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Module 5: Workshop 14
Lesson Plan

Overall Learning Goals	**Lesson Topic**
Strategies for Developing Common Core Skills in Content Areas (Math & Science): to train administrators and adult educators *to develop test readiness strategies* to further cement Common Core skills in content areas to better prepare their ESOL, ABE, and pre- HSE student constituency for the TASC exam.	Math Components – Developing increasingly complex skills set to analyze texts about Math and the Physical Sciences, Engineering, and Application of these Math and Sciences skills in a problem-solving test environment.
Curriculum Developer Tyler Holzer **Workshop Trainer**	**Date** **Location**

Intended Audience

- **Instructors** (content was designed as a workshop for Instructors).
- Note: Sample student material (e.g., readings and TASC exam questions) is included for Instructors to analyze during the workshop. Instructors may also use sample student materials in their classes.

Standards Alignment

- The Three Key Shifts in Literacy/ELA:
  - Shift 1: Regular Practice with Complex Texts and Their Academic Language.
  - Shift 2: Reading, Writing, and Speaking Grounded in Evidence from Texts.
  - Shift 3: Building Knowledge through Content-Rich Nonfiction.

NGSS Conceptual Shifts

- Shift 1: Science Education Should Reflect the Real World Interconnections in Science.
- Shift 2: Using Crosscutting Concepts to Teach Core Ideas.
- Shift 3: Science Concepts Build Coherently.
- Shift 4: Deeper Understanding and Application of Content.
- Shift 5: Science and Engineering are Integrated in Science Education.
- Shift 6: Science Standards Coordinate with English Language Arts and Mathematics Common Core State Standards.

Goals and Objectives (SWBAT)

- Participants will know how to use data and readings in the sciences to support the NGSS Conceptual Shifts.
- Participants will know how to create classroom situations for applied math investigation in the sciences.
- Participants will know how to use writing activities in their classrooms to build their students' background knowledge and vocabulary in math and science.
- Participants will have the skills to teach students how to answer constructed-response questions on the TASC mathematics and science subtest.
- Participants will know the concept of interleaving and how it can improve performance on assessments like the TASC.
- Participants will know how to create meaningful interdisciplinary activities that hone students' skills in both mathematics and science, and that prepare students for the TASC.
- Participants will become familiar with TASC science questions that involve mathematical thinking and processes. They will learn effective strategies to help their students decode complex scientific language and take the appropriate steps to solving math problems with applications to science. They will learn about how "interleaving" can help students in a testing environment, and they will feel comfortable creating rigorous interdisciplinary activities for use in their classrooms.

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Warm-Up/Review

- Participants will review the concept of interdisciplinary teaching from Workshop 13.
  - Questions for discussion: "What does it mean to take an interdisciplinary approach to teaching mathematics? How could it benefit us as adult educators? How could it benefit our students?"
    - Participants should share what they remember from the discussion at the end of Workshop 13. If some participants didn't attend the previous workshop, they will have an opportunity to review the basic concepts of interdisciplinary teaching.
    - Interdisciplinary teaching supports the instructional shifts in both mathematics and ELA by exposing students to applications of math and writing in other disciplines, like science and social studies. It also helps teachers to make the most of their classroom time by building math and writing skills during science and social studies activities.
    - Some sample responses from a previous workshop: Interdisciplinary teaching means integrating different disciplines; contextualized learning; incorporating all subjects; connections and overlap across disciplines. We should do it because it helps students develop understanding by making connections; students get an overview of everything; it promotes the idea that there are no separate subjects; it offers an opportunity for multidimensional learning; it allows for repetition and reinforcement; and it promotes critical thinking and retention of content.
- The facilitator will explain the goal of workshop 14 to the participants, and shift the discussion toward the critical thinking skills we need in instill in students so that they can be successful on the TASC.
  - Question for discussion: "What are some activities you have tried in the classroom to get students curious about—or interested in—math and science topics?"
  - As participants respond to the question in a group discussion format, the facilitator should record their responses on chart paper.
    - This discussion should help teachers to see what their colleagues are doing in the classroom so that they get new ideas to try out with their own students.

