STEAM Tales

Lesson plans

Zita Martins

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Zita Martins's biography

Zita Martins holding an iron meteorite (Source: MIT Portugal Program)

Zita Carla Torrão Pinto Martins was born in 1979 in Lisbon and she has two siblings, a brother and a sister. In her childhood, she was passionate about the Universe and as an adult, she became an Astrobiologist and Cosmochemistry Scientist. She works in the Centre for Structural Chemistry at the Institute of Technical Sciences of the University of Lisbon and she is a co-investigator on two European Space Agency missions. Her research explores how life may have begun on Earth by looking for organic compounds in meteorite samples. Zita Martins has been a pioneer in the field of Astrobiology in Portugal, allowing many dreamers of the Universe to pursue their dream with her help.

Currently, she lives in Lisbon and is in her 40s.

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Lesson plan 1

Find a meteorite Keywords: asteroid, meteoroid, meteorite, space dust, magnetism	
Duration: 65 min	**Age:** from 6 to 9 years old
Place: Classroom, outdoors	**Related STEAM areas**: **S (Science):** Understanding meteorites, asteroids, meteoroids, and comets, learning about space dust and its impact on Earth, and concepts of magnetism. Geology: examination and analysis of collected dust particles.
Description	During this experiment, children will be able to understand basics of astronomy and physics concepts such as magnetism, micrometeorites and their fall from the Universe to the Earth, and children will be able to find a meteorite in the schoolyard.
Learning objectives	At the end of this experiment, children will be able to: • Explain in their own words about the micrometeorites. • Perform a simple demonstration showing how a

	magnet works. • Describe how magnets attract some metallic objects (like iron).
Connection to the female role model	This experiment was inspired by Zita's work. Zita Martins is an astrobiologist who works with meteorite samples that fall to Earth and analyses those samples. It will help children understand how micrometeorites are present in many places and represent material that came from the Universe.
Individual or group	Individuals or small groups of 3 children or less.
Safety	This experiment is safe to perform.
Materials	❑ Strong magnet (more if possible so each child can try it) ❑ Transparent plastic bags (1 per each magnet) ❑ Magnifying glass (more if possible so each child can try it) ❑ Small plastic container or cup (1 per magnet) ❑ 2 Glasses or vessels ❑ Liquid soap ❑ Water ❑ Paper towel ❑ Sieve ❑ Test tub

	❑ Microscope (optional)
Lesson plan	
Introduction (10 min)	Begin with a question to spark the children's curiosity: **"What do you know about the Universe?"** Let the children talk about it and maybe list what they know can be found in Universe (Moon, planets, stars, Sun, asteroids, etc.) **"Do you know something from Universe that falls on Earth? Do you think pieces from the Universe can be found in your country or town? What about in your schoolyard?"** Imagine a piece of space dust travelling through the Solar System until it reaches the Earth and falls into a place where it is available for us to admire, touch and learn about the Universe. Imagine you have a piece of space dust that has been in the Universe and now you have found it in your playground and it is in your hands. Briefly remember Zita Martins' first fieldwork, collecting samples and space dust from pieces of the Universe that fell to Earth. Refer also to her daily work of analysing these samples of pieces of the Universe to see their properties, aspect and characteristics.

Research question/hypothesis (5 min)	Ask: “How can we find dust particles from the Universe in the schoolyard?” Explain to children that this will be our question for this experiment and that these kinds of questions are called research questions and are used all the time by scientists like Zita. Children should be encouraged to give their answers even the wrong ones. All opinions should be included and not discarded right away even though the teacher knows they are not right. The experiment will serve to answer the research question, mimicking the scientific method.
Step-by-step instructions (35 min)	**Step 1: Prepare the magnet** • Take your strong magnet and place it inside a plastic bag. • Secure the bag: hold the top of the plastic bag with one hand and twist the upper part of the bag tightly to ensure the magnet stays securely inside. This twisting action will also create a handle that makes it easier to hold. • Once the bag with the magnet inside is ready, hold it by the twisted section so that the magnet is facing downward.

Step 2: Attract the space dust

- Walk around the schoolyard, holding the magnet a few millimetres above the ground.
- Move the magnet in a sweeping motion across various surfaces. Make sure to cover a range of surfaces, including grass, pathways, and playground equipment.
- As you sweep, check the magnet and the inside of the plastic bag for any collected particles.
- If the bag starts to get too dirty or full, you may need to replace it or clean it out.

