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Bathroom Wonders

Conceptual introduction

'Bathroom Wonders' offers children a multitude of opportunities to investigate and explore. The short stories and corresponding experiments can be read and done independently of each other and are adaptable regarding their order.

The first story in the chapter, 'Lilu and the Water-Lilu' (→ page 10), is about Lilu discovering his mirror image in puddles and introduces children to the phenomenon of reflection, which plays an important role throughout the whole unit.

In the first exercises the children work in pairs, one child playing the mirror and the other one standing in front of 'the mirror'. By listening to the stories of Lilu and Alina, the children are given instructions, such as imitating each other's movements (→ page 13) or putting coloured dots on their faces (→ page 15).

Combining science with art, the children use mirrors to draw pictures of themselves. The resulting artworks are suggestive of the Spanish artist Joan Miró (→ page 17).

Additionally, there are several experiments about condensation on mirrors. Children learn why mirrors fog up, possible ways to clean them and how they can prevent them from fogging up in the first place (→ page 19, → 26 and → 28).

Lilu and Alina also discover the nature of various reflecting surfaces, i.e. what happens if the surface is not plane but curved (→ page 22) or what other shiny objects are in the bathroom and might be used as mirrors (→ page 26).

The chapter is complemented by a few more complex experiments, such as producing 'elephant toothpaste' (→ page 28), building a water purification centre (→ page 33) and growing your own crystals (→ page 33). Furthermore, the children learn more about the reflection of light as well as reflectors by playing the 'flashlight game' (→ page 33).

- **You can find the plain texts and dialogues as well as the room outline in a printer-friendly version online. A selection of pictures and videos which document some of the experiments is also available online.** [1]

Lilu and the Water-Lilu

SUMMARY
A story about Lilu discovering his reflections in puddles and mirrors introduces the children to the experiments and tasks in the teaching unit.

LEVEL
medium

DURATION
15 minutes

VOCABULARY
home, body parts, descriptive language

MATERIAL
- images [1]
- word cards – Home [1]

Pin the images on a whiteboard, so that the children can observe while the story is being read aloud. [1]

It has just stopped raining, when Lilu returns home from school. Because of the rain, there are a lot of puddles. The wind has stopped blowing, so the surface of the puddles is calm and smooth.

The heavy rain has formed a large puddle in the middle of the path. Lilu steps happily into it. Just as he is about to step into another puddle, he becomes frightened. At the exact moment he wants to step into the puddle, he looks down at the ground and another Lilu looks back at him out of the dark water.

The Water-Lilu does not want to let Lilu pass through the puddle: If Lilu steps to the right, the Water-Lilu steps to the right too. If Lilu steps to the left, the Water-Lilu does the same. Whatever he does, whenever he does it, the Water-Lilu seems to anticipate everything. The Water-Lilu leaves Lilu in peace and disappears only when he steps away from the puddle.

But as soon as Lilu looks back over the edge of the puddle – BAM! – the Water-Lilu is back. Taking a lot of detours, Lilu finally reaches home, but it takes much longer than he planned.

At home, Lilu's mother tells him that she has a surprise for him – a new mirror in the bathroom, a mirror that extends from the ceiling to the floor.

Full of anticipation, Lilu totally forgets to tell his mother about the encounter with the Water-Lilu. Quickly, Lilu goes into the bathroom and opens the door. But what is this?

This cannot be true!

The moment Lilu discovers the mirror in the bathroom, who is looking right at him when he looks into the mirror? Again another Lilu! The Mirror-Lilu plays the same game with him:

- If Lilu winks, the Mirror-Lilu winks back at the same time.
- If Lilu wiggles his ears, the Mirror-Lilu does the same.
- Even when Lilu sticks out his tongue, the Mirror-Lilu does not stop.

Then Lilu has to laugh out loud. The Mirror-Lilu does as well but one thing is funny: Lilu does not hear anything apart from his own laugh. He does not hear the laugh of the Mirror-Lilu. This is something peculiar and Lilu wants to investigate. Very carefully he approaches the mirror with his index finger. As expected the other Lilu does the same. Their fingertips touch each other. But when Lilu wants to move his finger further toward the tip of his nose to tickle the Mirror-Lilu there, he does not manage it. How is that possible?

Then the doorbell rings and his friend Alina comes to visit. Lilu tells her about the strange Mirror-Lilu experience in the bathroom. Together they start to investigate the secret of the mirror. What will they discover? Can you help them?

Follow up language activities

- The children train their vocabulary by using the word cards – Home. [1]
- The children draw a plan of their home or of Lilu's home.
- The children collect verbs about the activities people do in the bathroom.
- The children invent a story with Lilu and Alina as main characters.

Lilu and Alina in the bathroom

SUMMARY

With the help of experiments, which require partner work, the children are asked to follow instructions in front of a mirror and to give instructions themselves. Through that, the children are introduced to the concept of mirrors and reflections.

LEVEL

medium

DURATION

2 × 30–45 minutes

VOCABULARY

body parts, adjectives, possessive adjectives, expressions describing directions, verbs of movement, formulating instructions

MATERIAL

- large mirror or reflecting surface
- jumping rope/string/stick, ca. 1 m long
- sticky notes
- word cards – Body parts [1]
- worksheet A – Picture of Alina and Lilu [1]

Story in motion

The children face a large mirror or a reflecting surface, e.g. stainless steel surfaces or reflecting window fronts, and follow the instructions of the teacher as described in the story in motion below. The children play the part of Lilu and the teacher gives advice like Alina.

Lilu stands in front of the mirror.
Alina: Point a finger at your nose!
Lilu points and says: My nose.
Alina: Point a finger at your mouth!
Lilu points and says: My mouth.
Alina: Point a finger at your eye!
Lilu points and says: My eye.
Alina: Take a step forward!
Lilu takes a step forward and says: I step forward!
Alina: Take a step back!
Take a step to one side!
Stick out your tongue!

Try out further mirror movements.

Stop and talk!

What did Lilu and Alina find out?

Observations could be the following:
- The reflection imitates everything/does everything at the same time.
- If you take a step back, the reflection steps back too.

Learned vocabulary overview

- nouns describing the whole body:
  eye, mouth, hand, leg (word cards – Body parts [1])
- adjectives:
  slow, fast
- possessive adjectives:
  my, your
- expressions describing directions:
  forward, backward, to the side, up, down
- verbs:
  walk, stick out, point, lift, stretch, touch, rotate, stroke
- sentences:
  Touch your … (e.g. head) with your hand.
  Point with your finger at … (e.g. your/his/her) head.
  Go one step backwards/forward/to the side.

Story in motion (without language)

As a second step, the children play the story in motion in front of a fictional mirror. The teacher continues to tell the story in motion reported below. Children position themselves in pairs facing each other.

A rope/string/stick serves as a symbolic mirror and is placed on the floor between the two children. They play the roles of Lilu and Alina – be careful not to use 'left' or 'right' during the story in motion.

Lilu says: 'Now you are my mirror! Everything I do, you do too! I will move very slowly so you can do everything at the same time. From now on, there is no talk! Later we'll switch.'

Lilu lifts his hands very, very slowly up. His fingertips point upwards, his palms face toward Alina. Alina, as the reflection, does everything simultaneously.

Lilu puts both of his hands slowly on his head and strokes his hair until he touches his ears. With his thumbs and his index fingers, he pinches his earlobes. With both index fingers, Lilu moves slowly towards the tip of his nose. There the index fingers touch each other. Lilu leaves one hand on the tip of his nose, with the other hand he moves slowly towards his belly button and then hides it behind his back. Alina, as the reflection, always does the same.

With the index finger on the tip of his nose, Lilu taps, one by one, his forehead, both eyes, his mouth, his chin, his belly and each knee.

Now Lilu slowly takes a step backwards, then one step to the side, then one to the other side and now forward again. They keep playing until they switch roles.

Language consideration and consolidation

- A 'reporter' (the teacher or a child) comments on the movement of the child in front of the mirror and maybe another 'reporter' on the movement of the reflection.
- A third child (or the teacher) gives instructions to the child 'in front of the mirror'.
- The children practice singular and plural forms of the nouns with the word cards – Body parts. [1]
- The children build sentences with the words on the word cards – Body parts. [1]
- The children write instructions for other children.
- The children form sentences with adjectives.

