



Reflecting on Your Community Model

Grades: 6-8

Prep Time: 30 Minutes

Lesson Time: 2-3 Hours



WHAT STUDENTS DO: Reflect on the Idea of Community Needs

Human discovery and innovation often depends on our curiosity about how we can improve our lives. Students identify the positive and negative elements of their home community. Building from their pros and cons lists, they draft a plan for an ideal community, and build a simple 3-dimensional model of it. Finally, students brainstorm a list of environmental needs a community has to sustain life. In this collection, this lesson provides students with an introduction to design, its purpose, and the first stages in its process. It originates from the Imagine Mars Project, co-sponsored by NASA and the National Endowment for the Arts: 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

What Is the Process for Developing Potential Design Solutions?

NRC ETS1.B: Developing Possible Solutions

INSTRUCTIONAL OBJECTIVES

Students will be able

IO1: to construct a simple model according to criteria



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. 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:

- White board or chart paper
- Multiple recent issues of local/community newspapers
- Materials from recycle bin for making 3-D community models
- Craft supplies for making models (tape, scissors, markers, etc.)

Please Print:

From Student Guide:

- | | |
|---|--------------------------|
| (A) Community Venn Diagram | – 1 per student |
| (B) Community Plan Checklist | – 1 per pair of students |
| (C) Rules of Brainstorming | – 1 per pair of students |
| (D) Community Resources Brainstorm Ticket | – 1 per pair of students |

Optional Materials

From Teacher Guide:

- (E) “Reflect” Assessment Rubrics
- (F) Example Community Venn Diagram
- (G) Alignment of Instructional Objectives, Standards, & Learning Outcomes

3.0 Vocabulary

Ask questions	scientists ask questions that can be answered using empirical evidence
Bird’s Eye View Plan	view of the community from above, as if the artist were a bird
Bubble Plans	a simple model used by architects early in their planning, in which one draws circles to represent a room or other feature that they want to include in their floor plan
Constraints	restricting or limiting circumstances
Design Criteria	the standards that are used to judge a proposal
Empirical Evidence	knowledge gained through direct or indirect observation
Explanation	logical description applying scientific information
Evaluate	check the scientific validity or soundness



Imagine	envision objects or processes that cannot be seen
Investigation	an exploration of a topic or question to gain information
Model	a simulation that helps explain natural and human-made systems and shows possible flaws
Reasoning	reaching conclusions based on facts
Skyline View Plan:	the horizon-line view of a community, showing the silhouette of the built and natural environments (Artist Andy Smetanka is famous for his skyline animations and work.)

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 instructional objectives, learning outcomes, and educational standards.

- Your general **instructional objective(s) (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, specific, and measurable **learning outcome(s) (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:

**EST1A:**

HOW DO ENGINEERS SOLVE PROBLEMS?			
<i>NRC Core Question: ETS1: Engineering Design</i>			
What Is a Design for? What are the criteria and constraints of a successful solution?			
<i>NRC Component Question ETS1.A: Defining & Delimiting an Engineering Problem</i>			
Instructional Objective <i>Students will be able</i>	Learning Outcomes <i>Students will demonstrate the measurable abilities</i>	Standards <i>Students will address</i>	Rubrics in Teacher Guide
IO1: to construct a simple model according to criteria	LO1a. to classify pros and cons in a Venn diagram LO1b. to identify criteria (environmental resources and community needs)	NSES (E): SCIENCE & TECHNOLOGY: Abilities of Technological Design, Identify Appropriate Problems for a Technological Design Grades 5-8: E1a	

EST1B:

HOW DO ENGINEERS SOLVE PROBLEMS?			
<i>NRC Core Question: ETS1: Engineering Design</i>			
What Is the Process for Developing Potential Design Solutions?			
<i>NRC Component Question ETS1.B: Developing Possible Solutions</i>			
Instructional Objective <i>Students will be able</i>	Learning Outcomes <i>Students will demonstrate the measurable abilities</i>	Standards <i>Students will address</i>	Rubrics in Teacher Guide
IO1: to construct a simple model according to criteria	LO1c. to plan, using criteria LO1d. to evaluate a model of a community	NSES (E): SCIENCE & TECHNOLOGY: Abilities of Technological Design Evaluate Completed Technological Designs or Products Grades 5-8: E1d	

5.0 Procedure**PREPARATION** (~15 minutes)

- A.** Provide, or have students provide, found (recycle bin) objects or craft supplies.
- B.** Print:
- Student Sheet (A) – 1 per student
 - Student Sheets (B), (C), & (D) – 1 per pair of students



STEP 1: ENGAGE (~20 minutes)


Identify pros and cons of a system.

