Module 5: Assessing Problem Solving

1	Title Slide	Welcome to the Assessing Problem Solving module in the Assessing Higher-Order Thinking series. To advance to the next slide, select the "forward" arrow located on the play bar at the bottom of your screen.
2	Introduction	In this module, we will be discussing assessing problem solving in terms of problem identification, identifying irrelevancies, describing multiple problem-solving strategies, modeling a problem, identifying obstacles, reasoning with data, using analogies, and solving problems backward. "Problem solving is cognitive processing directed at achieving a goal when no solution method is obvious to the problem solver" (Mayer, 1992). Brookhart (2010) defines a "good" problem solver as someone who identifies exactly what the problem is, what might be obstacles to solving it, and what solutions might be expected to work, and then attempts at least one of the solutions.
3	Learning Objectives	By the completion of this module, the learner will be able to create problem solving assessment tasks.
4	IDEAL Problem Solving	Before we go into depth about the different kinds of problems, let's first uncover Bransford and Stein's (1984) five-stage process of problem-solving, known as the "IDEAL" Problem Solver. This process starts with the letter I, which stands for Identifying the problem. D – Defining and representing the problem. E – Exploring possible strategies. A – Acting on strategies. And L – Looking back to evaluate the effects of the strategies. The process presented as an acronym makes the concepts easy to remember for students. These steps can aid students in working through problems and also assist teachers in focusing in one on or more problem-solving tasks for instruction and assessment. For example, an instructor can teach students how to identify problems and why identifying problems is important, and then be able to specifically use assessment tasks that ask students to identify problems.
5	Defining Different Kinds of Problems	Before we begin the discussion of how to assess problem solving, we will first need to define different kinds of problems. Some exercises that are called "problems" do not require higher-order thinking. Problems vary in the amount of structure you provide to students. The more decisions that are open to the student, the less structured the problem. For the purpose of this module, we will define two types of problems: structured and unstructured. Structured problems present all of the information needed to solve the specific problem. In structured problems, there are limited correct answers and an identified goal. Highly-structured problems allow the teacher more control over the content of students' work. On the other hand, unstructured problems are more typical of real-life problems, because there may be multiple correct answers that can be found in a multitude of ways. In these problems, there may be an extended number of

<table>
<tr><td></td><td></td><td>solutions to consider when solving the problem. Unstructured problems allow students to use metacognition (the awareness of their own thought process) and reasoning.

Teachers can use varying amounts of structure, but they should recognize what sort of problem they are using and make sure the problem requires the specific problem-solving skills they intend to assess.

We will be going more into specific problem-solving skills beginning in the next slide, with “Identifying a Problem to be Solved.”</td></tr>
<tr><td>6</td><td>Assessing Problem Solving: Identify a Problem to Be Solved</td><td>Consider this quote by Albert Einstein: “Given one hour to save the world, I would spend 55 minutes defining the problem and 5 minutes finding the solution.” According to the Rockefeller Foundation, students need to be able to identify the problem before being able to apply thinking and resources into understanding how to solve it. If problems are especially complex, students may not be able to solve the problem by just breaking it down into specific components, there could be several interlinking and underlying issues that may need to be addressed in order to find the solution.

To assess problem identification, present students with a scenario or problem description and ask students to identify the problem that needs to be solved. Or present a statement that contains the problem and ask students to pose the question that needs to be answered in order to solve the problem.</td></tr>
<tr><td>7</td><td>Assessing Problem Solving: Identify a Problem to Be Solved</td><td>Consider the following animal science example for selecting herd sires based on expected progeny differences.

Based on the following data of Angus Performance Bulls, determine which bull you would select to use if the bulls were being selected for use on yearling heifers. Female progeny will be retained as replacements and steer progeny marketed either at weaning or fed and sold at harvest at the end of the feeding phase.

Rank the bulls first through fourth according to their qualification as a sire for this herd, and then explain your reasoning. In your explanation of the sire you placed last, identify areas of the EPD that could be modified in order to make the bull a stronger, more desirable sire candidate for the herd.

<table>
<tr><th colspan="7">Sire 1</th></tr>
<tr><th colspan="7">Bull 131 – Tehama Fullback</th></tr>
<tr><th colspan="2">Birth</th><th colspan="2">Weaning</th><th colspan="2">Yearling</th><th>Milk</th></tr>
<tr><th>BW</th><th>EPD</th><th>205 wt</th><th>EPD</th><th>365 wt</th><th>EPD</th><th>EPD</th></tr>
<tr><td>104</td><td>+5.5</td><td>666</td><td>+36</td><td>1144</td><td>+70</td><td>+19</td></tr>
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Sire 2						
Bull 131 – Tehama Ambush						
Birth		**Weaning**		**Yearling**		**Milk**
BW	**EPD**	**205 wt**	**EPD**	**365 wt**	**EPD**	**EPD**
70	+2.1	602	+25	1076	+51	+15

Sire 3						
Bull 131 – Tehama Bando						
Birth		**Weaning**		**Yearling**		**Milk**
BW	**EPD**	**205 wt**	**EPD**	**365 wt**	**EPD**	**EPD**
70	+2.6	659	+30	1064	+52	+20