Variations of the game

The class/several children observe a mirror pair and have to guess who is the mirror image/reflection.

Good working teams switch roles during the mirror scene without arranging it beforehand.

Follow up language activities

Stop and paint!

Print worksheet A – Picture of Alina and Lilu [1] in black and white in A4 size. One child gives the task: 'Colour the hand.' Another child colours and repeats: 'I colour the hand.'

- Name and colour the different body parts!
- Label the body parts!

Stop and play!

An uncoloured and unlabelled picture of Alina and Lilu is given out. One child asks: 'Where is the hand?' or 'Show me the hand!', the other child points at the picture and says: 'This is a hand.' As supporting material, children can use their coloured and labelled picture.

- Name and point out the different body parts!

Stop and play!

Cover the words on your coloured and labelled picture, e.g. with sticky notes. Only the picture is visible. Name the body parts and uncover the words to check your answers.

Background information: Plane mirrors

In a plane mirror:

- The reflection is the same size as the original in front of the mirror. It appears as if the reflection is behind the mirror. From the viewer's perspective, the reflection seems to have the same distance to the mirror as the viewer.
- A reflection is always upright, it does not reverse up and down.
- A mirror only reverses the front and the back.

Carnival-Dots-Action

SUMMARY

By listening to a short story, the children are requested to follow Lilu and Alina as they put coloured dots onto their faces. Subsequently, the children are asked to discuss their observations.

LEVEL

medium

VOCABULARY

instructions, body parts, directions

DURATION

45–60 minutes

MATERIAL

- coloured sticky dots
- mirror

Story in motion

While the teacher reads out loud the story in motion below, all the children do the actions at the same time.

Today Lilu and Alina are going to play carnival. Alina gets sticky dots out of her bag.

Lilu and Alina stand in front of each other like a mirror. Alina gives Lilu a sticky dot and says: 'You have to stick it on yourself the same way I do, just like in a mirror.'

Carefully Alina lifts her hand and sticks a blue dot on her cheek. Lilu does the same thing facing her. Then Alina sticks a yellow dot on her nose. Lilu does the same. Alina sticks a white dot on her chin.

Lilu's mother enters the room. Both friends turn around towards Lilu's mother and say: 'See, we look exactly the same!' Lilu's mother asks: 'Are you really sure? Stand next to each other in front of the mirror!'

Stop and ask!

What does the mother notice?
Where do Lilu and Alina have their dots?
What do you notice about the position of the dot on the nose?

Observations could be the following:

- The dots which have been placed on a cheek, a shoulder or a knee are inverted.
- The dots which have been placed in the centre (e.g. on the nose) are identical for both children.
- This transfer is very difficult for children and only suitable for top-performing children.

Please note

- At this point, the terms 'left' and 'right' are not being used on purpose, as it could lead to confusing discussions during the actions.
- Each time they place a sticky dot, both children need to use the same colour.

Stop and play!

- The same pairs stand again facing each other and put more dots all over their bodies.
- Then partner 1 says to partner 2: 'Point to the same blue dot, to which I point to on my face.'
- During this, partner 2 can only use partner 1 for orientation.
- The partners then switch roles.

Language considerations and consolidations

- The children give and understand instructions.
- The children repeat body parts, verbs, directions, etc.

Stop and play!

- Depending on the level of performance of the children, several groups can take part.
- Between two and four children are the mirror experts and step outside the room.
- Now the remaining children each choose a partner. All teams receive identical sets with different coloured dots. Together each team sticks the five dots on their faces.
- Then the children stand apart, randomly in the room. The mirror experts are asked to come back inside. Now they have to reunite the pairs using the pattern of the coloured dots. The aim is to place the correct pairs facing each other like in a mirror.

Link to mathematics

To keep the coloured dots as closely as possible in the same place, the children measure the distances, e.g. from the nose to the dot using their fingers (fingerbreadth). Subsequently, the following questions could be explored: What kind of length units of measurement exist? For example: the ell, the hand span, the foot, etc. Which units of measurement are used in other cultures?

Further mirror activities

Further mirror activities could be to explore how specific letters and written words look in a mirror (e.g. differentiate between the horizontal and the vertical axis).

Miró faces

SUMMARY

In pairs, the children are asked to draw their faces on a sheet of paper with the help of a mirror. The results of this task are small artworks, which are suggestive of the Spanish artist Joan Miró.[2]

LEVEL

easy to medium

DURATION

2 × 30 minutes

VOCABULARY

accompany one's own actions by describing or commenting on them

MATERIAL (PER PAIR OF CHILDREN)

- mirror (ca. 15 × 15 cm)
- overhead or whiteboard marker
- white paper
- pencil
- coloured pencil / wax crayons / water colours
- word cards – Parts of the face [1]

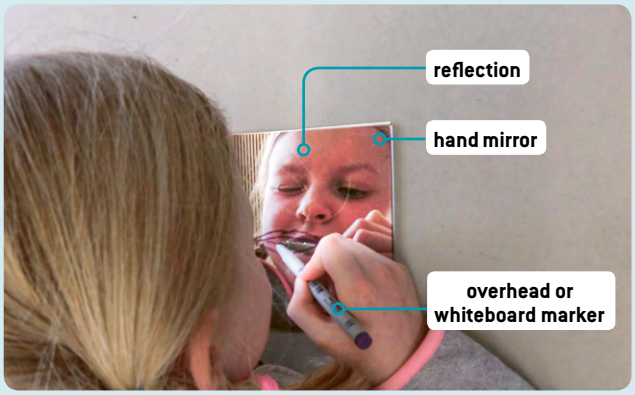
Lilu and Alina find Lilu's mother's lipstick in front of the mirror. The lipstick is such a shiny, pretty red that they want to paint with it immediately! They most want to trace their faces on the mirror. Will they manage? Try it out yourself!

Stop and jot down!

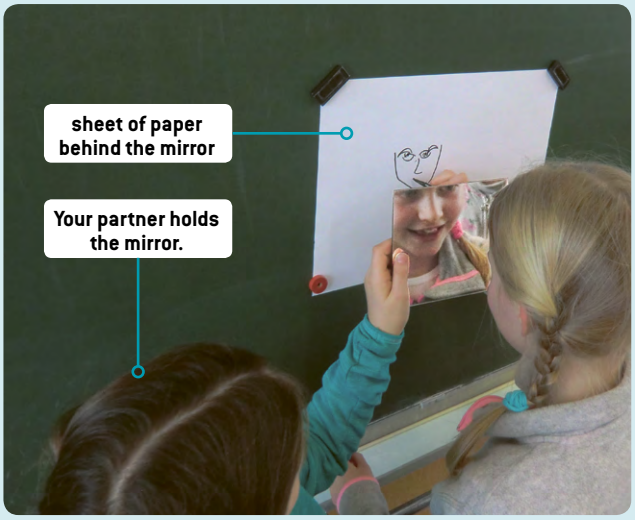
Make assumptions about the feasibility of tracing your own face on a mirror. (The children probably assume that this is very easy.)

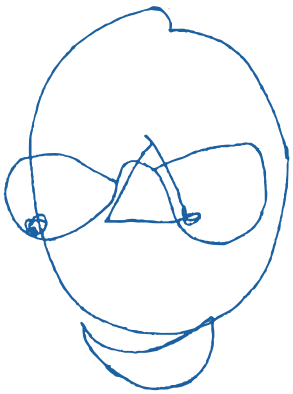
Stop and paint!

- Hold the mirror in front of your face. Trace your face on the mirror using the overhead/whiteboard marker. What do you observe?
- Now close one of your eyes. Hold the mirror in front of your face and trace your face on the mirror using the overhead/whiteboard marker. What do you observe?



- Choose a partner. Attach a sheet of white paper to the wall and stand an arm's length away in front of it. Your partner holds the mirror in front of your face. Now trace your face with a pencil on the sheet of paper behind the mirror!





Possible result

Stop and paint!

Look at your work and colour it. Give your picture a pretty name! The image can also be scanned. You can edit it using an image editing programme.

