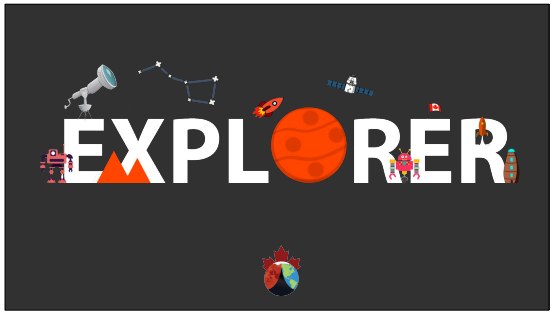


Welcome to L1 of the 'Martian Garden' project from the **Mars Explorer Program**. The purpose of this lesson is to introduce students to the challenges of growing plants on Mars and set up a scientific experiment using the scientific method to answer the question: Can food grow on Mars?

Required Resources

For this lesson, students will need access to Mars Simulant soil, vegetable seeds (lettuce, kale, wheatgrass, basil or microgreens work), something to store the soil in (clay pots work) and some type of plant food (either fertilizer pellets or liquid plant food). All required materials can be found (1 per group of students) in the Martian Garden Kit that can be ordered here.

Feedback

We rely on your feedback in order to improve projects and ensure that students are getting the best learning experience possible.
If you'd like to provide feedback on the project as a whole, or on a specific lesson, please complete this form.

Volunteer

The **Mars Explorer Program** is an open-source project developed by the Mars Society of Canada, and is operated by a team of dedicated volunteers. If you'd like to become a volunteer, please email: mars.explorer@marssociety.ca

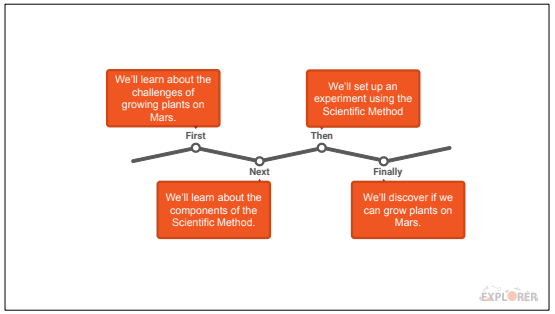
Donate or Subscribe

The **Mars Explorer Program** is open-source and provides detailed curriculum for free. This will always be the case, however if you'd like to support the project, please consider donating to the project by following this link and scrolling to the bottom of the page.

Follow

The **Mars Society of Canada** is on social media! Consider following us to stay up to date with humanity's efforts to become interplanetary!
Twitter: @canada_mars

Thank you for choosing to deliver a project from the **Mars Explorer Program**. On to Mars!

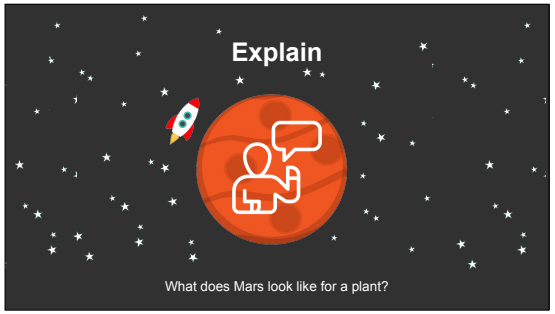


Explain what students will be learning in this lesson.

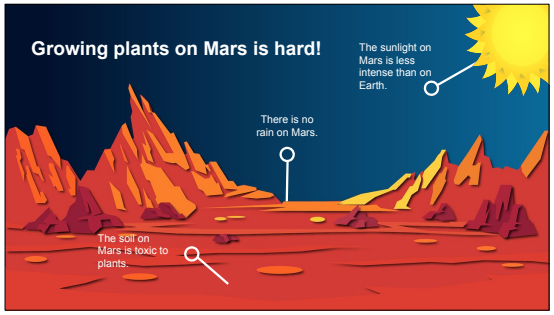
Activate tasks are designed to engage the learners in the lesson, as well as activate their prior knowledge.

?What do plants need to survive?

Check for understanding, then explain to students that traditionally, plants need 1) water (from the rain), 2) light (from the sun) and 3) nutrients (from the soil) to survive.