References (APA Style)

- Burns, M. (1996). *Writing in math class: Resource for grades 2–8*. Sausalito, CA: Math Solutions Publications.
- Burns, M. (2004). Writing in math: Innovative teachers can make writing an invaluable part of math instruction. *Educational Leadership*, 62(2), 30–33.
- Carey, B. (2014) *How we learn: The surprising truth about when, where, and why it happens*. New York: Random House.
- Carey, B. (2014, November 22). Studying for the test by taking it. *The New York Times*. Retrieved from http://www.nytimes.com/2014/11/23/sunday-review/studying-for-the-test-by-taking-it.html
- McClain, J. (2013, July 29). The James River: Comeback central for bald eagles. Retrieved from https://www.wm.edu/news/stories/2013/the-james-river-comeback-central-for-bald-eagles123.php

Technology and Handouts

Technology Needs

- AV cart with projector, laptop, and speakers will be provided.
- Laptop or tablet computer for each student with access to Internet.
- Latest version of Adobe Flash installed on laptops.

Presentation Needs & Handouts

- Chart Paper.
- Markers.
- TI-30XS Multiview Calculators.

Each item listed below will be available in PDF format.

- Bald Eagles Lesson Plan.
- Graph of Bald Eagle Population along the James River.
- NGSS Conceptual Shifts.
- The James River Reading.
- A Traditional Activity Involving Data.
- The Three Key Shifts in ELA.
- Sample CR Questions from CTB.
- Developing Constructed Response Questions.
- Writing about Math.
- Writing about Math Responses.
- Writing in Math.

Lesson Plan Activities

Part 1: Getting Students to Ask Questions about Math and Science Topics

Lesson Content

Participants will analyze a graph about eagle populations and explore ways of getting students to ask precise questions based on the information.

Lesson Materials

- Handout Graph of Bald Eagle Population along the James River.
- Handout of article "The James River: Comeback Central for Bald Eagles."

Questions to Answer

- How can we encourage students to begin investigating science topics without being prompted?
- Why is it worthwhile to let students formulate their own questions during classroom activities?

Background/Opening

- The facilitator should introduce the next activity by discussing chart and graph reading with participants. This is a skill that crosses disciplines on the TASC test: students will be expected to analyze charts, tables, and graphs on the science, social studies, and math subtests.
  - For discussion: In order to be successful on the TASC, students should begin asking questions of the material while they are reading it. Getting into the habit of anticipating questions will help them to become more careful and inquisitive readers, and it will help them to make connections across disciplines.
- The facilitator will distribute the handout A Traditional Activity Involving Data, and participants should solve it. Solving should only take a few minutes, and the facilitator may need to support participants by reminding them how to calculate mean (average).
  - While this problem does involve chart reading and asks students to know how to calculate average, it is still simplistic and formulaic. Moreover, the situation might feel a little artificial. This is typical of a standard test question. The problem does not invite student investigation into the topic, and it is an exercise in building skills. That is, can the student read the chart, calculate averages, and compare the two.
  - Question for discussion: "Does this problem get you interested in the subject? Does it build background knowledge of any key topics?"
    - The answer to both of these questions is *no*. The facilitator should give participants a chance to voice their thoughts about the problem. Some will feel that it is an effective problem to use in the classroom, which is something that should be discussed. There needs to be time in class for solving the kinds of questions that might appear on the test, but these kinds of questions should not be the bedrock of instruction.