Language considerations and consolidations

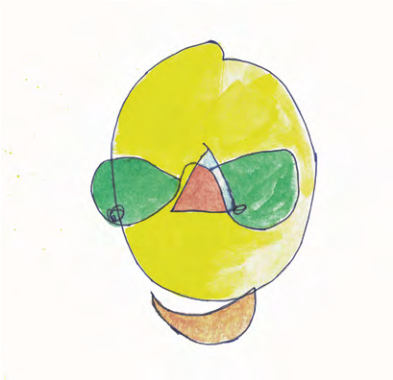
Everything can be accompanied orally while doing the task:

▸ I will draw the eye/the eyes.	▸ Maria will draw the eye/the eyes.
▸ I will draw the mouth.	▸ Maria will draw the mouth.
▸ I will draw … … the lips. … the hair. … the nose. … the ear/the ears. … the eyebrows. … the eyelashes.	▸ Maria will draw … … the lips. … the hair. … the nose. … the ear/the ears. … the eyebrows. … the eyelashes.

More language activities like word cards are available online. [1]

Background information: Reflection and mirror plane

- During the first task, it will be difficult for the children to trace their faces on the mirror as the actual reflection is behind the mirror plane. Due to stereo vision with both eyes, the image and the reflection are not congruent.
- During the second task, it is possible to draw a congruent image with the reflection as only one eye is used and therefore spectroscopic vision is 'disturbed'. The reflection is not behind the mirror plane anymore but on it.
- During the third task, the children experience that their reflection is behind the mirror plane, so to speak 'on the sheet of white paper' behind the mirror.



Coloured Miró face

Face number 6

Greenling

Moustache face

Condensation on the mirror

SUMMARY

Through exploratory learning, the children are supposed to work out under what conditions a mirror fogs up and how to clean it again. The task is accompanied by another short story about Lilu and Alina.

LEVEL

medium to difficult

DURATION

60 minutes

VOCABULARY

adjectives and their opposites, nouns for objects used in daily life, verbs for scientific working

MATERIAL

- **mirror**
- **fridge or cooler bag**
- **cup**
- **materials and devices to remove condensed water on the mirror, e.g. cling film, paper towel, hair dryer**
- **word cards – Condensation** [1]

Lilu steps out of the shower and wants to play with the Mirror-Lilu. He walks towards the mirror. But what is going on? The Mirror-Lilu is not there anymore. Where has he gone?

Stop and ask!

What has happened? Do you have an idea why Lilu cannot see the Mirror-Lilu anymore?

Stop and discuss!

Talk about your own experiences with mirrors in the bathroom. You could also talk about foggy car windows when it is cold.

Observations could be the following:

- The mirror is fogged.
- The mirror is wet.
- It is fog on the mirror.
- The mirror turns white.

Stop and experiment!

Put a mirror into a fridge or a cooler bag. Take it out again after 5 to 10 minutes. Observe what happens.

Observations could be the following:

- As soon as the cold mirror comes into contact with the warm and humid air of the classroom, it fogs up.

Stop and experiment!

Put the mirror, with the fogged up side upwards, on your hand and observe what happens.

Observations could be the following:

- An imprint of the hand or the finger becomes visible gradually. The fogged up mirror surface slowly becomes clear, where it is warmer. This process takes up to one minute and so the children need to be patient.

Stop and investigate!

Consider the different options to make the mirror reflective again. Which of the following devices and materials could help you to remove the condensed water on the mirror? Try some of them out yourself!

Paper towel, cling film, aluminium foil, baking paper, towel, dish scrubber, blackboard eraser, cotton fabric, polyester fabric, hand-held fan, hair dryer (⚠ to be used by the teacher), bicycle pump, electric hand fan, cooking spoon, newspaper, straw, balloon, electric torch/flashlight, sun, radiator, etc.

Note your assumptions and observations in a table.
Example:

Material	Assumption	Solution
paper towel	☺	☺
cling film	☹	☹
…		

Observations could be the following:

- All absorbent materials soak up the condensed water and become moist or damp.
- All devices which generate warmth or an air current dry the mirror surface.
- All other materials and devices are not suitable to remove the condensed water.

Stop and discuss!

Collect all your results and have a group discussion about the condensed water on the mirror.

Stop and jot down!

What can you do to make the mirror fog up again?
Which of the following materials could help you with that: hot water, ice cold water, a cup, a mirror?
Think about a solution!

Stop and experiment!

Put hot water in a cup and put the mirror, with the mirror surface facing down, over the cup. Leave it there for 30 to 60 seconds. Afterwards, pick it up carefully at the frame and turn it over again to see the mirror side. Observe and compare.
Safety! Be careful with the hot water!

Observations could be the following:

- After about one minute, the surface of the mirror fogs up because of the steam.

Stop and experiment!

Use your finger to draw a 'secret' message (e.g. a letter or a number) on the fogged mirror. Leave the mirror to dry.

Please note:

- The mirror surface should not be touched again.
- The mirrors should be stored where they will not be disturbed to dry.

Draw the same 'secret' message on a piece of paper and give it to your teacher. In the next lesson your teacher will spread these pieces of paper randomly throughout the classroom. You receive one 'secret message mirror'. Fog the mirror up again. Can you recognise the secret message on the mirror and find the corresponding paper message?

Language considerations and consolidations

- The children collect adjectives and their opposites.
- The children use nouns for objects from daily life.
- The children use verbs for scientific working.
- The children think about their work and write their considerations in their notebooks.
- Sentence beginnings to formulate considerations:
  I was amazed by …
  I (especially) liked …
  It was new for me that …
  I am happy that …
  I did not like that …
  It was interesting for me that …
  I have been surprised that …
  It was difficult to …
  I had not thought that …
  I would like to remember that …
- Sentence beginnings to help write assumptions:
  I guess …
  I believe …
  I think …
- Possible assumptions of the children:
  I guess …
  … that the mirror is blurred.
  … that it is wet because Lilu has sprayed the mirror.
  … that there is steam on the mirror.
  … that steam rises when showering.
  … that the mirror steams up because of the heat.
  … that Lilu has the wrong perspective.
  … that the air in the bathroom is like exhaled air.

Learned vocabulary overview

- adjectives:
  wet/moist – dry, hot/warm – cold, thin – thick, chilled – heated
- nouns:
  air, aluminium foil, baking paper, balloon, bicycle pump, blackboard eraser, cling film, cotton fabric, dish scrubber, electric hand fan, electric torch/flashlight, finger, hair dryer, hand-held fan, moisture, newspaper, paper towel, polyester fabric, radiator, steam, straw, sun, temperature/temperature difference, thermometer, towel, vacuum flask, water, water drop, water droplet, wind
- verbs:
  fog up, dry, hold, condense, cool down, heat up, blow, wipe, rub, pour, turn around, measure, observe/record

The word cards can be used to label materials and devices. [1]

Background information: Condensation

Warm air can absorb a lot of water vapour without it being visible to the naked eye. The cooler the air, the less water vapour can be absorbed. The water vapour starts to attach itself to small dust particles and to form miniscule water droplets. This process is scientifically called 'condensation'.

Vapour trails in the sky are created in a similar process: jet engines emit a high pressure stream of combustion gases and water vapour. As soon as these gases leave the airplane, they relax (this means the pressure decreases) and they cool down. As a consequence, the previously invisible water vapour is transformed into many miniscule water droplets. These droplets form the vapour trails in the sky.

In the same way, water vapour is created when showering. The warm air in the bathroom absorbs the water vapour. But the glass of the mirror is still cooler than the warm air. When the warm and humid air comes into contact with the cooler mirror surface, the water vapour condenses in the form of many miniscule water droplets on the mirror surface. As soon as the mirror surface is warmed up again, e.g. by using a hair dryer, the mirror becomes clear again.

Lilu's and Alina's observations in spherical mirrors

SUMMARY

In this chapter, the children experiment with flexible mirror foil and kitchen utensils. They are being introduced to curved mirrors and challenged to find reflecting, convex or concave surfaces in their surroundings. In a discussion afterwards, the children can formulate their observations and assumptions.