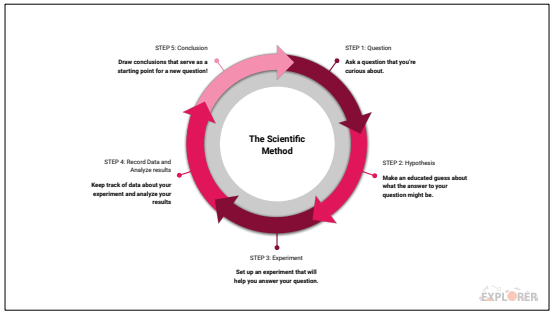


Explanation sections introduce the new learning to students. The new learning in this section is understand the challenges of growing plants on Mars, as well as introduce the scientific method.



Explain to students that Mars is difficult to grow plants on because:

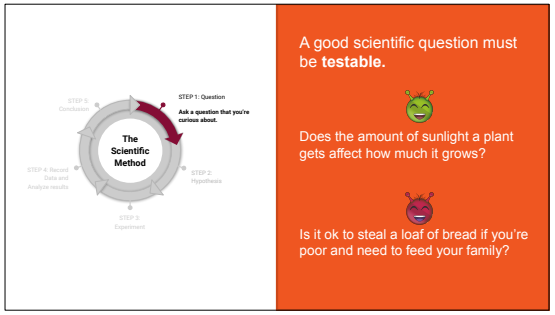
- The soil on Mars is toxic to plants. Safe to use!
- There is no rain on Mars.
- The sun on Mars is less intense than the sun on Earth (since Mars is further away from the sun).



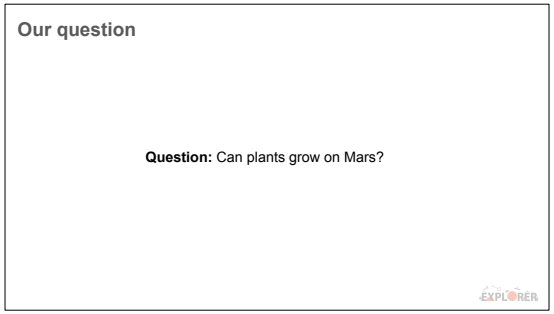
Explain to students that they are going to learn about plant growth on Mars using the scientific method. The scientific method has 5 main steps:

1) Ask a question that you're curious about.
2) Make an educated guess or prediction about what the answer to your question might be
3) Set up an experiment that will help you answer your question
4) Keep track of data about your experiment and analyze your results
5) Draw a conclusion that will serve as a starting point for a new question

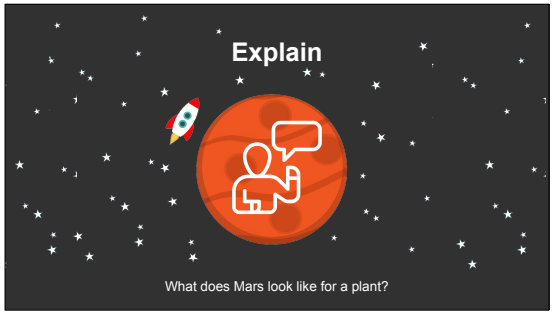
Then the process starts all over again.



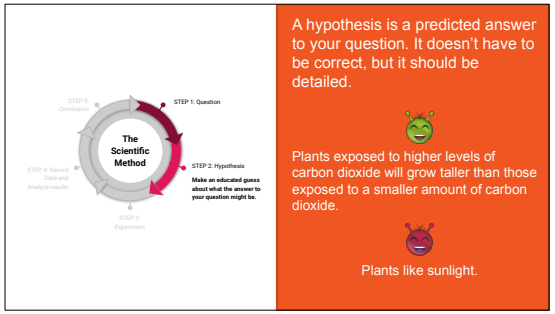
Explain to students that a good scientific question must be testable. For example: Does the amount of sunlight a plant gets affect how much it grows? A question that isn't testable isn't a scientific question, although it might still be an interesting one. For example, is it ok to steal a loaf of bread if you're poor and need to feed your family? This is a really interesting question! But it's not a question that can be answered with the scientific method.



Explain the question we're trying to answer.