Sire 4						
Bull 131 – Tehama Attack						
Birth		**Weaning**		**Yearling**		**Milk**
BW	**EPD**	**205 wt**	**EPD**	**365 wt**	**EPD**	**EPD**
78	+1.8	679	+30	1066	+50	+19

No.	**Herd No.**	**Birth Date**	**BW**	**WW**	**YW**	**Milk**
No. 1	904	2-25-09	+0.5	+42	+74	+16
No. 2	907	2-28-09	+3.5	+43	+80	+16
No. 3	909	3-03-09	+1	+55	+97	+22
No. 4	911	3-03-09	+3.1	+45	+82	+21
Breed average EPD			+2.1	+45	+82	+21

This question asks students to identify the need of the future progeny of the

		herd for replacement heifers and market steers. Once the problem has been identified, the solution and explanation fall into place. Additionally, the question asks students to identify what qualities the last steer falls short in and then asks them to resolve the problem. Let's now transition into ways we can assess how students identify irrelevancies. (CTE Online Official Rank: 3-4-2-1)
8	Assessing Problem Solving: Identify Irrelevancies	Many real-life problems require students to figure out what information is important or relevant and what is not in order to identify and solve the problem. To assess how students identify what is and isn't relevant to a particular problem, present interpretive materials, a problem statement, and ask students to identify all irrelevant information. A common example of identifying irrelevancies includes students searching for information for an assignment. To avoid students just looking up information about a topic in a search engine, provide students with a research question that will allow them to be engaged in verifying and drawing concepts. For example, instead of asking students to write a paper about animal behavior, ask students: "How can what is known about educational learning theories be used to improve aggressive animal behaviors?" The research questions calls on students to research applicable learning theories to connect with what they have researched about common aggressive animal behaviors, whereas asking students to write a paper about animal behavior gives them the opportunity to aimlessly fill a document with words. Next, we will discuss ways to design assessments that ask students to describe and evaluate multiple strategies.
9	Assessing Problem Solving: Describe and Evaluate Multiple Strategies	Describing several different strategies that could be used to solve a problem is a real-world skill. To assess how students describe multiple problem-solving strategies, state a problem and ask students to solve the problem in two or more ways and show their solutions using pictures, diagrams, or graphs. Alternatively, state a problem and two or more acceptable strategies for solving it, and ask students to explain why the strategies are correct. Consider the following example adapted from Brookhart (2010): The Environmental Protection Agency identifies nutrient pollution as an issue when fertilizers and animal manure are not properly managed on farms, causing excess nutrients to impact ground water quality. 1. Name at least two things that farmers can do that will solve the problem. Which one should be tried first? Explain.

		2. Name at least two things the local government could do to help solve this problem. Which one would you recommend they try first? Explain. Criteria for feedbacks or rubrics for these questions could include: • Identification and prioritization of two reasonable methods available to farmers or local government. • Appropriateness of evidence. • And soundness of reasoning and clarity of explanation. These questions assess both problem-solving skills and content knowledge, because students would need to know about or research the resources and methods available to farmers and the local government. When asking questions that have multiple proposed solutions, you can also ask students to evaluate their solutions for efficiency and potential negative consequences. In the upcoming slide, we will be discussing identifying obstacles or additional information for solving a problem.
10	Assessing Problem Solving: Identify Obstacles or Additional Information for Solving a Problem or Scenario	Solving problems well is sometimes as much about figuring out the right information to use as it is about inventing a solution. To assess how students identify obstacles and decide whether additional information is needed for solving a problem, present a complex problem to solve and ask students to explain why it is difficult to complete the task, what the obstacles are, and what additional information they need. Assess whether students can identify the obstacle to solving the problem. Consider the following example: In Belize, there are only four main paved highways for transport of goods and the rural roadways are composed of dirt or fine gravel, which are maintained by the country's Ministry of Works. Additionally, there is zero accessibility for in-country transport of goods by rail or water, asides from the port located in Belize City that is used for exports. Belize is a primary producer of citrus fruits, with 98% of the crop produced being processed into juice for export. A large portion of the population, especially in rural areas, survives on products that are locally grown. Currently, there are two citrus processing plants that are located in the southern part of the country. Changing weather patterns may increase the rate of deterioration of current infrastructure, which will undoubtedly affect the transportation of goods that relies on four major highways, dismantled rural roads, and one port. If anything disrupted one or more of those routes, agriculture would be dramatically impacted, which will affect the exports and local consumption of citrus fruits, which could in turn create food security issues for rural families. Let's hypothesize that Belize is impacted by a hurricane which damages major

