Documenting the Mission

Challenge Guiding Question: *How can we use experiments, models, and rehearsals here on Earth to understand other solar system objects and plan a successful mission to Icy Worlds?*

Unit Level Question: *How do we figure out where to go and what to do when planning a mission to another body in the Solar System?*

Lesson Level Question: *Why is clear written documentation so important to planning successful, long-term, complex projects?*

Lesson Summary: *First, students will consider the reasons and methods of preserving information for the future. Then, they will examine past examples of Mission Development Logs (MDLs) to get ideas for their own MDLs. Next, students will make a timeline and plan for their own MDL. Finally, students will begin their MDLs in groups and enter important mission information.*

Notes for Adapting This Lesson to Remote Learning: *Most of this lesson is readily adaptable to remote learning. Students will need to work with peers to have small- and large-group discussions. There is an option to create MDLs either in hardcopy or electronically. An electronic MDL is recommended for remote learning.*

Materials Needed

Available from NESSP Support Form	***Supplied by the Teacher***
	If making hard-copy MDLs, 1 blank notebook per group of 3-5 students. Preferably with numbered, non-tear-out pages, such as: https://smile.amazon.com/NATIONAL-Chemistry-Notebook-Narrow-Sheets/dp/B0007LTJPY/ Access to this website with example MDLs: https://nwessp.org/programs/pages/challenges/past/roads-on-mars/topteams/

Before The Lesson

- **Engage**: Have image slide deck ready
    - In Person - Display prompts on the screen or board

    - Remote - Write prompts in the chat or have students write them down on their own paper
- **Explore**:
    - Access to the website with example MDLs from previous challenges
    - In Person - Display prompts on the screen or board
    - Remote - Write prompts in the chat
- **Explain**: N/A
- **Elaborate**: Have electronic or printed copies of 'Mission Objectives' list
    - If participating in Student Challenge, have electronic or printed copies of 'Challenge Timeline' document
- **Evaluate**: Have electronic or printed copies of 'Mission Development Log'
    - If students are participating in the NESSP Student Challenge, groups should remain consistent throughout the Challenge. Consider how to group your students into teams before reaching the "Evaluate."
    - Printed MDL - 1 blank notebook per group (3-5 students)
    - Electronic MDL - Use template provided, 1 digital shared, editable copy per group (3-5 students)
- **Extend (optional)**: Have links ready for students to explore

Middle School Standards

Obtaining, Evaluating, and Communicating Information (Explore) Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s). **Engaging in Argument from Evidence (Explain)** Respectfully provide and receive critiques about one's explanations, procedures, models and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. **Obtaining, Evaluating, and Communicating Information (Elaborate/Evaluate)** Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.	The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (MS-ETS1-1) (secondary to MS-PS3-3) Models of all kinds are important for testing solutions. (MS-ETS1-4)	**Systems and System Models** Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.
<u>Other Content Standards (Math, Computer Science, ELA, 21st Century)</u> **English Language Arts (Common Core State Standards)**		

CCSS.ELA-LITERACY.SL.6.5
Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.

21st Century Skills
Work Creatively with Others
1.B.1 Develop, implement and communicate new ideas to others effectively
1.B.2 Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work
1.B.3 Demonstrate originality and inventiveness in work and understand the real world limits to adopting new ideas
1.B.4 View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small successes and frequent mistakes

Communicate Clearly
3.A.1 Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts
3.A.2 Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions
3.A.3 Use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade)
3.A.4 Utilize multiple media and technologies, and know how to judge their effectiveness a priori as well as assess their impact

High School Standards

Obtaining, Evaluating, and Communicating Information (Explore) Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. **Engaging in Argument from Evidence (Explain)** Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence and challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining what additional information is required to resolve contradictions. **Obtaining, Evaluating, and Communicating Information (Elaborate/Evaluate)** Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and	Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1)	**Systems and System Models** Systems can be designed to do specific tasks. Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

mathematically).		