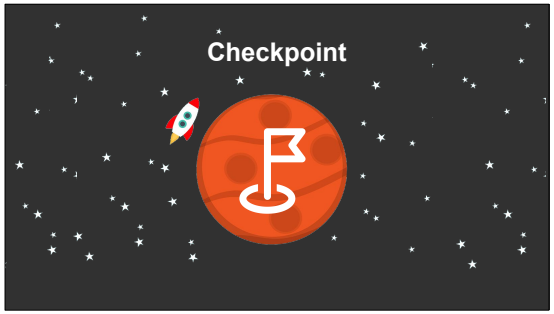
Explanation sections introduce the new learning to students. The new learning in this section is understand what makes a good scientific hypothesis.



Explain to students that a hypothesis is an educated guess or predicted answer to your scientific question. It does not need to be 'correct', but it does need to be precise in language and provable.

The first hypothesis is good because it uses precise language and is detailed enough to be valuable.

The second hypothesis is not a good hypothesis since it is not clear how you can tell what a plant 'likes'.



Checkpoints are meant to assess the learning of students. This checkpoint assesses whether students have understood what makes a good hypothesis good? And what makes a bad hypothesis bad?

Which of these are good hypotheses?

- Plants can communicate with each other through underground networks.
- If a plant is exposed to blue light instead of white light, it will grow taller and have more leaves.
- Plants grown in a room filled with positive energy will grow taller and stronger than those grown in a room with negative energy.
- If the concentration of nitrogen in soil is increased, the growth rate of tomato plants will increase.

EXPLORER

?Which of these are good scientific hypotheses?

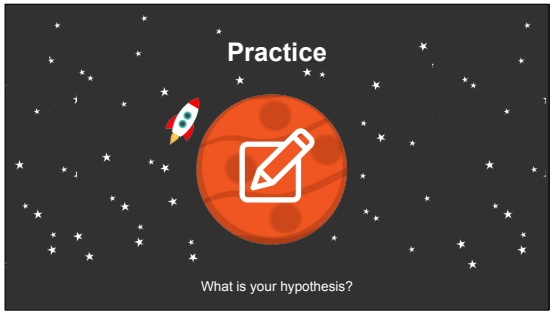
If the concentration of nitrogen in soil is increased, the growth rate of tomato plants will increase.
This hypothesis is good because it predicts a specific relationship between two variables (nitrogen concentration and tomato growth) and suggests a cause-and-effect relationship that can be tested through experimentation.

If a plant is exposed to blue light instead of white light, it will grow taller and have more leaves.
This hypothesis is good because it predicts a specific relationship between a variable (light color) and two specific outcomes (plant height and number of leaves). This hypothesis can also be tested through experimentation.

Plants can communicate with each other through underground networks.
This hypothesis is untestable because while there is some evidence to suggest that plants can share information and resources through their root systems, the idea of "communication" between plants is too vague and subjective to be empirically tested. It is also difficult to operationalize the term "communication" in a way that allows for empirical testing.

Plants grown in a room filled with positive energy will grow taller and stronger than those grown in a room with negative energy.

This hypothesis is untestable because the concepts of "positive energy" and "negative energy" are not scientifically validated. These terms are based on subjective interpretations of emotional and psychological states and cannot be measured or quantified in a way that allows for empirical testing. Additionally, the hypothesis does not propose a specific cause-and-effect relationship between a variable and an outcome, making it impossible to design an experiment to test it.



Practice tasks are designed to assess whether students have taken on board the new learning in the lesson. In this practice task, students will write their own hypothesis.

What do you predict?

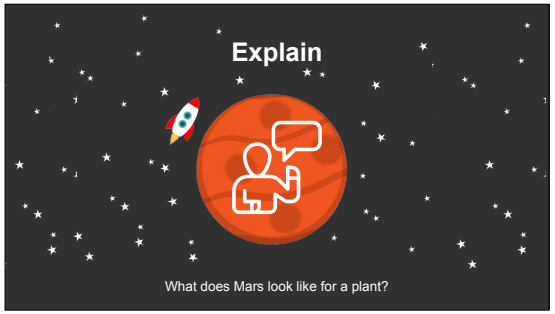
Hypothesis:
_____ will grow successfully in when planted in _____ soil and watered every _____ hours.