Step 3: Collect the space dust

- Once you have finished collecting, carefully remove the magnet from the bag.
- Transfer the collected particles to a small container or cup to transport them safely back to the laboratory. A spoon or two of dust is enough for the experiment.

Step 4: Wash your space dust

- Prepare a glass or a vessel and pour 2-3 pumps of liquid soap and 250-350 ml of water into it.

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	• Add the collected dust. • Stir the mixture and let it sit for a few minutes until the dust settles at the bottom of the glass. • Once the dust has settled, pour the liquid into another vessel. The dust should remain at the bottom of the first glass. • Transfer the remaining sediment onto a paper towel, spread it and let it dry. **Step 5: Sieve the space dust** • Use a sieve to sift the dried sediment to remove large pieces of dust. • Transfer the sediment that passed through the sieve (the smallest particles) into a test tube to examine if the cleaned sediment is cosmic dust. **Step 6: Examine the space dust** • Use a magnifying glass to observe the tiny particles of space dust. • If you have a microscope, children can observe the microscopic structure of meteorites that have travelled to our planet.
Source	"How To Find a Meteorite (In Your Garden!)" by BBC Earth Kids

Conclusion (5 min)	Encourage children to think about where all those particles might come from. How far away might they have travelled? Could it be from really far away? How old might these particles be? Let children explore and discuss these possibilities and their implications. Not all of the magnetic particles extracted from the collected dust originate from space, but some of them might—which is quite exciting! To determine if the material is truly from space, scientists use powerful microscopes.
Explain the experiment (5 min)	14 tons of space dust/micrometeorites fall to Earth every day. The micrometeorites come from iron-rich asteroids in the Asteroid Belt and therefore have metal particles such as iron in their composition. Magnetism is a force that acts between objects that have magnetic properties. These objects are called magnets and have the ability to attract or repel metallic objects. The magnet makes it possible to recover magnetic particles, such as micrometeorites because of their iron composition.

The science behind	**Solar System and the Asteroid Belt**: The solar system is a collection of eight planets and their moons in orbit around a star, the Sun, together with smaller bodies in the form of asteroids, meteoroids, and comets. The planets of the solar system are (in order of distance from the sun) Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. Mercury, Venus, Earth, and Mars are the first four planets closer to the Sun and are telluric or terrestrial planets characterised by their rocky composition and solid surfaces. Jupiter, Saturn, Uranus, and Neptune are the last four planets and are gas giants' planets primarily composed of hydrogen and helium, lacking solid surfaces. Early in the life of the solar system, dust and rock circling the sun were pulled together by gravity into planets. But not all of the ingredients created new worlds. A region between Mars and Jupiter became the asteroid belt. The asteroids and comets are remnants of the planet-building process in the inner and outer solar system, respectively. The asteroid belt is home to rocky bodies ranging in size from the largest known asteroid, Ceres with a diameter of roughly 940 km, to microscopic

dust particles that are dispersed throughout the belt. Some asteroids travel in paths that cross the orbit of Earth, providing opportunities for collisions with the planet.

Meteorite: A meteorite is a fragment of spatial matter that falls to the surface of a planet. Most meteorites that fall to Earth come from the Asteroid Belt.

Meteorites are the last stage in the existence of space rocks that fall to Earth's surface. Before they were meteorites, the rocks were meteors. Before they were meteors, they were meteoroids. Meteoroids are lumps of rock or metal that orbit the sun. Meteoroids become meteors when they crash into Earth's atmosphere and the gases surrounding them briefly light up as "shooting stars." While most meteors burn up and disintegrate in the atmosphere, many of these space rocks reach Earth's surface in the form of meteorites of different sizes.

Dust-sized particles called micrometeorites make up 99% of the approximately 50 tons of space debris that falls on Earth's surface every day.

