Linking STEM and SDGs in the primary school!

The Pale Blue Dot Programme (PBD)

MODULE 1

Looking out and back to Earth

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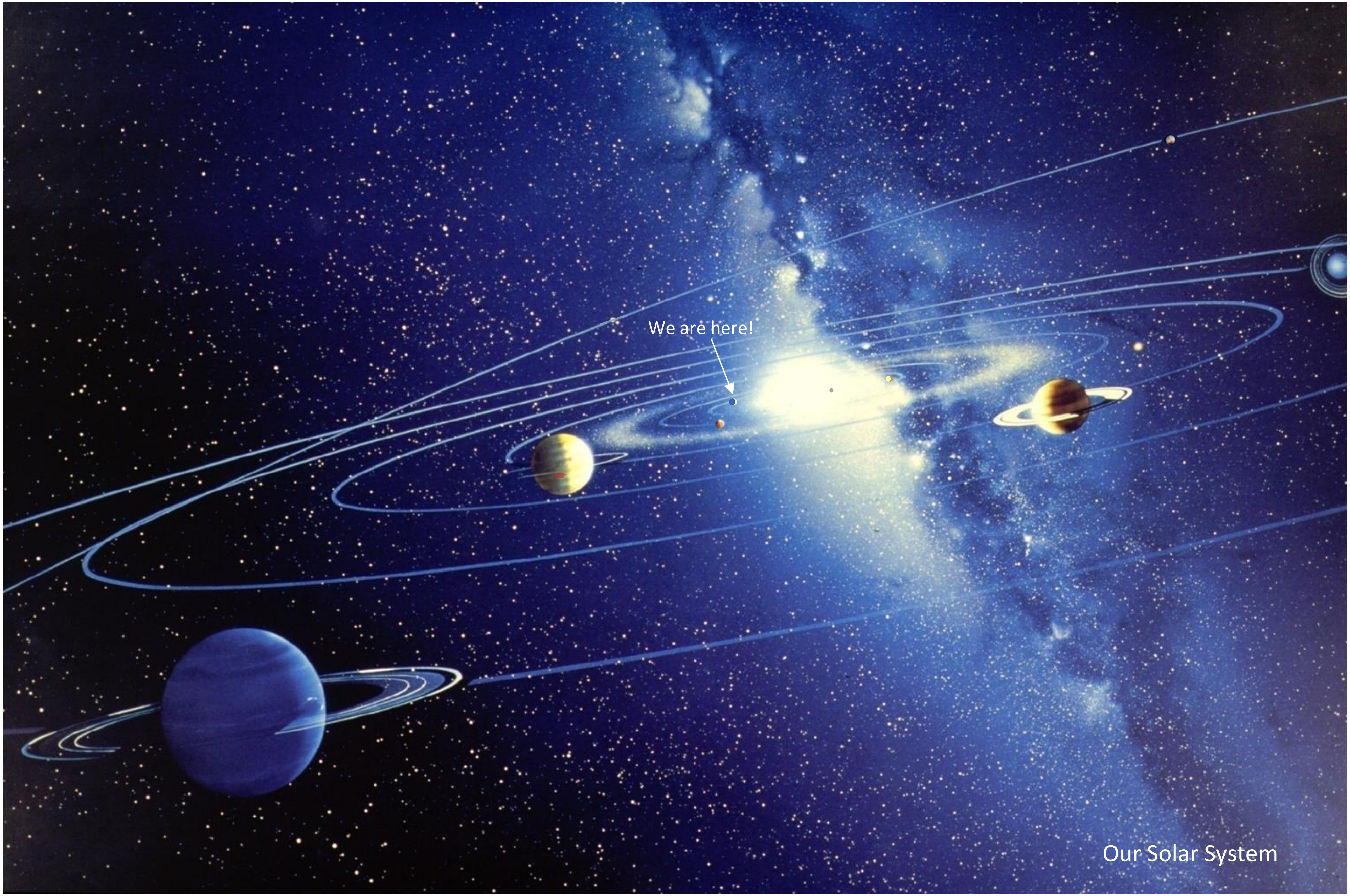

We are here!
Our Solar System

Contents

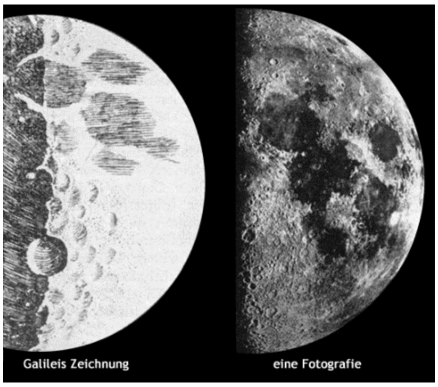
1 Looking out and back to Earth – Basic knowledge for teachers

The following story shows how the sight of our planet from space awakens in us a sense of awe and also the need to protect the Earth's climate, as our existence depends on certain habitability conditions.

Even in ancient times, people looked at the night sky to find answers to fundamental questions such as "Are we alone in the universe?". The regular rhythmic recurrence and order of the movements of the sun, moon and planets in the sky have been well known for thousands of years and prompted many cultures around the world to use the sky as a great calendar and clock. Primarily to determine sowing and harvesting, but also to celebrate the gods and thank nature.


Source: ESO

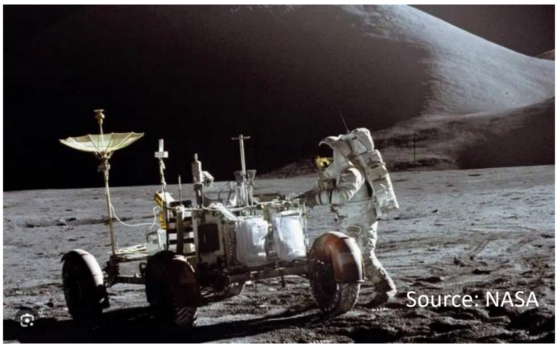
When Galileo Galilei pointed his self-made telescope at the night sky in December 1609, it surpassed anything that mankind had seen with the naked eye on dark nights for thousands of years. He discovered huge craters and very high mountains on the moon! Because there was no camera back then, he painted what he saw!



Galileo discovered four moons orbiting the planet Jupiter, like a solar system in miniature. He hypothesised that the Earth and the other planets orbited the sun in a similar way. He was accused of this by the Inquisition and sentenced to house arrest.

360 years after Galileo's observations of the moon, on July 16, 1969, three astronauts from NASA's Apollo 11 programme began their journey to the moon. It took them three days and three nights to get there. Their names were: Neil Armstrong, Edwin "Buzz" Aldrin and Michael Collins. While Collins continued to orbit the moon in the Apollo capsule, Armstrong and Aldrin were the first humans to land on the lunar surface. There they collected rock samples. There are many craters on the moon and some mountains that are over 5000 metres high!

Source: NASA



Source: NASA

Source: NASA

There were a total of 17 Apollo missions, the last in 1972 with Apollo 17, after which the programme was stopped for cost reasons. Left: Astronauts explore the lunar surface with a moon car. Right: The mirror on the moon, which still allows to measure the distance between the earth and the moon with a laser beam (credits: NASA).

There are people who don't believe that the astronauts were on the moon! However, they left a mirror there that can still be used today to measure the distance to the moon with a laser beam! And they brought rock samples home with them. A chemical analysis revealed that the moon is made of earth material!

The astronauts on the various Apollo missions were able to see the whole Earth from the moon! Many of them felt overwhelmed by the sight of our planet and reported mystical and religious experiences.

The photo on the right is called "Rising Earth" or "Blue Marble". In the foreground, it shows the crater-covered surface of the moon, while the globe of the earth is silhouetted against the deep black of space in the background. It looks as if it is just rising on the horizon.

Source: NASA

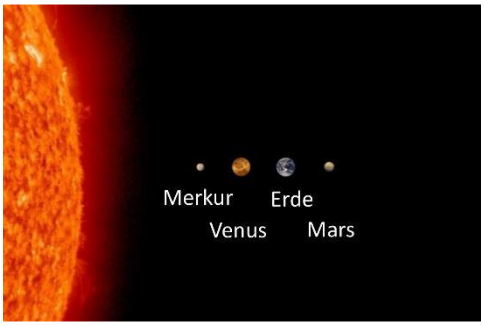
Apollo 8 astronaut Mitchell wrote: *"Suddenly, from behind the rim of the moon, in long, slow-motion moments of immense majesty, there emerges a sparkling blue and white jewel, a light, delicate, sky-blue sphere laced with slowly swirling veils of white, rising gradually like a small pearl in a thick sea of black mystery. It takes more than a moment to fully realize this is Earth ... home." "Now I know why I'm here. Not to take a closer look at the moon, but to look back at our home, the Earth!"*

"It suddenly struck me that that tiny pea, pretty and blue, was the Earth.
I put up my thumb and shut one eye, and my thumb blotted out the planet Earth.
I didn't feel like a giant. I felt very, very small." Neil Armstrong, Apollo 11

Video Landung von Apollo 11: https://www.youtube.com/watch?v=nOcDftgR5UQ

The spirit of research was now awakened and the question was soon asked: If there are such high mountains on the moon, what does the surface of our neighbouring planet look like?

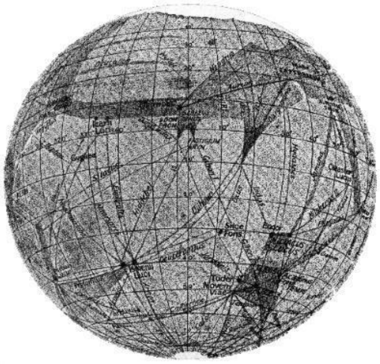
To this day, manned journeys to neighbouring planets remain a distant goal. For this reason, space probes were only sent to the nearest neighbouring planets, Venus and Mars. Because of the high temperature, Mercury was not explored. This is because it is only 50 million kilometres away from the sun. Venus, also known as the morning star, appears bright in the sky. It is the same size as the Earth, which raises the question of whether the conditions there are similar to those on Earth.

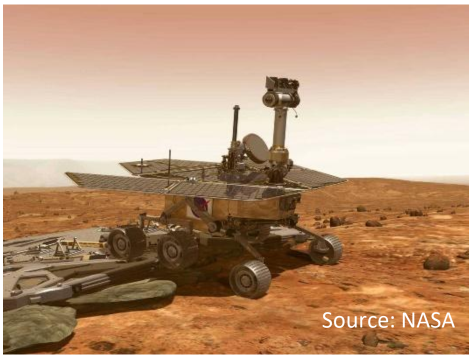


Source: NASA

The Russians were the first to send a space probe to Venus that could land on the planet. It was called Venera. The researchers were astonished to learn that the instruments on board measured an atmospheric temperature of 470°C! Venus' atmosphere is very dense and consists of 99% carbon dioxide, a greenhouse gas!
Due to the very high temperatures and the enormous atmospheric pressure, the probe was flattened in just a few minutes. It was immediately clear: Venus is a planet on which life is not possible.