EXPLORER

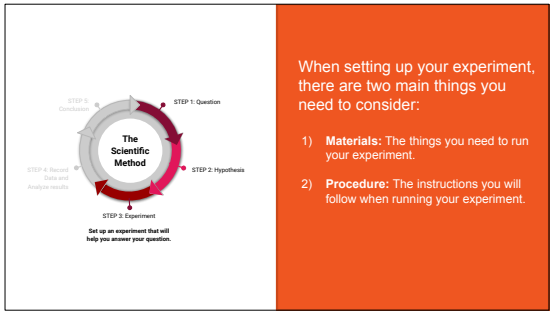
Students can use this sentence scaffold to write their hypothesis.

Make it easier:
- Complete the hypothesis together with the students

Make it harder:
- Remove the above scaffold



In this section, you will introduce the idea of materials and procedure.



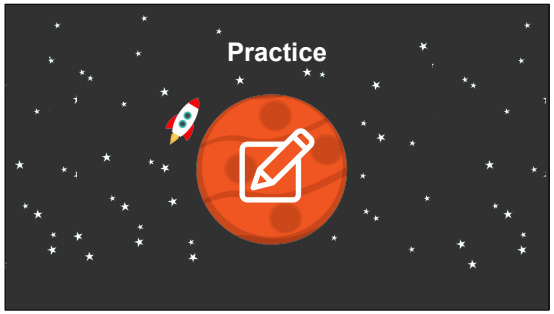
When setting up your experiment, there are two main things you need to consider:

1) **Materials:** The things you need to run your experiment.
2) **Procedure:** The instructions you will follow when running your experiment.

Explain to students that scientific experiments require materials and a procedure.

Materials are all the things needed to run the experiment.

A procedure is the set of instructions to actually run the experiment.



In this practice section, students will write their materials and procedure.

Record the materials your team is using

Materials:

- Course Mars Soil Simulant/Fine Mars Soil Simulant
- Fertilizer Pellets/Plant Food
- Lettuce/Kale/Micro Seeds
- Measuring Cup
- Automatic water pump and microbit
- Clay pot

Have students write down the materials that their group are using.

Record the procedure that your group is going to follow

Procedure:

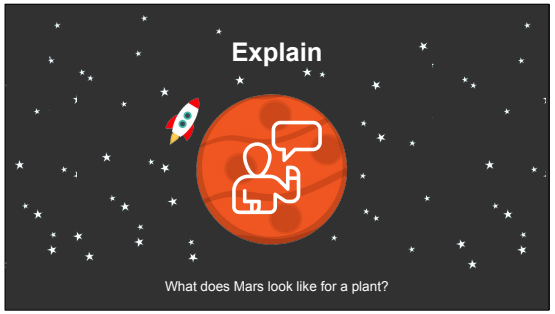
- A clay pot was filled with _____ soil
- _____ seeds were placed in the soil
- Fertilizer pellets were placed on the soil
- The plant was watered every _____ hours with hydroponic plant food.
- Observations were made over a period of _____ weeks

Have students write down the procedure they are going to follow for their experiment.

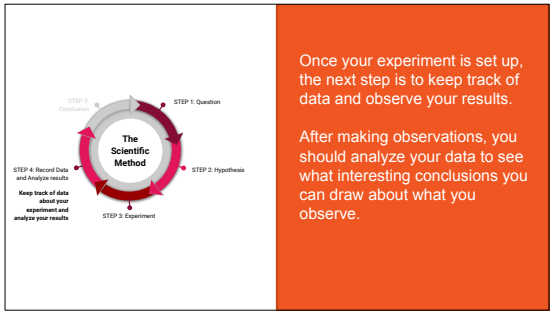
Set up your experiment

Follow the instructions set out in your procedure to set up your experiment.

Have students actually set up their experiment by following the instructions they laid out in their procedure.