LEVEL

medium

DURATION

2 × 30 minutes

VOCABULARY

formulating observations, household items

MATERIAL

- flexible mirror (can be made from self-adhesive mirror wallpaper, which can be purchased from hobby or decoration markets and art supplies shops)
- little toy/figure with movable arms
- ladle
- spoon

Lilu got a special present from his friend Alina: a mirror that can be bent and cannot be broken. Lilu and Alina are looking at themselves in it. First, they place it straight against the wall: they see themselves just like in a regular mirror. Then Lilu stays in front of the mirror while Alina pushes the top of the mirror down so it bends from top to the bottom. Lilu starts laughing. 'Look at this!' Lilu says. Then Alina stands in front of the mirror while Lilu pushes it from the sides, so it bends from side to side.

Stop and discuss!

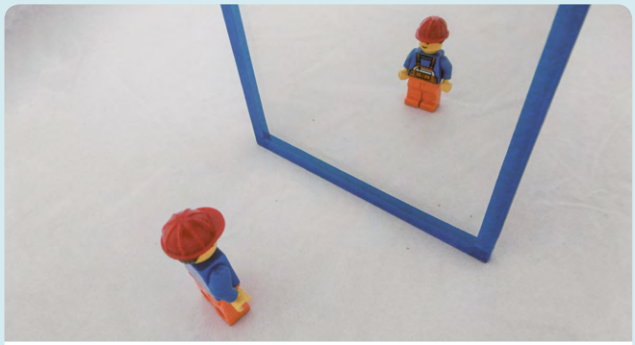
What happens with Alina's and Lilu's mirror image? Make assumptions.

- What happens to Lilu's reflection when the mirror is bent from top to bottom?
- Is there any difference if the middle of the mirror is pushed out, towards Lilu or in, away from Lilu?
- What happens to Alina's reflection when the mirror is bent from side to side?
- Is there any difference if the middle of the mirror is pushed out, towards Alina or in, away from Alina?
- Will the reflection change if Alina waves her hand while Lilu is bending the mirror (when first bending the mirror towards Alina and then away from her)?

Stop and experiment!

Plane mirror:

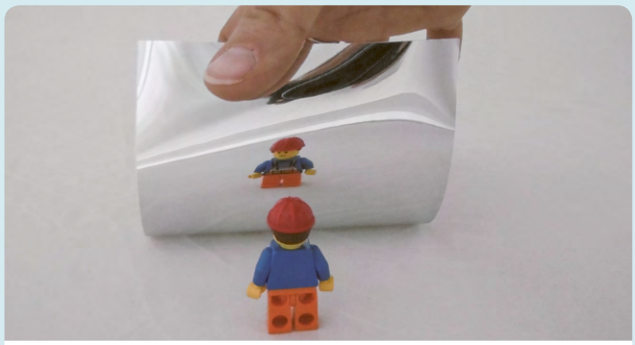
- Keep the flexible mirror straight and look at it so you can see the little toy the same way as in a plane mirror.



Plane mirror

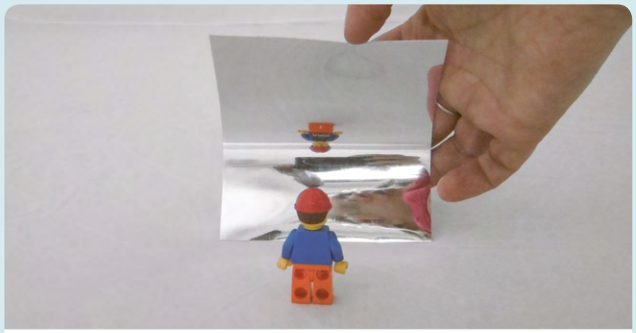
Mirror bent vertically:

- Hold the upper and lower side of the flexible mirror and press them gently towards each other so the mirror bends.
- Watch the little toy's reflection.



Mirror bent vertically

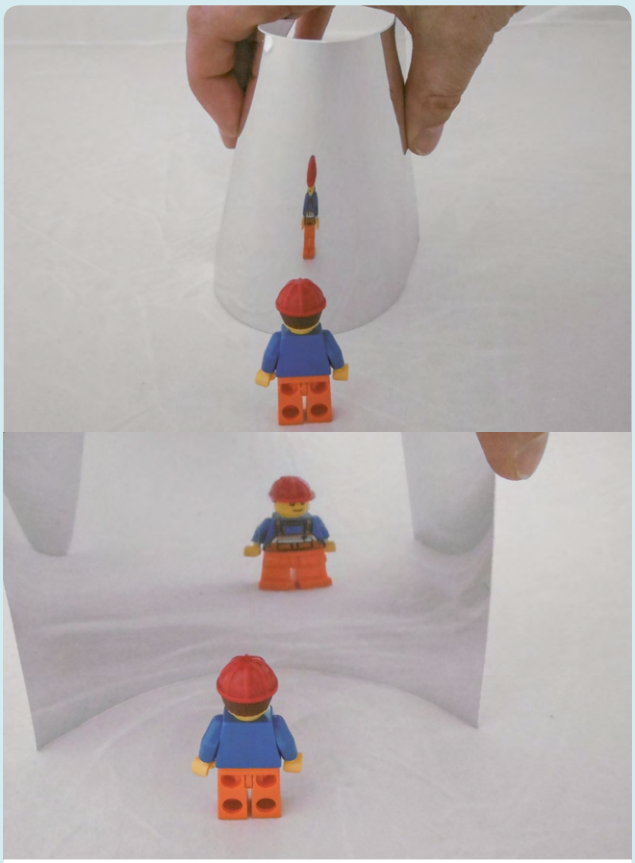
- Bend the middle of the mirror in the other direction and watch the toy's reflection change.



Mirror bent vertically: Bottom and top are flipped

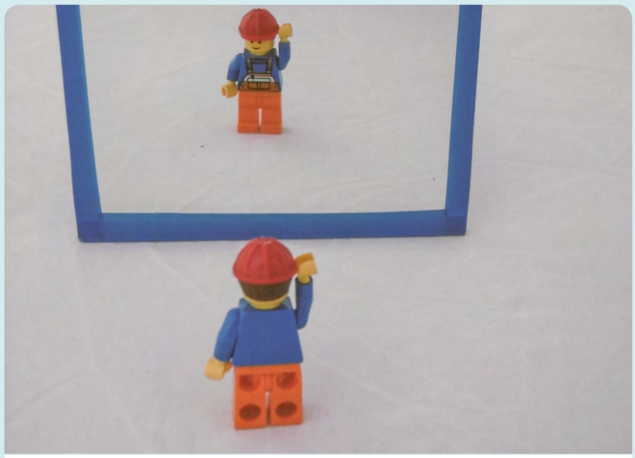
Mirror bent horizontally:

- Hold the left and right sides of the mirror and press them gently towards each other so the mirror bends.
- Watch the little toy's reflection.
- Bend the middle of the mirror in the other direction and watch the toy's reflection change.

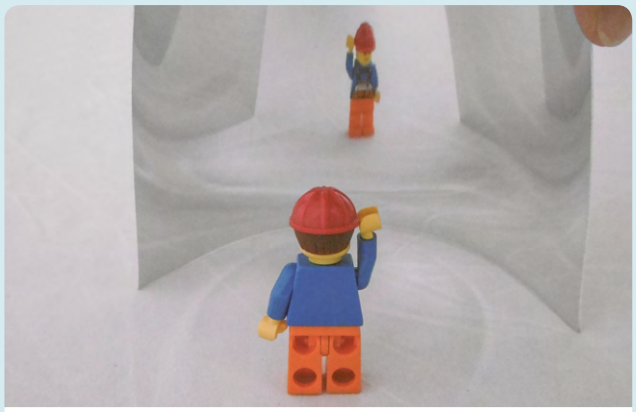


Mirrors bent horizontally

- Lift one hand of the little toy.
- Place the toy in front of a plane mirror and watch its reflection.
- Place the toy with one hand up in front of a flexible mirror.
- Bend the flexible mirror towards the little toy and watch the little toy's reflection.
- Bend the flexible mirror away from the little toy and watch the toy's reflection change.



Plane mirror



Bent mirror: sides are flipped

Stop and talk!

Describe what you see!

Depending on their language knowledge, the children use simple terms or whole sentences. Examples:

- I can see myself/the toy smaller.
- I can see myself/the toy upside down.
- I can see my/the toy's left hand on the right.
- I can see my/the toy's image deformed.

Lilu's mother calls Lilu and Alina to dinner. Before dinner, the two friends help to set the table. Lilu is looking at the ladle. Another Lilu is looking up at him from inside the ladle, but he is upside down! He tries to rotate the ladle to get the reflection right. Can he fix it this way?

