National Aeronautics and Space Administration

**Follow Your Curiosity: A 2012 NASA Summer of Innovation Collection**

**Lesson 14**

# Sharing Designs of Sustainable Communities on Mars

**Grades: 6-8** **Prep Time: 10 Minutes** **Lesson Time: 2-3 Hours**



## WHAT STUDENTS DO: Present Designs

In designing a sustainable community for the extreme environment on Mars, where did students' curiosity lead? What did it enable them to create? How can curiosity and creativity inspire others? Communicating and collaborating is a key component of 21st-Century Skills. In this activity, students listen to experts give advice on presentations. They review Tips for Presentations and complete an outline of information to prepare for a talk about their community on Mars. Finally, students present their design for a community on Mars and other aspirations. In this collection, this lesson provides a synthesis and summative experience for students, allowing them to share their newly developed problem-solving skills and their design-based solutions with others. It originates from the Imagine Mars Project, co-sponsored by NASA and the National Endowment for the Arts: http://imaginemars.jpl.nasa.gov

### NRC CORE & COMPONENT QUESTIONS

## HOW DO ENGINEERS SOLVE PROBLEMS?

*NRC Core Question: ETS1: Engineering Design*

### What Is a Design for? What are the criteria and constraints of a successful solution?

*NRC ETS1.A: Defining & Delimiting an Engineering Problem*

### INSTRUCTIONAL OBJECTIVES

*Students will be able*

**IO1: to produce** a presentation of a model that aligns with design and communications criteria

*See Section 4.0 and Teacher Guide at the end of this lesson for details on Instructional Objective(s), Learning Outcomes, Standards, & and Rubrics.*

## 1.0 About This Activity

This activity is part of the Imagine Mars Project, co-sponsored by NASA and the National Endowment for the Arts (NEA). The Imagine Mars Project is a hands-on, STEM-based project that asks students to work with NASA scientists and engineers to imagine and to design a community on Mars using science and technology, then express their ideas through the arts and humanities, integrating 21st Century skills. The Imagine Mars Project enables students to explore their own community and decide which arts-related, scientific, technological, and cultural elements will be important on Mars. Then, they develop their concepts relating to a future Mars community from an interdisciplinary perspective of the arts, sciences, and technology. http://imaginemars.jpl.nasa.gov

The Imagine Mars lessons leverage *A Taxonomy for Learning, Teaching, and Assessing* by Anderson and Krathwohl (2001) (See *Section 4* and *Teacher Guide* at the end of this document). This taxonomy provides a framework to help organize and align learning objectives, activities, and assessments. The taxonomy has two dimensions. The first dimension, cognitive process, provides categories for classifying lesson objectives along a continuum, at increasingly higher levels of thinking; these verbs allow educators to align their instructional objectives and assessments of learning outcomes to an appropriate level in the framework in order to build and support student cognitive processes. The second dimension, knowledge, allows educators to place objectives along a scale from concrete to abstract. By employing Anderson and Krathwohl's (2001) taxonomy, educators can better understand the construction of instructional objectives and learning outcomes in terms of the types of student knowledge and cognitive processes they intend to support. All activities provide a mapping to this taxonomy in the Teacher Guide (at the end of this lesson), which carries additional educator resources. Combined with the aforementioned taxonomy, the lesson design also draws upon Miller, Linn, and Gronlund's (2009) methods for (a) constructing a general, overarching, instructional objective with specific, supporting, and measurable learning outcomes that help assure the instructional objective is met, and (b) appropriately assessing student performance in the intended learning-outcome areas through rubrics and other measures. Construction of rubrics also draws upon Lanz's (2004) guidance, designed to measure science achievement.