- A. Divide students into small groups.
- B. Hand out newspapers and
- C. Have the students find, cut out, and paste into a collage images and words that are either “pros” (positive aspects, people, jobs, opportunities) or “cons” (things that they don’t like, things they would change, things that worry them) about their community.

STEP 2: EXPLORE (~20 minutes)

Classify information.

- A. Draw a large Venn Diagram on the board and give each student (A) *Community Venn Diagram* and direct their attention to Part 1 Directions.
- B. Have the groups present their collage ideas, explaining if each item is a pro, con, or center category, and write the item in the appropriate space.
- C. Direct students to place each idea on the Venn Diagram. Their Venn Diagrams do not have to be the same; students may disagree about the categories.

 **Teacher Tip:** In the Teacher Guide at the end of this lesson, refer to (F) *Community Venn Diagram Example* for ideas.

- D. At the end, allow students to share their placement thoughts. Encourage discussion and courteous debate.
- E. Engage students in a culminating discussion using topics such as:
 - i. What kinds of careers are needed to help a community function?
 - ii. What would you keep? What would you change?
 - iii. How has your community changed over time? Why?
- F. Students should keep a copy of the Pros/Cons list so that they can refer to it throughout the Imagine Mars Unit.


STEP 3: EXPLAIN (~60 minutes)


Create a simple model/design plan.

- A. Define the purpose of community planning: Community planning is the process of thinking through neighborhood-based problems and situations systematically. (The Enterprise Foundation, 1999).



- B.** Explain to students that their next goal is to create a model of a new community, including the elements that they identified on the Venn Diagram. Students can choose a design plan, including bird's eye view, skyline, bubble plan, or student choice.

 **Teacher Tip:** Refer to vocabulary (Section 2.0) for definitions of different plan types.

 **Teacher Tip:** You may set the amount of time for this activity to be short or long, based on your class needs.

- C.** Go over the requirements and write them on the board as you explain:
- Use Venn Diagrams to generate ideas for your community.
 - The design should represent relative size. If you want a giant field, the graphic should be large; if you want a small park, the graphic should be small.
 - Include at least 5 different elements.
 - Include visual clues in your design. For example, a park might have some trees, grass, picnic benches.
- D.** Give students *(B) Community Plan Checklist* and review the instructions.
- E.** Once students have a draft, direct them to build a 3-dimensional community out of found objects (items from the recycling bin or available in class).
- F.** Ask each group of students to share the elements they included in their community.
- G.** As they share, write the big ideas on the board. For example, if students have a subway system, write "transportation system" on the board.


STEP 4: ELABORATE (~10 minutes)

Identify community resources and needs.

- A.** Explain that students will need to brainstorm with their partners. Give each pair of students *(C) The Rules of Brainstorming* and review each rule.
- B.** Give each student a *(D) Brainstorming Ticket* and review directions.
- C.** With elbow partners, students should brainstorm natural and human-made resources that humans need to survive and that their communities would need to thrive.
- D.** For each resource, students should brainstorm the purpose of those resources. For example, we use wood to build structures. Students should categorize the resources and include a title for each category.



- E. Students should organize this information to clearly display their thoughts.
- F. Review student ideas about resources and write on chart paper.
- G. Allow students to add resources during this time.

 **Curiosity Connection Tip:** For making a connection to NASA's Mars Rover "Curiosity," please show your students additional video and slideshow resources at:
<http://mars.jpl.nasa.gov/participate/marsforeducators/soi/>

STEP 5: EVALUATE (~10 minutes)

Evaluate suitability of model community.

- A. Refer students to the *(A) Community Venn Diagram, Part 2 Directions* and their models. Explain that now is the perfect time to reflect on their 3-D models.
- B. Once students have finished, ask groups to share what they included, what they excluded, and their rationale for the decisions.
- C. Collect student work to evaluate their proficiency per *(E) "Reflect" Rubric*

6.0 Extensions

Field trips to explore your community! Consider going to a waste-water treatment facility, an architecture firm, a green technology center, a botanical garden, or just a walk about town.