Lesson Activities

- Activity1: The facilitator will distribute the handout Graph of Bald Eagle Population along the James River.
  - The facilitator should tell participants that this is an example of an activity they might try in their own classes. Our goal is to get students interested in science topics, and to begin asking questions before they are prompted. This can help them to anticipate the kinds of questions they will see on the TASC.
- Activity2: Participants will spend ten to fifteen minutes analyzing the graph and formulating questions. If the participants are primarily math teachers, the facilitator may ask them to write questions about the graph that would involve mathematical solutions.
  - Participants should be guided to create as many questions as they can. At this stage, participants should not share their questions—or answers to their questions—with anyone else. This will happen later in the activity.
  - The facilitator should circulate around the room and support participants who may be struggling with the activity. The questions that they formulate do not have to be complex; they may involve extracting information about the graph, or predicting the eagle population in future years.
  - Some questions that the facilitator should attempt to draw out are:
    - "What happened between 1972 and 1980 that led the eagle population to rise so dramatically?"
    - "Beginning in 1980, does the eagle population grow at a constant rate?"
    - "What will likely happen to the eagle population in future years?"
- Activity3: After participants have worked for about fifteen minutes developing questions, the facilitator should begin a discussion about the questions they developed. All participant responses should be recorded on chart paper.
  - One goal of this activity is to make sure that the questions are as precise as possible. When a participant submits one of their questions, the facilitator should ask if anyone else asked a similar question.

        - If other participants came up with something similar, the whole group should discuss the language of the question to make sure that it is clear and precise. This should happen for each question submitted.

Wrap Up/Assessment

- The facilitator will wrap up the activity by asking participants to individually reflect on the activity.
    - Questions for consideration: "What did you like about this activity, as opposed to the more "traditional" activity we did earlier? What would be the benefit of doing this with students?"
        - Here, participants should notice that they had more agency in analyzing the graph asking their own questions. This was a real-world scenario with interesting results that can lead to further discussion and analysis, and it encourages deep thinking and curiosity about the topic, unlike the traditional activity done earlier in the workshop.
    - If participants do not have the NGSS Conceptual Shifts handout from the previous workshop, the facilitator should distribute it now. The facilitator may choose to briefly review the conceptual shifts.
        - Question for discussion: "How does an activity like this meet the conceptual shifts called for by the Next Generation Science Standards?"
        - The activity is a good example of how science plays a key role in the way we interact with the world (Shift 1). The activity builds background knowledge and emphasizes deep understanding and application of science content (Shift 4). This research-based activity also mirrors the process of scientific inquiry, which helps students prepare for the kinds of tasks they will be asked to do in college-level science courses (Shift 6).
- For assessment, the facilitator will ask participants to create an anticipation guide for this activity. Participants will spend ten minutes thinking about how this activity might play out in their classrooms. They should consider supports that students might need and anticipate aspects of the activity that might be challenging.
    - Question for reflection: "Before we move on to, please take ten minutes to think about how this activity might work in your class and try to anticipate the supports that students might need. What would you do to support students who are struggling, and how could you encourage deep thinking about the graph?"
    - After participants have finished free-writing, the facilitator will ask for volunteer to briefly share their thoughts.

Part 2: From Scientific Readings to Extended Activities and Rigorous Classroom Tasks

Lesson Content

In this lesson, the participants will further develop classroom tasks based around the graph from the previous activity. Participants will also briefly examine the Key Shifts in ELA/Literacy, and the staircase of complexity as it applies to a reading in the sciences.

Lesson Materials

Participants will use the same handouts from the previous lesson, as well as the James River Reading handout.

Questions to Answer

- How do the Six Instructional Shifts in Mathematics and the Key Shifts in ELA/Literacy influence our teaching of applied math and science?
- How can teachers promote coherent instruction by integrating tables, charts, graphs, and readings into their math and science instruction?

Background/Opening

- For the second part of the workshop, the facilitator will ask participants to start thinking about answers to the questions they developed during the previous activity.
    - If they haven't been guided to already, participants should focus primarily on the questions: "What happened between 1972 and 1980 that caused the eagle population to increase so dramatically?" and "Will the eagle population continue to grow at the same rate in the coming years?"
    - Participants should take five to ten minutes to predict what the answers to these questions might be. After they have taken time to think about the questions individually, they should discuss their answers in groups.
    - The facilitator will then open the discussion up to the group. Participants will offer possible explanations for the changes seen in the graph, and the group will discuss them.
        - The facilitator should not provide answers to the questions yet. Instead, participants should be allowed to make predictions, and they should discuss why those predictions might be accurate or not. This models the process of scientific inquiry.