After dinner, the two friends go through the house looking for everything that can work as a mirror.

Stop and jot down!

Make assumptions about what happens with Lilu's image in the ladle.

Supporting questions:

- Can the upside down image inside the ladle be corrected by rotating the ladle?
- Is the image upside down if you look at the ladle from the other side?
- When looking into a spoon, can we see the same effect?

Stop and experiment!

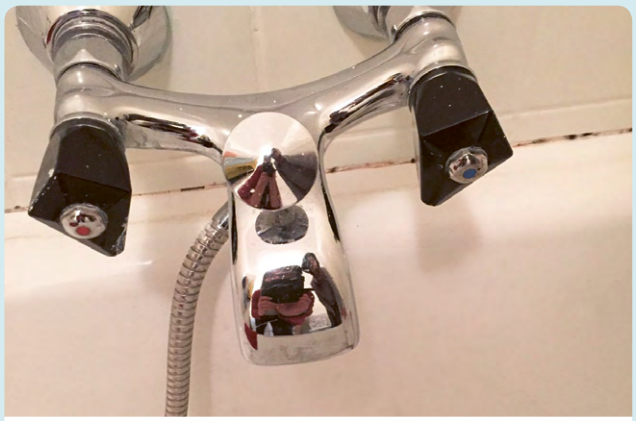
- Look at your image in a kitchen ladle. Look at the ladle carefully from outside and inside.
- Try the same with a spoon.

Reflection in kitchen ladle – outside

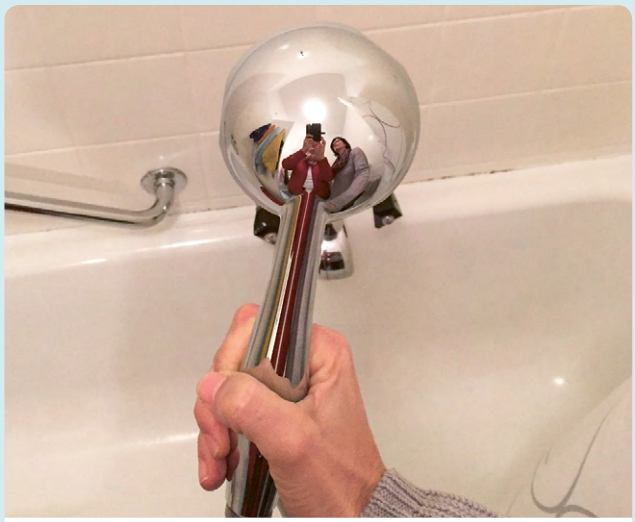
Reflection in kitchen ladle – inside: bottom and top are flipped

- Go around the house, classroom or school and look for things that work like mirrors.
- Decide which of them work like flat mirrors and which like bent mirrors.
- Where is your reflection normal and where is it deformed?

Some examples of things that work like mirrors:



Reflection in a tap



Reflection in a shower head

Reflection in a teapot

Stop and talk!

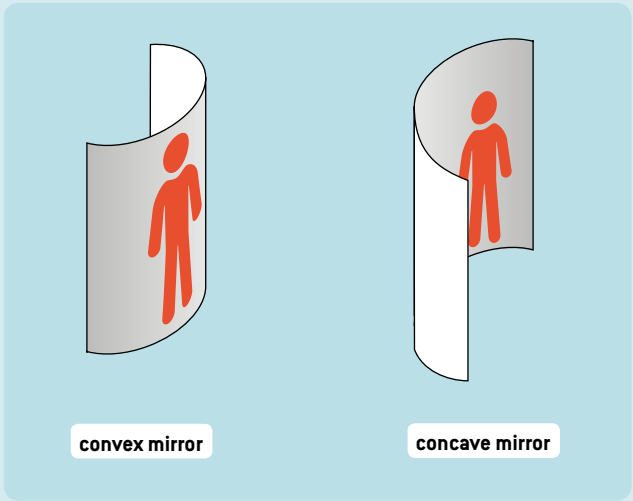
Name the different reflective things and describe how you see yourself in them.

Learned vocabulary overview

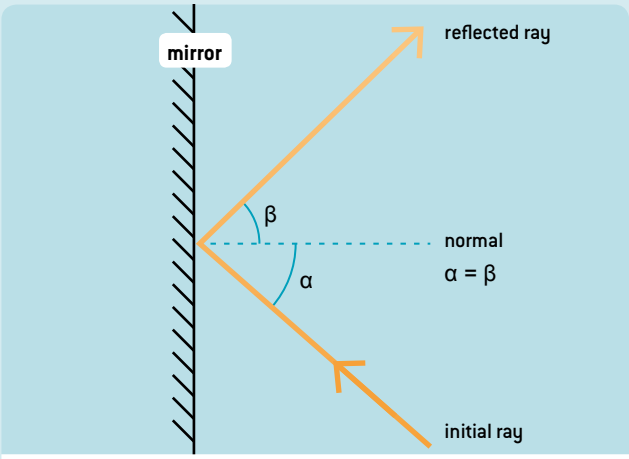
- comparative adjectives, nouns and verbs, e.g. big, bigger, bottom, fix, inside, ladle, large, larger, left, outside, overturned, right, short, shorter, slim, slimmer, small, smaller, spoon, tall, taller, top, turn, upside down
- names of different reflective things at home, e.g. handle, kettle, ladle, lock, tap, shower, spoon

Background information: Reflection on mirrors

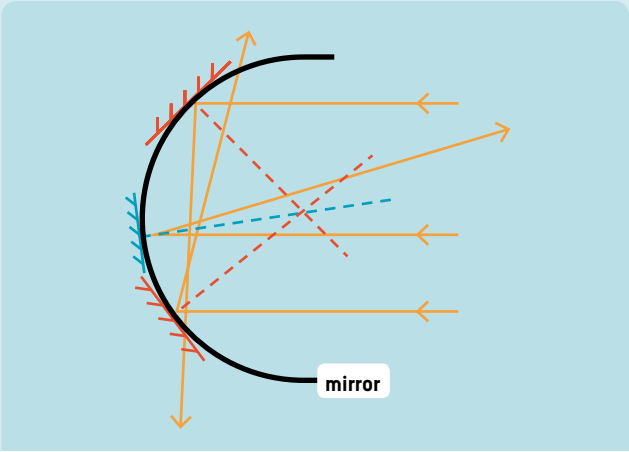
- **Plane mirrors** give images that are upright, have the same size as the object and are symmetrical with the object in the plane of the mirror.
- **Convex mirrors** give images that are upright and smaller.
- **Concave mirrors** give images that can be smaller or bigger, and upright or upside down, depending on the proximity of the object to the mirror.



The mirrors reflect light rays according to the laws of reflection: the angle the reflected ray makes with a normal to the reflecting surface (a normal is a line perpendicular to the surface) is the same as the angle the initial ray makes with that normal, both rays stay in the same plane. The curved mirror can be imagined as composed of a lot of very small plane mirrors placed tangentially to the surface of the mirror at individual points of the curved mirror. [3]



Plane mirror with a normal and one ray



Curved mirror with three rays

Lilu likes shiny objects

SUMMARY

The focus in this chapter is on the following scientific tasks: ordering and sorting. These are introduced to the children through a simple text about Lilu, who loves shiny objects.

LEVEL

easy

DURATION

- Why is the mirror foggy?: 45 minutes
- The shiny spoon: 45 minutes
- Shiny objects: 2 × 45 minutes

VOCABULARY

words related to showering, objects in the bathroom, different materials, body parts

MATERIAL

worksheet B – Why is the mirror foggy? [1]
- scissors

worksheet C – The shiny spoon [1]
- matches or lighter
- teaspoon
- tea light
- glass of water

Safety! Be careful not to burn yourself!

worksheet D – Shiny objects [1]
- scissors

Why is the mirror foggy?

Lilu loves things that shine. One morning Lilu's mother takes a shower and when Lilu comes into the bathroom to take a look in the mirror, it is not shiny anymore.

Stop and jot down!

What do you think Lilu sees in the mirror?

Stop and investigate!

Cut out the drawings on worksheet B – Why is the mirror foggy? [1] Place the drawings in the right order to find out what has happened to the mirror.