*How Students Learn: Science in the Classroom* (Donovan & Bransford, 2005) advocates the use of a research-based instructional model for improving students' grasp of central science concepts. Based on conceptual-change theory in science education, the 5E Instructional Model (BSCS, 2006) includes five steps for teaching and learning: Engage, Explore, Explain, Elaborate, and Evaluate. The Engage stage is used like a traditional warm-up to pique student curiosity, interest, and other motivation-related behaviors and to assess students' prior knowledge. The Explore step allows students to deepen their understanding and challenges existing preconceptions and misconceptions, offering alternative explanations that help them form new schemata. In Explain, students communicate what they have learned, illustrating initial conceptual change. The Elaborate phase gives students the opportunity to apply their newfound knowledge to novel situations and supports the reinforcement of new schemata or its transfer. Finally, the Evaluate stage serves as a time for students' own formative assessment, as well as for educators' diagnosis of areas of confusion and differentiation of further instruction. This five-part sequence is the organizing tool for the Imagine Mars instructional series. The 5E stages can be cyclical and iterative.

## 2.0 Materials

### Required Materials

**Please supply:**

- LCD projector and computer
- Note cards (several per student)

**Please Show:**

- 30-second MBA video: How Do I Prepare for an Important Presentation?
  http://www.30secondmba.com/question/how-do-i-prepare-important-presentation

**Please Print:**

**From Student Guide**

| | | |
|---|---|---|
| (A) | Tips for Presentations | – 1 per student |
| (B) | Topics to Include in Presentation | – 1 per team |
| (C) | Presentation Checklist | – 1 per student |

### Optional Materials

**From Teacher Guide**

(D) "Share" Assessment Rubrics
(E) Alignment of Instructional Objectives, Standards, & Learning Outcomes

## 3.0 Vocabulary

| | |
|---|---|
| **Community planning** | the process of thinking systematically through neighborhood-based problems and situations (The Enterprise Foundation, 1999) |
| **Constraints** | restricting or limiting circumstances |
| **Critique** | a helpful analysis meant to point out areas for improvements |
| **Design Criteria** | the standards that are used to judge a proposal |
| **Explanations** | logical descriptions applying scientific and technological information |
| **Evaluate** | check the scientific validity or soundness |
| **Inflection** | altering the pitch or tone of your voice for dynamic speaking |
| **Investigation** | an exploration of a topic or question to gain information |

| | |
|---|---|
| **Models** | a simulation that helps explain natural and man-made systems and shows possible flaws |
| **Reasoning** | reaching conclusions based on facts |

## 4.0 Instructional Objectives, Learning Outcomes, Standards, & Rubrics

Instructional objectives, standards, and learning outcomes are aligned with the National Research Council's *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, which serves as a basis for upcoming "Next-generation Science Standards." Current National Science Education Standards (NSES) and other relevant standards are listed for now, but will be updated when the new standards are available.

The following chart provides details on alignment among the core and component NRC questions, instructional objectives, learning outcomes, and educational standards.

- Your **instructional objectives (IO)** for this lesson align with the NRC Framework and education standards.
- You will know that you have achieved these instructional objectives if students demonstrate the related **learning outcomes (LO)**.
- You will know the level to which your students have achieved the learning outcomes by using the suggested **rubrics** (see Teacher Guide at the end of this lesson).

**Quick View of Standards Alignment:**

The Teacher Guide at the end of this lesson provides full details of standards alignment, rubrics, and the way in which instructional objectives, learning outcomes, 5E activity procedures, and assessments were derived through, and align with, Anderson and Krathwohl's (2001) taxonomy of knowledge and cognitive process types. For convenience, a quick view follows:

| HOW DO ENGINEERS SOLVE PROBLEMS?<br>*NRC Core Question: ETS1: Engineering Design*<br>**What Is a Design for? What are the criteria and constraints of a successful solution?**<br>*NRC Component Question ETS1.A: Defining & Delimiting an Engineering Problem* | | | |
|---|---|---|---|
| **Instructional Objective**<br>*Students will be able* | **Learning Outcomes**<br>*Students will demonstrate the measurable abilities* | **Standards**<br>*Students will address* | |
| **IO1:**<br><br>**to produce** a presentation of a model that aligns with design and communications criteria | **LO1a. to explain** the way in which the design addresses human needs in the context of environmental constraints and culture<br>**LO1b. to summarize** priorities in a design that address societal challenges per criteria<br><br>**LO1c. to explain** how technologies can overcome societal challenges<br>**L01d. to critique** presentation skills against criteria<br><br>**L01e. to execute** criteria-based presentation | **NSES (E): SCIENCE & TECHNOLOGY: Abilities of Technological Design**<br><br>**Grades 5-8:** E2e: Technological designs have constraints.<br><br>**NSES (E): SCIENCE IN PERSONAL & SOCIAL PERSPECTIVES: Science & Technology in Society**<br><br>**Grades 5-8:** F5b<br><br>**21st Century Skills: Communication & Collaboration**<br><br>**Communicate Clearly** | ***Rubrics in Teacher Guide*** |