Lesson Activities

- Activity1: After participants have talked about possible answers to the questions they developed, the facilitator should distribute the handout The James River Reading.
  - The facilitator should tell the group that they will find answers to some of the questions in the reading. The participants should make note of these answers in the reading, and be prepared to share them with the group.
  - Participants should take ten to fifteen minutes to read the passage and locate the answers.
  - When everyone has had time to read the passage, the facilitator should lead a discussion about what caused the increase in eagle population, and whether or not the eagle population would continue to grow at a rapid rate.
    - From the reading, participants will learn that the eagle population grew because of a ban on the pesticide DDT in 1972. Growth was slow at first, but as more breeding pairs of eagles populated the James River, they produced offspring that also survived and bred.
    - Participants will also learn that the James River is getting close to its saturation point. The river's carrying capacity is limited, and so the growth in population will slow down or stop altogether sometime in the future, and more and more eagles compete for the same amount of resources.
- Activity2: Up until now, the facilitator has been taking on the role of the teacher, and participants have acted as students. At this point in the workshop, the facilitator will invite participants to reflect as teachers on the activity of an analyzing a graph, formulating questions, making predictions, and then finding answers in a text.
- Activity3: The facilitator will distribute handout of the Three Key Shifts in ELA/Literacy for review and discussion. Because the science subtest contains both mathematical content and readings, effective instruction should incorporate the Standards for Mathematical Practice as well as the Key Shifts in ELA/Literacy.
  - The Key Shifts in Literacy are based on the Eight Instructional Shifts in ELA/Literacy, and components of the Key Shifts will impact our teaching of science content.
  - Science questions will contain complex language and content-specific academic vocabulary. The Key Shifts call for a staircase of complexity in scientific readings, and they require students to ground their claims in evidence from textual sources. Readings used in science instruction should allow for student immersion into the topic so that they can build background knowledge and feel more comfortable exploring topics further on their own.
  - Question for discussion: "How do you see the key shifts reflected in the James River reading?
    - The text reflects the first key shift in that it offers practice with a **complex text** that has the kind of **scientific language** students could expect to see on the TASC. Paired together, the graph and the reading require students to make inferences, conclusions, and arguments based on **evidence from texts**. The text is also an example of **content-rich nonfiction**. In becoming fluent readers of this type of text, students will be better able to study on their own and learn independently.
- Activity4: In the last part of the activity, the facilitator will direct participants to structure classroom exercises in math and reading/writing based on the graph and reading about eagle populations along the James River.
  - The facilitator should divide the participants into either two or four groups, depending on the number of participants. One group should be tasked with creating a rigorous math exercise based on the data from the graph and reading. The other group should be tasked with creating a writing exercise that could build upon the earlier parts of the activity. If participants are having a hard time getting started, the facilitator could plant some possibilities for the participants to explore.
    - Some possible suggestions in **math**: One activity might involve asking students to put the information from the graph into a table. Another activity could involve finding the mean number of eagles over the years shown. Students could be asked to examine the rate of change in eagle populations and analyze why the population started to grow at an increasing rate beginning around 1980. Students could be asked to extend the graph of eagle population for ten more years, based on evidence from the text that the James River is nearing its maximum capacity. Students could be asked to examine whether or not an eagle population could grow at a linear rate for an indefinite amount of time. Students could also be asked to make predictions about the eagle population in the years before those represented on the graph.
    - Some possible suggestions in **reading/ELA**: The teacher could ask students to identify the main ideas from the reading and present a short summary. The teacher could also create a science vocabulary exercise in which students learn and apply key science vocabulary. Students could be tasked with thinking and writing about why it is important to maintain eagle populations, and creating an argument in favor of or against conservation of species.
    - These are just a few possibilities. Participants should be encouraged to be creative and think about the kinds of activities that would work in the classes they teach.
  - Each group should write out their activity on chart paper. The facilitator should direct participants to explain all