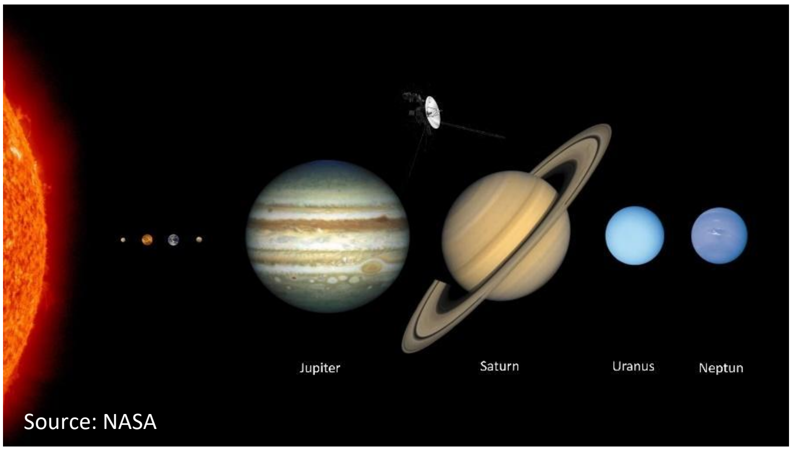
The nearest neighbouring planet is Mars. The astronomers Giovanni Schiaparelli and Percival Lowell had already observed large, easily recognisable channels on it with telescopes. A veritable fever broke out, a search for the Martian builders of the channels. In short, for the first time life was being searched for on other planets. By 1965 at the latest, the photos taken by the US space probe Mariner 4 put an end to all speculation about the red planet: There were no Martian canals, but a reddish desert. Schiaparelli's Martian canals turned out to be an optical illusion. To this day, Mars robots (see NASA image below right) are still searching for signs of life on Mars. It has now been proven that there was liquid water there a long time ago, as evidenced by dry river beds, sediments and rocks. However, it escaped into space due to the very thin atmosphere.





Source: NASA

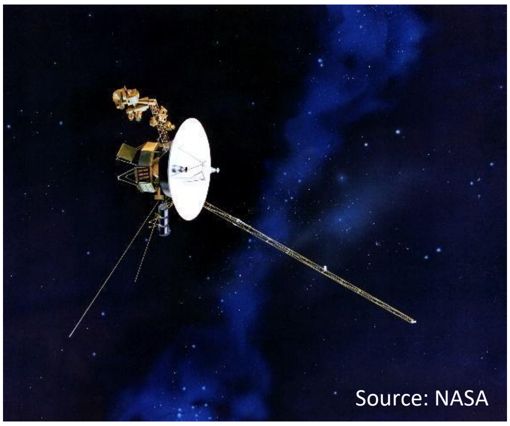
The more distant planets Jupiter, Saturn, Uranus and Neptune remained unexplored. They were only known as bright but otherwise blurred discs in the telescope (bottom right image).



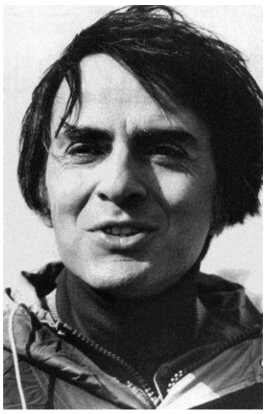
Source: NASA

NASA therefore launched a space programme in the early 1970s with the aim of using space probes to explore and photograph the outer planets Jupiter, Saturn, Uranus and Neptune and their moons at close range with high spatial resolution.

After five years of intensive work, two identical NASA probes named Voyager 1 and Voyager 2 began their long journey through the solar system in 1977.


Source: NASA

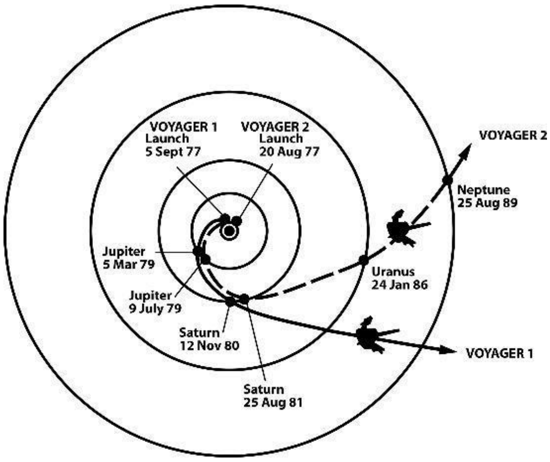
On board, in addition to the measuring instruments and the camera, they also carried a golden disc containing images and sound recordings of Earth and people from different cultures, music and astronomical information about our solar system. The record team, led by the well-known astrophysicist Carl Sagan, developed the message to suspected extraterrestrial civilisations. In the distant future, these could possibly track down the Voyager probes and realise that they are not alone in the universe.



Carl Sagan will achieve world fame in the early 1980s with his programme series "Our Cosmos".

But first back to the technical challenges of travelling to the edge of the solar system! After all, the two probes would be so far away from the sun that solar cells were out of the question for their energy supply, as the sun's radiation would be far too weak to serve as an energy source so far away. This is why the decision was made in favour of plutonium batteries. Heat is released in them through spontaneous nuclear decay, which is converted into electrical energy.

However, the decay of the plutonium meant that the thermal output of the batteries was constantly reduced during the long journey. As a result, more and more scientific equipment and functions had to be gradually switched off over the course of the mission so that enough energy remained for the control and communication systems. Communication with the probes was planned for a period of 50 years. NASA therefore assumes that contact with the probes can be maintained until 2025.

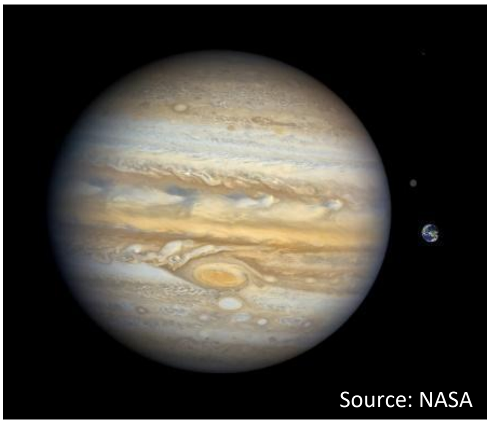


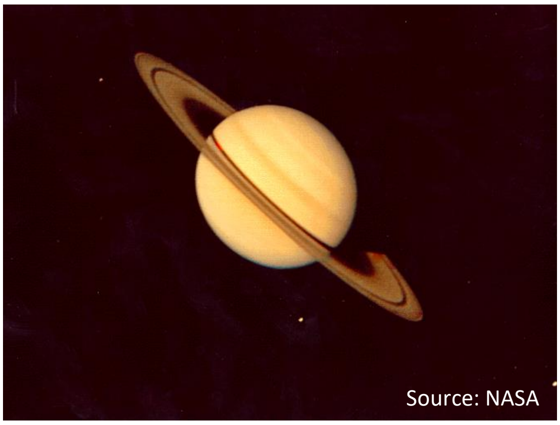
Voyager 2 was launched before its sister probe on August 20, 1977. It took a different trajectory towards Jupiter. This enabled it to overtake Voyager 1 in December 1977 and take the lead, so to speak, to explore Uranus and Neptune. Image source: NASA

Thanks to their newly developed cameras and measuring instruments, the Voyager probes were able to take incredibly impressive images with strong contrasts and high spatial resolution.

When Voyager 1 reached Jupiter at a speed of 16 km/sec on March 4, 1979, after a year and a half in flight, the images of the largest planet in the solar system and its known and newly discovered moons were simply breathtaking and opened up a whole new chapter in the exploration of the solar system.

Much of what their cameras and instruments showed and recorded was completely new. The largest planet Jupiter, its turbulent surface and its moons showed features that no human had ever seen before! A year later, Voyager 1 reached Saturn and revealed the secret of Saturn's rings. They consist mainly of pieces of ice the size of a house!


Source: NASA

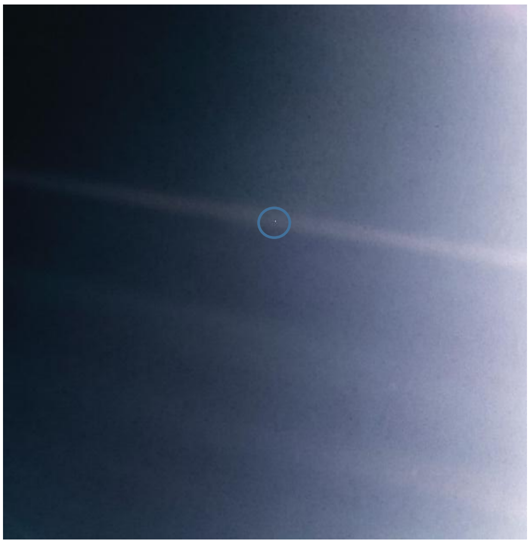

Source: NASA

After orbiting Saturn in 1980, Voyager 1 left the plane of the planets to continue its journey beyond the edge of the solar system. Carl Sagan therefore suggested at the time that Voyager 1 should take one last look in the direction of home shortly after passing Saturn. However, there was a problem involved: seen from the outer solar system, the Earth was too close to the sun at this time and from this position. Should the camera really be so close to the sun? There was a risk that the spacecraft's camera could be burned out.

The team of scientists therefore decided to wait until 1989. By then, both space probes would have passed the orbits of Neptune and Pluto. On February 14, 1990, Carl Sagan's wish was finally granted: Voyager 1 obediently turned the camera back to the distant planets and took 60 photos and stored them in digital form on its tape recorder. It then transmitted the data back to Earth in March, April and May 1990. It was the first "portrait" of our entire solar system! Each image consisted of 640,000 pixels. The space probe was 6 billion km away from Earth, so far that each pixel took 5.5 hours to reach Earth at the speed of light. Images were taken of Earth, Venus, Jupiter, Saturn, Uranus and Neptune.

From this great distance, the planets only appear as points of light - some blurred, others sharp. The scientists searched for the Earth in the photos and found it in the middle of the sunlight reflected by the probe. Sagan was incredibly moved by this view of the Earth. Touched and thrilled, he would express it, first in an interview and later in his book "Pale Blue Dot", in very "unscientific" but deeply human language as follows:

„Look again at that dot. That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives.“ […] „Our posturings, our imagined self-importance, the delusion that we have some privileged position in the Universe, are challenged by this point of pale light. Our planet is a lonely speck in the great enveloping cosmic dark. In our obscurity, in all this vastness, there is no hint that help will come from elsewhere to save us from ourselves.“ [..] „There is perhaps no better demonstration of the folly of human conceits than this distant image of our tiny world. To me, it underscores our responsibility to deal more kindly with one another, and to preserve and cherish the pale blue dot, the only home we've ever known.“



The little blue pearl tells us all this in its own way. Our eyes see the only place in the universe where we can live. Only here are we human, only here can we be. A gift that is entrusted to us and that we should guard as carefully as our eyes that see this photo.

2 Implementation of the Pale Blue Dot Programme

The Pale Blue Dot Programme (PBD) can be implemented at fixed times or as part of project weeks in schools. Two hours per week would be ideal. In this way, the children have enough time to fully engage in their research assignment and carry out their experiments and activities in small teams. We must keep in mind that both the teacher and the children will be exploring together, trying out new methods and a variety of participatory activities.

Introduction of the PBD Programme using stories

As mentioned in the pedagogical concept of the programme in section 1.6, the PBD is constantly illustrated by stories. However, it is not necessary for the teacher to know the story word for word. It is sufficient if the story is brought to life through gestures and facial expressions. The children should be emotionally involved and encouraged to listen in more detail. It is good to use the voice in different ways (e.g. loudly, softly, quickly, etc.) or to create sound effects. This helps the children to pay attention and stay motivated. During the storytelling, it is helpful to plan small pauses in which you ask questions and thus invite the children to participate in the story.

