STEAM Tales

Lesson plans

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Samantha Cristoforetti's biography

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Samantha Cristoforetti was born in Milan, Italy on April 26, 1977. She grew up in Malè, in Val di Sole, Trentino-Alto Adige, where she attended local schools. From a young age, she showed a strong interest in space and aviation, inspired by science fiction books and stargazing. After earning her scientific high school diploma in Trento, she decided to pursue studies in aerospace engineering. She graduated in Mechanical Engineering from the Technical University of Munich, specialising in aerospace propulsion and lightweight structures. She then joined the Italian Air Force Academy in Pozzuoli, becoming a military pilot and gaining experience on various aircraft.

In 2009, she was selected as an astronaut by the European Space Agency (ESA), becoming the first Italian woman to be part of ESA crews. She has participated in two space missions: the first in 2014-2015 with the Futura mission, during which she set the European record for the longest single spaceflight with 199 days; the second in 2022 with the Minerva mission, during which she became the first European woman to serve as commander of the International Space Station. Among her many honours, she was awarded the title of Commander of the Order of Merit of the Italian Republic.

Samantha Cristoforetti is married to a French engineer, Lionel Ferra. She is a mom of two children, a girl born in 2016 and a boy born in 2021. She can speak Italian, English, German, French, Russian, and Chinese.

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Lesson plan 1

Exploring the Solar System **Keywords: Solar system, Sun, planets**	
Duration: 50 min	**Age:** from 6 to 9 years old
Place: Classroom	**Related STEAM areas:** **S** (Science): Children are introduced to the Solar System, and the planets in our Solar System, and they experiment creatively with the principle of displacement.
Description	In this experiment, children will explore the Solar System, learning about the different planets and their characteristics. They will also explore the principle of displacement, helping them understand how objects can displace liquid when submerged.
Learning objectives	At the end of this experiment, children will be able to: • Identify the planets in the Solar System, their main characteristics and their relative positions to the Sun.

	• Understand the principle of displacement by observing how the water is pushed aside by the jar, creating a visible space under the water.
Connection to the female role model	This experiment is inspired by Samantha's journeys into space and her awe-inspiring observations of the ink-black, starry cosmos and the ocean-blue planet Earth. During this activity, children will have the opportunity to observe a model of the Solar System on their desks, mimicking the view of space from the International Space Station (ISS).
Individual or group	Individual or in groups.
Safety	This experiment is safe to perform. Make sure to use a non-toxic black colour. Consider protective clothing or covers to avoid stains.
Materials	☐ A clear glass plate/baking dish/container ☐ A glass or a plastic bottle of water (approx. 350 ml of water to cover the whole bottom of the glass dish) ☐ Black ink, tempera or food colouring ☐ A clear glass jar (small size, 150 – 250 ml) ☐ A paper and colours ☐ Alternatively, a sheet of paper with a printed solar system on it (see attachment 1)

<table>
<tr><td></td><td>☐ Checklist of planets in the Solar system (see attachment 2)</td></tr>
<tr><td colspan="2">Lesson plan</td></tr>
<tr><td>Introduction

(10 min)</td><td>Have you ever looked up at the night sky and wondered what lies beyond the twinkling stars? Imagine you could travel into space, just like Samantha did during her missions to the International Space Station (ISS)!

Today, we’re going to take our own journey through space and explore our Solar System. While Samantha couldn’t see all the planets from space because they are too far to be clearly visible from Earth's orbit, we can mimic a path that takes us to the edge of the Solar System, searching for planets in the dark expanse of the cosmos. We’ll learn about each planet, their sizes, and their positions relative to the Sun.

Teachers can start by talking with children about the Solar System. Ask questions and let them share their knowledge:
What do you know about the Solar System?
Can you name the planets in it?
What do you know about the planets?</td></tr>
</table>

Research question/hypothesis (5 min)	Set the research question: **How can we do it to see the planets clearly through the black opaque liquid? Do you have any ideas?** Let children discuss how they can do it before asking the following questions: • How can we use our empty glass jar to reveal what is underneath the liquid? • Do you know what happens when you push the jar into water until it touches the bottom? Let's get ready to explore space and have some fun with science!
Step-by-step instructions (25 min)	**Before the experiment**, the teacher should prepare the checklist with the planets. **Step 1: Setting** ➢ Distribute the checklist with the planets to each child (attachment 2) and review the planets in the Solar System with them. ➢ Children will place the paper with the planets of the solar system and the sun on it on a desk (attachment 1). ➢ Children will take a clear glass plate or a glass

baking dish and place it on top of the paper. The container must be at least as large as the paper underneath to ensure all the planets are covered.