- phases of the activity on their piece of chart paper. Where would they start? What would they do to draw out student thinking? What would be the goals for learning?
  - Once all groups have been given time to create an activity and present it on chart paper, participants will do a gallery walk in which they look at each group's activity.

Wrap Up/Assessment

- The facilitator will lead an introductory discussion about how using student questions helps to create a student-centered learning environment.
  - Question for discussion: "What does it mean to have a student-centered classroom?"
  - The facilitator will point out that even if students don't develop rigorous questions on their own, teachers can help guide students toward more nuanced understandings of scientific data. For example, if students notice a pattern in the data, they might be asked if the relationship is linear or not. How could it be represented visually? What can we deduce will happen in the future based on these numbers? Is there a rule we could use to predict what would happen after *t* years?
  - These activities help to develop conceptual understanding alongside computational fluency. The facilitator should point out that this can help students succeed on the new constructed-response TASC questions. These two-part questions may require students to write about a concept and then produce a numerical answer.
- Participants will be given a lesson plan based on this activity, and they should try the activity in their classroom. Participants should meet after using the lesson plan to discuss how the activity went and how they might change it next time.
- For assessment, participants should answer the question below and share their responses with the group.
  - Assessment question: "A similar activity that I want to try in class is ________. This activity will help my students become better test-takers because ________."

Part 3: Helping Students Succeed on Constructed Response Questions in Math and Science

Lesson Content

Participants will discuss the different item types on the TASC, and they will analyze samples of constructed-response questions that might appear on the mathematics or science subtests of the TASC.

Lesson Materials

- Handout of constructed response questions provided by CTB.
- Participants will make use of the TI-30XS Multiview calculator during this activity.

Questions to Answer

- What will students be expected to produce in order to successfully answer constructed-response questions on the TASC?
- How can we use the instructional shifts to make sure that we are preparing our students for these types of questions?

Background/Opening

- The facilitator will ask the group to talk about their experience with constructed-response questions in math and science.
  - For discussion: "Has anyone looked at the 2015 sample questions on the CTB website or taken the 2015 Readiness Assessment? What did the constructed-response questions look like?"
    - Some participants will not be familiar with constructed-response questions, and the facilitator may need to provide some background. Constructed-response questions require students to write a sentence or paragraph about their thinking, and they may also ask students to produce a mathematical solution to a problem. In math, constructed-response questions might also ask test-takers to show their work. These questions can involve one or two parts. On the 2015 TASC, these questions will not be scored, though they will count toward a test-taker's score in 2016 and beyond. These questions will count for 2 points instead of 1. Constructed-response questions reflect an increase in rigor, and these questions tend to fall under DOK 3 in that they ask students to explain or defend their thinking.
  - Participants should be given time to share their thoughts and discuss the challenges of helping students prepare to answer these types of questions.
- The facilitator will distribute the handout of sample constructed-response questions provided by McGraw-Hill/CTB.
  - Participants should not spend time solving these questions. Instead, they should analyze the questions and the accompanying answer rubrics. The discussion should focus on what will be expected of student answers to these questions.
  - **Math:** This is a straightforward problem, but participants will likely notice that even though the answer rubric

awards points for showing work, the question itself doesn't prompt students to show their work. The instructions on the actual TASC will be much clearer.