7.0 Evaluation/Assessment

In the Student Guide, use the *(A) Community Venn Diagram* and the *(B) Community Plan Checklist (B)* as formative assessment tools, allowing students to improve their work and learn from mistakes during class. In the Teacher Guide, use the *(E) "Reflect" Rubric* as a formative and summative assessment that aligns with the NRC Framework, National Science Education Standards, and the instructional objective(s) and learning outcomes in this lesson.



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

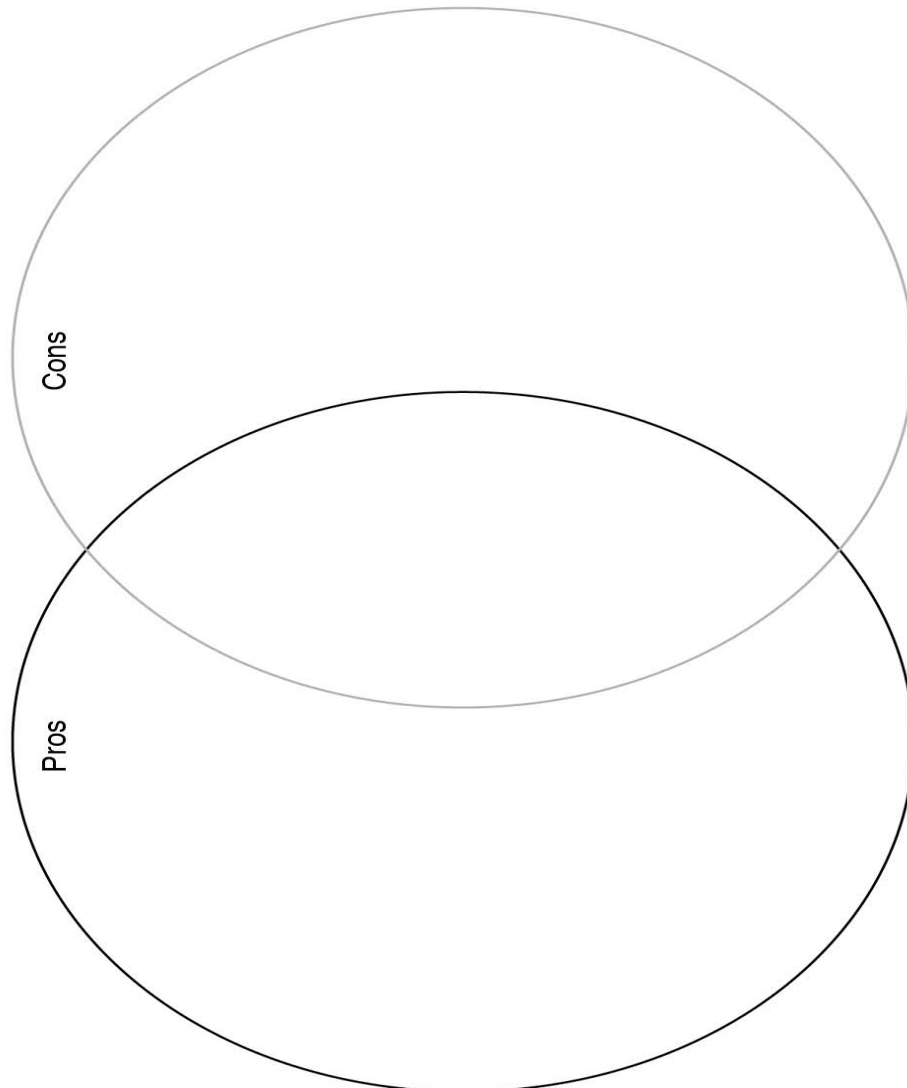
**(A) Student Handout. Community Venn Diagram**

Part 1 Directions: *Used at the Beginning of the Project.*

1. List all pros and cons about the community in the Venn Diagram.
2. Place items that can be both pros and cons in the center.

Part 2 Directions: *Used at the End of the Project.* Evaluate your community model.