## 5.0 Procedure

## PREPARATION (~15 minutes)

**Set up:**

- LCD Projector and computer, linked to:

  30 Second MBA video – How Do I Prepare for an Important Presentation?
  http://www.30secondmba.com/question/how-do-i-prepare-important-presentation

## STEP 1: ENGAGE (~10 minutes)
### Understand the basics of successful presentations.

**A.** Explain to students that they will be presenting information about their communities.

**B.** Show students video of expert giving tips on presentations.

**C.** Have students jot down the big ideas that the expert shares.

**D.** At the end of the video, ask students to share their ideas.

## STEP 2: EXPLORE (~10 minutes)
### Self-assess presentation skills.

**A.** Give students *(A) Tips for Presentations*.

**B.** Direct students to put a ☺ by tips at which they excel and a ☹ by tips which need improvement.

**C.** Allow students to share their reflections with a partner.

## STEP 3: EXPLAIN (~30 minutes)
### Prepare talking points.

**A.** Give students *(B) Topics to Include in Presentation*.

**B.** Explain that their presentations will need to include an explanation about how each technology in their communities addresses the criteria.

**C.** Allow students time to work in groups to complete information on each topic.

## STEP 4: ELABORATE (~10 minutes)
### Practice presentations.

**A.** Remind students of presentation time limitations (recommended: 10 minutes) and that everyone must participate equally.

**B.** Give each student notecards and review the Tip about using notecards.

**C.** In groups, students should write key points on notecards for their presentation.

**D.** Once they have finished, give each student *(C) Presentation Checklist for Students* and review directions (be sure to point out the difference between self-reflection & group feedback).

**E.** Direct students to practice in their groups.

**F.** If there is time, allow students to practice presenting to a different group, with that group giving feedback based on the Checklist.

## STEP 5: EVALUATE (~60 minutes)

### Present Information.

**A.** Allow students to present their information.

**Teacher Tip:** You can mark student proficiency using the *(D) "Share" Rubric*.

## 6.0 Extensions

Allow students to use an online program, such as Voki.com to create an avatar to give the presentation.

Use a digital storytelling site.

Invite parents, guardians, siblings, local industry representatives, teachers, administrators, or other interested persons to hear student presentations.

## 7.0 Evaluation/Assessment

In the Teacher Guide, use the *"Share" Rubric (D)* as a formative and summative assessment to evaluate the activities using 21st Century Skills, NRC Framework Endpoints, and National Science Education Standards.

## 8.0 References

Anderson, L.W., & Krathwohl (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* New York: Longman.

Bybee, R., Taylor, J., Gardner, A., Van Scotter, P., Carson Powell, J., Westbrook, A., Landes, N. (2006) *The BSCS 5E instructional model: origins, effectiveness, and applications.* Colorado Springs: BSCS.

Donovan, S. & Bransford, J. D. (2005). *How Students Learn: History, Mathematics, and Science in the Classroom.* Washington, DC: The National Academies Press.

Lantz, H.B. (2004). *Rubrics for Assessing Student Achievement in Science Grades K-12.* Thousand Oaks: Corwin Press.

Miller, Linn, & Gronlund. (2009). *Measurement and assessment in teaching*. Upper Saddle River, NJ: Pearson.