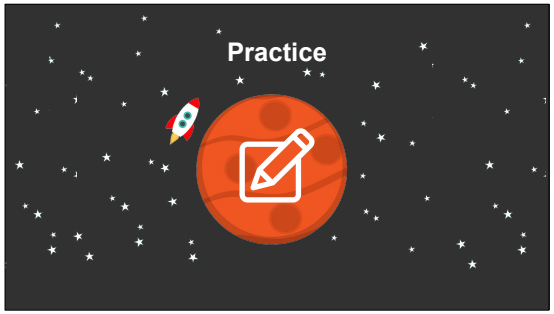
In this section, students will learn about recording observations about their plant growth. This will take place over several weeks as the plant grows.



Once your experiment is set up, the next step is to keep track of data and observe your results.

After making observations, you should analyze your data to see what interesting conclusions you can draw about what you observe.

Explain to students that scientists must make detailed observations as the experiment is conducted. In the case of this experiment, take pictures at regular intervals of the plant growth and record the results using the observation sheet located in this lesson's resources section.



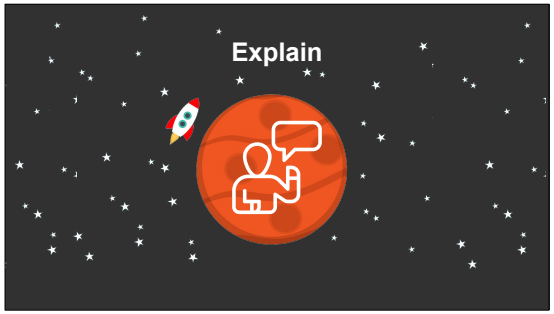
Over the span of several weeks, students will record their observations.

Making Observations

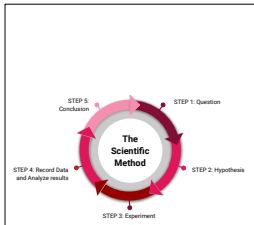
Observations:

	Image
Date: May 21, 2023 **Notes:** • No growth from the plant	
Date: **Notes:**	

Have students record their observations over several weeks.



In this section, you will explain to students what makes a good scientific conclusion.

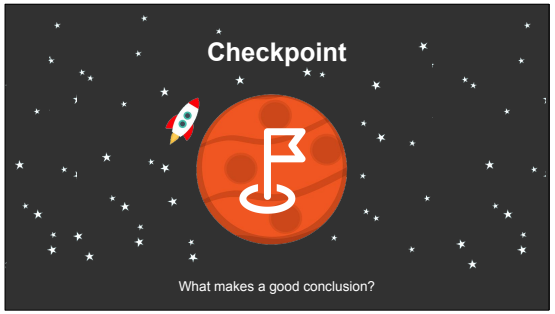


A conclusion is a statement about what you found out.

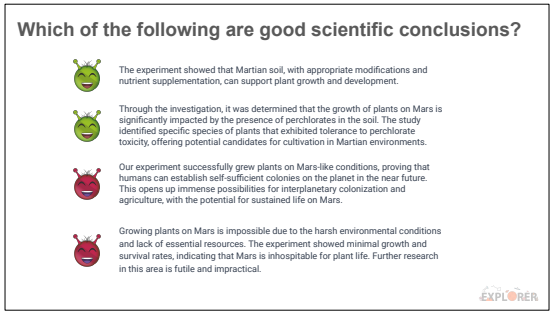
A good conclusion:
- Summarizes findings
- Answers the research question
- Provides interpretations of the data
- Provides some ideas for future experiments

Explain to students what makes a good scientific conclusion.

A good scientific conclusion:
- Summarizes findings
- Answers the research question
- Provides interpretations of the data
- Provides some ideas for future experiments



The purpose of this checkpoint is to assess whether students understand the purpose and form of a good scientific conclusion.

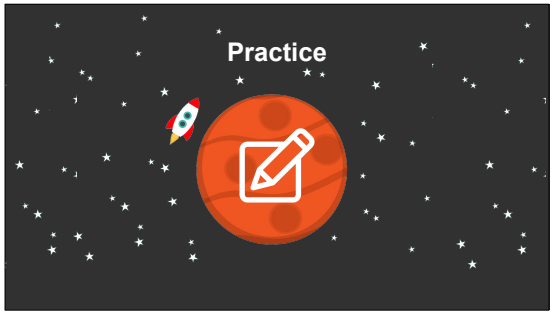


?Which of the following are good scientific conclusions?