1. Place a star by the items you included in your model.
2. Place an X by the items you did not include in your model.
3. Circle items you did not include, but would like to add in the future.
4. Write in any items you included that were not on the original list.

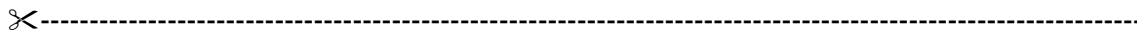




(B) Student Handout. Community Plan Checklist

Community Plan Checklist

- I spent time to create a comprehensive community.
- I considered the ideas of others.
- My plan includes at least 5 elements in the community.
- Each element is represented by a visual clue.
- My graphics represent relative size (for example, a big park has a larger graphic than a small park).



Community Plan Checklist

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**(C) Student Handout. The Rules of Brainstorming****Avoid critique.**

It is hard to be creative when you feel unsafe or judged. Ideas have to spring out and allow others to build on them. A good idea can come from a completely crazy thought. Every person should feel comfortable sharing any idea.

Foster outrageous ideas.

Crazy thoughts allow others to consider different perspectives and break out of their shells. When considering a wild idea, we think about the constraints and criteria; it helps us define what we truly want.

Add to others' ideas.

The goal is to be positive and encouraging of others' ideas so we can jumpstart our own minds. Try to avoid saying "but" or "no" and focus on saying "and" or "yes"

Stay on target.

Keep your comments on the task and avoid distracting the group.

Focus discussion.

Wait your turn. Write down ideas you are afraid you might forget, and be sure that your ideas relate to the topic. If a group member mentions an idea that seems off task, ask yourself if there is a way it might relate.

Be colorful.

Use pictures, graphic organizers and colors in your idea sharing. It is okay if you are not an artist! The big ideas behind your artwork or graphic description are what matter.

More is more.

Try to share as many ideas as possible. The more ideas you have, the more likely you are to have many good ideas!

Credit: <http://www.openideo.com/fieldnotes/openideo-team-notes/seven-tips-on-better-brainstorming>



(D) Student Handout. Community Resources Brainstorm Ticket

Community Resources Brainstorm Ticket

Directions: Organize the information listed below in a format that best conveys your learning.

1. Include a list of resources that humans depend upon for survival.
2. For each resource, describe the use.
3. Categorize your resources into like groups and give each category a title.

✂-----

Community Resources Brainstorm Ticket

Directions: Organize the information listed below in a format that best conveys your learning.

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**(E) Teacher Resource. Reflect Rubric**

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 construct a simple model according to criteria**National Science Education Standards (NSES)****(E) Science and Technology: Identify Appropriate Problems**

Students should develop their abilities by identifying a specified need, considering its various aspects, and talking to different potential users or beneficiaries. They should appreciate that for some needs, the cultural backgrounds and beliefs of different groups can affect the criteria for a suitable product. (Grades 5-8: E1a)

	Expert	Proficient	Intermediate	Beginner
LO1a: Classify pros and cons of community in Venn Diagram	Numerous, relevant, & insightful pros and cons are all categorized correctly	Numerous, relevant pros and cons are all categorized correctly	Numerous pros and cons are mostly categorized correctly	Very few pros and cons are categorized correctly, or are not relevant
LO1b: Identify Criteria	Brainstorming ticket includes numerous, relevant, & insightful resources & needs	Brainstorming ticket includes numerous & relevant resources & needs	Brainstorming ticket includes numerous resources & need, although some are not clearly relevant	Brainstorming ticket includes very few relevant resources & needs