Other Content Standards (Math, Computer Science, ELA, 21st Century)

English Language Arts (Common Core State Standards)
CCSS.ELA-LITERACY.SL.9-10.4
Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
CCSS.ELA-LITERACY.SL.9-10.5
Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

21st Century Skills
Work Creatively with Others
1.B.1 Develop, implement and communicate new ideas to others effectively
1.B.2 Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work
1.B.3 Demonstrate originality and inventiveness in work and understand the real world limits to adopting new ideas
1.B.4 View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small successes and frequent mistakes

Communicate Clearly
3.A.1 Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts
3.A.2 Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions
3.A.3 Use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade)
3.A.4 Utilize multiple media and technologies, and know how to judge their effectiveness a priori as well as assess their impact

Lesson Plan

Phase	Middle School	High School	Materials/Prep
Engage (30 Min)	***Students will examine a series of images to spark their thinking about the kinds of information it is important to record and various ways of recording information (writing, photos, drawings, tables, graphs, videos, etc).*** Display the images found in the file in the sidebar link. Ask students to think generally about the images. For example, they don't need to know what specific information is on the graph, just that the graph is a TYPE of information that we can record. Give students 10 minutes to discuss the following questions with a partner: ● *What kinds of information are being recorded in each picture?* ● *How is the information being recorded?* ● *Why is that information being recorded?*		Image Slide Deck

	Take a few student responses for each photo. During a project, the main reasons we write things down are so that all team members are on the same page and the client or other interested party can check on progress. After a project is over, one of the main reasons we write something down is for evidence--or proof--of what happened. For the remainder of this Unit, each team will keep a Mission Development Log, or "MDL" for short.	
Explore (60 Min)	***Students will review examples of Mission Development Logs (MDLs) from previous student challenges to evaluate various approaches to their own MDLs.*** Remind students of Mission Objective 01 (MO-01), and revisit the description of this Mission Objective. Review all Mission Objectives here? The lesson where that was done is now eliminated. *"Every mission starts with an idea, often sketched out on a scrap of paper. To make it a reality, details are added and modified through discussions with all your team members. Those discussions and decisions need to be documented. Your Mission Development Log (MDL) is the record of your mission that tells us about your activities. Document what you planned and tried, what worked and what didn't. Each team member should contribute. Your MDL can be in hard-copy format or electronic format."* Before your students start their own MDLs, they are going to examine several MDsL from a previous NASA Student Challenge mission. These are provided as examples only--not as a "how to" guide that your students should replicate exactly. Remind students to be kind with their feedback and questions about the student work they see-- though these students may not be in our class, they were kind enough to share their work with us! It is also important to understand that these students had a different set of Mission Objectives for exploring a different part of our solar system. Divide the students into groups of three to five students each. Provide students with access to the website (see sidebar link) and ask them to explore the MDL examples, with these questions in mind: Students should examine the MDL example with these reflection questions in mind: ● What different kinds of overall formats do you see in these examples? Which format do you like the best and why? ● Is the MDL organized in a way that helps you understand the contents and find what you need? What could be done to make it more organized? ● Which parts of the MDL draw your attention and which do not? What makes the interesting parts of the MDL interesting? ● If you were tasked with giving advice to these students on at least three specific things they could do to improve each MDL? (This question will be discussed in the "Explain" portion, so students may wish to take notes.) Additional prompts (if students have more time), could include: ● How well does the MDL allow you to answer the questions WHO, WHAT, WHERE, WHEN, HOW, and WHY for each Mission Objective? ● Did the team include their failures as well as their successes?	MDL Examples (link no longer available)