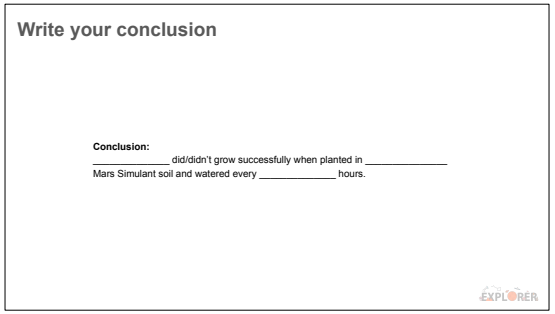
Explanations for bad conclusions:

The third conclusion is bad because it makes grandiose and unsupported claims without sufficient evidence. The experiment's success in growing plants under Mars-like conditions does not automatically imply the feasibility of establishing self-sufficient colonies or sustained life on Mars.

The fourth conclusion is bad because it makes an overly generalized statement based on limited evidence from a single experiment. While the experiment may have encountered challenges and limitations, concluding that growing plants on Mars is entirely impossible without considering potential alternative strategies or future advancements in technology is premature and unsupported.



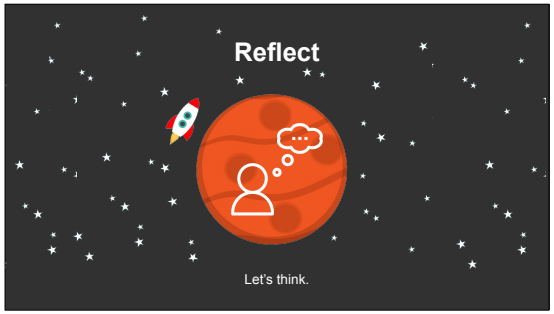
In this section, students will write their conclusion based on their observations.



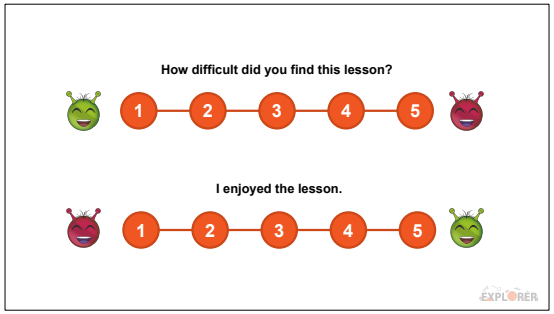
Have students write their conclusions.

Make it easier:
Use the above sentence scaffold or write the conclusion as a class/group.

Make it harder:
Remove the scaffold.
Have students include ideas for future experiments in their conclusion.
Have students interpret the data in different ways.



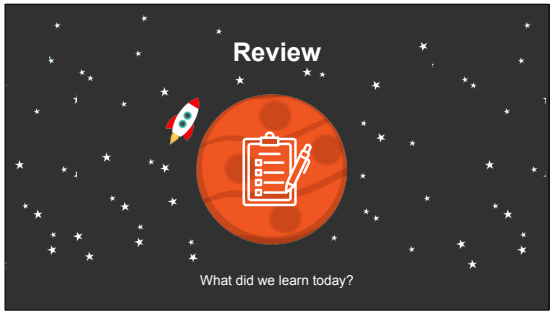
Reflection sections are designed to engage the students's meta-cognition.



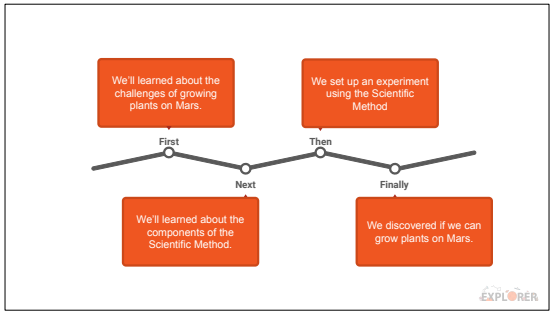
?Ask students to reflect on the difficulty and facility of the lesson.?

Each question can be rated using fingers, the alien system, or a system of your choice.

In order to further engage student meta-cognition, consider discussing particular aspects of the lesson with students depending on their answer to these questions.



Review sections are designed to review the learning journey of students throughout the lesson.



Review the learning journey with students.