Background information: Condensation

The children use drawings to explain from their own experience why taking a hot shower will result in a foggy mirror. In this approach on cause and effect, the children train their observation skills and how to sort events in chronological order. The vocabulary used contains words like steam, fog, water, mirror, hair, wet and bath.

How does it work? When the air in the bathroom is heated by the hot shower, it makes the water evaporate. Upon reaching the cold surface of the mirror, the water in the moist air condenses, thereby creating the fog on the mirror (see also background information page 21).

The shiny spoon

Lilu tries to wipe the fog away with his towel, but it keeps coming back. Instead he decides to use a spoon as a mirror. Lilu thinks the spoon is not shiny enough to function as a mirror and then he gets an idea. On the Internet, he has seen someone making an egg look like it is coated with chrome. Perhaps he could do the same with the spoon?

Stop and experiment!

Follow the procedure on worksheet C – The shiny spoon [1] to make the spoon shine like chrome.

Background information: Total reflection

Since the mirror is fogging up, Lilu decides to use a spoon as a mirror. However, the spoon is not shiny enough and so Lilu tries to make it look shiny. The children have to repeat this process. By doing this, the children train their vocabulary of the things they use, such as matches, lighter, teaspoon, tea light, glass and water. Afterwards, they can describe how the spoon looks like before and after the activity, using words like chrome and shiny.

How does it work? When the stearin is burning, carbon is released. It is the carbon that gives the spoon its black appearance. Carbon repels water and a small pocket of air is being formed between the water and the carbon. When light hits the interface between water and air at a certain angle, all of the light is reflected. This phenomenon is called total reflection. The light does not get through to the carbon layer. That is why you do not see the carbon layer and the spoon looks like it is made of chrome.

Shiny objects

Lilu's idea works and the spoon seems exactly as if it was coated with chrome. Looking at the shiny spoon, Lilu gets excited and decides to search for other things that are shiny.

Stop and investigate!

Help Lilu to find the things on worksheet D – Shiny objects.[1] You could also cut out the pictures on the worksheet and sort them by function or by material.

Summary and learned vocabulary overview

Here the children have to recognise items from the bathroom that are shiny. By doing this, the children train their vocabulary of different bathroom items. Besides this, the pictures can be cut out and the children can sort them by material, which will train the children's vocabulary of different materials like metal, plastic and wood. The pictures could also be sorted by the areas of the body on which the different items are being used (e.g. hair, mouth, hands, face, armpits), by the situations where the items are being used (e.g. in the shower, doing your hair, doing your nails, putting on make-up, brushing your teeth, shaving your face) or perhaps by when the items are being used, training the understanding of prepositions describing time (e.g. before showering, while showering, after showering).

PROPOSED ACTIVITIES (please visit the library from page 67 for a detailed description of the proposed activities)

	Before reading	While reading	After the activity
Why is the mirror foggy?	Word wheel (shower)	Listening	Extend word wheel
The shiny spoon	Word wheel (spoon)	Listening	Extend word wheel
Shiny objects	Word wheel (materials)	Listening	I. Extend word wheel II. Mapping of the whole story

Lilu, Alina and the scientific experiment

SUMMARY

The focus in this chapter is on designing a scientific experiment where the children make their own toothpaste for elephants. In a second experiment, they make their own fog and afterwards try to come up with a solution to avoid fog on the bathroom mirror.

LEVEL

medium

DURATION

- The elephant toothpaste: 2 × 45 minutes
- Fog or no fog?: 3 × 45 minutes

VOCABULARY

amounts, shapes, sizes, colours, everyday products

MATERIAL

worksheet E – The elephant toothpaste [1]

- 10 ml hydrogen peroxide (10 %)
- food colouring (optional)
- dish soap
- dry yeast
- warm water
- narrow and tall glass (250 ml)
- cup
- goggles
- lab coat
- gloves

Safety! Find out whether it is allowed to use hydrogen peroxide in your school and what kind of safety rules apply to this chemical. Even though the foam looks like toothpaste, you must not put it in your mouth. Make sure to wear goggles, gloves and a lab coat, and do the experiment on a washable surface.

worksheet F – Making fog [1]

- hairspray
- ice cubes/snow
- hot water
- glass jar with lid
- small mirror
- liquid soap

Safety! Be careful that the children do not get scalded from the hot water and that they do not point the hairspray toward anybody's face!

worksheet G – Preventing fog [1]

- mirror (or window)
- hot steaming pot of water
- masking tape
- paper towels
- different products to test (e.g. shaving cream, bar soap, toothpaste, mouthwash, hand cleaner, baby shampoo and saliva)

Safety! Be careful with the hot water! Be aware of the safety rules for the products you use! When using toothpaste be aware that the toothpaste contains abrasives, which is why it should be rubbed on gently to avoid scratching the mirror.

The elephant toothpaste

'What makes me curious?' the spider asks itself and looks around the bathroom. 'I wonder why the toothpaste doesn't run out of the tube, when the tube isn't closed and is hanging upside down.' 'That's a great question, spider. I've never thought about that. Let's try to see what happens when the toothpaste isn't in the tube.' 'We can put a bit of toothpaste on the mirror and see if the toothpaste will run down,' the spider suggests and continues: 'What if we have a race – me against the toothpaste?' 'What a great idea, spider. We can draw a starting line and a finish line with this lipstick,' Lilu says. 'On your marks, get set, go!'

'Yeah! I won! I crossed the finish line even before the toothpaste started moving,' the spider shouts out. 'You know what, spider? I know a recipe for toothpaste that can move by itself. Well, it's not really toothpaste, but people call it that, because it looks like toothpaste for elephants.' 'That sounds fun. Let's do that!' the spider says. 'OK, but first I'll ask Alina to come and join us. She loves doing experiments,' Lilu replies.

Background information: Toothpaste

Toothpaste is a certain type of fluid called Bingham plastic, that acts as if it is a solid, below a certain threshold. This threshold relates to the force applied to it. This means that if toothpaste hangs upside down and the only force that affects it is gravity, the toothpaste acts as a solid and will not run out the tube, no matter how long you wait. When e.g. the toothpaste tube is squeezed, there is sufficient stress on the toothpaste, which is why the toothpaste will start flowing, acting as a liquid. However, the race between the toothpaste and the spider down the mirror shows that gravity is not strong enough to make the toothpaste move down the mirror. It is not necessary that the children understand the phenomenon. Instead the experiment should engage curiosity and make them wonder about other things.

Stop and experiment!

Follow the procedure on worksheet E – The elephant toothpaste [1] to make your own toothpaste for elephants.

Background information: Elephant toothpaste

By producing the elephant toothpaste the children can test how different parameters influence the amount of foam. The children train their vocabulary for describing amounts (e.g. small, big, a lot, a little, half a teaspoon, two teaspoons) and for describing the shape and the size of the glass (e.g. tall, narrow, conical, wide, big, small). If food colouring is used, the children can also train their colour vocabulary.

How does it work? Hydrogen peroxide separates into water and oxygen. Yeast works as a catalyst, speeding this reaction up, which combined with the dish soap produces lots of bubbles filled with oxygen.

Fog or no fog?

'Wow, that was great fun! Can we investigate something else?' the spider asks. 'Hmm,' Alina says, 'I actually have something on my mind. Every time my sister takes a bath, the mirror gets foggy.' 'I know why,' Lilu says, 'the fog is caused by condensation. When warmer air which contains water droplets in a gaseous state hits a cold surface, the water changes from a vapour back to a liquid state and appears as droplets on the mirror. The fog you see is basically forming little raindrops on the mirror – just like a cloud is full of lots of little raindrops.' 'Yes, I know that too. What I don't understand is why there is nothing we can do about this. Everyone must have had this problem,' Alina wonders. 'I know a solution,' the spider says and continues: 'I once lived in a bathroom of a family who had a little girl. Every time she took a bath in the bathtub, she spat in her diving goggles to prevent the glasses from fogging up. If we rub saliva on the mirror, I don't think it will get foggy.'

Stop and experiment!

Follow the procedure on worksheet F – Making fog [1] to make your own cloud.

Background information: Water vapour

How does it work? The hot water warms the air in the jar and some of the water evaporates. The ice on the lid cools the hot, moist air in the jar and the water vapour in the air condenses on the particles of the hairspray, forming a cloud in the jar.