- **Science:** This is a very difficult question that requires a good deal of background knowledge about the processes of translation and transcription. Moreover, the end products in the diagram are not written out, and so students would be expected to have knowledge of proteins, peptides, and polypeptides.
- Questions for discussion: "How do these problems represent an increase in rigor/DOK on the TASC? What specific skills will students need to have in order to answer them thoroughly?"
    - As participants respond, the facilitator should record their responses on the board or on chart paper. If participants have attended previous workshops on the Six Instructional Shifts and the Common Core Standards for Mathematical Practice, the facilitator will ask participants to make explicit connections between the demands of the problem and the shifts.

- The facilitator will point out that there are relatively few workbooks that ask students to complete constructed-response questions, and so it's up to us as teachers to make sure that we are always asking students to discuss their reasoning during classroom tasks. We need to make sure that our instruction aligns with the Common Core Instructional Shifts as well as the Next Generation Science Standards Conceptual Shifts.
    - The Common Core Instructional Shifts are very much reflected in the sample constructed-response questions provided by CTB/McGraw-Hill. To answer constructed-response questions in mathematics, test-takers will need to have deep understanding of math concepts. In order to build **deep understanding**, math instruction should be **coherent**, **focused**, and **rigorous**.
    - Teachers need to be mindful of the NGSS Conceptual Shifts in order to prepare students to pass the TASC science subtest. Test-takers will need to understand the **interconnectedness** of science in the **real world**. Test-takers also need to evidence **deep understanding** of science concepts in order to write coherently and analytically in their responses. In order to prepare our students to succeed on constructed-response questions, teachers need to **use crosscutting concepts**, such as patterns, cause and effect, and models.
        - The facilitator may need to remind participants that crosscutting concepts are those that apply across disciplines and science topics. Crosscutting concepts unify the study of science and engineering through their common application across fields.

Lesson Activities

- Activity1: Participants will be given the handout Developing Constructed Response Questions. Though the questions vary in difficulty—but not necessarily rigor—they can all be solved using routine methods. Participants do not necessarily need to solve each question, though if time allows, they should be given time to work out the problems on their own.
    - Here, the facilitator should distribute calculators to the participants to aid them in solving the problems. The facilitator should be sure to note that test-takers are allowed to use the TI-30XS Multiview calculator on both the math and science tests.
    - Solutions:
        - Math #1: The probability is 0.
        - Math #2: The solution is 47.1238898… (irrational number)
        - Math #3: The second table represents a function; the others do not.
        - Science #1: The work done is 90 Joules.
        - Science #2: The gravitational force is 783.93 Newtons.
- Activity 2: The facilitator should direct participants to work in groups to turn these questions into constructed-response questions that ask for more than a numerical answer. These questions should involve asking students to explain a particular concept, show their work, or make inferences about the formulas and concepts. Some possible suggestions are listed below for participants who are struggling with the activity. The facilitator should not plant these, but should instead ask questions that get participants to think about different aspects of the problems and the concepts underlying them.
    - **Math #1:** This simple problem tests students' knowledge of how to calculate probability. Some possible questions that could turn this into a CR question are:
        - What does it mean for a situation to have a probability of 0?
        - What are the maximum and minimum values for probability?
        - Define a favorable outcome.
        - Explain why the probability is 0.
    - **Math #2:** When calculated, this problem produces an irrational number. TASC test-takers should have knowledge of the difference between rational and irrational numbers. Possible questions are:
        - What is the difference between an irrational number?

  - Explain why the product of a rational number and an irrational number is irrational.
  - Explain why multiplying pi by an integer will produce a result with nonrepeating, nonterminating decimals.
- **Math #3:** Test-takers need to know the basic definition of a function, and they need to be able to identify if a graph, table, or set of ordered pairs represent a function. Some possible questions are:
  - Explain why the table you chose represents a function.
  - Define the terms domain and range
  - Consider a situation in which two items from the domain were mapped to the same item in the range. Is this still a function? Why?
- **Science #1:** This question tests the use of formulas and is relatively simple to calculate. Some possible questions are:
  - Explain the difference between work and force.
  - Show all your work for this solution.
  - Explain the relationship between work and distance.
- **Science #2:** This is the most challenging question, but it is similar to one that students could actually see on the TASC. In order to solve successfully, test-takers must know how to use scientific notation on the calculator. However, if a student can do that, then this is a simple substitution problem. Possible questions are:
  - What do you predict would happen to the total gravitational force if the same person were standing on the moon?
  - Explain what happens to gravitational force as the two masses move further apart from one another.
  - Solve the equation for *r* and show all your work.