Step 2: Mix the colour

In a glass, children will mix water with black colour to create a very dark, opaque liquid. Alternatively, they can mix the water with the black colour directly in a plastic bottle to avoid spills. Next, children will pour this liquid into the glass dish on the desk. The liquid should cover the entire bottom of the dish, reaching a height of roughly 2-3 cm.

Step 3: Set the lens

- Children will take an empty glass jar and gently submerge it into the inky water, with the opening facing downwards. As you lower the jar, the black, inky water will be displaced by the air inside, allowing you to see the paper beneath the glass.
- Explain to the children that the water is pushed aside to make space for the jar, which is why they can now see what's underneath (this demonstrates the principle of displacement).

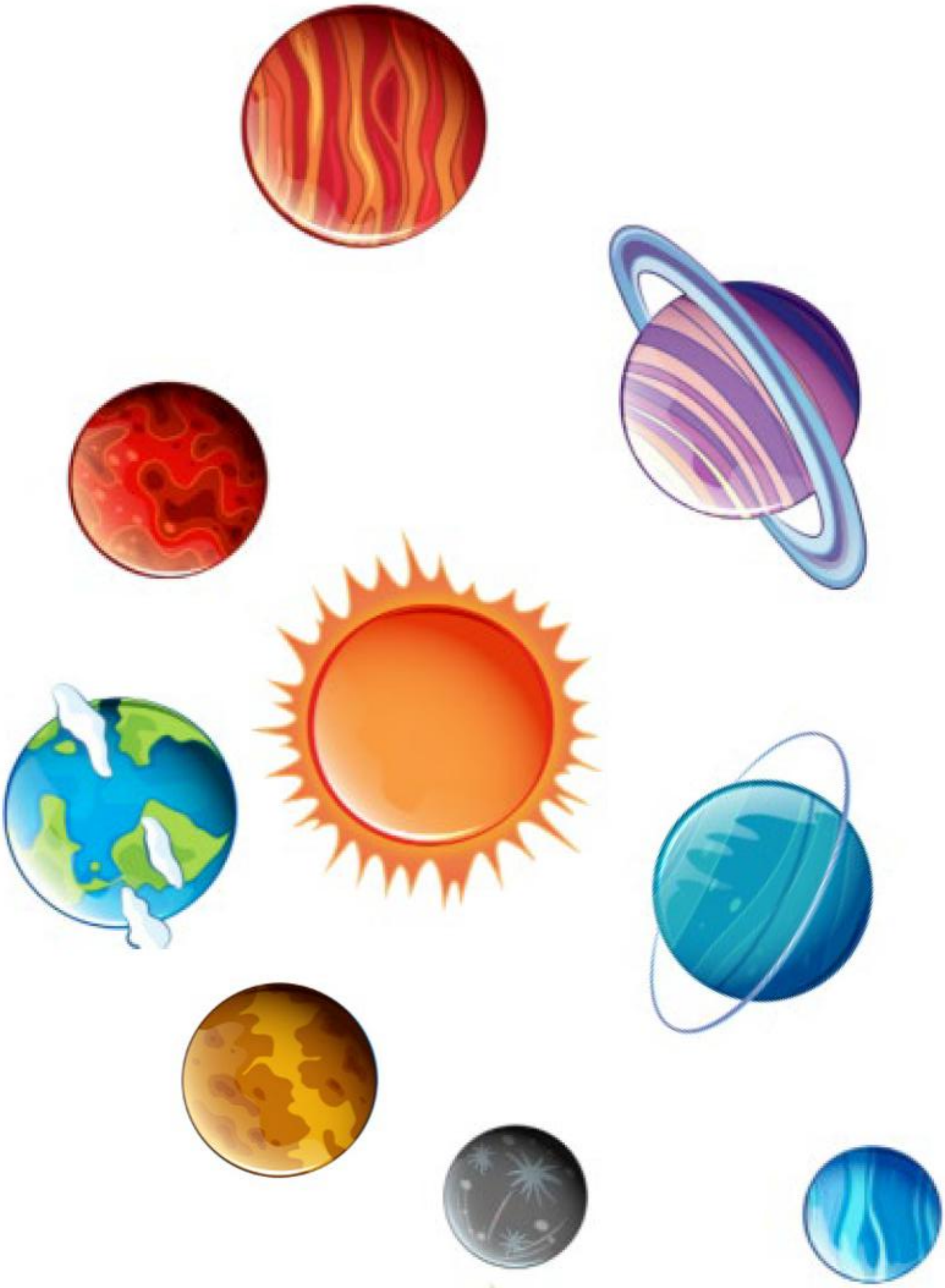
Step 4: Find the planets

	➢ By moving the glass tightly against the bottom of the container, each planet will become visible one at a time. ➢ Ask the children to find each planet of the Solar System in the order of proximity to the Sun. You can also vary the assignment by asking: • Find the planet closest to the Sun. • Find the planet closest to Earth. • Find the most distant planet from the Sun. • Find the planet with the most moons. • Find the hottest planet.
Source	Video and pictures with steps: "SIMPLE Water Planets GAME for kids" by A TOY DAY
Conclusion (5 min)	Children will consult the checklist to make sure they have found and checked off each planet they visualise. Using the checklist, they will also learn some facts and curiosities about each planet in our Solar System. Discuss the children's answers to the research question: **How could we see the planets clearly through the black opaque liquid?** When we submerged the glass jar in the dark water, the water moved aside to make space for the jar, revealing the planets underneath. This principle is called **displacement.** Displacement is when an object

	pushes liquid out of the way as it sinks or moves (see the explanation in the section "Science behind the experiment").
Explain the experiment (5 min)	In this experiment, children explored the planets of our Solar System by searching for them in a dish filled with dark, opaque water. Thanks to the principle of displacement, the planets became visible as the glass jar was submerged, allowing the water to move aside and reveal the planets beneath. By carefully moving the jar, the children uncovered each planet one by one, checked them off their checklist, and learned some basic facts about each one. This hands-on activity helped them connect a scientific concept of displacement with exploring our Solar System.
The science behind	**The Solar System**: Our Solar System is a group of celestial objects that are bound together by the Sun's gravity. The Sun is a star at the centre, and around it, eight planets travel in orbits: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. There are also moons that circle some planets, like Earth's Moon, and other space objects like asteroids and comets. **Displacement**: Displacement is when an object pushes liquid (or gas) out of the way as it sinks or moves. This