Micrometeorites are small particles of cosmic dust that enter the Earth's atmosphere at high speeds. These

	particles are usually the size of a grain of sand or smaller and are composed of materials such as silicates, carbon and iron. Micrometeorites can have various origins, including detritus from comets, asteroids and even interstellar dust. Micrometeorites play a crucial role in understanding the origin and evolution of the solar system. They provide insight into the processes that have shaped celestial bodies over billions of years and help scientists reconstruct the history of our solar system. "Astrobiology and origin of life" by Zita Martins at TEDx Talks

Lesson plan 2

Meteorite impact on Earth Keywords: meteoroid, asteroid, meteorite, impact, craters, gravity	
Duration: 70 min	**Age:** from 6 to 9 years old
Place: Classroom, outdoors	**Related STEAM areas:** **S (Science):** Children are introduced to the concept of asteroids, meteoroids and meteorites, and the impact of meteorites on Earth. They experiment with the concept of force and its relation to the size and weight of an object through the impact depth of balls.
Description	During this experiment, children will be able to understand concepts of astronomy and physics, such as force and its relation to the size and weight of an object through the impact depth of balls and relate it to meteorites impacts.
Learning objectives	At the end of this experiment, children will be able to: • Explain, in their own words, how a crater is formed. • Describe the relation between the size of the

	meteorites and the size and depth of the rater. • Compare their observations and discuss the different results.
Connection to the female role model	This experiment is inspired by Zita's work on studying the meteorite that fell in the Holland. It will help children understand how a meteorite's impact on Earth creates craters and what they look like.
Individual or group	Group activity: 6 children or fewer, each group.
Safety	This experiment is safe to perform.
Materials	❑ A large baking tray ❑ A pack of flour ❑ A pack of cocoa powder ❑ Marbles ❑ Balls of different sizes and weights such as a bouncy ball, a regular ball, a ping pong ball, a golf ball, and a tennis ball-alternatively small stones or rocks ❑ A ruler
Lesson plan	
Introduction (10 min)	Begin with a question to spark the children's curiosity: What do you know about the Universe? Do you like the Universe? Do you know that sometimes things from

	Universe can fall on Earth? Have you ever heard of something like this? Imagine a space rock travelling through the solar system until it reaches Earth and falls in a place of Earth that makes it available for us to admire and touch to discover about the universe. Imagine having a piece of rock that was in the universe and now it is in your hands. More, imagine that you can see the place where the meteorite falls and the crater it forms. Do you remember that Zita Martins, our astrobiologist, had the desire to explore a little piece of the Universe and left Portugal to go to the country where there are meteorites and craters and where she could study and analyse meteorites, a piece of rock that has travelled through space? She wanted to analyse the meteorites and their composition, and she had a lot of them in her hands.
Research question/hypothesis (5 min)	Just like Zita asks herself questions before she starts to explore, we will try to find answers to our research questions with the help of an experiment. **So, our research questions will be**: How does the use of different round objects, such as different balls and

	marbles, affect the crater? How does height and weight affect the size of the crater? (Children should be encouraged to give their answers, even the wrong ones. All opinions should be included and not discarded right away even though the teacher knows they are not right. The experiment will answer the research question, mimicking the scientific method.)
Step-by-step instructions (40 min)	**Step 1: Prepare the "soil"** • Fill a large baking tray with layers of flour and cocoa powder. These layers will mimic soil and provide a clear surface to observe crater formations. • For smaller classes (6 children or fewer), use one tray so that each child can take turns dropping a ball and measuring the results. • For larger groups (more than 6 children), consider preparing multiple trays or resetting the tray after a few ball drops by smoothing out the "soil" before starting again. **Step 2: Ball drop activity** • Each child will take turns dropping various balls.

Ensure all balls are dropped from the same height into the prepared tray.

- After each drop, the children will observe the indentations or "craters" created by the impact, which represent craters formed on Earth.

Step 3: Explore the impact

- After each ball drop, closely observe the “craters” created by each marble and ball.
- Discuss the differences in the size and depth of the craters.
- Ask the children: "Which ball made a bigger impression?" and "Which one created a deeper impact?"

Step 4: Measure the craters

- The children will measure the diameter and depth of each crater using a transparent plastic ruler for precision.