At the beginning of the programme, we suggest that the teacher introduces Carl Sagan to the children by showing them a poster with his photo and encouraging them to talk about the work of "astronomers" and "astronauts". After their curiosity has been awakened, the children are told that they have received a package from the astronomers in their town. In it they find badges and invitation cards to take part in the PBD research mission!

Total Duration: 25 min

Goal: Presentation of the astronomer Carl Sagan and introduction to the role of researchers: the children are invited to take part in a research mission.
Discussion about the different professions of *"astronomer"* and *"astronaut"*.

Material:

- Poster 1 (Carl Sagan), Poster 2 (Carl as a child) and Poster 3 (Carl with his telescope in the backpack)
- Postal package with invitations and badges

Keywords: astronomer, astronaut, telescope, outer space

Step 1: Introduction of Carl Sagan and the Pale Blue Dot Programme

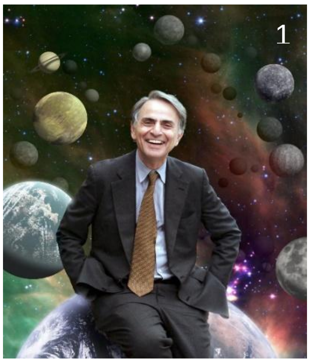
10 min

Learning arrangement: Children sitting in a semi-circle around the teacher

Participatory activities: Creating space for questions, discussions and debates

The teacher holding poster 1: ***"Today you are going to meet an extraordinary scientist. His name is Carl Sagan. He was an astronomer and lived in the USA from 1934 to 1996. Do you know what an astronomer does?"*** A distinction is made between the professions of astronomer and astronaut (see glossary).

"Even as a child, Carl wanted to explore outer space, also known as the cosmos. As an adult, he therefore became an astronomer".



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The teacher holding poster 3: ***"Carl loved watching the sky with his telescope! He had a great wish: that all children in the world could explore the earth, the moon and all the planets. That's why he travelled all over the world with his telescope in his backpack, visiting many children and exploring the night sky with them".***

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"Carl wanted research to continue after his death - through you! He wanted the children of the earth to continue the research and thus help to protect the earth, our only home, in the future!"

Allow for the children to ask questions and make comments.

Step 2: Receiving invitations and buttons to participate in the Pale Blue Dot Programme

10 min

Learning arrangement: Children sitting in a semi-circle around the teacher

Participatory activities: Creating space for questions, Bring the children to interact with each other

Teacher: ***"Look! The astronomers from...*** *(insert local institution such as Munich University Observatory)* ***invite you, the children of class ..., to a big research mission! They have sent a package in the mail: Let's find out what's inside!"***

Presentation of the box with the badges and the invitation cards for each child.

Teacher: ***"Look at your invitation card. Can you see a small light blue dot on it? Let's find out together what this dot could be."*** The children discuss the questions on the card.

"I am now your research leader. We are all members of the Pale Blue Dot research mission." We are going to explore the moon, the earth and all the planets in the solar system, carry out experiments and discover how wonderful our planet is.

Step 3: Reflexion

5 min

The children are first working in small groups:
Each group receives two A3 posters with the following questions. The children write their answers to these questions on small pieces of paper:

- *What do you expect from our research mission? What do you think we will do?*

- *What questions do you have? What do you want to find out or know?*

The children arrange their answers on the posters and exchange ideas. Each group selects particularly interesting questions.

Selected questions are presented in plenary. The teacher also has the opportunity to clarify any misunderstandings.

Every child works for themselves:
Which question did you find particularly interesting? Which question particularly surprised you? Each child selects one or more questions and writes them down in their own Pale Blue Dot booklet. The children can regularly check whether they have already found answers, but also whether new questions have arisen.

3 Module 1: Our wonderful planet Earth

Module Description: By comparing the Earth with the Moon and the other planets in the solar system through playful activities, children discover and become aware of how special and unique our planet is. By looking at images of the Earth taken from space, especially from the moon and during exploration missions to our neighbouring planets, children can visualize the vast distances and tiny size of the Earth. *Both reinforce an awareness of the human family that lives on it and a realization that we are all citizens of the Earth!*

3.1 Exploration of the moon

Description: During the following two activities, the children will explore the surface of the moon, learn about the significance of the moon in different cultures through stories and relate the phases of the moon to the months of our calendar. They will also learn about observation methods and instruments as well as recognising patterns, which promotes abstract and mathematical thinking.

Activity 3.1.1: Exploring the surface of the moon

Total Duration: 55 min

Goal: The children use a magnifying glass as their first instrument to explore the surface of the moon.

Material:

- Poster 3 (Carl with a telescope in his backpack) and poster 4 (Carl observing the moon with a child)
- Poster 5 (moon)
- Figures on transparent foils for storytelling (poster 6)
- Several magnifying glasses
- Set of 25 pictures of the moon in small format (A4) and transparencies for the children
- 25 slide pens
- Posters 7, 8 and 9 (for the story of the man in the moon)

Keywords: moon, instrument

Step 1: Motivating the children through storytelling — 5 min

Learning arrangement: Children sitting in a semi-circle around the teacher

The Teacher holding posters 3 and 4: ***"As you know, Carl travelled around the world with a telescope in his backpack and observed the night sky with lots of children from different countries! The first object in the sky he observed was the moon!"***

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Step 2: Exploring the surface of the moon with a magnifying glas

10 min

Learning arrangement: Children sitting in a semi-circle around the teacher

Participatory activities: Visualise ideas and start an exchange about them

Activating prior knowledge

- Draw a picture of the moon!

The different pictures are then viewed and organised in a circle. The colours, surface structure and the difference between the full and half moon will stand out.

The teacher holding the poster with the moon: ***"First, let's take a look at what the moon actually looks like on the surface. For this we need a real photo and not a painted picture."*** Let the children describe what they see. Give them a magnifying glass and invite them to explore the surface. ***"What do you see?"*** Talk about "observation tools", such as magnifying glasses, binoculars, telescopes.

Step 3: Detecting figures on the moon

5 min

Learning arrangement: Children sitting in a semi-circle around the teacher

Teacher: ***"Did you know that people from different cultures imagine figures on the moon? They also tell tales about these figures!"***

The teacher places transparent figures on the moon one after the other:

The moon

The man in the moon

The rabbit

The crocodile

Step 4: Recognising patterns - student activity with the figures on the moon

10 min

Learning arrangement: children work in groups of 2-3 children

Participatory activities: activation prior knowledge, small group work

Realisation: In pairs, the children are given a picture of the moon and transparencies. Together they trace the moon figures and then place them on the moon.

Teacher: *"Did you find the rabbit, the crocodile and the man on the moon?"*

The teacher invites them to imagine and draw their own characters!

Aimed at: Discovering patterns promotes abstract and mathematical thinking!

Step 5: Tales from the moon

15 min

Learning arrangement: Children sitting in a semi-circle around the teacher

There are many different stories that link the moon to different cultures. We have selected two of them:

The man in the moon (poster 7, 8 and 9)

Once upon a time there was a tailor who was known for his unusual designs. Many people in the city had their clothes sewn by him. One day, the moon looked down on the earth and saw these beautiful clothes! So he said to the tailor: "I would like to commission one of those elegant winter coats that so many gentlemen on Earth wear in winter and that come from this very workshop". The tailor felt honoured and immediately began to take measurements. The moon stood round and shining in the sky while the tailor eagerly noted down the measurements. The coat should be ready in a fortnight!

Just in time, after 14 days, the moon appeared at the window of the tailor's house and put on his new coat. But, oh horror, what was that? Had the tailor mismeasured himself? The coat was far too big and hung like a sack from the slender crescent moon. The tailor was visibly upset and promised to alter the coat immediately. The moon was measured again and two more weeks passed. When the moon tried on his new coat for the second time, he couldn't believe his eyes: this time the coat was too tight! How could a round moon fit into a crescent-shaped coat? The moon was very disappointed and was about to disappear into the clouds when the tailor had an idea: he presented the moon with two coats: one to wear when it appeared as a full moon and one to wear two weeks later when it was crescent-shaped. Overjoyed, the moon smiled and took his two coats. In gratitude for his services, the moon had the tailor's picture painted on the surface of the moon with his suitcase sewing machine, where it can still be seen today!

The rabbit

A long, long time ago, a fox, a monkey and a little rabbit lived together peacefully as friends. During the day they went to the mountains to play and in the evening they returned to the forest to spend the night. This went on for many years. Until the moon heard about this and wanted to see it with his own eyes. So he disguised himself and appeared to them as an old traveller. "I have wandered through mountains and valleys and am now tired and hungry. Can you give me something to eat?" he asked as he put down his staff and joined them.

The monkey immediately went in search of nuts and brought them to him; the fox gave him a fish he had caught. But the rabbit was desperate, for although he had searched everywhere, he had nothing to give the poor wanderer. The monkey and the fox mocked him: "You're good for nothing". The little rabbit was now so discouraged that he asked the monkey to fetch wood and the fox to light it. Both did as they were asked. Then the rabbit said to the moon: "Eat me!" and wanted to throw himself into the fire. The wanderer stopped him at the last moment and was so moved by this sacrifice that he wept.

Then he said: "Everyone deserves praise and recognition. There are neither winners nor losers! But this rabbit has given us great proof of his love!" He took the rabbit to the moon, where it has been happily living on the lunar surface ever since.

Suggestions for further activities: Create a role play from the stories using animal masks or invite the children to create a short animated film to accompany the story.

Step 6: Reflexion

10 min

The children draw a second picture of the moon, this time in their Pale Blue Dot booklet, and write their impressions, e.g. on the following questions:

Which figures did you detect on the picture of the moon?

What did you like best about the story?

How would you describe the surface of the moon that you explored with the magnifying glass?

Will you try to find the figures on the real moon?

Suggestion: The teacher could set up a small BP corner where all the materials and models that the children develop during the project are stored and displayed.

The first moon pictures and the figures that the children have discovered on the moon can be collected here.

Activity 3.1.2 The phases of the moon and the months of our calendar

Total Duration: 35 min

Goal: Learning about the importance of the moon for timekeeping and our calendar

Material:

- Styrofoam ball attached to a wooden skewer
- a torch
- dark room
- inflatable globe
- moon 10 cm diameter
- paper figure of a child
- Moon phase box (see instructions in the document "Templates"
- small torch
- Annual calendar with the phases of the moon (poster 10)
- poster 11 (sequence of the moon phases)

Keywords: Moon phases, model, sun, reflection, orbit, month, calendar

Step 1: Exploring why the moon shines - reflected light

5 min

Learning arrangement: Children sitting in a semi-circle around the teacher

Participatory activities: activating prior knowledge, exploring the moon phase model

Activating prior knowledge

*- Referring back to the children's moon pictures: "**You have painted the moon very differently. Sometimes it's completely round, then a crescent. Some of you have drawn it narrow or a little thicker. And you're all right."***

Teacher: ***"Now we're going to discover why the moon changes shape!"***

Realisation: Show the children the polystyrene ball attached to the wooden skewer. It is white in colour. Now switch off the light: The children will realise that they can't see the ball in the dark because it doesn't glow by itself! Then use the torch (as a sun) to illuminate the ball: It will look very bright from the illuminated side because it reflects the light. Depending on the direction of the light, you can even show the children that the sphere is fully visible (full moon) or half visible (half moon) (according to the phases of the moon). Let the children try it out for themselves and report which phases of the moon they can see from which location.