	principle helps us understand things like why boats float or why objects sink or float, depending on how much water they displace and their density. Displacement is directly connected to Archimedes' Principle, which explains how objects float in liquids or gases. Archimedes' Principle states that an object submerged in a fluid (like water) experiences an upward buoyant force equal to the weight of the fluid displaced by the object. In simple terms, when you place an object in water, it pushes the water aside (displaces it). The amount of water displaced determines how much buoyant force is acting on the object. **The buoyant force** is the upward force a fluid exerts on an object. If the object displaces enough water to equal its own weight, it will float. If it displaces less water than its weight, it will sink. This principle explains why large ships, which displace a lot of water, can float even though they are much heavier than small objects.

Attachment 1



Attachment 2

Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
							
Mercury is the closest planet to the Sun. It's also the smallest planet in the Solar System. It's very hot during the day and freezing at night. There's no air on Mercury. It has craters, like the Moon.	Venus is the hottest planet, even though it's not the closest to the Sun! Its clouds are made of poisonous gas. Venus spins the opposite way from most planets. A day on Venus is longer than a year on Earth.	Earth is the only planet where we know life exists. It has lots of water, land and air, perfect for living creatures. Earth orbits the Sun once a year. It's the third planet from the Sun. The Moon orbits Earth, and it's our closest space neighbour.	Mars is known as the "Red Planet" because of its clouds. It has the tallest volcano in the Solar system, called Olympus Mons. It's much colder than Earth. Mars used to have water, and scientists wonder if life ever existed.	Jupiter is the largest planet in our Solar system. It's a gas giant, which means it's mostly made of gas and has no solid surface. It has a giant red spot, which is actually a huge storm. Jupiter has over 75 moons!	Saturn is famous for its beautiful rings made of ice and rock. It's also a gas giant, like Jupiter, and has some wild weather. There are massive storms, some bigger than Earth, with strong winds. Saturn has at least 83 moons.	Uranus is tilted on its side, so it spins like a rolling ball! It's made of gas and ice, and it's very cold. Uranus has a light blue-green colour. Uranus has at least 27 moons and faint rings.	Neptune is the farthest planet from the sun. It's a deep blue colour and has very strong winds. Like Uranus, it's made of gas and ice. Neptune has 14 moons. It takes 165 Earth years for Neptune to go around the Sun!

