**Moon Exploration Lessons (Lesson 1 of 2)**

**Moon Exploration and Artemis Missions**

**STEM Topics -** Equipment used for space exploration. Gathering or mining of resources such as water, rare earth metals, helium-3. Upcoming Artemis moon exploration missions. Using a graphical programming language to animate the movement of objects.

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**Grade Level:** 6-8 Grade

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**Goals**: Learn about future moon exploration and Artemis missions as well as natural resources that can be gathered from the moon. Learn how to program the movement or animation of a helicopter that could fly on another planet.

**Learning Objectives:**

1. SWBAT know the upcoming Artemis moon exploration missions and the components that make them up.
2. SWBAT know the resources we can obtain from the moon for life support, energy and materials purposes.
3. SWBAT make a simple computer program that controls the movement of a helicopter using the graphical SCRATCH programming language.

**Materials:**

Videos :

1. Apollo 11 : One small step on the moon for all mankind -

<https://www.youtube.com/watch?v=w4wx_3XOrns> – 2 min 24 s

2. NASA’s 2024 Artemis moon landing mission explained –

<https://www.youtube.com/watch?v=B2lA3Uu29KI> - 6 min 18 s

1. Artemis announcement : NASA selects human landing systems –

<https://www.youtube.com/watch?v=dlHJAKIaALg> - 2 min 14 s

1. Dynetics human landing system

<https://www.youtube.com/watch?v=GFBeVQ3STZ0> - 1 min 34 s

1. See the Blue Origin team’s Artemis human landing system in new animation –

<https://www.youtube.com/watch?v=OLeWbRdW6rY> - 1 min 46 s

1. Mining the Moon –

<https://www.youtube.com/watch?v=n9EMcyfGMDA&feature=emb_logo> – 6 min 35 s

Power points:

Lunar Exploration and Missions Lesson.pptx

Helicopter Game.pptx

Documents:

Lunar Exploration Colonization Matching.doc

Lunar Exploration Matching Pieces.doc

Lunar Exploration Answer Key.doc

Code for Helicopter Animation Program.doc

Web sites and Resources

Scratch programming website account creation – <https://scratch.mit.edu/join>

JPL Instructions for coding a Mars Helicopter game - <https://www.jpl.nasa.gov/edu/learn/project/code-a-mars-helicopter-video-game/> -

Materials (Alternative or optional):

Scissors for each student

Hard copies of the documents above

Glue stick for each student

**Vocabulary:**

**Artemis Exploration Missions:** NASA funded future missions to the moon meant to explore water resources on the surface and establish a small lunar colony for a continued presence on the moon. Consists of 9 missions dating from 2021 – 2029.

**Orion Spacecraft –** The main spacecraft used by NASA to transport astronauts from Earth to the moon, the Gateway space station and back to Earth again. It has enough room for about 4 astronauts. There will be at least six different constructions of Orion because it is partially destroyed once it comes back to Earth from a mission.

**Gateway Space Station:** A smaller sized space station for about 4-5 astronauts that will orbit the moon allowing them to transport and execute exploration missions to the lunar surface. It has its own life support system, habitation module and docking ports for cargo ships and the Orion spacecraft. It is the future launching pad for further deep space exploration missions such as travel to Mars.

**Human Landing Systems:** Spacecraft built by private contractors meant to transport supplies, equipment and astronauts to the lunar surface from Earth or the space station during missions. Three different kinds of systems will be built by Dynetics, Space X and Blue Origin National Team.

**Helium-3 –** A substance found within the lunar soil (regolith) that can be mined and utilized to create power from nuclear fusion.

**Regolith –** The layer of unconsolidated rocky material covering bedrock that is present on Earth, the Moon, Mars, some asteroids, and other terrestrial planets and moons.

**Volatiles –** Gaseous substances that are associated or contained with the lunar soil and rock samples collected from the moon. They consist of methane, carbon dioxide, ammonia and water vapor.

**Rare Earth Metals (REM): -**  A set of 17 nearly indistinguishable lustrous silvery-white soft heavy metals that tend to occur together in nature and are difficult to separate from one another.