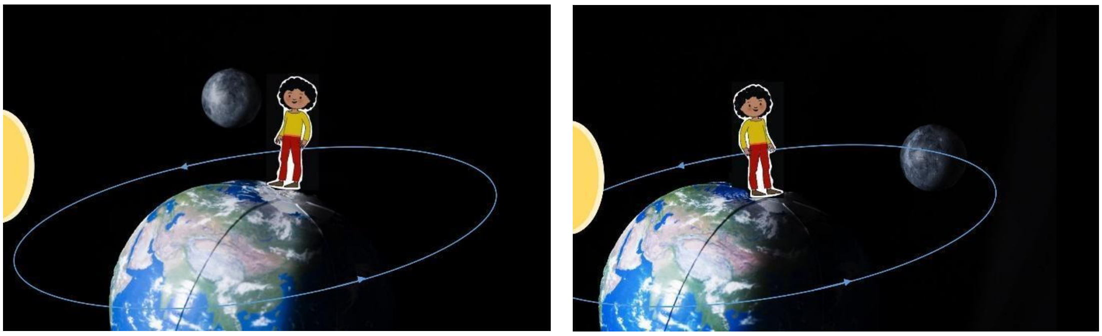
Step 2: Visualising the phases of the moon and linking them to our calendar

20 min

Learning arrangement: Children sitting in a semi-circle around the teacher, children work in groups of 4 children with the model

Participatory activities: building and exploring the moon phase box

***The teacher holding the inflatable globe, a paper figure on the globe and a model of the moon:* "The moon orbits the earth and is illuminated by the sun. It takes 28 days to orbit the earth once. For the little girl in the picture, who is standing on the earth, the moon changes its shape depending on which side of the moon is currently illuminated by the sun."**



The phases of the moon can be visualised with a small box! (See craft instructions for the moon phase box in the document 'Templates')

Realisation: Insert the small torch into the hole provided in the moon phase box and switch it on. Ask the children to look into the four holes in the moon phase box while they turn the box round. What do they see? Ask the children to identify the corresponding moon phases shown below (poster 11) each time they look into the box.

Teacher: *"People used to observe the moon and count the days between one full moon and the next full moon. They called the period from new moon to new moon 'a month'. Take a look at this year's calendar with the months! Without the moon, we wouldn't have months! So the phases of the moon allow us to keep track of our time!"*

Mondphasen 2024

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	Januar	Februar	März	April	Mai	Juni	Juli	August	September	Oktober	November	Dezember
1	Mo	Do	Fr	Mo	Mi ☾	Sa	Mo	Do	So	Di	Fr ●	So ●
2	Di	Fr	Sa	Di ☾	Do	So	Di	Fr	Mo	Mi ●	Sa	Mo
3	Mi	Sa ☾	So ☾	Mi	Fr	Mo	Mi	Sa	Di ●	Do	So	Di
4	Do ☾	So	Mo	Do	Sa	Di	Do	So ●	Mi	Fr	Mo	Mi
5	Fr	Mo	Di	Fr	So	Mi	Fr	Mo	Do	Sa	Di	Do
6	Sa	Di	Mi	Sa	Mo	Do ●	Sa ●	Di	Fr	So	Mi	Fr
7	So	Mi	Do	So	Di	Fr	So	Mi	Sa	Mo	Do	Sa
8	Mo	Do	Fr	Mo ●	Mi ●	Sa	Mo	Do	So	Di	Fr	So ☽
9	Di	Fr	Sa	Di	Do	So	Di	Fr	Mo	Mi	Sa ☽	Mo
10	Mi	Sa ●	So ●	Mi	Fr	Mo	Mi	Sa	Di	Do ☽	So	Di
11	Do ●	So	Mo	Do	Sa	Di	Do	So	Mi ☽	Fr	Mo	Mi
12	Fr	Mo	Di	Fr	So	Mi	Fr	Mo ☽	Do	Sa	Di	Do
13	Sa	Di	Mi	Sa	Mo	Do	Sa	Di	Fr	So	Mi	Fr
14	So	Mi	Do	So	Di	Fr ☽	So ☽	Mi	Sa	Mo	Do	Sa
15	Mo	Do	Fr	Mo ☽	Mi ☽	Sa	Mo	Do	So	Di	Fr ○	So ○
16	Di	Fr ☽	Sa	Di	Do	So	Di	Fr	Mo	Mi	Sa	Mo
17	Mi	Sa	So ☽	Mi	Fr	Mo	Mi	Sa	Di	Do ○	So	Di
18	Do ☽	So	Mo	Do	Sa	Di	Do	So	Mi ○	Fr	Mo	Mi
19	Fr	Mo	Di	Fr	So	Mi	Fr	Mo ○	Do	Sa	Di	Do
20	Sa	Di	Mi	Sa	Mo	Do	Sa	Di	Fr	So	Mi	Fr
21	So	Mi	Do	So	Di	Fr	So ○	Mi	Sa	Mo	Do	Sa
22	Mo	Do	Fr	Mo	Mi	Sa ○	Mo	Do	So	Di	Fr	So ☾
23	Di	Fr	Sa	Di	Do ○	So	Di	Fr	Mo	Mi	Sa ☾	Mo
24	Mi	Sa ○	So	Mi ○	Fr	Mo	Mi	Sa	Di ☾	Do ☾	So	Di
25	Do ○	So	Mo ○	Do	Sa	Di	Do	So	Mi	Fr	Mo	Mi
26	Fr	Mo	Di	Fr	So	Mi	Fr	Mo ☾	Do	Sa	Di	Do
27	Sa	Di	Mi	Sa	Mo	Do	Sa	Di	Fr	So	Mi	Fr
28	So	Mi	Do	So	Di	Fr ☾	So ☾	Mi	Sa	Mo	Do	Sa
29	Mo	Do	Fr	Mo	Mi	Sa	Mo	Do	So	Di	Fr	So
30	Di		Sa	Di	Do ☾	So	Di	Fr	Mo	Mi	Sa	Mo ●
31	Mi		So		Fr		Mi	Sa		Do		Di

Step 3: Reflexion

10 min

The children answer the following questions in their Pale Blue Dot booklet:

Why does the moon change shape?

Where do the months of our calendar come from?

Can you name the months of a year?

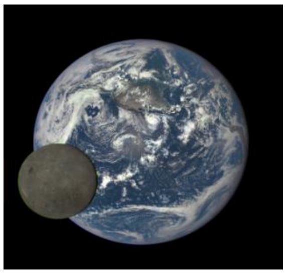
Can you find the full moons on the calendar?

3.2: Comparing Earth and Moon

Description: In these activities, we will encourage the development of the children's observation and maths skills by looking at the size and distances of objects, as well as scale models. Again, by comparing the earth and the moon, the children will realise how special our planet is!

Activity 3.2.1 Exploring and comparing the size of the earth and the moon

Total Duration: 20 min



Goal: This activity gives the children an idea of the size of the moon and the earth compared to each other.

Material:

- Three globes of different size, one is the inflatable globe
- Three models of the moon in different sizes
- spherical objects of various size (ball, orange, …)

Keywords: globe, scaled model

Step 1: Exploring the size of the earth and the moon

15 min

Learning arrangement: children work in groups of 4 children

Participatory activities: activating prior knowledge, exploring models of the earth and the moon

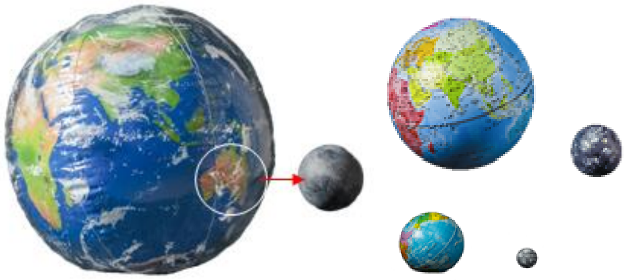
Activating prior knowledge:
"From these spheres, find a pair for the earth and moon that you think matches their size ratio as closely as possible." (Display spherical objects of various size like different balls, oranges etc.)

Teacher: ***"The Earth and the Moon are very big and it is very difficult to imagine how big they are! But we can try to imagine their size with models! Models are a substitute for reality. Scientists work with them when the original is too big, for example."***

Show the children the inflatable globe and the three models of the moon. ***"Look at the earth!***

- ***Do you know where we live?***
- ***Do you know where Australia is? What do you know about Australia? Which animals live there?***
- ***Now I'll give you a hint! The moon has about the same circumference as Australia!"***

Teacher: ***"I have three globes and three moons. Take each earth and find the corresponding moon!"*** It is important that the ratio of the models is correct. This is how children develop an idea of scientific models.



Step 2: Reflexion

5 min

The children answer the following questions in their Pale Blue Dot booklet:

How big is the moon compared to the Earth?

Why can Australia help with this comparison?

How appropriate was my / our original guess?

Activity 3.2.2 How far apart are the Earth and the moon? The first journey to the moon!

Total Duration: 35 min

Goal: Using a model to visualise the distance between the moon and the earth

Material:

- Cardboard model of the earth and the moon, connected with a string (see craft instructions in the document 'Templates')
- Instructions for folding a paper rocket (in the document 'Templates')
- Origami paper for the rockets
- poster 12 (Apollo 11-Crew)
- poster 13 (female astronauts)

Keywords: Apollo 11, rocket, spaceship

Step 1: How far away is the moon from the earth?

10 min

Learning arrangement: Children sitting in a semi-circle around the teacher, children work in groups of 4 children

Participatory activities: activating prior knowledge, working with models of the earth and the moon

Activating prior knowledge*:*

The teacher showing one of the modes of the earth and the moon from the previous activity:
"Guess how far away the moon is from the earth."
Let the children try it out. Mark the different ideas of distance in the room.

Teacher: ***"We will use another model made of cardboard to show this!"***
The teacher holding the cardboard model asks the children again: ***"Do you know how far away the moon is from the earth?"***

Now let the children open the model: one child holds the earth, another the moon, and they move apart until the rope is fully stretched.

Then compare the original assumptions with the actual circumstances together with the children.

The children can each make their own Earth-Moon model, which they can then take home in their Pale Blue Dot backpack to show their families and friends.

Step 2: The first journey to the moon - astronauts on their way to the moon!

20 min

Learning arrangement: Children sitting in a semi-circle around the teacher, children work with their partner to make the paper rocket

Participatory activities: discussions and debates, folding a paper rocket

The teacher showing poster 12 with the Apollo 11-Crew: ***"Many years ago, astronauts flew to the moon in a spaceship and travelled for three days and three nights to reach the moon! These were the three astronauts: Neil A. Armstrong, Michael Collins and Buzz Aldrin. Can you identify them on the poster?"*** (The astronauts have their names on their astronaut suits.)

Folding the paper rocket

The teacher asks the children to each fold a rocket (see instructions in the document 'Templates').
Once the origami rockets are ready, it's time to launch the rockets! The children move them from the earth model to the moon along the string in between!

Teacher: ***"The astronauts who went to the moon landed in a special capsule on the belly of the man on the moon!"*** Let the children look for the man on the moon.

"But it's not just men who become astronauts! Women too! Take a look at these two female astronauts!" **(poster 13).**

Femal german astronauts:
Susanna Randall and Insa Thiele-Eich

Step 3: Reflexion

5 min

The children discuss the following questions in small groups (3-4 children):

How long did the astronauts travel to reach the moon?