National Academies Press. (1996, January 1). *National science education standards*. Retrieved February 7, 2011 from http://www.nap.edu/catalog.php?record_id=4962

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

The Partnership for 21st Century Skills (2011). *A framework for 21st century learning.* Retrieved March 15, 2012 from http://www.p21.org/

wikiHOW. (2011, November 9). *How to do a presentation in class*. Retrieved January 18, 2012 from http://www.wikihow.com/Do-a-Presentation-in-Class

## (A) Student Handout. Tips for Presentations

1. **Do your research.**
   In order to give an engaging presentation, you need to know what you're talking about. You don't have to become an expert, or read every book or website ever written about your topic, but you should be able to answer questions.

2. **Write note cards.**
   Write main ideas; you can use the worksheet, *(B) Topics to Include in Presentation*. Don't write details. Put in some fun facts, interactive questions, and other interactive activities on the cards to share with the class.

3. **Practice.**
   In most presentations, it is pretty obvious who has practiced and who hasn't. Practice in front of your family or friends, or in front of the mirror, and give your presentation. You'll feel a lot more confident when you do the real thing and you'll eliminate the "likes" and "ums" that those who try to "wing it" will have.

4. **Smile at your audience.**
   When it comes time to present, there's nothing that draws your audience into your presentation than a good old fashioned smile. Be happy; you're about to teach your entire class something they didn't know before.

5. **Make eye contact.**
   Nothing is more boring than listening to a presenter who looks at the floor or at notecards. Relax. Talk to your audience like you would your friends.

6. **Be sure to have inflection in your voice.**
   Your goal is to engage your audience, not put them to sleep. Be animated about your topic. Talk about it as if it was the most interesting thing in the world. Your classmates will thank you for it.

7. **Use hand motions.**
   Move your hands along as you talk, using them to emphasize points and keep the audience interested. It will also channel your nervous energy into a better place.

8. **Have a good conclusion.**
   You've probably heard the presentations that end in something like "um... yeah, Your conclusion is your final impression on your audience, including your teacher. Make it exciting by introducing a final statistic, or come up with something creative to do at the end. Your conclusion can be anything so long as your audience knows you're finished.

Source: wikiHOW. (2011, November 9). *How to do a presentation in class*. Retrieved January 18, 2012 from http://www.wikihow.com/Do-a-Presentation-in-Class

## (B) Student Worksheet. Topics to Include in Presentations

**You will have 10 minutes to complete your presentation. All group members must participate equally. Topics to include in your presentations include the following:**

**1.** Your names and the name of your community.

**2.** The location of your community on Mars and the reason(s) you selected it.

**3.** Summarize how the priorities in your community design addressed societal challenges and human needs, including sustainability, cultural, and other factors.

**4.** Explain how your community model provides scientific and technological solutions to meet human needs given environmental constraints (the extreme environment of Mars):

- Temperature
- Radiation
- Lack of oxygen
- Reduced Atmospheric pressure
- Dust
- Gravity
- Water
- Food
- Other ideas (sports, music, education, etc.)

**5.** Conclusion

**(C) Student Handout. Presentation Checklist**

## Self-reflection

**Directions:** use this checklist to evaluate **your own** practice presentation.

- ☐ My part of the presentation takes no more than a few minutes.
- ☐ I participate equally.
- ☐ I introduce myself.
- ☐ I include the name of our community.
- ☐ I use environmental constraint vocabulary correctly.
- ☐ I explain how a technology (or part of our community model) addresses a problem.
- ☐ My presentation ends with a strong conclusion.
- ☐ I smile when speaking.
- ☐ I make eye contact with the audience.
- ☐ I speak with inflection in my voice.

## Group Feedback

**Directions:** use this checklist to evaluate **your group's** practice presentation.

- ☐ Our presentation takes no more than 10 minutes.
- ☐ All group members participate equally.
- ☐ We include the name of each group member.
- ☐ We include the name of our community.
- ☐ We use environmental constraint vocabulary correctly.
- ☐ We explain how each technology (or part of our community model) addresses a problem.
- ☐ Our presentation ends with a strong conclusion.
- ☐ Each person smiles when speaking.
- ☐ Each person makes eye contact with the audience.
- ☐ Each person speaks with inflection in his or her voice.