- Activity3: As participants are working, the facilitator will prepare five sheets of chart paper—one for each of the five problems. The facilitator should write the problem number at the top of each and post them in the room.
- Activity4: When participants have had enough time to work in groups and create questions about concepts, the facilitator will ask them to write their questions on the sheets of chart paper. Each group or pair should write one question on each sheet.
  - The facilitator will lead a discussion of these questions, and groups will have a chance to see the questions written by their colleagues.
  - The facilitator should prompt participants to discuss why the addition of these questions increases the complexity and DOK level of these problems.
  - The discussion should end with the facilitator pointing out that these sorts of activities must be done with frequency in the classroom so that students are prepared for these kinds of questions on the TASC in 2015 and beyond. One way to accomplish this is through "interleaving," which will be analyzed during the wrap up.

Wrap Up/Assessment

- The facilitator will introduce the concept of "interleaving," as discussed by Benedict Carey in his book *How We Learn* (2014).
  - Interleaving is the idea that students can most effectively remember new skills and concepts when they are spread out—and tested upon—throughout a class cycle. What this means is that instead of teaching a one-week unit on functions and then moving on, teachers should incorporate functions into many classes after the class has moved on. Benedict Carey argues that frequent quizzing and summative assessment helps students become better test-takers, and it forces them to continually work with and apply concepts that the class has covered previously.
- The facilitator will distribute the handout "Studying for the Test by Taking It."
  - Participants will read the short article and discuss its implications for TASC test-takers.
  - Questions for discussion: "Is this a model that you currently use in your classes? Has it been successful?"
    - Participants should be invited to talk about assessments they use in their own classes. They should focus on discussing ways that they integrate previously learned material into activities/lessons involving new content.
- For assessment, the facilitator will introduce the following prompt. The facilitator will go around the room and solicit responses each participant.
  - Prompt for assessment: "To prepare my students for the constructed-response questions on the TASC, I will ________."

Part 4: Using Writing to Draw Out Student Thinking and Forge Connections

Lesson Content

Participants will analyze ways to use writing in the classroom to draw out student thinking, develop vocabulary in math and science, emphasize clarity and precision, and reflect on process. This will help them to develop deep conceptual understanding and successfully answer constructed-response problems on the TASC.

Lesson Materials

- Solving a Linear Equation handout, along with sample student responses.
- Handout of Burns's "Writing in Math."

Questions to Answer

- How can writing help students become better thinkers and problem-solvers?
- How can it help them in testing situations?

Background/Opening

- Participants will examine how writing can be used as a tool for reflection on math applications in the sciences, and how writing can help draw out student thinking.
- The facilitator will distribute the handout "Writing in Math."
  - The facilitator will begin by asking participants to read the first page of the article. Here, Burns articulates explains why writing in the math classroom helps to support student learning.
    - Writing about math builds conceptual understanding and helps students to clarify their own thinking about a topic.
    - Participants should consider how writing could be used alongside science topics as well. Encouraging students to write about math and science will help them build the skills they need to successfully answer constructed-response questions on the TASC.
  - The facilitator should then direct participants to the section "A Variety of Writing Assignments."
    - Possible ideas include keeping journals or logs, solving math problems, explaining mathematical ideas, and writing about learning processes.
    - The facilitator and participants should briefly discuss each form of writing activity
  - Participants should also read through the section "Strategies for Incorporating Writing." These are Burns's reasons for incorporating writing into the math classroom and strategies for using writing. The strategies are:
    - Establish the purpose for writing in math class.
    - Establish yourself as the audience.
    - Ask students to include details and explain their thinking as thoroughly as possible.
    - Have students discuss their ideas before writing.
    - Post useful mathematics vocabulary.
    - Write a prompt on the board to get students started on a writing assignment.
    - Give individual assistance as needed.
    - Have students share their writing in pairs or small groups.
    - Use students' writing in subsequent instruction.
    - Use student papers to create class inventories.
    - Keep each student's work in an individual folder.
  - The facilitator will lead a discussion of Burns's suggestions for incorporating writing into the math classroom.
  - Question for discussion: "Have you tried integrating writing into your math instruction? What of the activities suggested by Marilyn Burns have you tried? Have you incorporated writing in other ways?"