Would you like to become an astronaut?

Activity 3.2.3 The importance of the Earth's atmosphere

Total Duration: 25 min

Goal: The children explore the importance of the atmosphere on Earth and the lack of one on the Moon!

Material:
- poster 14 (Neil Armstrong on the moon)
- The vacuum container with the pump
- A balloon filled with a little air and tied up

Keywords: Oxygen, atmosphere, air pressure, vacuum

Step 1: Why do astronauts wear spacesuits?

15 min

Learning arrangement: Children sitting in a semi-circle around the teacher

Participatory activities: activating prior knowledge, experimenting with the vacuum pump

Activating prior knowledge:

The teacher holding poster 14 with Neil Armstrong on the moon: ***"Why do astronauts have to wear spacesuits?"*** Collect and sort the different answers of the children on cards or a poster.

Information for teachers

What the spacesuit is for:
- The suit supplies the astronauts with oxygen so that they can breathe.
- The suit warms or cools the astronauts (in direct sunlight it can get very hot on the moon, but without the sun it is very cold).
- The suit generates the same pressure that prevails on Earth so that the astronauts do not burst.

What the spacesuit is not for:
- The suit is not there to prevent the astronauts from flying away. Gravity on the moon may be less than on earth, but it is still there. The astronauts therefore do not need any aids to prevent them from flying away. The situation is different if they have to get out of their spaceship on the way to the moon, for example to carry out repairs. Then, in addition to the spacesuit, they also need a tether to tie themselves to the spaceship to prevent them from flying away.

Teacher: ***"As we have seen, there are several reasons why astronauts have to wear a spacesuit. We will take a closer look at one of them in an experiment!"***

Experiment 1: Pumping out air and simulating the moon

Teacher: ***"Our Earth is surrounded by a very thin layer of air called the atmosphere! The atmosphere is very important: it allows us to breathe and keeps the earth warm! It also exerts pressure on the earth's surface, on the water, on the land and on us! We don't feel this pressure because we are used to it!"***

Realisation: Take the vacuum container with the pump and the balloon filled with a little air.

Teacher: ***"This balloon now represents an astronaut on the moon in our experiment".***

Place the balloon in the container and seal it. Now show the children the pump.

Teacher: ***"You're probably familiar with the air pumps we use to inflate bicycle tyres. This pump I have in my hand works the other way round: it pumps air out! Try it out with your finger!"***

Let the children experience the pump sucking out the air.

Teacher: ***"Now we are going to pump the air out of the container to see what happens to an astronaut on the moon when he or she is not wearing a spacesuit."***

Now place the pump on the vacuum container and ask the children to pump out the air. It's easy at first, but then you have to pump really hard.

Observation: When the air is pumped out of the container, the balloon inside the vacuum container begins to expand! <u>The air pressure inside the balloon</u> is greater than in the container on the outside! Astronauts who land on the moon without their spacesuit inflate! They even explode!

Teacher: ***"If you want to travel into space or to the moon one day, don't forget your spacesuit!"***

Step 2: Reflexion

10 min

The children answer the following questions in their Pale Blue Dot booklet:

Why do astronauts need a spacesuit?

What happened during the experiment with the vacuum pump? Draw a picture of it.

Can you explain the result?

Activity 3.2.4 The gravity of the earth and the moon

Total Duration: 25 min

Goal: The children explore gravity and relate it to weight

Material:

- Two identical-looking rice packets, one of which contains only 1/6 of the original quantity
- The inflatable globe
- two figures: one for the earth and one with an astronaut suit for the moon
- Two landscapes representing the earth and the surface of the moon

Keywords: gravity, weight

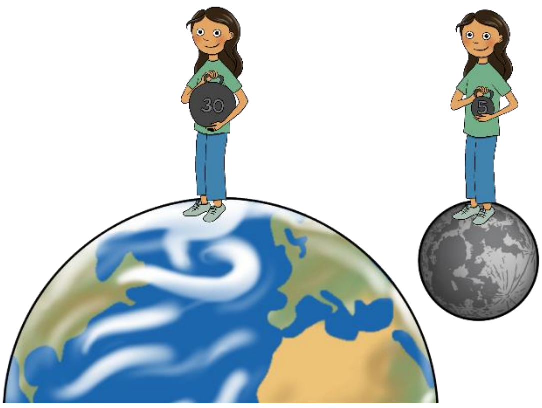
Step 1: Exploring and visualising gravity

5 min

Learning arrangement: Children sitting in a semi-circle around the teacher

Participatory activities: Create space for questions, example from everyday life

The teacher showing the inflatable globe with the figure of the child on it: ***"Did you know that there is a force that pulls us towards the centre of the earth? We don't fall to the centre of the earth because the ground stops us! Try to jump high and fly! And what happens?"*** (We always fall down!) ***"On the moon, this gravity is less because the moon is also smaller than the earth. It therefore doesn't 'pull' so strongly on the astronauts. Neil Armstrong and all the astronauts who landed on the moon were therefore able to jump very high! Higher than a kangaroo!"***



Realisation: The children hold figures of children in their hands and simulate jumps on the pictures of the earth and the lunar landscape.

Astronauts train for spacewalks in water. This experience feels similar to being on the moon because the astronauts feel lighter in the water.

Task for the children: The next time you go swimming, do big jumps in the water and see how it feels.

Step 2: Comparing weights on earth and on the moon

10 min

Learning arrangement: Children sitting in a semi-circle around the teacher

Participatory activities: Model to illustrate the difference in weight on the moon and the earth due to gravity

The teacher holding two rice packets: ***"Now let's imagine that we are having lunch on Earth and on the moon! Please close your eyes and take the rice box from the Earth first. Now take the rice box from the moon. What do you feel? Try to imagine how light the astronauts felt on the moon!"***

Step 3: Reflexion

10 min

The children discuss the following questions in small groups (3-4 children):

Why do objects fall down?

Can you feel the force of gravity?

What did you notice when you compared the two rice boxes?

What would happen if an astronaut tried to lift a heavy stone on the surface of the moon?

How do the astronauts feel when they walk on the moon?

Activity 3.2.5 The first picture of the blue marble and messages for the human family

Total Duration: 25 min

Goal: The children see the first image of the entire Earth taken from the Moon and listen to the astronauts' messages as they cover the entire Earth with their thumbs in the Earth-Moon model!

Material:

- poster 15 (the first picture of the blue marble)
- poster 16 (Mitchel on the moon)
- Cardboard model of the earth and the moon, connected with a string from activity 3.2.2

Keywords: Apollo 8, sphere

Step 1: The first image of the Earth as seen from the moon

5 min

Learning arrangement: Children sitting in a semi-circle around the teacher

Participatory activities: activating prior knowledge

Teacher: ***"Before the two astronauts from Apollo 11 landed on the moon, another rocket was sent there with astronauts on board: Apollo 8. These astronauts did not land on the moon, they just flew around the moon in the rocket and looked through their windows at the lunar surface. Then something very special happened: they saw our Earth from the moon and took this picture! They called it 'The blue marble'!"***

Activating prior knowledge:

The teacher showing the blue marble picture: ***"Take a look at this picture! What do you see? Why is the earth so blue? What are the white spots on the earth? Why can't we see the whole globe? Where is the sun?"***

Wait for the children's answers.

Step 2: Hiding the earth behind our thumbs!

10 min

Learning arrangement: Children sitting in a semi-circle around the teacher

Participatory activities: Working with models of the earth and the moon, discussions and debates

The teacher showing poster 16 with Mitchell: ***"There wasn't just one trip to the moon with astronauts! Different astronauts visited the moon six times and collected rocks to bring back to Earth. One astronaut named Edgar Mitchell was very impressed when he stood on the moon and looked at the Earth from there. He raised his hand and covered the entire Earth with his thumb".*** *Mitchell wrote:*

"Suddenly, from behind the rim of the moon, in long, slow-motion moments of immense majesty, there emerges a sparkling blue and white jewel, a light, delicate, sky-blue sphere laced with slowly

swirling veils of white, rising gradually like a small pearl in a thick sea of black mystery. It takes more than a moment to fully realize this is Earth ... home."

Teacher: ***"We can also try to hide the Earth with our thumbs! Let's take our model of the earth and the moon again and try it."***

Realisation: The pupils tie up the earth-moon model. The teacher holds the earth model at one end and the pupils stand near the moon. They raise their thumbs, cover the earth with them and re-enact what Mitchell experienced on the moon.

Mitchell: "Now I know why I'm here. Not to take a closer look at the moon, but to look back at our home, the Earth!"

Step 3: Reflexion

10 min

With the help of the blue marble picture and inspired by Mitchell, the children look for (lyrical) comparisons. (The earth is like a drop of water that shines in the sun; like a plum on a tree, ...)

These comparisons are collected on cards and displayed.

The children are then asked to draw a picture of a comparison that they particularly like in their Pale Blue Dot booklet.

3.3. Our wonderful Earth as part of the solar system

Description: During the following activities, students will use a Voyager 1 model to explore the planets of the solar system and compare them to our marvellous Earth. They will learn about the conditions of Earth's habitability and discover how special our planet is! The image of the pale blue dot is presented.

Activity 3.3.1 Exploring the solar system and the planets with Voyager 1

Total Duration: 30 min

Goal: Telling the story about Carl Sagan and the exploration mission through the solar system with the space probe Voyager 1. Observing and describing the planets of the solar system.

Material:

- poster 1 (Carl Sagan), poster 17 (Voyager 1), poster 18 (solar system)
- poster 19 (the planets)
- a finished paper model of the Voyager 1 space probe (see document 'Templates')
- Yellow cloth for the sun
- Four models of rocky planets: Mercury, Venus, Earth, Mars
- Four gas planet models: Jupiter, Saturn, Uranus and Neptune
- A model of the dwarf planet Pluto and a model of the moon
- Asteroids made from wrapping paper or news paper
- Piece of blue foil for the habitable zone
- String with knot to measure the distances between the planets

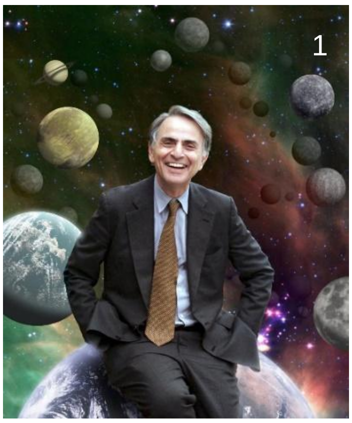
Keywords: Solar system, space probe, Voyager 1, planet, rocky planet, gas planet, dwarf planet, asteroid, asteroid belt, habitable zone

Step 1: Carl Sagan and his colleagues explore the solar system with Voyager 1! 5 min

Learning arrangement: Children sitting in a semi-circle around the teacher

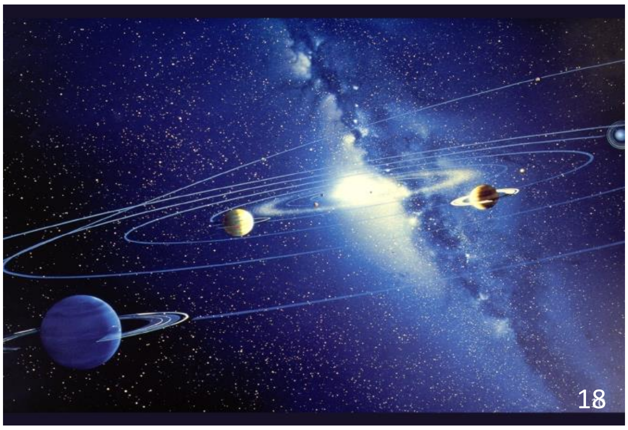
Participatory activities: activating prior knowledge, using visual tools

The teacher showing poster 1 (Carl Sagan) and then poster 17 (Voyager 1): ***"Do you remember Carl Sagan? To explore the entire solar system, Carl Sagan and other researchers once developed an unmanned space probe, a kind of spaceship! They called it Voyager 1. It was about the size of a car and had batteries, cameras and measuring instruments on board."***



The teacher showing poster 17 (Voyager 1) and then poster 18 (solar system): ***"After its launch, the Voyager 1 space probe travelled through our solar system for many years. It orbited the gas planets and took many photos. From Earth, Voyager 1 flew to Jupiter, Saturn, Uranus and Neptune. And at some point, the probe reached the edge of our solar system and flew out into the empty depths of space."***

The teacher moves the paper model of Voyager 1 along the planets on the poster.