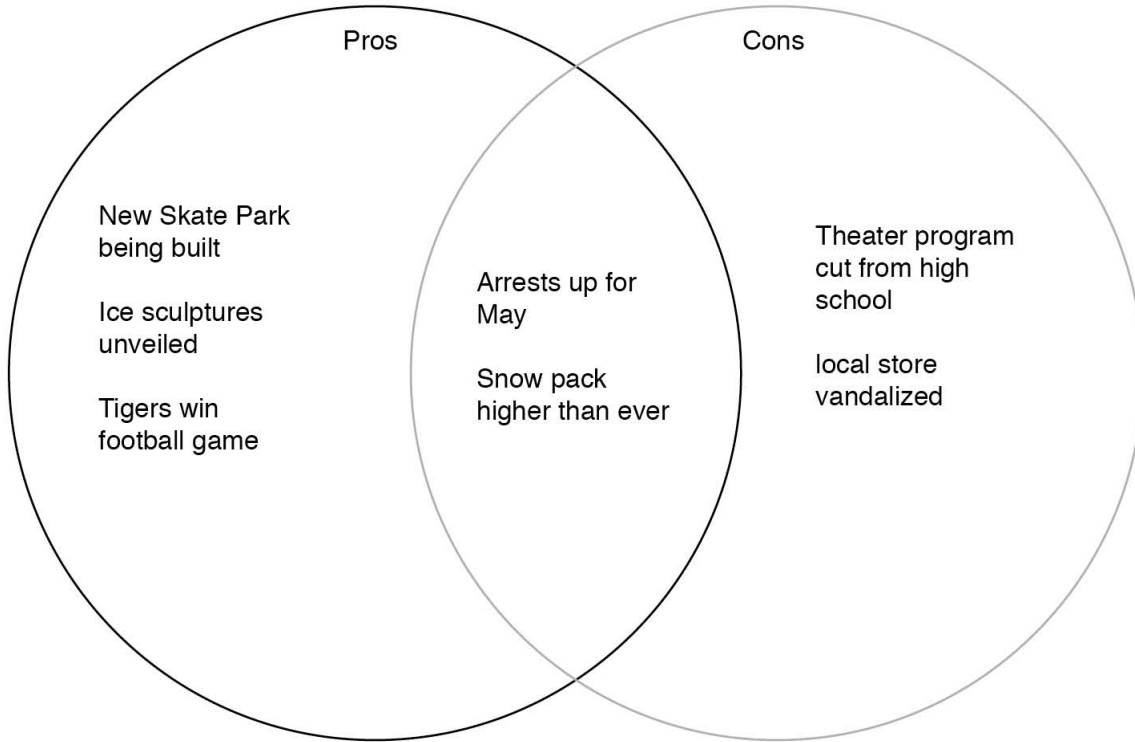
(E) Science and Technology: Evaluate Completed Technological Designs or Products

Students should use criteria relevant to the original purpose or need, consider a variety of factors that might affect acceptability and suitability for intended users or beneficiaries, and develop measures of quality with respect to such criteria and factors; they should also suggest improvements and, for their own products, try proposed modifications. (Grades 5-8: E1d)

	Expert	Proficient	Intermediate	Beginner
LO1c: Plan, using criteria	Plan meets all criteria in an innovative way.	Plan meets all criteria.	Plan mostly meets criteria.	Plan does not meet criteria.
LO1d: Evaluate model community	Evaluation includes complete list of thoughtful items to include & exclude based on Venn Diagram list	Evaluation includes complete list of items to include & exclude based on Venn Diagram list	Evaluation includes list of items to include & exclude based on Venn Diagram list	Evaluation includes very few items to include & exclude based on Venn Diagram list

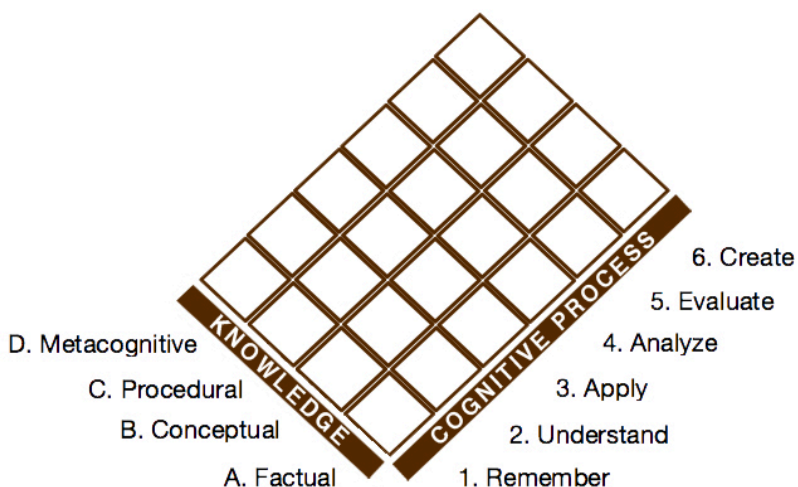


(F) Teacher Example. Community Venn Diagram – relates to Student Worksheet (A)





