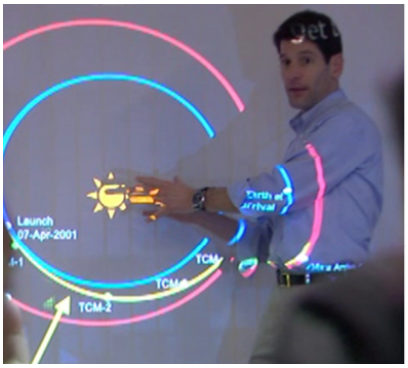
Lesson 4

Discovering Information About Mars

Grades: 6-8 Prep Time: 5 Minutes Lesson Time: 1 Hour



WHAT STUDENTS DO: Increase Knowledge of Mars

Curiosity leads to discovery. In this activity, students get their first glimpse into what Mars is really like. If you want to build a community on Mars, what would you need to know about its environment? How are natural resources different there? How is it different from Earth? Students gain background knowledge about environmental factors on Mars through taking notes while viewing a PowerPoint presentation. To culminate, they clarify the challenges of living on Mars by generating a list of potential environmental problems. In this collection, this lesson provides students with introductory, contextual material for the hands-on activities in Lessons 2 and 3 and 5-11, all part of the "Discover" phase. 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	INSTRUCTIONAL OBJECTIVE
HOW DO EARTH'S SURFACE PROCESSES AND HUMAN ACTIVITIES AFFECT EACH OTHER? *NRC Core Question: ESS3: Earth and Human Activity*	*Students will be able*
How do humans depend on Earth's resources? *NRC ESS3.A: Natural Resources*	**IO1: to categorize** environmental data

See Section 4.0 and Teacher Guide for details on Instructional Objectives, Standards, & Learning Outcomes.

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:

- Computer and projection system.

Please download and show:

- DISCOVER PowerPoint Presentation.

Please Print:

From Student Guide:

(A) Note-taking Sheet – 1 per student

Optional Materials

From Teacher Guide:

(B) Note-taking Sheet: Teacher Key
(C) "Discover" Assessment Rubrics

3.0 Vocabulary

Discover	to notice or learn, especially by making an effort www.thefreedictionary.com/**discover**
Atmosphere	the gases that surround a planet
Atmospheric Pressure	the pressure at any location on a planet caused by the channel of air above
Elevation	the height to which something rises
Gravity	the force of attraction between any two bodies in the universe; a force that causes two objects to pull toward each other.
Hydrogen	a colorless, very light gas that forms water when combined with oxygen
Magnetic Field	a field of force which deflects moving particles
Radiation	photons, electrons, & other particles moving through the air

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** (C).

Details of alignment and the way in which instructional objectives and learning outcomes were derived through an adaptation of Anderson and Krathwohl's (2001) taxonomy can be found for reference in the Teacher Guide, along with rubrics and other resources for educators.

HOW DO EARTH'S SURFACE PROCESSES AND HUMAN ACTIVITIES SUPPORT EACH OTHER?

NRC Core Question: ESS3: Earth and Human Activity

How do humans depend on Earth's resources?

NRC Component Question ESS3.A: How do humans depend on Earth's resources?

Instructional Objective *Students will be able*	**Learning Outcomes** *Students will demonstrate the measurable abilities*	**Standards** *Students will address*	
IO1: **IO1: to categorize** environmental data	**LO1a. to identify** relevant environmental data **LO1b. to represent** relevant environmental data **LO1c: to execute** data collection	**NSES (A): SCIENCE AS INQUIRY:** **Abilities of Technological Design** **Use Appropriate Tools and Techniques to Gather, Analyze, and Interpret Data.** **Grades 5-8:** A1c **NSES (D): EARTH & SPACE SCIENCE:** **Structure of the Earth System** **Landforms and the processes that created them, water, atmosphere.** **Grades 5-8:** D1b, D1e, D1g **Earth in the Solar System** **Gravity; Sun's influence on seasons** **Grades 5-8:** D3a; D3d **NSES (F): SCIENCE IN PERSONAL & SOCIAL PERSPECTIVES:** **Personal Health** **Natural environments and environmental health.** **Grades 5-8:** F1g	***Rubrics in Teacher Guide***

5.0 Procedure

PREPARATION (~15 minutes)

A. Set up LCD Projector and computer.

B. Make copies of:

- (A) Note-taking Sheets – 1 per student
- (C) Discover Assessment Rubrics – 1 per student

STEP 1: ENGAGE (~10 minutes)
Identify need for more information about Mars.