Stop and experiment!

Design an experiment to investigate if saliva or other products can prevent the mirror from fogging up. You could be inspired by the experiment on worksheet G – Preventing fog. [1]

Background information: Fog

How does it work? Fog consists of a lot of tiny droplets of water. By rubbing different products on the surface of the mirror, it is possible to make the condensed water on the mirror form a see-through film, instead of tiny droplets.

The children can design their own experiment. Besides practicing words like hot, cold, warm, cloud, fog, etc., they train their vocabulary of different everyday products. The test would probably show that shaving cream and toothpaste work best. But to conclude something from the test, it is crucial that the children have a control area and that they understand the difference between rubbing and wiping.

PROPOSED ACTIVITIES (please visit the library from page 67 for a detailed description of the proposed activities)

	Before reading	While reading	After the activity
The elephant toothpaste	Word wheel (toothpaste)	Listening Reading Dialogue recitation (without narrator)	I. Extend word wheel II. Make a video describing the experiment you designed
Fog or no fog?	Word wheel (fog)	Listening Reading Dialogue recitation (without narrator)	I. Extend word wheel II. Mapping of the whole story III. Make an advertisement for the product you would sell as an antifogger

Lilu, Alina and scientific models

SUMMARY

The focus in this chapter is on the use of models in science, which is introduced through a conversation between Lilu, Alina and the spider about where water comes from. Among other things, this conversation leads the children to make a purification centre and their own crystals.

LEVEL

difficult

DURATION

- Drawings on the mirror: 2 × 45 minutes
- A purification centre: 2 × 45 minutes (observation time: 1 day)
- Is clean water clean?: 45 minutes (observation time: 2 weeks)
- Reflection of light: 45 minutes

VOCABULARY

everyday products, verbs related to cleaning, adjectives related to appearance, colours, action verbs, professions

MATERIAL

worksheet H – Drawings on the mirror[1]

- mirror (or window)
- different products you can use to draw on the mirror (e.g. lip balm, shaving cream, hand lotion)
- different things you can use to remove the drawings (e.g. toilet paper, water, liquid soap)

Safety! Be aware of the safety rules for the products you use!

worksheet I – A purification centre [1]

- two plastic bottles with screw caps
- coffee filter
- sand
- small pieces of charcoal
- gravel
- container
- cord
- muddy water
- scissors
- hole punch
- two pieces of duct tape (each with a length of approximately 7 cm)

worksheet J – Making crystals [1]

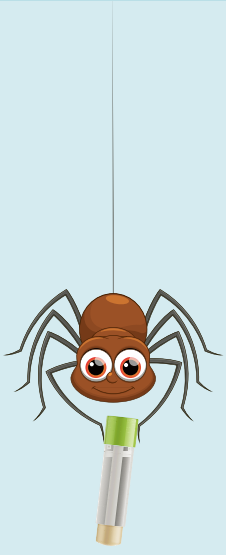
- cup of hot water
- clean jar
- salt
- spoon
- coffee filter
- funnel
- cord
- pencil
- paper clip
- food colouring (optional)

Safety! Be careful with the hot water!

worksheet K – Flashlight game [1]

- hanging mirror
- flashlight

Safety! Be careful that the children do not point the flashlight towards someone's eyes!



Drawings on the mirror

Lilu washes his hands. The spider watches him curiously and says: 'Lilu! I want to know how it's possible that water goes down there,' the spider walks around the drain of the sink 'and still water comes from the tap all the time. Where does the water go? Where does it come from?' 'Wait a moment,' Lilu says, 'I'll get some paper and pens.' 'Oh, no need!' the spider says and rolls the lip balm over to Lilu. 'There you go, pen number one!' Lilu smiles and passes the lip balm to Alina. 'OK, let's draw a model of the water cycle. Let's begin with a cloud,' Alina suggests while making a drawing on the mirror. 'The drawings with lip balm are clouds! Then it starts raining. The shaving cream can be the rain,' Lilu explains and hands Alina the shaving cream. Alina draws raindrops on the mirror. Then Lilu takes the hand lotion and uses it to draw the surface of the earth and fills in the layers of the ground while continuing to explain: 'The rain falls on the earth's surface. The water goes through the layers of the soil, underground, heading towards the sea. Part of this water is going to be drinking water.'

Lilu continues drawing and explaining, but suddenly he hears his father and starts looking a little bit worried. He does not think his father would appreciate him using the mirror as a canvas for painting.

Stop and experiment!

How would you help Lilu and Alina to remove the drawings from the mirror? You could get inspiration from the experiment on worksheet H – Drawings on the mirror. [1]

Stop and research!

Use the Internet to search for more information on the water cycle or about the water supply in different parts of the world.

Summary and learned vocabulary overview

Lilu and Alina use a drawing as a model to explain a minor part of the water cycle to the spider. Afterwards, the children are asked to investigate how different products can be removed from the mirror. Doing this, the children train the names of the products used first to make the drawings, and the ones used to remove them. Beside this, a wide range of verbs can be trained (e.g. remove, clean, rub, wipe, dry) while the children are trying to clean the mirror.

A purification centre

After Lilu and Alina have cleaned the mirror, the spider starts thinking aloud: 'I don't understand. If the water we drink comes from the ground, why does it look so clear?' 'Because all the layers in the ground work as a filter,' Lilu explains and Alina suggests: 'Hey, why don't we make our own purification centre? Do you think you can find a flower pot and a coffee filter, Lilu?' Lilu finds one of his mother's clay flower pots, one of those with a hole in the bottom. In the bottom of the pot, he puts a coffee filter. 'Now all we need is some sand, some gravel and some coal,' Alina says. 'The sand and gravel, we can find in the garden. If you get that, I'll go and look for some coal in the shed,' Lilu replies. After finding the things they need, Lilu and Alina place the sand in the pot, then the coal and lastly, the gravel. 'Now we have a model of the layers in the ground of the earth. Let's try to see what happens if we pour dirty water over our model,' Alina says. 'We can use the soil from mother's flower pot to make the water dirty,' Lilu suggests and the spider, having been quiet for a while, suddenly shouts out, 'Great idea! I love it!'

Stop and experiment!

Make your own purification centre like on worksheet I – A purification centre. [1]

Summary and learned vocabulary overview

Lilu and Alina explain to the spider how the subsoil cleans our water and after this, the children are asked to create a model of the water filtration through the different ground layers. When asked to describe what they see and what they do, the children train verbs like run, move, soak, fill, etc. as well as different adjectives like muddy, brown, clear.

Is clean water clean?

'Look at the mirror. We've just cleaned it, but now it's full of little white spots! I don't understand. Where did the spots come from?' the spider asks. 'It is lime. It comes from the water we used to clean the mirror,' Alina explains. 'From the water? That's not possible. The water is clean. You've just shown me how it is cleaned by the different layers of the ground,' the spider says. 'No,' Lilu replies, 'the filtration only filters impurities out. It doesn't remove all the particles. Some particles are very small and others are dissolved in water. Let me build a model, so you can see that it's possible to make crystals out of a solution that looks like it contains nothing but clean water. Take this glass of water. It's completely see-through, but it still contains lime and other minerals. I'll put some salt in it, but after I stir it, you can't see the salt. It's because the salt has dissolved in the water, but if the water evaporates, the salt crystallises.' 'And now what happens?' the spider asks. 'Now we have to wait,' Lilu says and ties a paperclip to a piece of string and ties the string to a stick. Every morning, the spider goes down from its web to find out if anything has happened. And one morning Lilu and Alinea wake up suddenly as the spider is walking on their faces. 'Oh, I got scared! Why are you walking on my face?' shouts out Lilu. 'Something happened in the glass. It is as if there's a little stone on the paper clip and I think the salt is trying to climb out from the glass. Come and see!' It's really dark, so Lilu takes his flashlight and all run to the bathroom.

Stop and experiment!

Make your own crystallisation by following the instructions on worksheet J – Making crystals. [1]

Summary and learned vocabulary overview

The children are asked to prepare a saturated solution of salt in water to make salt crystals. Salt is poured into water and more salt is added until there is an excess of salt on the bottom. When it is not possible to dissolve more salt in the water, the solution is said to be saturated.