Step 2: A journey through the solar system

15 min

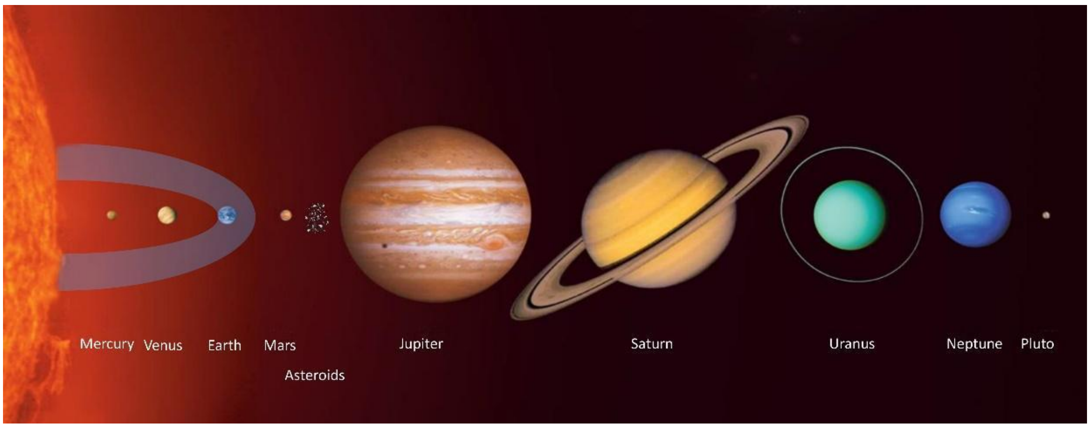
Learning arrangement: Children sitting in a semi-circle around the teacher

Participatory activities: activating prior knowledge, children work in groups of 3-4 children, Using a model of the solar system

Activating prior knowledge*:*

The teacher showing poster 19 with the planets: ***"Look at this picture! What do you see? Can you find the Earth? Which planets do you know? Which are our neighbouring planets?"***

Wait for the children's answers.



Teacher: ***"Now let's organise the planet models together and put them in the right order, just as they are shown on the poster. First the sun.*** (We can only see part of it in the picture because it is huge!)

Then the four rocky planets Mercury, Venus, the Earth with the Moon and Mars. These planets have a solid surface so we can stand and jump on them!
After Mars comes the asteroid belt. A ring around the sun in which there are lots of asteroids. These are large pieces of rock with different shapes."

Let the children make lots of little asteroids out of wrapping paper or newspaper.

"After that come the giant gas planets Jupiter, Saturn, Uranus and Neptune. All the gas planets are like round clouds, we couldn't stand on them! We would sink right in the centre! Far behind Neptune we find the dwarf planet Pluto!

Now we place the 'habitable zone' (blue piece of foil)***, this is the zone where water can be liquid! We know that life on Earth originated in water! We are very lucky that the Earth is located exactly in the habitable zone."***

Questions for the cildren: What happens to the water on a planet that is very close to the sun? And what happens to water when it is on a planet that is very far away from the sun? How cold is it there?

Leave the model of the solar system on one side of the classroom.

The description for building the model of the solar system can be found in the document 'Templates'

Step 3: Reflexion

5 min

The children answer the following questions in their Pale Blue Dot booklet:

How did Carl Sagan and his colleagues explore the solar system?

What is the Voyager 1?

What is the habitable zone of the solar system?

Which of the planets are located in the habitable zone?

Activity 3.3.2 Exploring the properties of the planets and compare them with the Earth

Total Duration: 30 min

Goal: Using a card game and the planet models, the children explore the properties of the rocky and gaseous planets, compare them with the Earth and discover how unique our planets are.

Material:

- poster 19 (the planets)
- planet cards, printed on both sides (see document 'Templates')
- table with planet profiles (see document 'Templates')
- Coloured pencils
- Scissors

Keywords: Rocky planet, gas planet, dwarf planet, moons

Step 1: Making the card game

2 min

Learning arrangement: Children sitting at their tables

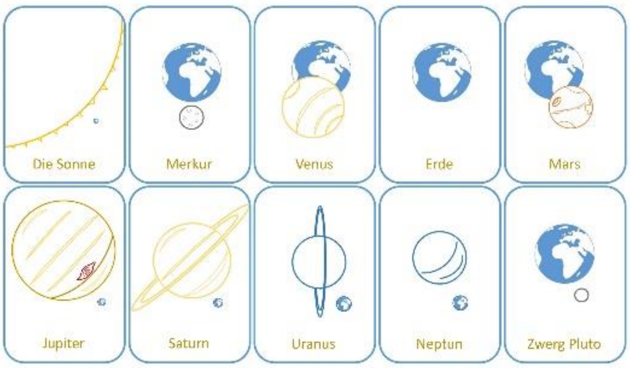
Realisation: First ask the children to identify the planets on their sheets of paper while looking at the large poster. Ask them to colour in the sun and planets according to the poster. Then ask the children to cut out the ten cards along the lines.

Step 2: Exploring the properties of the planets

2 min

Learning arrangement: children work in groups of 10 children

Participatory activities: The children work actively and form groups of ten to play the card game.



Realisation: On the back of each card is a summary of the most important characteristics of the individual planets. At the bottom is a question whose answer refers to another object in the solar system.
Each child receives a card. One child starts and reads out the text on their card and the question underneath. The children think together about which object is meant by the question.
Then the child who has the card with the corresponding object reads out the information on their card and asks the next question. You need ten children to play the game.

Step 3: Reflexion

2 min

Realisation: With the help of their card games and the table with properties of the planets, each child finds an order for the planets. (The table can be found in the document 'Templates')

There are many ways to find an order: Colour, number of moons, temperature...
Both group orders (e.g. rocky and gaseous planets) and series orders (e.g. by weight or distance from the sun) are possible.

This also trains information retrieval (reading skills) and stimulates information processing (order formation).

Realisation: The children then get together in small groups and explain to each other according to which order they have organised the planets.

Alternatively, the children can also guess the order of a classmate.

Each child then writes down an order that they particularly like in their Pale Blue Dot booklet.

Activity 3.3.3 Understanding and visualising the image of the pale blue dot

Total Duration: 30 min

Goal: The pupils reach the final goal of their mission: they explore and understand the image of the pale blue dot on their invitation card. They recognise the image of the Earth taken by Voyager 1 at a distance of 6.4 billion kilometres and discuss Carl Sagan's thoughts about our home planet.

Material:

- The solar system model from Activity 3.3.1
- A set of planet cards
- Cards with different photos of the earth
- The invitation cards for each student
- poster 20 (photo of the pale blue dot in large format)
- a magnifying glass
- Voyager 1 paper models for each child (see document 'Templates')
- a blue marble

Keywords: Image of the pale blue dot

Step 1: Recreating the flight of Voyager 1 with paper models

20 min

Learning arrangement: Children sitting at their tables

Participatory activities: activating prior knowledge, group work, building a Voyager 1 model

Realisation: The children fold, cut and glue their Voyager 1 models. They then line up along the solar system model (activity 3.3.1). A team of children places the planet cards near the corresponding planet. Together with the teacher, they briefly describe the most important characteristics of the objects in the solar system, starting with the sun, then Mercury and so on.

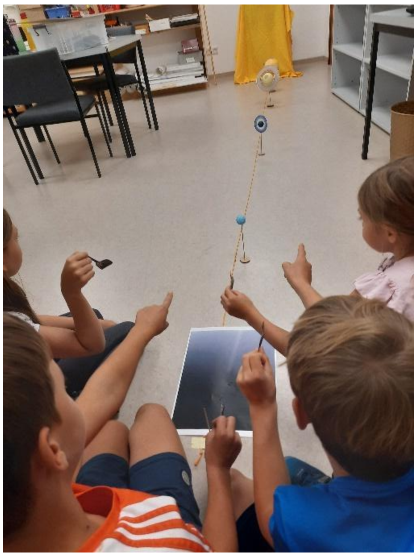
Teacher: ***"Here are some photos of the Earth taken by different space probes. Let's think together about from where in the solar system the photos were taken."***

The children think together about which photos were taken 'close' to the Earth and which were taken from further away. They orientate themselves on the size of the Earth in the various pictures and on other objects that can be seen next to the Earth.
The pictures are then placed in the appropriate places in the solar system model.

Teacher: ***"Do you remember Carl Sagan and the journey of Voyager 1 through the solar system? Where did it begin?"***
Let the children tell what they remember.

The children launch their Voyager paper models from Earth and travel along Mars, the asteroid belt, Jupiter, Saturn, etc. and fly beyond the dwarf planet Pluto.

"At a distance of 6.4 billion kilometres (Pluto's distance), the scientists wanted to switch off the instruments on Voyager 1 in order to save energy for the rest of the journey outside the solar system. Then Carl Sagan had a great idea: he sent a signal so that the Voyager 1 space probe would turn round one last time and take photos!"
The children make 'click, click, click' noises.



Step 2: Visualisierung des Bildes vom hellblauen Punkt

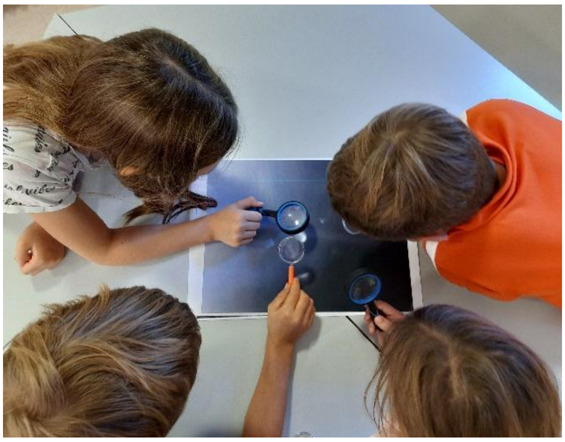
20 min

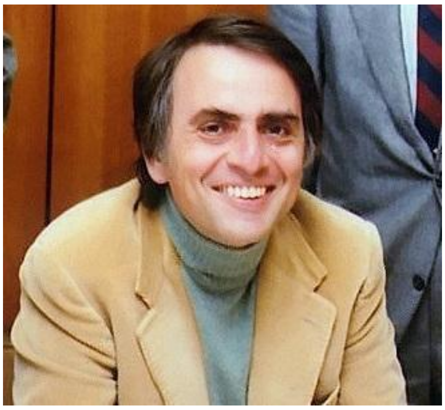
Learning arrangement: Children sitting in a semi-circle around the teacher

Participatory activities: activating prior knowledge, using visual resources, Use the magnifying glass to find the pale blue dot

The teacher showing the picture of the pale blue dot: ***"Here you can see the photo that was taken by Voyager 1. Can you see anything? Can you recognise anything?*** (The children search with a magnifying glass.) ***The pale blue dot is very small in these photos - do you know what it is?"***

The teacher guides the students so that they recognise the earth as it looks from a great distance!