A. Ask students to jot down responses to the Component Question, ESS 3.A

How do humans depend on Earth's resources?

Remind them to consider the needed resources for the communities they created in the REFLECT stage (Activity 1 in this lesson collection).

B. Allow students to share answers.

C. Ask students how they think the need for planetary resources would change if they moved to Mars.

STEP 2: EXPLORE (~50 minutes)
Gain information.

A. Give students *(A) Note-taking Sheets.*

Teacher Tip: Differentiation. For students who have difficulty taking notes, cut up the sections of *(B) Note-taking Sheet: Teacher Key* and allow those students to match the notes with the topic.

B. Direct them to fill out note-taking sheets as you go through the Discover PowerPoint.

C. Give students *(C) Discover Rubric* and have them check notes for accuracy and completeness.

D. Collect student work and assess using the *(C) Discover Rubric* in the Teacher Guide.

STEP 3: EXPLAIN

In this Collection, steps 3-5 will be iterative, and include Lessons 2-3 and 5-11.

STEP 4: ELABORATE (~10 minutes)

STEP 5: EVALUATE (~60 minutes)

6.0 Extensions

Add to the experience of learning about Mars by inviting a volunteer speaker from the Solar System Ambassador Network to visit your group. The Solar System Ambassadors Program is a public outreach program designed to work with motivated volunteers across the nation. These volunteers communicate the excitement of space exploration and information about recent discoveries to people in their local communities.

You can search for an ambassador in your state through the following website.
http://www2.jpl.nasa.gov/ambassador/

7.0 Evaluation/Assessment

In the Teacher Guide, use the *(C) "Discover" Rubric* as a formative and summative assessment using the NRC Framework 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/

(A) Student Handout. Note-taking Sheets (1 of 2)

Directions: Paraphrase (write in your own words) information about Mars.

Topic	Notes
Sun	
Temperature	
Seasons	
Radiation	
Atmosphere & Oxygen	
Atmospheric Pressure	

(A) Student Handout. Note-taking Sheets (2 of 2)

Topic	Notes
Water	
Soil	
Wind & Dust	
Gravity	
Landforms on Mars	

(B) Teacher Resource. Note-taking Key (1 of 2)

Topic	Notes
Sun	• ¼ amount of power from solar energy • Mars is 1½ times farther away from sun than Earth • This makes Mars colder too
Temperature	• Mars is colder than Earth. • -190 to 75 degrees F • Father from sun • Atmosphere doesn't trap warmth from sun
Seasons	• Martian seasons last 2 times as long as Earth • Martian year = 687 Earth days • Martian year = 669 sols • Sol = Martian day
Radiation	• Mars has thin atmosphere • Mars doesn't have a magnetic field • Radiation levels are twice as high on Mars • Metal conducts radiation • Hydrogen protects from radiation
Atmosphere & Oxygen	• The air of Mars is mainly carbon dioxide (95%). Only 0.1% is oxygen. • No oxygen to breathe • Earth's atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor • The atmosphere changes at different elevations
Atmospheric Pressure	• Atmosphere is thin • Only 1/100 of Earth's surface pressure • 15 lbs of pressure on Earth • 0.15 lbs of pressure on Mars

(B) Teacher Resource. Note-taking Key (2 of 2)

Topic	Notes
Water	• Little, if any, liquid water on surface now • There was probably water long ago • There is water ice below the surface of the planet
Soil	• Toxic • Hard to grow plants in Martian soil
Wind & Dust	• Mars has reddish-brown dust • Winds blow dust around • wind speed increases to 50-100 meters per second during dust storms • sometimes almost the whole planet is covered in dust storms
Gravity	• Mars has 1/3 the gravity of Earth • You could jump 3 times as high • Astronauts lose muscle and bone mass at 0 gravity • They exercise 2 hours a day • Gravity is a force that causes two objects to pull toward each other. • It keeps planets in orbit around the sun and governs the rest of the motion in the solar system. • It holds us to the earth's surface