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



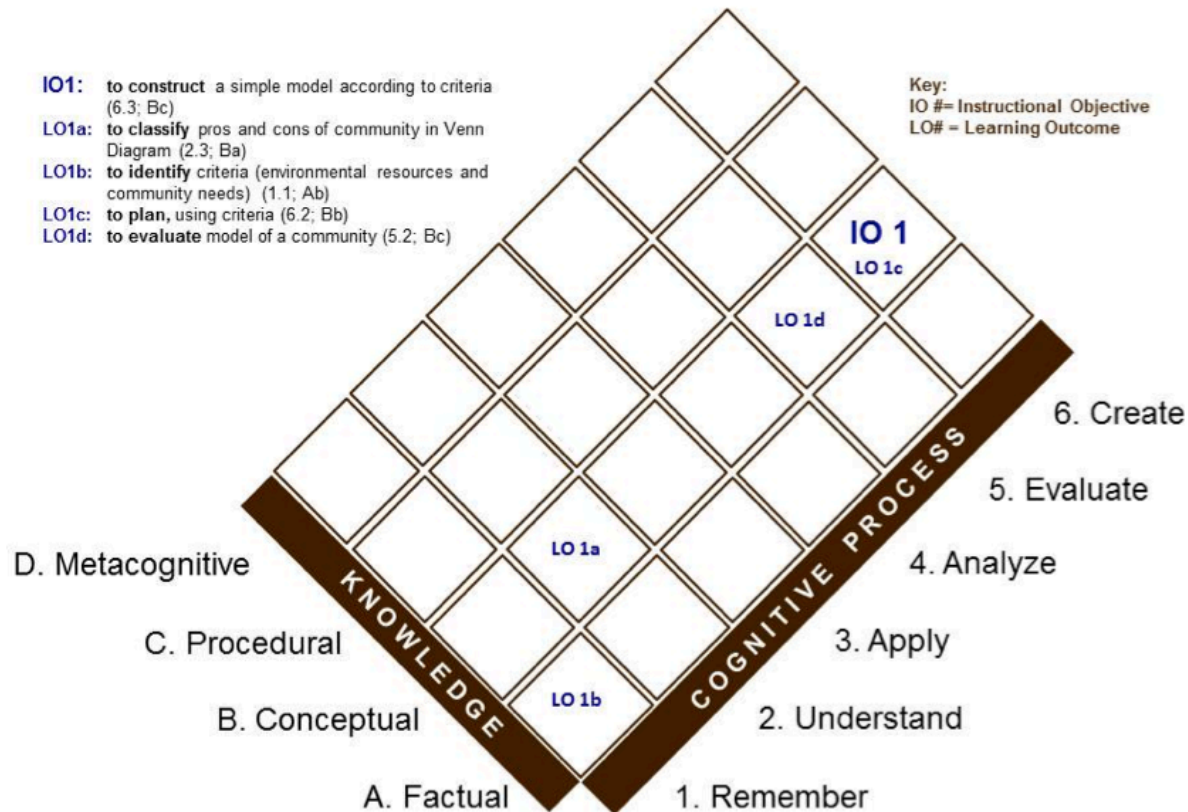
This lesson adapts Anderson and Krathwohl's (2001) taxonomy, which has two domains: Knowledge and Cognitive Process, each with types and subtypes (listed below). Verbs for objectives and outcomes in this lesson align with the suggested knowledge and cognitive process area and are mapped on the next page(s).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

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



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

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.



**(G) 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 Section 5.0 *Procedures*) and the formative assessments (worksheets in the Student Guide and rubrics in the Teacher Guide) are written to support those instructional objective(s) and learning outcomes. Refer to (G, 1 of 3) for the full list of categories in the taxonomy from which the following were selected. The prior page (G, 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 construct a simple model**6.3:** to construct**Bc:** knowledge of theories, models, and structures

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

LO1a: to classify pros and cons

2.3: to classify

Ba: knowledge of classifications and categories

LO1b: to identify criteria

1.1: to identify

Ab: knowledge of specific details and elements

LO1c: to plan using criteria

6.2: to plan

Bb: knowledge of principles and generalizations

LO1d: to evaluate model community

5.2: to critique

Bc: knowledge of theories, models, and structures