Teacher: ***"Carl Sagan was very moved and impressed when he found the tiny earth in the photo. He said:***

„Look again at that dot. That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives." […] „Our planet is a lonely speck in the great enveloping cosmic dark." No wonder the space probe's camera almost missed this little pearl.

"[This picture] underscores our responsibility to deal more kindly with one another, and to preserve and cherish the pale blue dot, the only home we've ever known."

Teacher: ***„Carl Sagan really liked this photo. His goal was to further explore this small pale blue dot, our Earth, and also to protect it. He found out a lot about the Earth during his lifetime. But he wanted the research to continue after his death - through you! Carl wanted the children of the earth to continue their research and thus help to protect the earth in the future! Do you want to join in? And do you want to find out how the Earth and all the planets were formed?" YES!***

„And now, as a finale, we are going to look for a small blue marble hidden somewhere in the classroom!" (This blue pearl came with the astronomers' package.)

4 Glossary

Key:
Words in blue are Keywords.
Words in green are for further explanation for teachers.

air pressure: To understand air pressure, we should imagine that we always have a column of air above us. The amount of air over us determines the amount of pressure we feel. It exerts a force on us that pushes us towards the surface of the **planet**. Having the right air pressure around us is essential for our survival. This is why **astronauts** have to wear a spacesuit when they go into **space** or to the **moon**. Without the right pressure, we would either explode or be crushed.

Apollo 8: The **Apollo missions** were a US space programme with the aim of bringing people to the **moon** and safely back to Earth. The eighth mission (Apollo 8) was launched in 1968. It was the second mission with a crew and the first to leave the Earth's **orbit** and travel round the moon.

Apollo 11: Apollo 11 is the space mission during which the first humans landed on the **moon**. The American **astronauts** Neil Armstrong and Buzz Aldrin took the first steps on the surface of the moon on 20 July 1969. The third member of the crew, Michael Collins, remained in the **spaceship** orbiting the moon and brought the entire crew safely back to Earth.

Apollo mission: The Apollo missions were a US space programme with the aim of bringing people to the **moon** and safely back to Earth. The eleventh mission (**Apollo 11**) was the space mission in which the first humans landed on the moon. The **astronauts** took many pictures, carried out measurements and also brought moon rocks back to Earth.

asteroid: Asteroids are small objects (compared to a **planet**), ranging in size from a few metres to hundreds of kilometres, which are under the **gravitational** influence of the **sun**. Most of them are located in the **asteroid belt** between Mars and Jupiter and are also influenced by the gravitational pull of the largest planet in our **solar system** (Jupiter). The presence of Jupiter protects us from the impact of many asteroids. Asteroids are not round in shape and scientists estimate that there are hundreds of thousands of asteroids orbiting the sun in our solar system. We also believe that the Earth was hit by many asteroids in its early life: One of them gave birth to the **moon** (the event is called a giant impact) and many others brought water to our marvellous planet. As they are mostly made of ice particles, they melted as they hit the Earth, releasing water on the planet. An asteroid that enters the Earth's **atmosphere** is called a meteor if it burns up in the atmosphere (also known as a shooting star) and a **meteorite** if it is so large that it does not burn up completely in the atmosphere but hits the Earth.

asteroid belt: An asteroid belt is a ring-shaped area in which a large number of **asteroids** are located. In our **solar system** there are two asteroid belts with the **sun** at the centre. One is located between Mars and Jupiter and the other outside Neptune.

astronaut: Astronauts are people who are trained and equipped for space flights. They are usually scientists who have to take part in very intensive training programmes. These include both physical and scientific sessions in which the astronauts familiarise themselves with the extreme conditions in **space**, such as the absence of **gravity**. They have to wear a spacesuit to breathe and maintain pressure on their bodies and they travel in **spaceships**. The most famous astronaut is Neil Armstrong, who was the first man to walk on the **moon**. Nowadays, however, many women also work as astronauts and carry out many interesting experiments in space.

astronomer: Someone who has studied astronomy or astrophysics is called an astronomer or astrophysicist. They study **stars**, **galaxies**, **planets**, **moons**, **comets** and much more and try to answer questions about the origin of the **universe** and the existence and development of life on other planets, among other things. Astronomers work closely with scientists from other disciplines such as physicists, biologists, geologists and chemists to investigate complex and interdisciplinary questions. They deal with both the observation of astronomical objects, using **instruments** such as **telescopes**, and theoretical matters such as modelling and understanding stars, planets and galaxies. Carl Sagan was a very famous astronomer.

atmosphere: The layer of air that surrounds a planet is called atmosphere. Not every **planet** or rocky body is capable of forming an atmosphere. The **moon**, for example, has no atmosphere because it is not heavy enough to hold it. The atmosphere of a planet can consist of different **gases**. On Earth, the most important gases in the atmosphere are nitrogen and **oxygen**. The presence of an atmosphere on Earth is very important as it protects us from **asteroid** impacts and from the **sun**'s UV radiation.

atom: Everything around us is made up of atoms. The air, water, earth and stones, plants, animals and us humans. An atom has a nucleus consisting of protons and neutrons. Electrons move in the shell around this atomic nucleus. The atoms of different elements (hydrogen, **oxygen**, carbon, etc.) differ in the number of protons and neutrons in their nucleus. The number of protons determines what kind of element it is. Hydrogen atoms, for example, have only one proton in their nucleus, helium atoms have two and oxygen atoms have eight. The number of neutrons for a particular element, on the other hand, can vary slightly.

black hole: A black hole is an object in which the entire mass is concentrated in a very small space. It is therefore extremely dense. From a certain distance from the black hole on, not even light can escape it.

comet: Comets are comparatively small celestial bodies with a diameter of usually a few kilometres. They consist of rock, dust, water ice, dry ice (frozen CO_2) and other frozen hydrogen and carbon compounds. Comets form at the outer edge of the **solar system**. When they approach the **sun**, they develop a tail. This is formed when frozen particles are vaporised by the heat of the sun and then pushed away from the comet (by the radiation pressure of the sun).

cosmos: See **universe**

dwarf planet: A dwarf planet is a rocky object that orbits the **sun** just like a **planet**. It is heavy enough that it has acquired an approximately round shape (see **gravity**). Unlike a planet, however, a dwarf planet has not cleared its **orbit** of smaller rocks (called planetesimals). Pluto is a dwarf planet.

fusion: Fusion or nuclear fusion is the process when two **atom**ic nuclei fuse and form a new, heavier nucleus. This releases a lot of energy, but the process is only possible at extremely high temperatures and high pressure. **Stars** in which such extreme conditions can be found generate the energy that makes them glow through fusion.

galaxy: A galaxy is a collection of several hundred billion **stars** with their **planets** as well as many clouds of gas and dust. There are different types of galaxies. Spiral and barred spiral galaxies are flat discs in which stars, planets and **gas** rotate around a centre in which there is usually a **black hole**. Elliptical galaxies are usually even larger and do not form a disc, but an ellipsoid.
The galaxy in which our **solar system** and the Earth are located is called the **Milky Way** and is a barred spiral galaxy.

gas: Any substance for example water can assume a solid (such as ice), liquid (such as water) and gaseous state (water vapour). A substance that is in a gaseous state is referred to as a gas. In this state, the individual particles (**atoms**) that make up the substance move more strongly and are therefore no longer as strongly bound together as in the liquid or solid state. For this reason, gases are less dense than liquids or solids.

gas planet: Planets that are much larger than the Earth and consist of a huge amount of **gas** are gas planets. Planets such as Jupiter and Saturn are known as gas giants. They consist of a solid core surrounded by a very extensive gaseous envelope. Uranus and Neptune are also known as ice giants because, unlike Jupiter and Saturn, they have an icy inner core within the gaseous envelope. Their gas composition also differs from that of the **rocky planets**: They consist mainly of hydrogen and helium.

globe: A globe is usually used to represent the map of the earth on the surface of this spherical object. It is often mounted on an axis that allows it to be rotated.

gravity: Gravity is a force that attracts lighter objects to heavier ones. The heavier an object is, the stronger its gravitational pull but the further away you are from this object, the weaker it becomes. The earth, for example, is significantly heavier than a human being. Every person is therefore pulled back to the earth when they jump into the air. When **astronauts** in a **spaceship** move away from the Earth, however, the Earth's gravitational pull becomes weaker and weaker so that the astronauts float in the spaceship.
Gravity also ensures that objects such as **stars**, **planets** or **moons** do not fall apart and many of them have assumed an almost round shape. To understand this, you can imagine a planet as a collection of rocks. If this cluster of rocks becomes heavy enough, the gravitational pull felt by the outermost rocks is so great that they move as close as possible to the centre of the cluster. The whole accumulation thus becomes a **sphere**.

habitable zone: The habitable zone is a ring-shaped area around a star that is just far enough away from the **star** for water to occur there in liquid form. Closer to the star it is so warm that the water evaporates, further away it is so cold that it freezes. The location of the habitable zone depends primarily on the mass of the star (heavier stars are hotter than lighter ones) but also on the pressure at the surface of the **planet**.
In our solar system, Earth is the only planet in the habitable zone. Mars and Venus lie on its edges.

image of the Pale Blue Dot: The image “Pale Blue Dot” was taken by the **Voyager 1** probe from a distance of 6 billion km from Earth. It shows the Earth as a tiny pale blue dot in empty **space**.

instrument: Instruments are devices or tools used for scientific purposes. An example of a scientific instrument is the telescope, which is used by astronomers to observe, characterize and collect data about the sky and astronomical objects. Instruments can vary greatly in terms of their size, purpose, shape and complexity.

light year: The light year is a unit used to measure distances in astronomy. A light year is the distance that light will cover when travelling for one year. A light year is 9 460 730 472 580 800 metres, or approximately 9.46 trillion kilometres.

meteorite: An **asteroid** that enters the earth's atmosphere and hits the earth is called a meteorite. An asteroid that does not hit the earth but burns up in the **atmosphere** is called a meteor or shooting star.

