes: model the thinking processes involved in your field/discipline of science. Students need to hear your thoughts to know what metacognitive processes "sound," "look," and "feel" like in science. Be explicit about "how you start, how to plan, how you decide what to do first and then next, how you check your work, how you know when you are done"

Based on my lesson for... I would like to incorporate the following:

Planning: Student Interactive Notebook Questions: Content Question: Content Prompt: Metacognitive Question: Metacognitive Prompt:
Monitoring: Student Interactive Notebook Questions: Content Question: Content Prompt: Metacognitive Question: Metacognitive Prompt:
Evaluation: Student Interactive Notebook Questions: Content Question: Content Prompt: Metacognitive Question: Metacognitive Prompt:

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Team Talk: 10 min.

Using your colleagues as professional resources, share your thoughts about your developed metacognitive questions and prompts. Think about how pushing all students in your classroom to be responsible for their learning can target achievement of the indicators for Standard 4. As you are discussing, record general notes and or suggestions from your colleagues in your Personal Learning Log.

Discuss as a group the perceived benefits and challenges to incorporating the metacognitive strategy.*

**This discussion can be as a department, small disciplinary group, or with a partner.*

Applications: 10 min.

Using your developed metacognitive questions and prompts, and the feedback from your peers, determine if modifications to your questions and prompts are warranted. Also, determine when you will implement the metacognitive strategies (when will you teach the lesson?). Describe your final metacognitive questions and prompts in your Professional Learning Log. Please note, in the last session, Session IV, you will share your results with your peers.

Based on peer feedback I would like to incorporate the following into my lesson about...

Planning: Student Interactive Notebook Questions: Content Question: Content Prompt: Metacognitive Question: Metacognitive Prompt:
Monitoring: Student Interactive Notebook Questions: Content Question: Content Prompt: Metacognitive Question: Metacognitive Prompt:
Evaluation: Student Interactive Notebook Questions: Content Question: Content Prompt: Metacognitive Question: Metacognitive Prompt:

Describe when you will implement the strategy (tomorrow, start of next lesson, etc.).

I will implement this strategy...

You must implement the tasks before moving to Session IV.

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Session IV:

Applications (continued): 10 min.

In this last session, Session IV, you will work in your small, non-discipline specific teams with a focus of reflection and future implementation of your metacognitive strategies (planning, monitoring, and evaluation questions and prompts). Describe the application of your metacognitive strategies to your peers so they understand what you did, what the students did, and your goal for the implementation.

Specifically, discuss:

- the metacognitive questions and prompts that you used in your lesson.
- how the metacognitive questions and prompts did or did not help you target the indicators for Standard 4.
- the aspects of your metacognitive strategies, which you implemented as questions and prompts, that you believe were effective at achieving the indicators of Standard 4.
- the aspects of your metacognitive strategies, which you implemented as questions and prompts, that you believe were ineffective at achieving the indicators of Standard 4.

Personal Reflection: 10 min.

After your small group discussion, think about your implementation, the results, and your peer's feedback. Effectiveness should be measured based upon the indicators for Standard 4:

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What would you change to make your implementation more effective? What evidence do you have to support your claims?

After thinking about the implementation, I would like to change...

I can support this change with (evidence)...

What went well in the implementation of your metacognitive strategies? What evidence do you have to support your claims?

Based upon (evidence)... I think my implementation went well because...

Can the implementation of metacognitive questions and prompts for students to plan, monitor, and self-evaluate their learning be a long-term strategy in your classroom? Why or why not?

Based upon... I would say that this (is/is not) a long-term strategy because...

Want to learn more about self-regulated learning, cognition, metacognition, or motivation strategies for science education? Visit:

[Self Regulated Learning in Science Education Schraw, Crippen, Hartley\(2006\).pdf](#)

<http://gse.buffalo.edu/fas/shuell/cep564/metacog.htm>

<http://cft.vanderbilt.edu/guides-sub-pages/metacognition/>