Module 3: Assessing Logic & Reasoning

1	Title Slide	Welcome to the Assessing Logic & Reasoning 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 ways to assess logic and reasoning in deductive and inductive ways. Unlike analysis, creation, and evaluation, logic and reasoning do not hold their own level on Bloom's Taxonomy pyramid, but they are still involved in higher-order thinking. Before we get started, let's describe the differences between logic and reasoning – two definitions that often mistakenly overlap. According to Webster's dictionary, logic is defined as a "proper or reasonable way of thinking about or understanding something" and reasoning is defined as the "process of thinking about something in a logical way in order to form a conclusion or judgment."
3	Learning Objectives	By the end of this module, the learner will be able to create deductive and inductive assessment tasks.
4	Sound Reasoning	Sound reasoning is required for analytical, evaluative, and creative tasks for all higher-order thinking. General reasoning skills include judging whether a single fact or claim is true and whether it is relevant to the argument or problem at hand, and judging whether two or more things are consistent. These skills are required for all types of reasoning. In this module, we will discuss two basic kinds of reasoning: deduction and induction.
5	Logical Errors	Before we dive into deduction and induction reasoning, we should take a moment and review some common errors in logic that students may have. Click on the tabs to learn more. "Overgeneralizing" is the reasoning from one or very few examples to an entire group. "Appeal to authority" is reasoning, because an important figure believes or does something means it is true or important. "Social acceptability" is also called the "bandwagon argument." This is reasoning that something is true because several people believe it, or that something is good to do, because others are doing it. These are just three examples out of many logical errors that might arise while assessing logical reasoning.
6	Logical Errors	Let's pause the module to watch a humorous example of extremely unsound logic and reasoning. Try to identify some logical errors that exist in this video that were presented in the previous slide. Click "play" in the video player to see the example. https://www.youtube.com/watch?v=X2xlQaimsGg
7	Assessing	As with other higher-order thinking assessments like we have discussed in

	Logic & Reasoning	previous modules, in order to assess reasoning - whether deductive or inductive - you first have to give students something to reason about. This can be done by supplying introductory material for multiple-choice, short-answer, and essay questions. For longer performance assessments and projects, you could also allow students access to resources they have seen before or ask them to locate their own resources. Then, ask questions that require students to reason about the material. We will be giving several examples of this throughout the module. Let's now get started by discussing deductive reasoning.
8	Deductive Reasoning	Deduction means reasoning from a general principle to an instance. In other words, deductive reasoning starts with a general statement or hypothesis and then examines the possibilities to reach a logical conclusion. For deductive reasoning to be sound, the statement or hypothesis must be correct. For example, "All plants are photosynthetic. Algae is a plant. Therefore, algae is photosynthetic." To assess how students make or evaluate deductive conclusions, give students a statement they are to assume is true and one or more logically correct and incorrect conclusions. Then ask them which conclusions to follow.
9	Deductive Reasoning Multiple Choice	Now, we are going to look at three examples of what deductive reasoning look like in both selection and generation assessments in plant science course. An example of a multiple-choice question could look like the following: Which of the following plant choices is most appropriate for use when the desired outcome is a year-round privacy screen (a long lasting group of plants capable of resisting disease and insect pressure while providing the desired result of privacy)? A. A screen of low growing deciduous ground covers B. A screen comprised of one species of evergreen conifers C. A mixed screen of deciduous conifers *D. A mixed species screen comprised primarily of evergreen species This question would only be scored right or wrong, and in this case the answer is D. This question calls for deduction in the form of reasoning from the definition given within the question stem [highlight]. This format requires students to read and then reason.
10	Essay Question	An essay question could be: Select a plant pest. Describe a specific scenario in which the pest could occur or cause an issue. The example can be from a real event or something you make up yourself, but it must be a clear illustration of one of the pests you select. Tell the story of your example, then explain which evidences are present, from the pest,

		and tell why. Criteria for feedback or rubrics could include: • Appropriate identification of particular symptom and pest • Appropriateness of example • Appropriateness of evidence • And soundness of reasoning and clarity of explanation If this question was to be used formatively, the listed criteria could be used to frame feedback and guide self-assessment or peer-assessment. If the essay was to be scored for the purpose of a grade, the criteria could be transformed into either a holistic or analytical rubric. This format requires students to read, reason, and write.
11	Performance Assessment	A performance assessment could ask students to create a notebook with a section for each pest discussed in class. Using stories from online articles and journals, illustrate each pest with at least one specific example. Include a copy of each article or journal. For each article/journal, write a brief essay explaining what specific pest and evidences are illustrated, and explain your reasoning. Criteria for feedback or rubrics could include: • Appropriateness and completeness of illustrations, examples, and literature • Appropriateness of evidence • And soundness of reasoning and clarity of explanation If this assignment requires students to create several sections for many different types of pests within the notebook, students could be assessed by each section separately, or alternatively, the entire notebook could be assessed as a whole. This format requires students to read, reason, locate resource material, write, and plan extensively.