Milky Way: The Milky Way is our home **galaxy**. It is a barred spiral galaxy with a **black hole** at its centre that is about 4 million times heavier than our **sun**. Our **solar system** lies on the edge of the Milky Way in a quiet region between two spiral arms.

model: A model is a simplified representation of reality. Scientists often develop models to better understand and simplify the processes that take place in nature. With the models of the earth and the

moon, for example, we want to visualise their relative sizes using different spheres or **globes**. As the dimensions of astronomical objects are very large, it is important to get a feel for them by comparing the objects and their relative size and shape.

moon: A moon is an object that orbits a **planet** and is also called a **satellite**. Moons orbit a planet as they move around the **star** together with the planet. The Earth has only one satellite, the moon (also called the Earth's moon), while other planets can have several. Jupiter, for example, has around 80 moons.

moons: See **moon**

moon phases: The phases of the moon describe the different shapes of the **moon** that we see on earth as the moon moves around our **planet** and the **sun**. It is important to understand that the Earth and Moon (as well as all other planets) do not shine on their own, but only **reflect** the light coming from the Sun. At night, we can see the moon in different phases. This is because the side of the moon that is visible to us is sometimes fully illuminated and sometimes only partially illuminated, depending on its position. Thus, the part of the illuminated surface of the moon that is visible on Earth can vary from 0 % (at new moon) to 100 % (at full moon). The phases of the moon change gradually over a period of around 29 days.

orbit: The path along which an astronomical object moves through **space** is called an orbit. This orbit can be closed, for example in the case of **planets** or **asteroids** orbiting a **star** on an elliptical path or **moons** moving around a planet. However, there are also objects that come to us from outside the **solar system**, are deflected by the **sun** so that they fly a curve and then disappear back into space without returning. Such orbits are called open orbits.

outer space: See **universe**

oxygen: Oxygen (O_2) is the component of air that is vital for us. We breathe in oxygen and breathe out carbon dioxide (CO_2). Plants, on the other hand, do exactly the opposite. They absorb CO_2 from the air and produce oxygen from it again. Oxygen makes up approx. 20.95% of the air around the earth.

planet: A planet is a round body that orbits around a **star**. There are 8 planets in our **solar system** that move around the **sun**. The first four planets are **rocky planets**, while the outer four planets are categorised as **gas planets**. A planet must have a round shape and its orbit must be clear of other objects. Since 1995, more than 7000 planets have been discovered orbiting stars other than our sun. They are known as exoplanets.

reflection: When light hits a surface and then returns back from it, this is called reflection. The best-known example of a reflective surface is a mirror. But metal, water or a snow surface can also reflect sunlight very well.

rocket: A rocket is a long, cylindrical object that is launched into the air. Rockets can be catapulted to great heights or long distances by burning material and are typically used as fireworks or signals. They are also used to launch **spacecraft**, **space probes** or **satellites** into their **orbit** and allow them to escape the Earth's **gravity**.

rocky planet: A rocky planet is a **planet** similar to our Earth. It has a solid surface that can be covered by both oceans and land. Depending on the size (and mass) of the planet, rocky planets can have an **atmosphere**. Earth, Venus and Mars have a thin atmosphere, while Mercury has none at all.

rotation: When an object spins around itself, this is called rotation. Almost all celestial bodies such as the **planets**, **moons** and the **sun** rotate around themselves. The planets and moons additionally move around a central body, i.e. the planets orbit the sun and moons orbit a planet.

satellite: A satellite is an object that orbits a celestial body. Human-made satellites are devices that orbit the Earth or another **planet** to collect data or take measurements. Unlike a **spaceship** or a **space probe**, they remain in a fixed **orbit** around a celestial body instead of moving between them. The **moon** is a natural satellite of the Earth.

scaled model: A scaled **model** is a replica of one or more actual objects. This replica is significantly larger or smaller than the original, depending on what is being modelled. However, the proportions and distances are exactly the same as those of the real object.

solar module: A solar module is an electrical component that can convert light (e.g. sunlight) into electricity. The module can therefore generate electricity from the energy emitted by the **sun**, which can then be utilised further. This form of electricity generation is therefore independent of raw materials such as coal, oil, uranium or similar. However, raw materials such as rare earths are still required to build a solar module. Solar modules are often used to supply **satellites** and **space probes** with electricity.

solar system: The solar system is one of many planetary systems in the **Milky Way**. A planetary system consists of one or more **stars** and some **planets** orbiting the star(s). It also includes all other smaller objects that are under the **gravitational** pull of the central star, such as **asteroids**, **comets**, **moons** and **dwarf planets**.

space: See **universe**

space probe: A space probe is an unmanned spacecraft that is controlled from Earth. It is equipped with various measuring **instruments** to explore our **solar system** in more detail and send the measured data back to Earth.

spaceship: A spaceship is a vehicle in which **astronauts** can travel through space. It consists of an air-filled room with the same pressure as on earth, so that the astronauts do not have to wear a spacesuit during the flight. It also has a drive and control elements and is usually equipped with various measuring **instruments** with which the astronauts explore the **universe**.

sphere: A geometrical three-dimensional object that is perfectly round is called a sphere. **Planets** are usually approximated as spheres, although they generally have some irregularities on their surface such as craters and mountains. The shape of the Earth is better described as a geoid, as it is a sphere compressed at the poles. This flattened shape is a result of the Earth's **rotation**.

star: A star is a **spherica**l object that consists of hot **gas**. They are much larger and heavier than **planets** and have such a high temperature and pressure inside that nuclear **fusion** can take place there. This means that two hydrogen nuclei fuse to form a helium nucleus. In very heavy stars (at least eight times heavier than our sun), the helium nuclei can also continue to fuse and form even heavier elements, which can then also fuse again until iron is finally formed in the innermost part of the star. Energy is released during all these processes, which is why stars shine. The closest star to us is the **sun**.

sun: The sun is the **star** at the centre of our **solar system** around which the earth and the other **planets** orbit. Like other stars, it also produces energy through the **fusion** of hydrogen into helium. This means that two hydrogen **atom**ic nuclei fuse and form a heavier helium nucleus. During this process, which is only possible at very high temperatures and high pressure, energy is released.

The sun has a diameter of around 1.39 million kilometres, which is about 109 times the width of the Earth. With an age of around 4.5 billion years, the sun is only about halfway through its life.

supernova: **Stars** that are more than eight times heavier than our sun explode at the end of their lives in a supernova explosion. In the process, they eject their shell, which consists of a mixture of different elements. These elements are formed during the lifetime of the star by nuclear **fusion** in its interior (see **star**). In this way, stars can enrich their surroundings with heavier elements (heavier than hydrogen).

telescope: A telescope is an astronomical **instrument** that can be used to observe distant objects such as **planets**, **stars** or **galaxies**. It consists of lenses and curved mirrors to magnify the light of a distant object. It was invented in the 17th century in the Netherlands but was first used to observe celestial objects by Galileo Galilei. Today there are many telescopes, both on the ground and in **orbits** around the earth.

universe: The universe, **cosmos** or **outer space** is the vast space in which everything else is located. All **galaxies**, **stars**, **planets** and **moons** are part of the same universe.

vacuum: Vacuum describes a space or area without any matter (also without air). The space between the **planets** and **galaxies**, for example, is very empty. There is an almost perfect vacuum there. To create a vacuum in a container on Earth, the air must be pumped out of the container. In most cases, it is not possible to completely empty the container and create a perfect vacuum, but even with an almost empty space, experiments can be carried out to explain, for example, how our body or other objects would behave in **space**.

Voyager 1: Voyager 1 is a NASA-built **space probe** that was launched from Earth in 1977. It then moved away from Earth and travelled towards the edge of the **solar system**. On its way, it explored Jupiter, Saturn with its rings and some of its **moons** in more detail. At a distance of 23.1 billion kilometres from the **sun**, Voyager 1 is now the most distant human-made object in the **universe**.

5 Literature for module 1

Educational content up close, Examining the learning dimensions of Education for Sustainable Development and Global Citizenship Education, UNESCO publication, 2020

Klahr, David, Exploring Science: The Cognition and Development of Discovery Processes, MIT-Press ISBN electronic: 9780262277228

Dr. Nicole Blum and Dr. Frances Hunt, Participatory activities in GCED, Global Education Course for Teachers, DERC, UCL Institute of Education

UNESCO Office Bangkok and Regional Bureau for Education in Asia and the Pacific: Preparing teachers for global citizenship education: a template, 2018

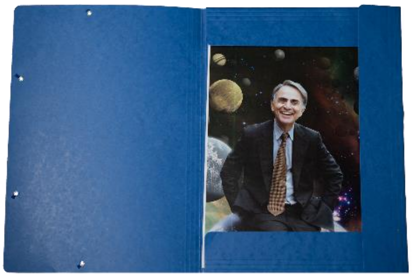
The Universe in the Box, UNAWE, https://www.unawe.org/resources/universebox/

World´s largest lesson WLL-Lesson-Plan-Apr2018-6.pdf (globalgoals.org)

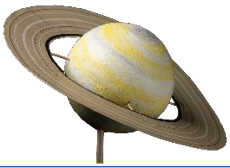
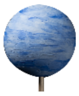
Shaple et al., 2014 in Innovating pedagogy 2014, The open university, https://www.openuniversity.edu/sites/www.openuniversity.edu/files/The_Open_University_Innovating_Pedagogy_2014_0.pdf

Ellis, G. & Brewster, J. (2014). Tell it Again! The Storytelling Handbook for Primary English Language Teachers. British Council. https://www.teachingenglish.org.uk/sites/teacheng/files/pub_D467_Storytelling_handbook_FINAL_web.pdf (accessed 28.07.2021)

6 List of materials for module 1

	Blue folder for handbooks	
	Blue folder (Din A3) with poster for storytelling	
	Package for invitation cards and badges	Activity 2.1
	Magnifying glass	Activity 3.1.1 and 3.3.3
	Moon phase box (For building instructions see document 'Templates')	Activity 3.1.2
	small torch	Activity 3.1.2
	Inflatable globe	Activity 3.2.1
	medium globe (11 cm diameter)	Activity 3.2.1

	small globe (6 cm diameter)	Activity 3.2.1
	Large moon (polystyrene ball with a diameter of 10 cm, painted grey)	Activity 3.2.1
	medium moon (polystyrene ball with a diameter of 4 cm, painted grey)	Activity 3.2.1
	small moon (polystyrene ball with a diameter of 2 cm, painted grey)	Activity 3.2.1
	Earth-Moon model (see document 'Templates')	Activity 3.2.2 and 3.2.5
	Origami rocket (Folding instructions see document 'Templates')	Activity 3.2.2
	Vacuum container with pump and balloon	Activity 3.2.3
	2 rice packages (different weights)	Activity 3.2.4
	yellow cloth (sun)	Activity 3.3.1

	Mercury (wooden ball 0.4 cm diameter, painted grey)	Activity 3.3.1
	Venus (wooden ball 1 cm diameter, painted yellow)	Activity 3.3.1
	Earth (wooden ball 1 cm in diameter, painted blue-green)	Activity 3.3.1
	Mars (wooden ball 0.6 cm diameter, painted red)	Activity 3.3.1
	Jupiter (polystyrene ball 12 cm diameter, painted red and white)	Activity 3.3.1
	Saturn (polystyrene ball 10 cm diameter, painted yellow, with rings)	Activity 3.3.1
	Uranus (polystyrene ball 4 cm diameter, painted blue-green, with rings)	Activity 3.3.1
	Neptune (polystyrene ball 4 cm diameter, painted light blue)	Activity 3.3.1
	Pluto (wooden ball 0.3 cm diameter, painted grey)	Activity 3.3.1
	Moon (wooden bead 0.3 cm diameter, painted grey)	Activity 3.3.1
	Habitable zone (blue foil)	Activity 3.3.1
	String with knot for measuring the distances in the solar system	Activity 3.3.1

	Voyager 1 model (see document 'Templates')	Activity 3.3.1 and 3.3.3
	Card game about the planets (see document 'Templates')	Activity 3.3.2
	Cards with photos of the earth	Activity 3.3.3
	Blue marble	Activity 3.3.3