Lesson plan 2

Build a rocket Keywords: Space Rocket, air pressure, motion	
Duration: 60 min	**Age:** from 6 to 9 years old
Place: Classroom and meadow	**Related STEAM areas:** **S** (Science): Children will observe how air pressure builds up and experiment with how it pushes the rocket into the air. **E** (Engineering): Children will experience some engineering principles when constructing their rocket, its body, fins, and nose design. **M** (Mathematics): When creating fins in the shape of right-angled triangles and choosing the cone shape for the nose, children will practice basic geometry concepts, such as angles, shapes, and symmetry.
Description	During this experiment, children will design, build, and launch their own rockets, simulating real space launch. Through this experiment, we will explore: - How air pressure and force make the rocket fly (Newton's Third Law of Motion).

	- How the design of the rocket (fins, body, and nose) affects its flight. - How shapes, angles, and symmetry help us create a stable rocket.
Learning objectives	At the end of this experiment, children will be able to: • Understand Newton's Third Law of Motion as they will observe how air pressure builds up and how the force exerted on the rocket creates an opposite reaction, launching it into the air. • Apply basic engineering principles by constructing their rocket, exploring how different body shapes, fins, and nose designs affect stability and flight performance. • Understand basic geometry concepts by designing fins as right-angled triangles and shaping the nose cone, practicing concepts of symmetry, angles, and spatial reasoning.
Connection to the female role model	This experiment is inspired by Samantha's journeys into space with the Soyuz spacecraft and the Crew Dragon, launched by the Falcon 9 rocket. The proposed construction is based on John Camara's Space Launch System.

Individual or group	Optional: individual or in groups.
Safety	This experiment is generally safe to perform. When launching, establish a safe launch zone. It is recommended to perform launches outdoors in an open space. Keep children at a safe distance (at least 2-3 meters) from the launch area and ensure no one stands directly in front of the rocket when launching. Also, encourage children to step on the bottle with controlled force. Do not jump on it to avoid slipping or injury.
Materials	☐ An empty plastic bottle ☐ 2 PVC pipes (approx. 30 cm long), alternatively, you can use a cardboard tube found inside a roll of plastic wrap. The diameter of the pipe needs to be slightly smaller than the bottle's neck. ☐ 90° or 45° PVC joint ☐ 2 sheets of paper ☐ Ruler ☐ Scissors ☐ Ping pong ball/table tennis ball ☐ Tape

Lesson plan	
Introduction (10 min)	Have you ever wondered how rockets blast off into space? Today, we're going to build our own rockets and launch them just like real space engineers do. Our challenge is to design, build, and test rockets to see which ones fly the highest and farthest. Let's get ready to launch!
Research question/hypothesis (5 min)	Before heading to the construction, do you think that the design of the rocket can affect its flight? Can the shape of the rocket's fins, body, and nose affect how fast, far and straight it goes? How do its shapes, angles, and symmetry help us create a stable rocket? How can we make our rocket fly without any motor? Can only air pressure and force make it blast off?
Step-by-step instructions (30 min)	**Step 1: Set the body of your rocket** • Take a PVC pipe and a sheet of paper. • Encourage children to be mindful of how tightly they wrap the paper around the pipe—if it's too loose, it might leak air, and if it's too tight, it could get stuck.

- Once you've wrapped the paper around the PVC pipe, use tape to seal it securely along the entire seam.
- Remove the pipe. You will use it again later.

Step 2: Create the fins

- Take the second sheet of paper and cut out four fins. Each fin should be in the shape of a right-angled triangle, with approximate side lengths of 10 cm, 5 cm, and 11.18 cm.
- Attach the four fins to the bottom part of the paper tube (the body of your rocket) using tape, spacing them evenly around the tube.
- These fins will help your rocket fly!

Step 3: Rounded or pointed nose?