**Nuclear Fusion -** A reaction in which two or more atomic nuclei are combined to form one or more different atomic nuclei and subatomic particles.

**Scratch programming language –** A graphical based programming language developed by MIT meant to demonstrate animation capabilities such as movement and sound with a chosen emblem.

**Setup:**

* Get all of the videos listed above ready to be viewed during the presentation of the power point lesson. These videos include **Apollo 11 : One small step on the moon for all mankind**, **NASA’s 2024 Artemis moon landing mission explained**, **Artemis announcement : NASA selects human landing systems**, **Dynetics human landing system**, **See the Blue Origin team’s Artemis human landing system in new animation** and **Mining the Moon.** They are shown at certain places within the power point presentation discussed in the Lesson Plan Procedure section.
* Have the power point file **Lunar Exploration and Missions.pptx** open for future presentation. Next have the three files **Lunar Exploration Colonization Matching.doc**, **Lunar Exploration Matching Pieces.doc**, **Lunar Exploration Answer Key.doc** ready to execute a picture matching activity that is done after the power point presentation. You can alternatively have hard copies of the above mentioned files along with scissors and glue sticks for them to do as a hands on activity if not executing the matching activity on the computer.
* Get the two websites related to the Helicopter programming activity already loaded on the computer (**Scratch programming website account creation page** and **JPL Instructions for coding a Mars Helicopter game page**). Go to the account creation page first and create your own scratch account before doing the lesson. Try to recreate the program shown in the file Code for **Helicopter Animation Program.doc** using the graphical programming blocks shown on the right of the programming console before doing the lesson as well. Also, save the recreated program project in your scratch account and demo it before. Have the power point presentation file **Helicopter Game.pptx** ready for presentation (you may also want to modify the file if you want for easier introduction and presentation of the scratch project they will do). Also load the file **Code for Helicopter Animation Program.doc** to show what the code of the program looks like and what they will replicate or do themselves as an activity.

**Lesson Plan Procedure**

1. Begin the lesson by discussing our past history of going to the moon with the Apollo missions in 1969 – 1972. Then show the video **Apollo 11 : One small step on the moon for all mankind.** Afterwards open up the power point file **Lunar Exploration and Missions.pptx**. On the first slide make sure to talk about the first and main goal of the Artemis missions are to land the first woman and also another man on the moon by 2024. Then discuss the history and future plans of the Artemis missions as mentioned by NASA. You will also want to mention our purpose of going to the south pole to explore the reserves of water/ice in that area and that those colored areas are the estimated deposits. Part of this exploration also involves finding suitable locations for human settlement or future small scientific colony. At the end of this slide show the video **NASA’s 2024 Artemis moon landing mission explained** and review some of the highlights of the mission from the video. [15 minutes].

2. On the next slide discuss the tools that astronauts use to collect moon rock and soil samples (rakes, tongs, hammers). Also mention that the tools must be designed so that they can be gripped properly by the astronauts and withstand the cold temperatures in space. The samples must be contained and stored right away to preserve the volatiles and ice/rock. Volatiles are the gases such as methane, carbon dioxide, ammonia and water vapor. The next slide talks about the Gateway space station. Mention it is the outpost used to coordinate the missions to the moon by housing the astronauts, keeping supplies and equipment and transporting all of them back and forth to the moon. The space station has a small habitation module and life support system that allows around 4 astronauts to live there. It also has docking ports for spacecraft and the Orion spacecraft. The Orion spacecraft is the main craft for the missions that transports astronauts from Earth to the moon and back to Earth again. Cargo spacecraft come once every several months to drop off supplies. We will use the Gateway station as a platform to launch future deep space missions to places like Mars. Human landing systems are a big part of the mission and may go from Earth to the moon or maybe back and forth from the space station. Next show the video **Artemis announcement : NASA selects human landing systems** at the end of the slide. [8 minutes].