## (D) Teacher Resource. Share Rubric (1 of 3)

You will know the level to which your students have achieved the **Learning Outcomes**, and thus the **Instructional Objective(s)**, by using the suggested **Rubrics** below.

## Instructional Objective 1: To produce a presentation that aligns with criteria

**Related Standard(s)** (will be replaced when new NRC Framework-based science standards are released):
**National Science Education Standards (NSES)**
**(E) Science and Technology: Abilities of Technological Design**
Technological designs have constraints. Some constraints are unavoidable (e.g., properties of materials, or effects of weather and friction); other constraints limit choices in the design (e.g., example, environmental protection, human safety, and aesthetics). (Grades 5-8: E2e)

| Learning Outcome | Expert | Proficient | Intermediate | Beginner |
|---|---|---|---|---|
| **LO1: Explain how proposed scientific and technological solutions address environmental and other constraints** | Explanation is grounded in sound and insightful scientific and technological facts and theory. | Explanation is grounded in sound scientific and technological facts and theory. | Explanation is grounded in mostly sound scientific and technological facts and theory. | Explanation is not grounded in sound scientific and technological facts and theory. |

## (D) Teacher Resource. Share Rubric (2 of 3)

**National Science Education Standards (NSES)**
**(F) Science in Personal and Social Perspectives: Science and Technology in Society**
Societal challenges often inspire questions for scientific research, and social priorities often influence research priorities through the availability of funding for research. (Grades 5-8: F5b)

| Learning Outcome | Expert | Proficient | Intermediate | Beginner |
|---|---|---|---|---|
| **LO2: Summarize how priorities in the design address societal challenges per criteria** | Summary of how priorities address societal challenges is clear and insightful. | Summary of how priorities address societal challenges is clear. | Summary of how priorities address societal challenges is mostly clear. | Summary of how priorities address societal challenges is unclear. |
| **LO3: Explain how technologies address societal challenges within constraints** | All technological solutions clearly link to a problem. | Most technological solutions clearly link to a problem. | Few technological solutions link to a problem. | Technologies are superfluous and not linked to a problem. |

## (D) Teacher Resource. Share Rubric (3 of 3)

**Related Standard(s)** (will be replaced when new NRC Framework-based science standards are released):

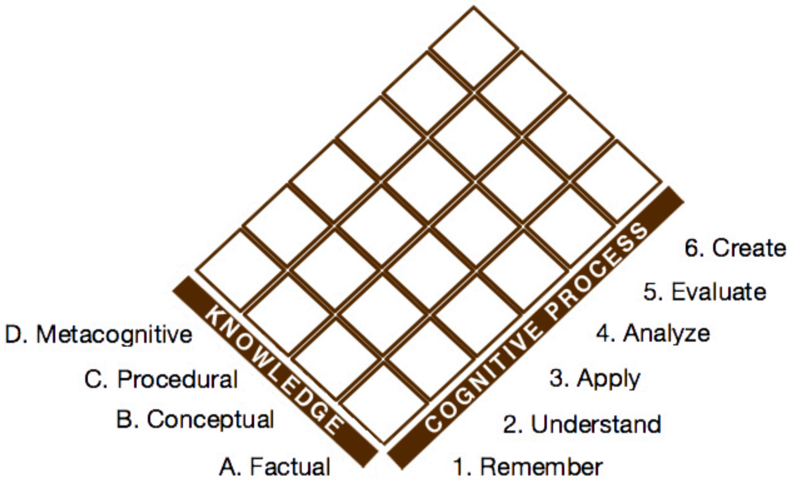
**21st Century Skills. Communication and Collaboration: Communicate Clearly.**

Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts.