Step 5: Discuss impact differences

- Guide the children in comparing the impressions left by the various balls, focusing on how the size, volume, and weight of the balls influence

	the resulting craters. • Encourage the children to predict what will happen before each different ball and marble is dropped and compare their observations after each impact. • Compare also the craters formed by the same ball or marble but from different heights.
Source	"Asteroid Impact Experiments" by Down 2ª Science "DIY Space: How to Make a Crater" by NASA-JPL Edu
Conclusion (5 min)	Check the research question/hypothesis. Explain to children how differences in size, volume, weight, and height affect the craters. The size, volume, and weight of the balls will influence the resulting crater.
Explain the experiment (5 min)	Use the specific examples to highlight the relationship between weight, volume, and size: 1. Bouncy Ball vs. Golf Ball: Although the balls are similar in weight, the bouncy ball's volume and size are greater than those of the golf ball, so the crater will be wider. Regular Ball vs Pig Pong Ball: Both balls may be similar in weight, however, the regular ball's

	volume and size are greater than those of the ping pong ball, so the crater will be wider. In conclusion, the volume and size of the balls will directly influence the width of the crater. In the real world, this means that the bigger the meteorite, the larger the crater formed. 2. Marble vs. Golf Ball: Although both may be similar in size, the heavier golf ball will leave a more substantial crater. Ping Pong Ball vs. Golf Ball: These balls are similar in size and volume but differ greatly in weight. Concluding, the weight of the ball will directly affect the size and depth of the crater. In the real world, this means that the heavier the meteorite, the deeper the crater formed. **Considering this, we can observe and explain that the weight and size of the meteorite will affect the depth and width of the crater.** Use the specific examples to highlight the relationship between different heights: 1. The higher the ball is dropped, the wider and deeper the crater will be, as the velocity

	increases as it descends. Concluding, the height of the ball will directly influence the size and depth of the crater. **Considering this, we can observe and explain that the height of the meteorite's fall will affect the depth and width of the crater.**
The science behind	**Solar system and the Asteroid Belt:** The solar system is a collection of eight planets and their moons in orbit around a star, the Sun, together with smaller bodies in the form of asteroids, meteoroids, and comets. The planets of the solar system are (in order of distance from the sun) Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. Mercury, Venus, Earth, and Mars are the first four planets closer to the Sun and are telluric or terrestrial planets characterized by their rocky composition and solid surfaces. Jupiter, Saturn, Uranus, and Neptune are the last four planets and are gas giants' planets primarily composed of hydrogen and helium, lacking solid surfaces. Early in the life of the solar system, dust and rock circling the sun were pulled together by gravity into planets. But not all of the ingredients created new

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Meteorite impact and formation of craters: Craters are round, bowl-shaped depressions surrounded by a ring; and are made when a meteorite collides with a planet or a moon. The craters are what make our moon look like Swiss cheese. Each round hole is the place where a meteorite impacted, or hit, the surface of the moon, so craters are often called impact craters.

Meteorites crash through Earth's atmosphere with tremendous force. The largest meteorites leave enormous holes in the ground called impact craters. The best-preserved impact crater in the world is the Barringer Meteorite Crater, near the U.S. town of Winslow, Arizona. There, more than 50,000 years ago, a meteorite weighing about 300,000 tons slammed into Earth. The impact blasted a hole one kilometre wide and about 230 meters deep. More than a hundred impact craters have been identified on Earth. Perhaps the most famous is the Chicxulub Crater, in Yucatan, Mexico. It is one of the largest impact craters ever discovered on Earth, measuring roughly 10 kilometres wide. Despite its size, the Chicxulub Crater is famous for another reason: many scientists think

	the large meteorite that created the Chicxulub Crater triggered the extinction of the dinosaurs and other animal and plant life 66 million years ago. Meteoroids are travelling around throughout space, and all of the moons and planets have been impacted by meteorites since the formation of our solar system. (Note: they are called meteoroids when they're still in space, and meteorites when they land on a planet or moon). On Earth, we only see a few impact craters because of a couple of different reasons. First, most meteoroids never reach the Earth's surface because they burn up in the atmosphere. This is what we are seeing when we watch a shooting star during a meteor shower (meteor refers to the visible streak of light). Second, impact craters from meteorites can be changed by geological forces (like earthquakes and continental movements) or eroded away by atmospheric agents (like wind or rain). There is no atmosphere on the moon, which means that falling meteoroids do not burn up and there is no weather to erode away the craters.

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Co-funded by the European Union

STEAM Tales (KA220-HE-23-24-161399) is funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the Nationalen Agentur im Pädagogischen Austauschdienst. Neither the European Union nor the granting authority can be held responsible for this.

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