Lesson Activities

- Activity 1: The facilitator will distribute the handout Solving a Linear Equation. Participants will solve the equation individually, and then they will work in pairs or small groups to write out their processes. For this problem, the emphasis is on process and clarity.
  - Participants should be given time to solve the equation on their own, and the facilitator should provide support as needed.
  - After they have arrived at a solution, participants should work in groups on writing out a step-by-step process that describes the steps they took to solve the problem.
  - Each group will need to carefully establish the language they want to use, and they should agree on the order of the solution steps.
    - The facilitator should help participants to use precise mathematical language in their write-ups. For example, participants should be encouraged to talk about how the same operation must be done on both sides of the equation. Participants should also use the words "variable" and "constant."
  - Groups will then write their processes on chart paper for discussion with the whole workshop group, and the facilitator will ask each group to present their process.
    - While groups are presenting, the facilitator should check with other groups to see if the language and process is

clear to everyone else in the room.
  - After the activity is finished, the facilitator should invite participants to look for commonalities and differences in the response.
    - Questions for reflection: "Did each group go through the same series of steps? Are their processes or vocabulary words that all of the groups' work have in common?"
- Activity 2: After all groups have finished presenting their solutions, the facilitator should distribute the handout Writing about Math Responses.
  - Side one of this handout is composed of sample student responses to the activity from an HSE class. In this case, the students were asked to work individually, and the instructor recorded their processes. Participants should read each one to get a sense of which aspects of the activity will be challenging for students.
    - Question for discussion: "What do you notice about the processes these students described? Are they clear to you?"
    - In these responses, some students correctly solved the problem, but their solution processes are very unclear, which shows that although they had the correct answer, they did not have a firm handle on how to talk about math. Most of the responses are very unspecific.
  - The facilitator will ask participants how they might help these students to revise their writing in order to make it clearer and more concrete. That is, what sorts of questions could you ask to help students write more clearly?
- Activity 3: The facilitator will then direct participants to look at side two of the handout.
  - The facilitator should point out that these students had already done the activity once before, and this was their second attempt at writing about solving an equations. The write-ups are much clearer here.
  - For discussion: "What is the main difference between the responses on side two and the responses on side one?"

Wrap Up/Assessment

- After the activity, the facilitator will lead a discussion in which participants think about trying this activity in their own class.
  - Question for discussion: "Is this an activity you would like to try with your students? What other math and science topics could we ask students to write about in order to clarify their thinking?"
- For assessment, the facilitator will give participants the following prompt.
  - "Think of a writing exercise involving math or science that you want to try in your class. What would the activity look like, and what would you do to support student thinking?"
  - Participants will write for five or ten minutes about the activity and share it with the group.

Overall Wrap Up

Note: this part will be done in a discussion format.

- Facilitator will lead a discussion of the connection between interleaving and interdisciplinary approaches to teaching math and science.
- Participants will reflect individually on changes they will make to their teaching practice and share their findings with the group.

Project/Homework

- Participants will try a writing exercise in the math classroom and report back to the group. Questions to consider: "What did you like about this activity? What were the benefits of doing it? What was challenging about this activity? What would I do differently next time?
- Participants should read the rest of Burns's "Incorporating Writing into Math Instruction" after the workshop.