12	Inductive Reasoning	On the other hand, induction involves reasoning from an instance to a general principle. In other words, inductive reasoning makes broad generalizations from specific observations. For example, "Most universities and colleges in Tennessee ban alcohol from campus. That means most universities and colleges in the United States ban alcohol from campus." Examples of inductive reasoning may already occur in your classroom whether you realize it or not. Consider an analytical task like identifying the theme in an author's work and supporting the theme with evidence from the text. This is an inductive task, as it requires reasoning from various aspects of the text to what it might mean as a whole. Or consider hypothesis testing in science. Students write hypotheses based on theory, and an experiment is designed to test the hypothesis. Results are analyzed and interpreted according to whether they support or disprove the hypothesis. Brookhart describes two forms of inductive reasoning, which we will cover in this module: reasoning by induction and reasoning by analogy. Let's now transition into specific examples of what reasoning by induction might look like in a multiple-choice, short answer, and essay question format.
13	Inductive Reasoning: Reason by Induction	One thinking skill needed for sound inductive reasoning is the ability to see patterns in data or other evidence. Another is the ability to decide which conclusions best explain the patterns. To assess how students make or evaluate inductive conclusions, give them a scenario, data, instances, and other bits of information in order for them to generalize or extract a principle. Then ask them to draw the proper conclusion from the information and explain why the conclusion is correct.
14	Inductive Reasoning: Reason by Induction	[Climate Change Graph] For example: Question 1 - The graph shows that… *A. Precipitation patterns will vary with some areas getting wetter and some areas getting dryer. B. Precipitation patterns will remain stable. C. In 2100, there will be fewer extreme precipitation land areas. Students can induce from the analyzing the data from the graphic that B and C are incorrect so therefore, the correct answer for this question is A. The essay question provided in the next slide invites students to use inductive reasoning to assess whether they can generate a plausible hypothesis that might explain the pattern.

15	Inductive Reasoning: Reason by Induction	[Climate Change Graphic] For example: Question 2 – What are some plausible explanations for the precipitation patterns shown in the graph? Explain why your explanations are reasonable. Suggested criteria for this essay question for giving students feedback or a score, could rest on the following criteria: • Clear, appropriate explanation(s). • Appropriateness of evidence. • And soundness of reasoning and clarity of explanation.
16	Inductive Reasoning: Reason by Induction	For a more in-depth essay, you could add an additional question, such as: Question 3 – What additional evidence might you collect to discern which of the answer choices from the original question is more likely to be the cause of the anticipated extreme precipitation patterns? For this question, your criteria for feedback or for an analytic or holistic rubric could change slightly: • Clear, appropriate suggestions for additional evidence to collect. • Soundness of reasoning about how the hypotheses would be tested. • And clarity of explanation. For this question, you would assess the students' responses according to whether the additional evidence they suggest is relevant to investigating the hypotheses they suggested and how well they explained why.
17	Inductive Conclusion: Reason by Analogy	Another type of inductive reasoning is reasoning by analogy. This is reasoning based on the similarity of two things, and the quality of the reasoning depends on whether the two things are similar in ways that are really relevant to the argument. Many of you have heard the quote: "Those who do not learn history are condemned to repeat it." This quote challenges us to think back to previous historical events and compare them to what is happening in our world now. Similarly, project assignments or test questions that ask students to see parallels in history require inductive thinking. Questions that present two historical events and ask students to point out the parallels would be Analysis-level questions in Bloom's taxonomy. Questions that ask students to do something with the parallels themselves would be at the Evaluation or Creation level.
18	Inductive Conclusion: Reason by Analogy	Consider the following question: "Gene drives have the potential to address public health threats, conservation-related issues, agricultural pests, and other challenges. In agriculture, a gene drive might be used to control or alter organisms that damage crops or carry crop disease." [Gene Drive. PDF]

		First, describe how gene drive technologies can improve the agriculture industry. Then, select one commonly miscommunicated agricultural topic listed below and answer the question: How were current conditions in society when these misconceptions occurred similar or different compared to the conditions now when communicating about gene drive technologies? What could the industry have done better during the time of that information? Where did we go wrong in disseminating information to consumers? Explain your reasoning. The two options for you to choose from are: • Animal antibiotics • Or pesticide application For this question, criteria for feedback or rubrics could include: • Complete and accurate summary of the function of gene drive technology • Clarity of explanation • Clear, appropriate thesis about what might have happened • Accurate recount of relevant details • Appropriateness of evidence regarding similarities and differences between releases of information then versus now. • And soundness of reasoning and clarity of explanation
19	Rubrics	For major projects, it is important to ensure that the rubrics specifically include reference to student thinking. Notice the general rubric for written projects on this slide. Examine that the content portion of the rubric talks about the accuracy of facts and details and the completeness of information, both in the context of whether the thesis is clear and logically supported. The accuracy and relevance of what the students think about is connected to their reasoning. [insert general writing rubric]
20	Formative & Summative Uses of Results	It is also important to discuss the need for incorporating formative assessment opportunities for your students by assessing plans, progress, or partial products. Do not make students wait until the end of a long assignment to get information about how the work is contributing to their learning. Students will not intentionally write unclear theses or poorly support their positions. But if the first time they are assessed on their thinking is at the end of the assessment, it's too late to clarify their thinking in a way that will improve the product. Examples of formative feedback could be self-assessment, peer assessment, teacher feedback, or a combination of these. This is to ensure that by the time the summative assessment arrives, students will better understand the expectations within the rubric and will be able to meet them.
21	Review	As we come to a close, let's consider all we have covered so far. We first discussed common errors in logic and then transitioned into analyzing examples of deductive reasoning and inductive reasoning. Deductive reasoning involves students being given general rules and asking them to deduce to a conclusion. On the other hand, inductive reasoning involves beginning from a specific instance and reasoning out to a general principle. Logic and reasoning are both needed to support critical thinking.

22	Sources	Brookhart, S.M. (2010) How to Assess Higher-Order Thinking Skills in Your Classroom. Alexandria, VA: ASCD. Utah State University. (2008). Inductive and Deductive Reasoning. Retrieved from http://ocw.usu.edu/English/introduction-to-writing-academic-prose/inductive-and-deductive-reasoning.html National Academies of Sciences of Sciences, Engineering, & Medicine. (2016). Gene-Drive Modified Organisms Are Not Ready to Be Released Into Environment; New Report Calls for More Research and Robust Assessment. Retrieved from http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=23405
23	Credits	Thank you for viewing this module.