3. Next go to the slide for Human Landing Systems. Mention that the HLS transport the astronauts, food, tools, equipment and samples to and from the moon. They can dock with the Gateway or in space with Orion. There are three different designs made by three sets of companies as shown in the slide. Show the two videos **Dynetics human landing system** and **See the Blue Origin team’s Artemis human landing system in new animation** and discuss for a few minutes the different HLS designs and purposes as shown in the three pictures below. Next go to the Lunar Outpost slide. You would want to mention that the Artemis mission has the goal of having a small moon colony in 2028. This will be made up of mainly astronauts that are scientists. It may be a place where they could further test & examine the soil and volatiles samples (maybe using a glove box). Our goal in the end is to have a sustainable exploration program with continued scientific research with the end of extracting resources from the moon. Having a presence on the moon is like a person starting out in the workforce, there are temporary, contract and permanent jobs that correlate to the carefulness (your dress) and amount of time you can stay (at your job - ~ time on the moon). The next slide talks about plans for future moon colonies. The main reason we would have colonies would be for the mining of resources. The resources would be water, rare earth metals and helium-3. Make sure to cover the purposes of having each as shown on the picture caption. Also talk about the importance of having 3D printed habitats. They are planning on using the regolith of the moon with 3D printers to make habitats. Robots would mainly do the mining work on the moon and not people. We may have more orbiters find suitable places for us to live. There are the Cubesats that could do this (maybe talk about those too). There is an organization called the Moon Village Association that wants to be involved in the development of sustainable projects that give us an economic presence on the moon (maybe do some further research on them before discussing). The last picture shows the importance of obtaining water from the moon. It is the most important resource you can get from the moon for those reasons listed below. The next slide discusses Helium-3. Mention what an isotope and what nuclear fusion is using the pictures and how it is different than nuclear fission. Its advantages over nuclear fission (clean, non-radioactive). Discuss how it gets deposited on the moon and why it isn’t on the Earth. How much is estimated to be on the moon and how much energy it could provide and the monetary worth of it. After this last slide show the video **Mining the Moon**. [20 minutes]

4. The next part of the lesson is executing a picture matching activity that helps to summarize the Artemis mission and moon colony/mining operations. This is made up of three files. The students use the **Lunar Exploration Colonization Matching.doc** as the template where you put the pictures from the **Lunar Exploration Matching Pieces.doc** into it. The template also has spaces for the descriptions or labels for the pictures. The pictures and labels consist of the launching system, Orion spacecraft, Gateway outpost, Artemis Exploration mission, Human landing system, Lunar colony and Mining operation. Have either hard copies of both the template and matching pieces along with scissors and glue sticks if you are not doing the activity over the internet or want to do this as an alternative method. If doing the activity over the internet have the students copy and paste the pictures and labels into the blank spaces in the template, they should be able to fit within the spaces. Or have the students cut out the labels and pictures and glue them into the blank spaces on the template. After they are done review the answers using the **Lunar Exploration Answer Key.doc** [35 minutes]

5. Start this part of the lesson explaining that you have programmed a small helicopter to move and say things using keystrokes. Open up your scratch account and demonstrate the program you wrote for the helicopter animation showing the actions that all the keystrokes do. Then open up the power point file **Helicopter Game.pptx** and discuss what the keystrokes do given the descriptions in the file. The second slide shows the logic piece that they will use the most in their program, which is the IF-THEN block. Talk about the IF-THEN logic piece and give some examples of it. Then next show the file **Code for Helicopter Animation Program.doc** to give the students an idea of what they will need to compose for their program. Show the IF-THEN pieces and describe how they work with certain actions. Show the action pieces on the left hand side of the coding window. Then give them the choice of making up a scratch program on their own or replicating the same program that was shown to them earlier. Next, go to the **JPL Instructions for coding a Mars Helicopter game** and follow them but before following the first set of instructions open up the **Scratch programming website account creation** page and demonstrate how to make an account. Find out if any of the students want to create their own account and help them through the process. Next open up a project and go to the coding window and follow the rest of the instructions on the JPL instructions page. This should allow one to download the helicopter image and place it in the animation window. After following the instructions have the students start putting pieces together by asking them what they want to do or telling them an action you want them to do. Put all the pieces together and then test/demonstrate the program. You may also alternatively want one of the students to take charge on zoom and coordinate the program activities with the other students. [45 minutes]