- Now it's time to create the rocket's nose! Each child can make their own version. Later, you'll be able to observe and discuss which design worked the best.
- Start by placing a table tennis (ping pong) ball at the top of the rocket (the end opposite the fins). Secure the ping pong ball to the rocket body with tape.

- Next, you can choose to leave the nose rounded or create a pointed cone. To make a cone, take the remaining sheet of paper, cut out a circle, and then make a single cut along the radius. Fold the circle into a cone shape and secure it with tape.
- Place the cone on top of the ping pong ball and secure it with tape. You can make the cone as short or as long as you like.

Step 4: Get the testing setup ready

- Prepare the testing setup by placing a PVC pipe inside the neck of the empty plastic bottle. Insert the pipe about 2 cm into the neck and secure it in place with tape.
- Connect the first pipe to the second pipe with a 90° or 45° PVC joint.
- Thanks to the joint, you'll be able to adjust the angle you launch your rocket at.
- To ensure it won't fall over, you can secure the tube by placing it in a small paper box with a cut-out hole for the pipe and fixing it with tape.

Step 5: Launch the rocket

	Finally, it's time for the launch. Aim at your target and step firmly on the bottle to launch your rocket! **Step 6: Repetition** After each launch, the teacher should blow into the pipe to restore the original shape of the bottle (so that the next child can launch the rocket).
Source	**External video resource**: • "Make a Paper Rocket Fly! Inspired by Boeing's Space Launch System" by Technovation • "Building Avionics to go to Mars with John Camara" by Technovation **Advanced version:** • "DIY Space: Stomp Rockets – Make the Rocket (Part 1)" by NASAJPL Edu • "DIY Space: Stomp Rockets – Launch, Measure & Calculate" (Part 2) by NASAJPL Edu • "DIY Space: Build and Launch a Foam Rocket" by NASAJPL Edu
Conclusion	Now that we've launched our rockets, let's discuss what we observed.

(5 min)	We could notice that rockets with different designs flew differently. The design, shape, and symmetry of the rocket's parts affect its flight. Additionally, the strength of the stomp and the amount of air influence the speed of the launch.
Explain the experiment (5 min)	The design of the rocket affects the rocket's flight. As we saw, different designs influenced how high, far, and straight the rocket flew. Some rockets travelled further, while others wobbled or fell quickly. The way we built the rocket played a big role in its performance. Also, the shape of the rocket's fins, body, and nose affects how fast, far, and straight it goes. **Fins**: Rockets with evenly spaced and properly attached fins fly straighter. If the fins are too small or uneven, the rocket wobbles or spins unpredictably. **Nose**: Rockets with pointed noses travel further and faster because they cut through the air more easily, reducing air resistance. **Body**: If the paper tube is too loose or too tight, it affects how well air pressure builds up inside before

launch. A well-sealed body helped the rocket take off with more force.

Shape, angles, and especially perfect symmetry help create a stable rocket.

If the fins are placed unevenly, the rocket loses balance and doesn't fly straight. The angles of the fins influence how the rocket moves. Fins slightly tilted help create a more stable flight path. The pointed nose helps guide the rocket smoothly through the air, while a rounded nose creates more drag (air resistance).

Finally, how did we make our rocket fly without a motor? Can only air pressure and force make it blast off? Of course, we saw it! When we stepped on the bottle, the air inside was forced out quickly through the PVC pipe, pushing against the air inside of the rocket. In response, the rocket was propelled upwards.

This is the same principle that real rockets use, but instead of air pressure, they burn fuel to create thrust.

The science behind	**Air pressure & Newton's Third Law of Motion** When you step on the bottle, you force air through the PVC pipe and into the rocket. That air pushes against the inside of the rocket, propelling it in the opposite direction—this is Newton's Third Law: For every action, there is an equal and opposite reaction. How does this law apply to our rocket? When you step on the bottle, you push the air out with force. The air rushes out through the tube, pushing downward. Other examples in everyday life: • Jumping on a trampoline: When you push down on the trampoline, it pushes you back up. • Kicking a ball: Your foot pushes the ball forward, but at the same time, the ball pushes back against your foot (though you don't move because you're heavier than the ball). **Rocket design & stability** A well-sealed body prevents air from escaping, giving the rocket a stronger push. The fins help keep the rocket stable so it doesn't spin out of control. The nose shape can affect how smoothly

	the rocket moves through the air: pointed noses may reduce air resistance.

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