Landforms on Mars	• Volcanoes
	• Olympus Mons is 3 X taller than 3 Everest & flat
	• Plains
	  ○ Nothing grows there
	  ○ Low and flat
	  ○ Opportunity saw its heat shield at Meridiani Planum
	• Craters
	  ○ Gusev Crater was possibly a water source
	• Canyons
	  ○ Valles Marineris is bigger than the Grand
	  ○ 2,000 miles long

(C) Teacher Resource. Discover 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 categorize environmental data

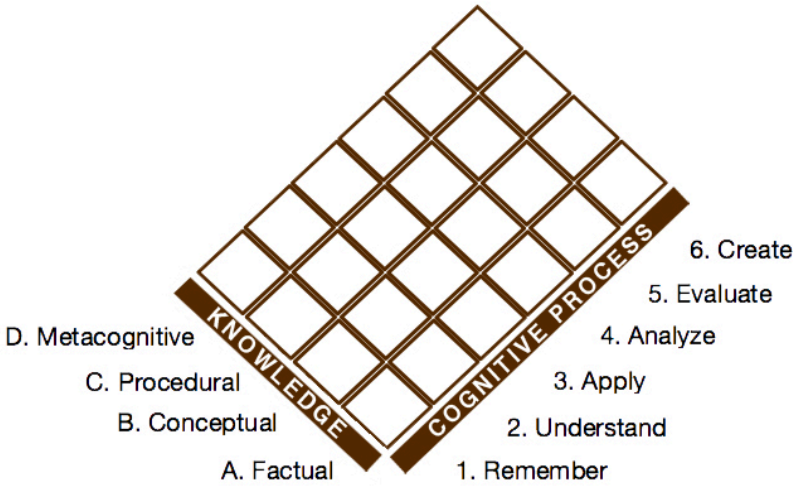
National Science Education Standards (NSES)
(A) Science as Inquiry: Use Appropriate Tools and Techniques to Gather, Analyze, and Interpret Data.
The use of tools and techniques, including mathematics, will be guided by the question asked and the investigations students design. The use of computers for the collection, summary, and display of evidence is part of this standard. Students should be able to access, gather, store, retrieve, and organize data, using hardware and software designed for these purposes. (Grades 5-8: A1c)

National Science Education Standards (NSES)
(D) Earth & Space Science:
Structure of the Earth System (landforms and the processes that created them, water, atmosphere)**; Earth in the Solar System** (gravity, sun's influence on seasons) (Grades 5-8: D3a; D3d)

National Science Education Standards (NSES)
(F) Science in Personal and Social Perspectives: Personal Health
Natural environments may contain substances (for example, radon and lead) that are harmful to human beings. Maintaining environmental health involves establishing or monitoring quality standards related to use of soil, water, and air. (Grades 5-8: F1g).

Learning Outcome	Expert	Proficient	Intermediate	Beginner
LO1a: to identify relevant environmental data	Learner always knew when key data appeared and identified it.	Learner mostly knew when key data appeared and identified it and rarely included incorrect data.	Learner often knew when key data appeared and identified it, and sometimes included incorrect data.	Learner did not often identify key data and often included incorrect data.
LO1b: to represent relevant environmental data	Information was placed in correct category with all relevant details.	Information was mostly placed in correct category with most relevant details.	Information was mostly placed in correct category with most relevant details.	Information is not represented correctly and completely.
LO1c: to execute data collection skills	Learner listened assiduously and always took notes when data appeared. Notes were extremely precise and complete.	Learner listened attentively and always took notes when data appeared. Notes were mostly precise and mostly complete.	Learner listened somewhat and often took notes when data appeared. Notes were precise and complete.	Learner did not listen carefully and often did not take notes. Notes were is not precise and not complete.