		roadways and floods the rural roads. The processing facilities are located in the south, but citrus producers are located all over the country. Infrastructure needs must be met for citrus producers. As a member of the Citrus Growers Association, or CGA -- a member-owned association that conducts research, provides education and outreach, and supports growers and members by coordinating crop management efforts and providing a voice to the government for producers -- what recommendations would you make to the Ministry of Works to ensure that the country maintains or improves the infrastructure? Identify two pieces of information not given above that you would need before you could address the Ministry of Works. Explain why each piece of information would be important. Criteria for feedback or rubrics include: • Clear, appropriate identification of two additional pieces of information. • Appropriateness of evidence. • And soundness of reasoning and clarity of explanation.
11	Assessing Problem Solving: Reason with Data	To assess how students reason with data, present interpretive material such as a story, cartoon, graph, or data table, and a problem that requires using information from the material. Then ask students to solve the problem and explain the procedure they used to reach a solution. For example, in a food science course, you could ask students to collect and analyze their own data from which they could draw conclusions. Students could be asked to keep a food diary for a week. "Write down everything you eat or drink at each meal and for snacks. Then make a bar graph to show how many servings per day, on average, you have eaten of grains, vegetables, fruits, oils, milk, and meat and beans. These are categories from the USDA's food pyramid. If you have consumed anything that does not fit these categories, you may need to add a category or two to your bar graph. After you have prepared your graph, write a brief essay interpreting what it means. What conclusions can you draw from your graph? How well does your eating follow the USDA recommendations? What have you learned from analyzing your own eating pattern for a week? Explain your reasoning." Criteria for feedback or rubrics for this assignment could include: • Accuracy and completeness of student data. • Clear thesis about what student learned about his or her own eating habits. • Appropriateness of evidence. • And, soundness of reasoning and clarity of explanation.
12	Assessing Problem Solving:	To assess how students use analogies, present a problem statement and a correct solution strategy, and ask students to describe other problems that could (by analogy) be solved by using this same solution strategy and explain

	Use Analogies	why the solution to the problem they generated is like the solution to the problem you gave them. Assess the analogical relationship of the students' solution strategy to the strategy you gave them. For example, in a natural resources management course, you could ask students to consider water equity in the United States. According to the LA Times, water poverty affects nearly 1.6 million people in the United States. The Census Bureau shows that the problem is experienced "most acutely by African Americans in the rural South, Latinos in the rural Southwest, Native Americans and Alaskan Natives, residents of deep Appalachia, and migrant and seasonal farmworkers." Then ask students to use the following resource guide to identify and research solutions for water inequity in affected populations in the United States. Then to describe how the solutions described in the resource guide could be used at the global level. [Water Equity PDF] Criteria for feedback or rubrics for this example could include: • Appropriate thesis for paralleling United States and global water inequity issues. • Appropriateness of evidence. • And, soundness of reasoning and clarity of explanation.
13	Assessing Problem Solving: Solve a Problem Backward	To assess how students solve more open problems backward, present a complex problem situation or a complex, multistep task to complete. Ask students to work backward from the desired outcome to develop a plan or a strategy for completing the task or solving the problem. Consider the following animal science scenario: You are wanting to artificially inseminate a fraction of your unsynchronized Hereford beef cattle herd to an Angus bull so that you will have black baldy calves born during the month of March to sell. What steps will you need to take in order for this to happen? Questions for this scenario could be as follows: 1. Identify which factors you will need to consider for your operation to be ready to meet this deadline. 2. Create a step-by-step list of your plan. Criteria for feedback or rubrics for this example could include: • Clear, appropriate solution. • And soundness of reasoning and clarity of explanation.
14	Formative & Summative	For both formative and summative assessment, problem-solving rubrics can be useful for organizing students' thinking. Try to use general problem-solving rubrics, not task-specific ones, so that students internalize as their goal the

	Uses	general strategies of identifying the problem, defining and representing the problem, exploring possible strategies, acting on the strategies, and looking back and evaluating the effects of the strategies. Using the same rubrics over and over again will help the students focus on the qualities described in those rubrics as their goal for successful problem solving. Listed on this slide are some potential problem solving rubrics that you might be able to use or modify in your classroom: https://usm.maine.edu/sites/default/files/assessment/Rubric-ProblemSolvingSkills.pdf http://manoa.hawaii.edu/assessment/resources/rubrics/ProblemSolving_value.pdf
15	Review	As we come to a close, let's revisit what was discussed. We started this module by defining "IDEAL" steps to problem solving, and then we compared structured and unstructured problems. We then discussed ways to assess how our students identify problems and irrelevancies, how to described and evaluate multiple strategies, model a problem, identify obstacles, reason with data, use analogies, and finally – solve a problem backward.
16	Sources	Brookhart, S.M. (2010) How to Assess Higher-Order Thinking Skills in Your Classroom. Alexandria, VA: ASCD. Jonassen, D. H. (2014). Assessing problem solving. Handbook of Research on Educational Communications and Technology. doi 10.1007/978-1-4614-3185-5_22. https://www.rockefellerfoundation.org/blog/defining-problem-find-solution/ https://www.epa.gov/nutrientpollution/sources-and-solutions-agriculture https://www.ncver.edu.au/__data/assets/file/0011/5015/nr2007.pdf https://www.cteonline.org/curriculum/lessonplan/expected-progeny-difference-epd/XBE6d1 https://www.propublica.org/article/california-drought-colorado-river-water-crisis-explained
17	Credits	Thank you for viewing this module.