	• Where do you see evidence of the scientific process or practices in this MDL? • Where do you see evidence of the engineering design process in this MDL? • Which parts of the MDL are clear and which are not? What makes the clear parts of the MDL clear? What makes the unclear parts of the MDL unclear? If you have additional time for students to explore other science notebooks, see the "Extend" segment of this lesson.	
Explain (30 Min)	***Students will share their three pieces of advice for improving the MDL examples.*** After each group has had a chance to examine and discuss the MDL examples, take turns sharing their advice with the rest of the class, noting any patterns or trends they see in the advice. After all groups have shared, ask each group of students to write down reminders to themselves that start with the sentence stem: "When we are creating our MDL, our group needs to be sure to…." Have each group share one reminder with the rest of the class.	
Elaborate (30 Min)	***Students will apply what they have learned about MDLs and the mission so far to plan their mission timeline.*** For the Elaborate, provide students with the list of Mission Objectives from this year's NASA Student Challenge. If your class is participating in the Student Challenge, also provide them with a list of all key dates for the Challenge. In addition, provide any other important information regarding class schedules, the Unit outline (so they can see the order in which objectives will occur), and other dates that might impact the mission. Then, collaboratively develop a mission schedule that includes estimated dates when each mission objective will be completed. This schedule will vary widely from teacher to teacher, especially considering that some students may participate in the Student Challenge and be required to meet certain dates, while others will be freer to complete the objectives as you decide. ***A note about Checkpoint Challenges:*** The Student Challenge includes several internal "Checkpoint" challenges that have their own deadlines. Teams must submit responses to these Checkpoint challenges by the dates listed in order to be considered for Checkpoint prizes. HOWEVER, teams will still be considered for the overall prize at the end if all elements of the MDL are present, even if they were not submitted for the Checkpoint challenges.	Challenge Timeline Mission Objectives (MOs) overview
Evaluate (90 Min)	***Students teams will begin their Mission Development Logs for this project.*** At this point in the project, it is ideal if you can identify 3-5 students who will consistently work together throughout the Unit. Each group should prepare and then continuously update a Mission Development Log (MDL), either as a hard-copy book OR as an electronic repository. All team members are expected to contribute to the MDL. If students will make a hardcopy MDL: Give each group a blank notebook. If the pages of the notebook are not numbered, have the students number each page. Then, have students reserve the first three pages for a Table of Contents and begin their entries on page 4. See below for more information on what needs to be included in each entry in the Table of Contents.	**Hard copy MDL option (see 'Supplies' section for details):** https://smile.amazon.com/NATIONAL-Chemistry-Notebook-Narrow-Sheets/dp/B0007LTJPY/

	If students will make an electronic MDL: Your students can use any electronic format that works for them (Google Doc, Google Slides, Wordpress website, Google sites, etc), as long as it is organized and includes the required Table of Contents (see below). A Google Doc template is provided as a starting point (see sidebar). If you wish to use the Google Doc, make a copy of the template file (see link in sidebar) for each group, and ensure that you AND all group members have edit access. Make sure that if students are creating an electronic MDL, any linked files include "anyone can view" permission so that evaluators can see them! Regardless of which method students are using, each entry in their MDL should be have a corresponding entry in the Table of Contents with at least the following information: ● Brief title of the entry ● Date the entry was made ● Page number where the entry begins (Electronic format can include a link to the entry instead) ● **If the entry includes a final submission required by a Mission Objective (MO), include the Mission Objective number in the Table of Contents**. (Note: Mission Objectives do NOT have to appear in numerical order in the MDL.) Let students know that they have already completed important tasks that they should document in their MDLs. They will now create three entries in their MDLs (one each for Lessons 1-3). Supervise students as they enter the results of the "Evaluate" from both Lesson 1 and Lesson 2 into their MDLs and ensure that they are properly included in the MDL's Table of Contents. ● Lesson 1: A list of the class consensus answers to the "big picture" questions about this year's mission. ● Lesson 2: A copy of the Engineering Design Process Diagram with student notes about important times for internal and external communication. ● Lesson 3: A list of all the Mission Objectives and the timeline that the class developed for the project.	**Electronic MDL option:** MDL Template
Extend (Optional)	***Students will explore notebooks that past and present scientists, engineers, and designers have made.*** Give students access to one or more of these websites to explore. Consider using these resources during the "Explore" portion. https://www.pinterest.com/levy6342/notebooks-of-famous-scientists-artist-nautralists/ https://www.fastcompany.com/3056991/16-famous-designers-show-us-their-favorite-notebooks https://www.bl.uk/collection-items/leonardo-da-vinci-notebook https://www.brainpickings.org/2011/05/18/field-notes/ https://aerospaceandengineeringacademy.files.wordpress.com/2015/09/engineering-notebook-example.pdf	