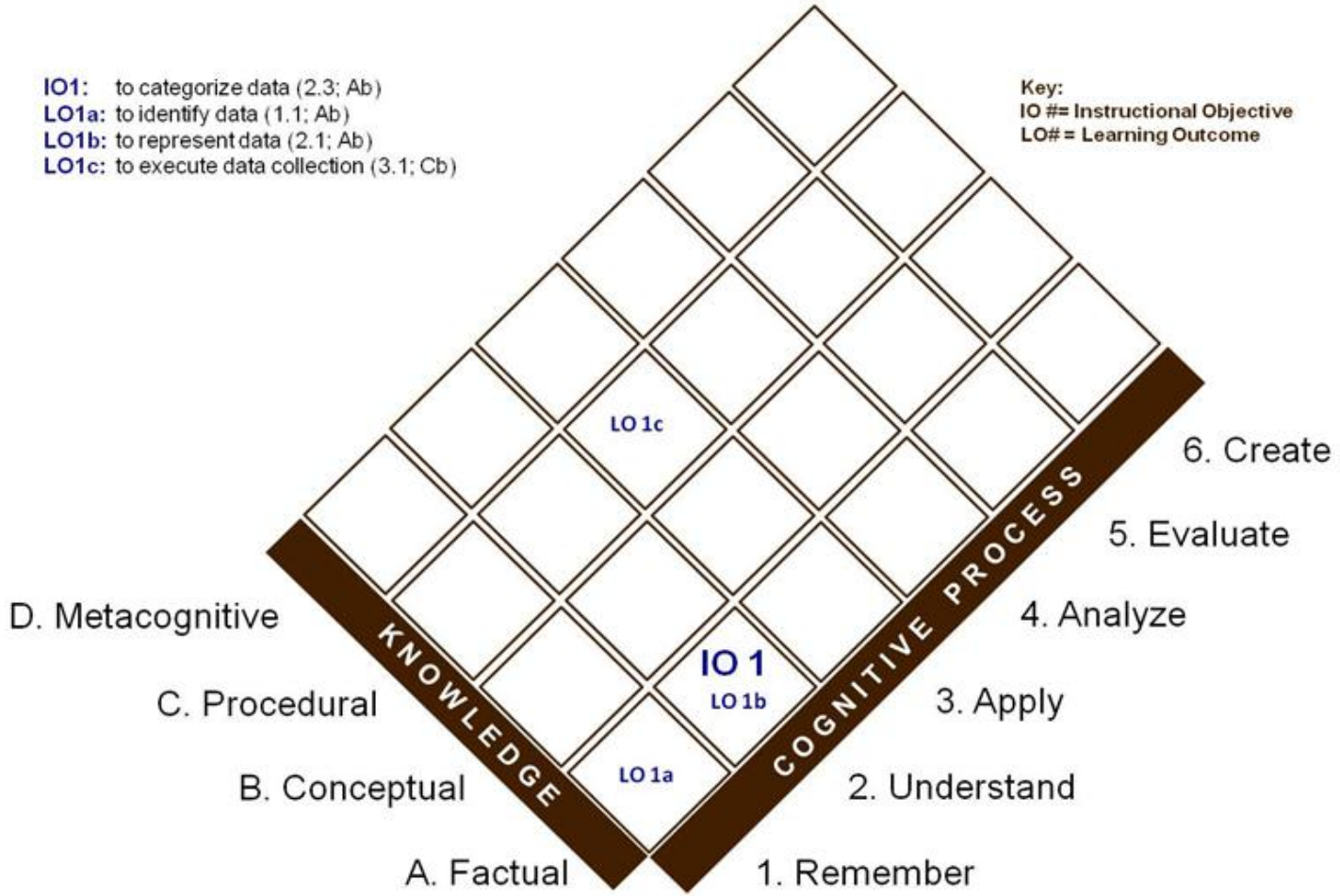
(D) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (1 of 3)



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)

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



(D) 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 (D, 1 of 3) for the full list of categories in the taxonomy from which the following were selected. The prior page (D, 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 categorize data

2.3: to categorize

Ab: knowledge of specific details and elements

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

LO1a: to identify data

1.1: to identify

Ab: knowledge of specific details and elements

LO1b: to represent data

2.1: to represent

Ab: knowledge of specific details and elements

LO1c: to execute data collection

3.1: to execute

Cb: knowledge of subject-specific techniques and methods