**Related Rubrics for the Assessment of Learning Outcomes Associated with the Above Standard(s)**:

| Learning Outcome | Expert | Proficient | Intermediate | Beginner |
|---|---|---|---|---|
| **LO4: Critique presentation skills per criteria** | Critique of presentation skills is honest and accurate. Critique informed all improvements. | Critique of presentation skills is accurate. Critique informed some improvements. | Critique of presentation skills is mostly accurate. Critique informed few improvements. | Critique of presentation skills lacks accuracy. Critique informed very few improvements. |
| **LO5: Execute communication per criteria** | Presenter used most Presentation Tips to deliver a well-conducted talk; communication of the design, its constraints, and the problems it solves was extremely clear. | Presenter used many Presentation Tips to deliver a well-conducted talk; communication of the design, its constraints, and the problems it solves was very clear. | Presenter used some Presentation Tips to deliver a fairly well-conducted talk; communication of the design, its constraints, and the problems it solves was clear. | Presenter used few Presentation Tips to deliver a talk; communication of the design, its constraints, and the problems it solves was not clear. |

## (E) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (1 of 3)



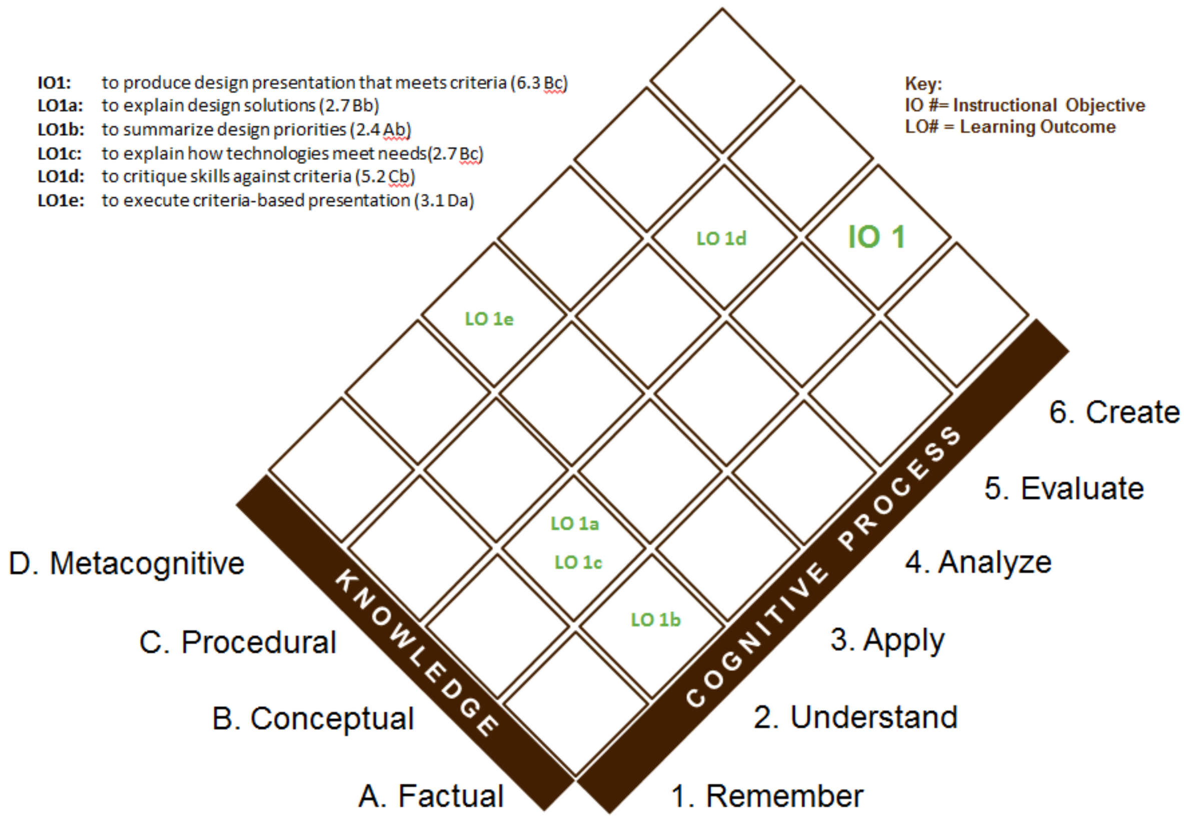

This lesson adapts Anderson and Krathwohl's (2001) taxonomy, which has two domains: Knowledge and Cognitive Process, each with types and subtypes (listed below). Verbs for objectives and outcomes in this lesson align with the suggested knowledge and cognitive process area and are mapped on the next page(s). Activity procedures and assessments are designed to support the target knowledge/cognitive process.