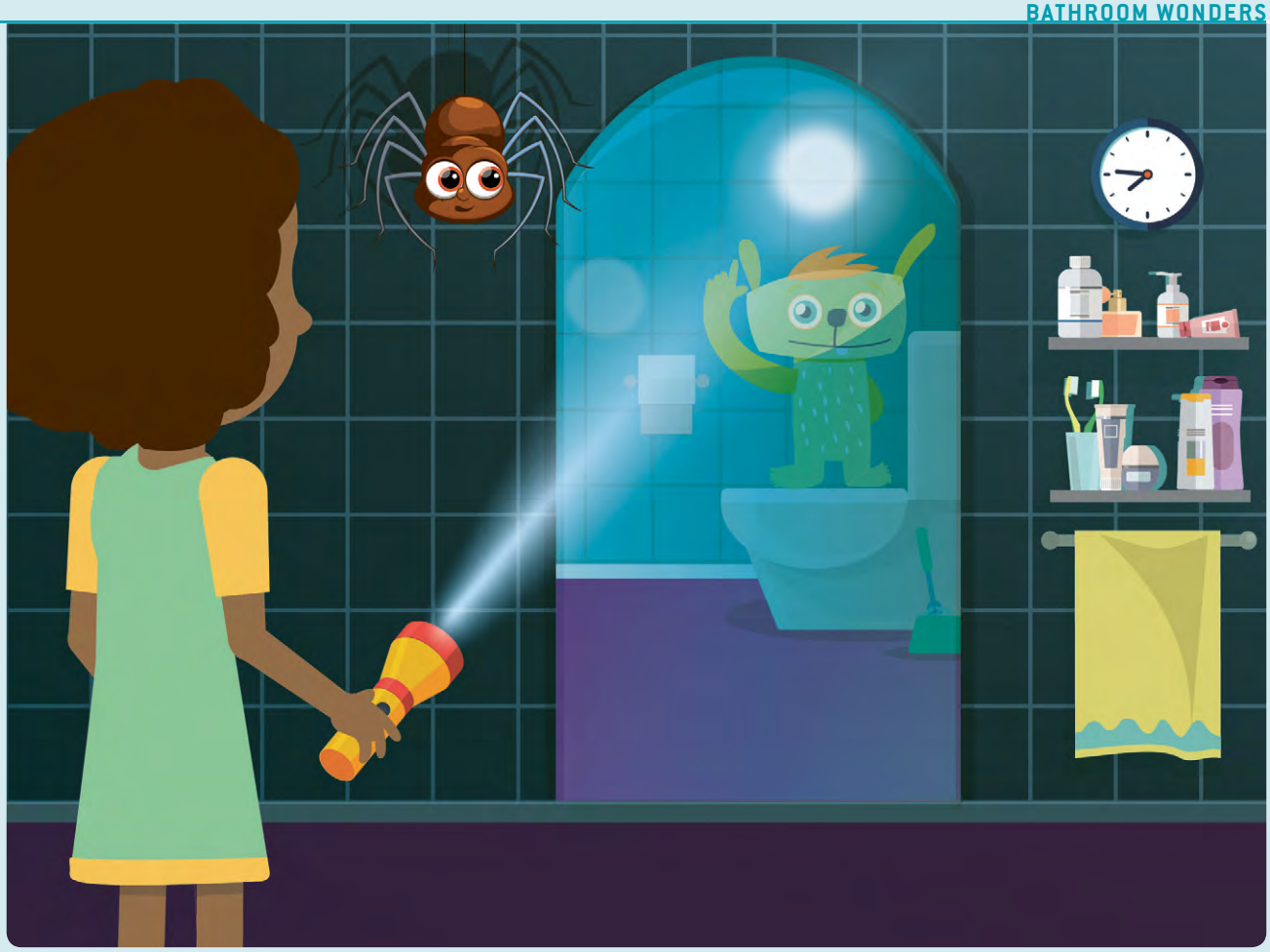
If the solutions are coloured, the children can train their vocabulary for colours. The materials proposed for the crystallisation are items from everyday life, and talking about the procedure while doing it can train the children's vocabulary of these everyday items. Beside this, the instructions contain verbs like add, pour, stir, take, place, put, tie and wait, and by following the instructions, the children can experience the meaning of the verbs by doing them.

Reflection of light

The spider is afraid of the reflection of the flashlight. 'The light is there, but why is it also there?' the spider asks fearfully, pointing in two directions at the same time. 'Light is not a frightening thing, spider. I think darkness is more frightening than light. But did you know that the mirror reflects light? That's why you can also see the light in the opposite direction from the flashlight,' Lilu says. 'Let's see if you can guess, where the reflection will go if I point at the mirror like this. Run to the place where you think the reflection will go,' says Alina to Lilu and the spider.

Stop and play!

Play the game on worksheet K – Flashlight game. [1] You could also create your own game.



'Do you know, spider, that all those people who save others always have reflective clothing – like police officers and firefighters. When light hits the reflective material, the light is thrown back and it looks like the clothes are glowing.' 'Ah, so when you pointed the light at the mirror and the light was reflected, you actually made a model of a reflector.' 'Exactly spider, but it's not a very good model. The mirror reflects the light in the opposite direction and a reflector reflects the light exactly in the same direction as it came from.' 'It would be nice if those flies would also wear reflectors. I could catch them with my web and a flashlight,' the spider says thoughtfully.

Stop and draw!

Make drawings of all the situations you can think of where reflectors are useful.

'You know what, Lilu? I have another question. The man or woman who invented reflectors, how on earth did they come up with that idea? It's a brilliant invention. The inventor must have been a genius.' 'You're partly right, spider. The invention of reflectors is brilliant, but brilliant solutions are not only developed by geniuses. In fact, the solution to various challenges has often been found in nature, so the real genius is nature. As you know, the eyes of a cat reflect light and the inventor of reflectors was actually inspired by scientific studies of cats' eyes reflecting light,' Lilu explains. 'I am an animal too, you know. Perhaps you could be inspired to invent something by observing me, or perhaps I could be inspired by observing you,' the spider says and becomes thoughtful: 'I have to think about this. I'll go back to my hiding place behind the mirror.'

Stop and research!

Use the Internet to find inventions inspired by spiders.

Summary and learned vocabulary overview

Finally, the children have to try out their understanding of reflection. This can be set in perspective by talking about the use of reflectors, which will train the children's vocabulary of different professions, such as firefighters, police officers and ambulance drivers.

PROPOSED ACTIVITIES (please visit the library from page 67 for a detailed description of the proposed activities)

	Before reading	While reading	After the activity
Drawings on the mirror	Word wheel (water)	I. Listening II. Reading III. Dialogue recitation (with narrator)	I. Extend word wheel II. What happens when the father enters the bathroom? Make a role play.
A purification centre	Word wheel (clean water)	I. Listening II. Reading III. Dialogue recitation (with narrator)	I. Extend word wheel II. Write a report on how surface water is being purified by running through the various layers of our subsoil before it reaches the groundwater level.
Is clean water clean?	Word wheel (crystal)	I. Listening II. Reading III. Dialogue recitation (with narrator)	I. Extend word wheel II. Use your knowledge of growing crystals to explain how to grow sugar crystals and make your own rock candy.
Reflection of light	Word wheel (reflection)	I. Listening II. Reading III. Dialogue recitation (without narrator)	I. Extend word wheel II. Draw situations where reflectors are useful. III. Mapping of the whole story

References

[1] All additional materials can be downloaded at www.science-on-stage.de/additional_materials_lilus_house

[2] Further literature for introducing children to the work of Joan Miró:

- Ana Salvador: Draw with Joan Miró; Frances Lincoln Children's Books, 2011
- Antony Penrose: Miró's Magic Animals; Thames & Hudson, 2016

[3] Further information about creating images by mirrors can be found at:

- Chris Woodford: Mirrors – the science of reflection, http://www.explainthatstuff.com/howmirrorswork.html (02/08/2018)
- Physics Lab, http://dev.physicslab.org/Document.aspx?doctype=3&filename=GeometricOptics_SphericalMirrors.xml (02/08/2018)
- Curved mirror, https://en.wikipedia.org/wiki/Curved_mirror (02/08/2018)

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