| Knowledge | Cognitive Process |
|---|---|
| **A. Factual**<br>**Aa:** Knowledge of Terminology<br>**Ab:** Knowledge of Specific Details & Elements<br>**B. Conceptual**<br>**Ba:** Knowledge of classifications and categories<br>**Bb:** Knowledge of principles and generalizations<br>**Bc:** Knowledge of theories, models, and structures<br>**C. Procedural**<br>**Ca:** Knowledge of subject-specific skills and algorithms<br>**Cb:** Knowledge of subject-specific techniques and methods<br>**Cc:** Knowledge of criteria for determining when to use appropriate procedures<br>**D. Metacognitive**<br>**Da:** Strategic Knowledge<br>**Db:** Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge<br>**Dc:** Self-knowledge | **1. Remember**<br>**1.1** Recognizing (Identifying)<br>**1.2** Recalling (Retrieving)<br>**2. Understand**<br>**2.1** Interpreting (Clarifying, Paraphrasing, Representing, Translating)<br>**2.2** Exemplifying (Illustrating, Instantiating)<br>**2.3** Classifying (Categorizing, Subsuming)<br>**2.4** Summarizing (Abstracting, Generalizing)<br>**2.5** Inferring (Concluding, Extrapolating, Interpolating, Predicting)<br>**2.6** Comparing (Contrasting, Mapping, Matching<br>**2.7** Explaining (Constructing models)<br>**3. Apply**<br>**3.1** Executing (Carrying out)<br>**3.2** Implementing (Using)<br>**4. Analyze**<br>**4.1** Differentiating (Discriminating, distinguishing, focusing, selecting)<br>**4.2** Organizing (Finding coherence, integrating, outlining, parsing, structuring)<br>**4.3** Attributing (Deconstructing)<br>**5. Evaluate**<br>**5.1** Checking (Coordinating, Detecting, Monitoring, Testing)<br>**5.2** Critiquing (Judging)<br>**6. Create**<br>**6.1** Generating (Hypothesizing)<br>**6.2** Planning (Designing)<br>**6.3** Producing (Constructing) |

## (E) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (2 of 3)

(F)

The design of this activity leverages Anderson & Krathwohl's (2001) taxonomy as a framework. Pedagogically, it is important to ensure that objectives and outcomes are written to match the knowledge and cognitive process students are intended to acquire.



## (E) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (3 of 3)

The design of this activity leverages Anderson & Krathwohl's (2001) taxonomy as a framework. Below are the knowledge and cognitive process types students are intended to acquire per the instructional objective(s) and learning outcomes written for this lesson. The specific, scaffolded 5E steps in this lesson (see 5.0 Procedures) and the formative assessments (worksheets in the Student Guide and rubrics in the Teacher Guide) are written to support those objective(s) and learning outcomes. Refer to (E, 1 of 3) for the full list of categories in the taxonomy from which the following were selected. The prior page (E, 2 of 3) provides a visual description of the placement of learning outcomes that enable the overall instructional objective(s) to be met.

**At the end of the lesson, students will be able**

**IO1: to produce design presentation that meets criteria**

**6.3:** to produce
**Bc:** knowledge of theories, models, and structures

**To meet that instructional objective, students will demonstrate the abilities:**

**LO1a: to explain design solutions**
2.7: to explain
Bb: knowledge of principles and generalizations

**LO1b: to summarize design priorities**
2.4: to summarize
Ab: knowledge of specific details and elements

**LO1c: to explain how technologies meet needs**
2.7: to explain
Bc: knowledge of principles and generalizations

**LO1d: to critique skills against criteria**
5.2: to critique
Cb: knowledge of criteria for when to use appropriate procedures

**LO1e: to execute criteria-based presentation**
3.1: to execute
Da: strategic knowledge